INDUSTRIAL CONFLICT IN THE DEVELOPMENT OF TECHNICAL EDUCATION IN ENGLAND, 1850-1910, WITH SPECIAL REFERENCE TO THE MECHANICAL ENGINEERING INDUSTRY

A Thesis submitted to the Council for National Academic Awards in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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ABSTRACT B.P.CRONIN

INDUSTRIAL CONFLICT IN THE DEVELOPMENT OF TECHNICAL EDUCATION IN ENGLAND 1850-1910, WITH SPECIAL REFERENCE TO THE MECHANICAL ENGINEERING INDUSTRY.

This study seeks to offer a sociological account of the emergence of non-university technical education and its development in England in the period 1850-1910.

The aim is to show that an explanation of the origin of the form and content of technical education needs to extend beyond changes in 19th century educational policies.

An attempt is made therefore to trace the relationship between changes in control of the labour process as exemplified in one of the leading manufacturing industries, mechanical engineering, and developments in technical education. The argument is twofold:

The forces underlying the substitution of unskilled for skilled workers and the implementation of new kinds of machines, were also those at work in the demise of the apprenticeship system and the development of a certain form of technical education.

The skilled engineering workers' struggles to maintain the apprenticeship system against the employers' reluctance to support it, may be seen as also part of an explanation of the origin and development of technical education

The importance of employers and skilled workers in these processes is acknowledged thereby, and a case is argued, which existing sociological and historical accounts neglect, that the conflictual nature of the social relations of the industry represented an industrial struggle against which plans for a technical education system were being formulated.

A key element is the analysis of the Great Strike and Lock-Out of 1897/1898, which is seen as the culmination of a series of conflicts originating in the 1850s. The outcome of the strike confirmed the economic 'short-termism' of employers, deriving from the dominant laissez faire doctrines of the period. Contradictions inherent in short-term profit seeking at the level of individual employers and expectations from long-term projections for a system of technical education at a national level, not only crucially influenced educational legislation, but fostered a neglect of technical education provision.

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PREFACE AND OVERVIEW

In this thesis I have offered a sociological account of the emergence of non-university technical education and its development in England from the middle of the 19th century. My particular concern has been technical education for manual workers as distinct from university-type education for management in industry.

My general position is that in order to offer an explanation of the origin and development of technical education it has been necessary to look beyond changes in educational policy. I believe that, contrary to existing accounts, the social and technological changes emanating from conflict within the mechanical enginering industry throughout the 19th century were a source of considerable influence on the development of technical education in the period 1850-1910. The main argument developed in the thesis is that analysis of struggles over the organization of work is central to an understanding of the sequence of events which led up to the formation of a national system of technical education in the last decades of the 19th century.

The questions I have addressed revolve around the interpenetration of new technologies, particularly the use of interchangeable manufacture, and the changing tactics of managerial control of work and labour:

What was the relation between technology and work?

What strategies did employers develop in order to increase their hegemony over industrial work?

In what ways did the invention of new tools and methods of precision measurement relate to the decline of the importance of skilled workers in the production process?

How did the response of the skilled workers to changing strategies of labour and work control determine their attitude to employers and unskilled workers?

What were the implications for young workers of the reorganization of work and changing definitions of skill particularly with respect to technical education?

Existing accounts do not address these questions but, evaluated within the parameters of their own specific disciplines, provide adequate explanations. None the less they seem to me to have certain limitations and do not provide entirely credible accounts. Much of the analysis is flawed by an over-reliance upon predominantly consensual models, articulated principally in terms of educational policy and/or the significance of influential policy-makers. It thus deflects attention from analysis of the attitudes and beliefs of powerful and influential groups, outside education, with strong vested interests in the development of technical education. Among such groups were employers, particularly engineering employers, who controlled large numbers of young workers, towards whom technical education was to be directed.

The nature of the impact of employer-employee interaction on technical education remains unexplored in many accounts due to their insistence on seeing technical education as an evolutionary growth out of the general education system.

Employers were clearly concerned with issues of labour control and work organisation. I have therefore argued that a different model of educational and technical change is needed which could identify and articulate a connection between the employers' concerns with work organisation and the way their views affected the development of technical education.

I have critically examined historical and sociological work which seeks to explain technological developments, such as the introduction of interchangeable manufacture', standards', and labour substitution. In the main this tends to be postulated in terms of what I refer to as 'technicist' or technologically determinist approaches. By this I mean abstracting technological developments from their concrete, historical context. This approach may be found in texts such as Clapham(1938),Cotgrove(1958,1968),Ashworth(1963)Ashby(1965),Musgrave(1966, 1967), Chadwick(1965), Steeds(1970), Cardwell(1972), Checkland(1972), Woodbury(1972), Ackrill(1987), Goss(1988). My reading of the literature suggests that it fails in particular to relate technological innovations to social transformations, such as radical changes in the control of labour, or recognize its significance for the development of technical education.

My particular technological emphases, on the implementation of 19th century machine tool technologies, methods of precision measurement, and the implications for changes in the recognition and definition of 'skill', were specifically elaborated in Sections One and Two of the thesis. I put the case that the imparting and consolidation of skills were located within a specific set of production relations, and derived credibility from a particular structure of management and organization. Definitions of skill therefore depended not on a priori categorizations of attributes of human performance or labelling, but more significantly on the interdependence of work and technology; the nature of the relations between the employers' ideology of production and the workers' perception of work organization. It is in this sense that the concept of skill has been used in this study. In definitions of skill most accounts seem to me to underestimate the significance of employer-employee/work interaction. As Piore and Sabel(1984) argue

> '...the success of mass production (and the concomitant decline of craft production)...lies in the politically-defined interests of producers and consumers-rather than in the logic of industrial efficiency...'(p.21). [My emphasis].

My prime aim in this exploratory analysis has been to show that a sociological perspective, based mainly on labour process theories not previously used in an examination of 19th century technical education, provides further insights into its origin and development. In this way I have challenged consensual models by stressing the conflictual nature of social relations both in industry and education.

This seems to me to be a more realistic approach because it acknowledges that the issues of labour control within the productive process could be linked to control over incipient technical education, a common element in both being the influence of the employers.

CONSENSUAL MODELS OF THE ORIGIN OF TECHNICAL EDUCATION

The wider impact of the interaction between engineering employers and skilled workers has either been underestimated or disregarded in existing scholarship on technological and technical education developments. It therefore seems to me to be limited in three significant areas of analysis.

First, technical education is not seen as a distinctive development but as a 'movement' within the growth of 19th century mass education in general. Historical accounts in particular, place much emphasis on the development of a technical education 'movement' after the 1870 Act, and focus on the formation of the City and Guilds of London Institute(CGLI) in 1878, the Royal Commission on Technical Instruction in 1884, followed by the Technical Instruction Act of 1889, (Clapham(1938), Argles(1964), Armytage(1964), Musgrave(1967), Bailey(1983).

These events were clearly significant but a common assumption seems to be that they were the only critical influences and developments in technical education operating at the time. This is paralleled by unqualified approval given to the significance of 19th century figures, such as Lyon Playfair, J.S.Russell, and T.H.Huxley, who promoted the idea of technical education as a means of improving industrial 'efficiency' to counter foreign competition. [Clapham(1938),Musgrave(1967),Ashworth(1963), Checkland(1968).

Second, in most technical education histories and sociological accounts of the labour process the industrial or craft apprenticehip system is not regarded as a form of technical education in relation to which new forms of technical education developed. The traditional craft apprenticeship mode of education is invariably viewed as separate in degree and kind from 'technical education'. It is asserted that technical education was a system of theoretical training instituted as a separate adjunct to practical work carried on in the workshops. In the separation of theoretical and practical elements in such a definition of technical education there is an unquestioned importance given to the former.

Such accounts fail to question why and how formal institutionalised education, separate from the workplace, came to supplement and virtually replace the apprenticeship system as the dominant form of technical education and training in the 19th century. Their narrow approach necessarily precludes any examination of the relation between changes in work organisation and education, as such a relation is not seen as relevant to an analysis of the development of technical education.

Third, existing historical and sociological accounts of technological innovation and development, and technical education, adhering legitimately to their respective disciplines, see no relevance in and hence no need to analyze the attempts by 19th century employers to widen their control of the labour process, against the resistance of the skilled workers. They do not explore the nature of the engineering employers' increasing control over the means of transforming raw materials, metals, into commodities, as part of the gradual domination over all their forms of labour, particularly young workers. Hence the relation between the struggle for control between skilled workers and employers and the emergence of skilled workers' demands for technical education remains unexamined. A number of issues arose from this and were expanded in the thesis: The employers' use of new kinds of technologies, such as automatic or self-acting machines; the mid-century swing from artisan to management control of the process of production itself; and the changes in the system of power relations in the industry.

With respect to the critical aspect of the employers' use of new kinds of technnologies a key feature of the new machines, introduced from the 1860s, was the manner of deployment so that untrained workers could be substituted for skilled artisans in their operation [Whitworth(1854,1856,1868,1872);Nasmyth(1854,1867)]. This process of substitution entailed a decline in the employers' dependence upon skilled craft labour and, the evidence showed, encouraged a subsequent devaluation by employers of the traditional method of reproducing skilled tradesmen through the apprenticeship system. In this proposition I have questioned recent views, exemplified by the work of Goss(1988) who argues that the managers' control over new technologies served to gain flexibility and increase productivity, not to deskill craftsmen:

> '...the exercise of managerial prerogatives was not used to deskill craft work...(but) to raise productivity and this not only broadened the range of skills held by craft workers but also gave an increase in wage levels and shorter working hours...'(p.419).

I examined evidence from both unofficial and official sources including the Children's Commission of 1864 and the Commission on the Depression of Trade in 1886, which shows this kind of contention to be unsupportable.

THE APPRENTICESHIP AND WORK ORGANIZATION

Nineteenth century artisans consistently challenged the increasing use of substitution in the workshops. A significant factor in this resistance took the form of demands for the retention of the apprenticeship system. They also argued, formally from 1868 when the first Trades Union Congress debated the issue, that they viewed the apprenticeship system as central to any technical educational system. Many of the industrial conflicts of the 19th century directly concerned, or were related to questions of skilled labour and the decline of the apprenticeship system. I therefore considered it critical to examine employers' and workers' attitudes towards changes in the apprenticeship pattern conceived as a fundamental part of work reorganisation and also part of the origin of technical education. I made the case that organisational and technological changes marked a gradual, but definite transfer of control of work from a predominantly artisan-controlled system to one involving employer-dominated technology. This shift of control implied a weakening of the artisans' traditional responsibilty for the training of young workers. For all practical purposes the apprenticeship system was the only form of technical education for most of the century. Thus the transfer of work control from workers to management from the middle of the century may also be seen as related to changes in the mode of technical education; that is, as a transfer of control of technical education.

What underlay changes in the system of power relations in the workshops as the structure of work control altered? In addressing this question I focused on the conflicts between employers and workers engendered by the struggle over the control of immediate productive processes and how they were expressed in the social and technical elements of the organisation of work. This was part of my attempt to demonstrate that the forces underlying the development and implementation of new kinds of machines were also those at work in the demise of the craft apprenticeship and the development of technical education.

The case I put against existing historical and sociological scholarship concerning the origin and development of technical education is that in not considering the interaction between forms of technology, the organisation of work, and the development of technical education it does not recognise the importance of industrial employers and skilled workers in such development. In effect, a) too much importance is placed on the ideas and influence of educational policy makers; b) it accepts uncritically a linear, evolutionary model of technological development; c) the apparent lack of involvement of engineering employers in technical education developments is treated at face value.

1.1.0. SELECTION OF CASE MATERIAL

I have limited my analysis of the organization of work to the mechanical engineering industry for three reasons.

First, the mechanical engineering industry was a principal manufacturing industry throughout the 19th century and one of the leading industrial employers of skilled and unskilled labour. The first census of production shows evidence of this: The total gross value of goods produced in the U.K. recorded at the time of the census in 1907 was £1.76bn, of which over £3.75m, or over 21 per cent, was generated by mechanical engineering trades. Between 1851 and 1911 the engineering trades were in the top three single employers, second only to agriculture in 1851; by 1911 nearly 1.5m workers were employed in the industry [First Census of Production (1907); British Labour Statistics, 1868-1968, (1971)]. It therefore seemed appropriate for my purposes to seek evidence within this major manufacturing industry regarding the attitude of leading employers towards the development of technical education from 1850.

Second, the industry was also the location for two of the most direct confrontations between unionized labour and employers in the 19th century, in 1852 and 1897. My particular emphasis in section three of the thesis was on the strike and lockout of 1897. I attempted to show that this specific event was highly significant, for it first highlighted the way in which the conflict of interests of skilled workers and their employers regarding technical education and the apprenticeship system reflected the struggle for control of the workplace. Secondly it revealed divergent interests on the part of employers and government. This revolved around the government's putative aim for a national policy of technical education,

implying long-term projections, while actively encouraging individual employers to satisfy short-term profit seeking within a free market policy. The successful outcome of the strike for employers served to reinforce their belief in economic 'short-termism'. The strike thus provided a relevant background against which to articulate the model of technical and social change I develop in this thesis.

Third, the mechanical engineering industry in the 18th and 19th centuries was fragmented and characterized by the small firm; but the changing industrial situation from the 1850s generated significant moves towards combination by employers. The structural situation clearly had implications for work organization and control, as Zeitlin(1987) says,

> 'British employers' labour strategies were also conditioned by the institutional organization of their firms...most sectors of British industry were dominated by fragmented, family-owned firms...there was little tendency towards cartellization or monopoly ...(p.174).

This is uncontentious but it seems to me to obscure the effects of engineering employer-employee conflicts in the events leading up to and during the strike and lockout of 1897/8. One of the employers' main concerns was constraint of the artisans' power in the workshops. [This I referred to as the employers' ideology of work, in which the structure of work needs to be seen as a social as well as a technical phenomenon]. As the struggles over power relations between the engineering employers and the workers intensified from 1852, the Engineering Employers Federation (EEF) concomitantly emerged. Thus by the great strike of 1897, the largest engineering union, the Amalgamated Society of Engineers (ASE), was confronted by a forceful employers' combination which had not existed in strength before the strike. Despite industrial fragmentation and the employers' apparent lack of coordination for much of the time, I believe that ideas concerning technical training and education often found expression in these employers' and workers' combinations and seem to be an unexplored source of data on the early stages of technical education development.

I therefore attempted to show that 19th century struggles over the organization of work within the mechanical engineering industry, determined by issues which centred on the questions of machine tool innovations and machine manning, were also questions of power relations in the industry which influenced technical education developments outside it.

OVERVIEW

There is an abundance of literature on socio-economic and labour history, and educational developments for the period. Much of this, including journals such as the British journal of Educational studies, British Journal of Industrial Relations, Economic History Review, Journal of Further and Higher Education, International Review of Social History, Past and Present, Social History, the Sociological Review is readily accessible.

I have argued however that standard texts and common theories of technical and educational change are limited. Access to different sources was crucial to my analysis if I was to avoid restatements of existing theories. My orientation was industrially-based, and I was examining a different set of hypotheses than the conventionally-related approaches. In researching evidence relevant to manufacturing industry I drew upon the resources of institutions not usually associated with accounts of 19th century technical education. Three in particular proved most fruitful: the library of the trades Union Congress[TUC Reports from 1868, Minutes of the London Trades Council]. The archives of the Engineering Employers Federation(EEF)[EEF Minutes, including reports on the various trade disputes up to and including the Great Strike of 1897/8; reports of the Iron Trades Employers Association(ITEA),(the precursor of the EEF)]. The library of the Amalgamated Engineering Union (AEU) which is the successor to the 19th century Amalgamated Society of Engineers(ASE)[Annual Reports of the Amalgamated Union].

The Public Record Office(PRO) provided much original material on the educational debates of the 19th century. It was a valuable source for Government Education Minutes, Reports of Inquiries, and the published works of HMSO.

The library of the Institution of Mechnical Engineers(I.Mech.E) enabled access to a wide variety of significant material, especially the work of the Victorian engineers Whitworth and Nasmyth. The published annual volumes of the Proceedings of the Institution were particularly valuable as they are complete from the year of the Institution's foundation in 1847. The Institution was also an invaluable source of relevant American technical literature, providing, inter alia, access to the work of the American engineer F.W.Taylor. Also held are the Proceedings of the American Society of Engineers(ASME)(the equivalent of the English

Institution of Mechanical Engineers); contemporary journals of the period, such as the American Machinist, the American Engineer, the Iron and Coal Trades Review.

The main source of evidence to Royal Commissions, Select Committees, and Public Inquiries; Labour and Trade Commissions and similar material are Parliamentay Papers, which are housed in the British Library. The Papers from 1850 are especially apposite in this respect. Whitworth's views on interchangeable manufacture, for example, were clearly demonstrated in his evidence to the Small Arms Commision of 1854. Similarly Nasmyth, another prominent employer-engineer, in his evidence to the Royal Commission on Trade Unions in 1867, provided uneqivocal views on technical training and the employment of unskilled labour.

The British Library was also my principal source of primary material for the 19th century, including the deliberations of the Workingmen's Educational Union(1853 on), the Workingmen's Technical Education Committee(1869); and the debates on technical education and related issues in the Journal of the Society of Arts, which later became incorporated into the City and Guilds of London Institute after 1878.

The Newspaper and Journal Library of the British Library is housed at Colindale and is crucial for contemporary accounts of the industrial conflicts during the period. The reports of the Great Strike were especially revealing, as some of the journals, such the Bee-Hive and the Labour Standard, edited by Kier Hardie, provided an alternative perspective to mainstream Press coverage.

The thesis has three sections. Section One, Control of Work and 19th Century Machine Tool Developments, comprises three chapters; Section Two, Control of the Labour Process and Technical Education', also of three chapters; Section Three, Changes in the Control of Work and the Influence on Educational Change, again three chapters.

In chapter one, *The Centrality of Industrial Conflict its Absence in in Existing accounts of Technical Education Development*, I examine the contribution of existing accounts to the understanding and explanation of the development of 19th century machine tool technology. The two main sources are socio-economic histories and histories of technology. My main argument is that much of the writing in this field is characterized by consensualist notions of technology, in which there is a concentration on

the hardware of production where the input of labour appears to be discounted, as is the nature of the disputes accompanying technological innovation.

In chapter two, *Victorian Engineer-Entrepreneurs as Employers: the Work of Maudslay, Whitworth and Nasmyth*, I offer an account of the development of machine tools from 1850 to the end of the century. The material in this chapter is particularly crucial for the technological elements of my thesis with its emphasis on the specifics of engineering craft work.** In the body of the chapter I examine the factors of technology I regard as an essential background to my study; and concentrate my analysis on three engineer-entrepreneurs of the period, Maudslay, Whitworth, and Nasmyth. I seek to make explicit the nature of technologies which these particular engineers were initiating, and which were indispensable to a generality of employers attempting to transform the organization of work and extend their control of the labour process.

In an attempt to move away from a 'heroic biography' approach regarding these Victorian engineers I have turned mainly to official primary sources for my evidence: Parliamentary Papers, and contemporary works in the field such as Whitworth(1856) and Nasmyth(1968), and Smiles(1873/4). This data is especially appropriate for my study for it represents the views of the most influential tool engineer-designers of the period, and also provides an insight into their thinking on trade training and development. A further point is that at a time when statistics were fragmentary and unreliable or unknown, official and contemporary sources can provide more credible evidence.

I elaborate on the issues raised in the preface and address questions which are not treated in existing accounts, such as what kind of work was actually done by 19th century artisans in engineering, how employers reorganized work when new tools were put into practice, and the reponse made by skilled workers to work reorganization.

** In addition to a detailed analysis in this chapter, I have included a number of detailed supporting appendices covering technological data concerned with cutting tools, tool metals, and rates of metal removal on machine tools.

Chapter three, *The Transition of Apprentices to Child Labour*, deals with another significant employer strategy, a new system of wage payment, introduced as an adjunct to the implementation of new technologies, deployed for operation by predominantly unskilled labour. I make a detailed analysis of the piece-work system of wage payment in order to point up its main characteristics in the increasing use of child labour as opposed to apprenticed labour.

There are two main sources of evidence for this chapter, notably the evidence submitted to the Children's Commission of 1864, as it presents verbatim reports of children involved in technical change such as the introduction of automatic machines and the detailed sub-division of work. Trade union reaction to the introduction of piece-work is well documented in their evidence to the Royal Commission on Trade Unions in 1867 and subsequent Reports.

Section Two follows and begins with chapter four, *Labour Process Theories and the Interaction of Work and Technology*, which is an examination and discussion of literature concerned with a sociological analysis of the labour process.

In chapter five on the *Craft Apprenticeship System and the Politicization of Apprentices*, I examine the hypothesis that the retention of the apprenticeship system as a means of reproducing skilled labour was central to the skilled workers' resistance to work reorganization and underlay many employer-employee conflicts throughout the century.

In this chapter I draw upon my critique of what I have referred to as the technicist approach to technological development, in which technology is perceived as an independent force, abstracted from its concrete, historical situation. I seek to show that there was a critical interdependence between innovative technologies, struggles over power relations and employer attitudes to work control and trade training and education.

Union sources are central to an understanding of their perception of skill. The ASE maintained systematic catalogues of their debates and these are recorded in their Annual Reports and Reports of the Proceedings of Union Congresses. Employer sources such as EEF archive material, together with union and employer evidence to Commissions of Inquiry, provide further data on the issues of skill and labour substitution.

In chapter six, *Contradictions and Struggle in Ideas about Education*, I examine relevant developments taking place in education during the period with specific reference to the early provisions for some form of technical education. I focus on the notion that much of the technical educational thinking of the time was premised on the idea of a provided system for a working class, dominated by work.

The development of state-sponsored education from the middle of the century, particularly the significance of the formation of official administrative organs at South Kensington, is well documented. I have also used sources such as Hansard and other Parliamentary Papers in addition to working class journals such as the 'Artizan', the 'Bee-Hive', the 'Labour Leader', and artisan perspectives in 'Technical Education Gazette', and the Journal of the Society of Arts.

The Society of Arts was particularly significant in providing a platform for artisan views, a prime example being the publication of the Artisan Reports on the Great Industrial Exhibitions, the first of which was produced in 1868 following the Exhibition in Paris.

Section Three, Changes in the Control of Work and the Influence on Educational Change, begins with chapter seven, *Historical Accounts of the Development of Technical Education and Socio-Economic Research Relating to Technical Education*. My immediate main aim will be to confront one of the dominant themes in existing scholarship, that in the second half of the 19th century, there evolved a technical education 'movement' or 'cause'. I shall examine the way the attitudes of employers and trade unions towards technical education is treated and question the emphasis in much research on the impact of technical education on economic efficiency as interpreted by concerned public figures outside industry.

The bulk of the literature examined in this chapter forms part of the conventional historiography in the field of 19th century technical education. I have also drawn upon some of the contemporary writings of figures frequently cited in such works such as Lyon Playfair, T.E.Huxley, Scott-Russell, Lord Armstrong, Philip Magnus(City and Guilds of London Institute), and M.E.Sadler.

Chapter eight, *Employers and the Ideology of Production*, focuses on the Great Strike of 1897/8, and is a crucial case study for the thesis. My aim is to show that the increasing use of unskilled workers, particularly displaced skilled workers and boys, underpinned employer management strategies and radicalized the political nature of machine production. The employers' attempts to extend the advantages derived from expanded machine tool technologies increased the level of conflict in the industry, culminating in a protracted and damaging strike which broke union power. The conflict is also seen as a manifestation of an underlying contradiction betwen the short-term economic strategies of both the State and employers and the expectations held by government with respect to a national system of technical education. The effects of the strike are examined in the light of subsequent legislation which served to consolidate employer power despite the seemingly irrational demise of the traditional craft apprenticeship system. The implications of this conflict for technical education are explored in detail in Chapter Nine.

The political and economic elements of the strike have been comprehensively examined in existing literature. I have drawn upon EEF archive material, TUC reports, ASE reports; and the contemporary Press, particularly the Times which provided extensive coverage, and journals such as the Labour Leader, The Engineer, Engineering, the Engineering Times.

Legislation for technical education which paralleled technical changes in the engineering industry, explored in earlier chapters, is the focus of Chapter Nine, *The State and Technical Education: The Formation of the City and Guilds of London Institute and the Reaction of Government and Employers*. My prime aim is to show that a combination of strong reliance upon the implementation of new technologies and the knowledge that the strongest union had been forcibly defeated in the 1897/8 conflict, strengthened employer resolve regarding control of the labour process. There was little incentive for employers to accede to a lessening of that control and much to be gained by extending it beyond the confines of the factory. The introduction of educational legislation failed to induce any radical alteration in employer attitudes to technical education. The industrial events in the last decades of the 19th century left unchallenged their continued disregard for long-term projections for skilled labour.

The issue of industrial conflict intensified the central problem facing a significant part of the skilled working class of the period. This was its relatively disadvantaged social position and the corresponding difficulties in obtaining benefit from the kind of general and technical education available.

Parliamentary debates frequently highlighted concern over technical education development, instigated primarily by fear of foreign competition; although sources such as Hansard reveal the low level of priority accorded technical education generally. Commissions and Inquiries, particularly after the 1870 Act are an important source for this period up to the turn of the century. Other sources, including TUC debates, reveal concern with the issues of mass education as well reflecting the conflictual nature of technical education provision.

Finally I draw my argument together in a Conclusion and Discussion in Chapter 10.

My analysis, focusing on a powerful 19th century group, engineering employers, has led me to investigate a wider base of sources than existing accounts, serving to broaden the main parameters of technical education analysis. I attempt a more flexible approach to the study of the origins and development of technical education and present a reconsideration of established theoretical positions in existing scholarship through a re-examination of some of its key concepts. I believe this perspective points to a broader conceptualization of work reorganization and technical education development and maps out possible routes for further research.

SECTION 1

CONTROL OF WORK AND 19TH CENTURY MACHINE TOOL DEVELOPMENTS.

Introduction

Issues to be Addressed

For the purposes of this thesis I cannot realistically embrace all 19th century technological developments, thus in Section One, my prime focus will be on one sector of engineering manufacture, machine tools. This is not to suggest that other significant engineering developments such as innovations in iron and steel production,the development of high-power steam engines and changes in boiler design are not worthy of analysis. My focus is on machine tools. That is, I am going to examine the specific use and deployment of machines requiring specialized manual labour used in the manufacture of other tools and machines.

The questions I wish to address in these chapters revolve around the interpenetration of new technologies, including the use of interchangeable manufacture, and the changing tactics of managerial control of work and labour:

What was the relation between technology and industrial work?

In what ways did the invention of new tools and methods of precision measurement relate to the decline of the importance of skilled workers in the production process?

What strategies did employers develop in order to increase their hegemony over the workshops?

How did the response of skilled workers to changing strategies of control determine their attitude to the employers and unskilled workers?

What were the implications for young workers, particularly with respect to technical education, of reorganizing work and changing definitions of skill?

My reading of the literature suggests that there was a close link between the implementation of new technologies and more systematic deployment of child labour other than apprenticed labour from the 1850s; an employment strategy underestimated in existing accounts. To provide a focus I shall concentrate on machine tools, the introduction of the Piece-work System and the increasing use of unapprenticed labour.

I have taken this particular emphasis on machine tools for two reasons. First, most accounts agree that it was in the machine tool sector of the engineering industry that significant changes in work organisation and control were taking place in the 1850's, related to the introduction of new technologies - Changes in machine tool design and metrology brought about corresponding changes in the method and pace of working from a predominantly artisan control to an employer-dominated way of working. I shall argue that employers in this sector of engineering were therefore a particularly significant body as they were among the leading employers and their views on workshop control and organisation influenced the attitudes of the generality of employers on issues such as the craft apprenticeship system and technical education.

Second, the construction and maintenance of machine tools required much specialised artisan labour upon which employers were heavily dependent because of the high level of manual skills needed in the industry. (See note on 'Fitting' at end of chapter for fuller statement of this point). For example, in 1811 in the field of arms manufacture the heavy reliance upon skilled artisans, called armourers, was evident:

> 'Even in England where skilled workmen were most available, there were not enough armourers to meet the demand ... the government had on hand 200,000 muskets barrels which, were useless for want of (skilled) men'. [Roe 1916, p.165]

By the 1880s it was argued that it took five years to produce a skilled filer (for lock making) and his handcraft skills were clearly indispensable:

> '... the lock filer not only held the other branches of the (trade) in his hand, but that upon his willingness to work, and upon the produce of his skill the safety and the very existence of the nation depended.' [Hackwood 1889 ch.8]

Existing accounts of the development of 19th century technologies tend to be set narrowly within the context of socio-economic history. Among those I examine, Clapham (1938), Musson (1957), Gilbert (1958), Floud (1966) stress for instance, the inventive genius of the Victorian engineers. They are inadequate for me in terms of the problems of control of the labour process I am addressing in this thesis. They are limited because they do not offer sufficient analysis of a) what kinds of work was done by skilled engineering workers on machine tools; b) what changes in methods of working took place as a result of the introduction of new machines; c) how employers reorganised work when the new tools were put to use.

Chapter 1

THE CENTRALITY OF INDUSTRIAL CONFLICT.

1.0.0.

Introduction

My main aim here is to examine a cross-section of accounts dealing with changes in a particular sector of industry, machine tools.

I shall focus my examination mainly on two areas: historical accounts of the development of machine tools, and references to machine tool technologies in socio-economic histories.

As part of my case in the overall study will be concerned with some of the effects on production relations of artisan occupational exclusivity, my third area of examination in this chapter will also be concerned with what has been referred to as the 'labour aristocracy', Engels (1882), Webbs(1912),Hobsbawm(1973)]. I include this here for it seems to me that the concept of an 'aristocracy of labour', held by engineering craftsmen in the 19th century, drew much of its legitimacy from the artisans' distinctive perception of craft skills particularly in machine tool work, and their attitude to the apprenticeship system.

There are two elements to this. The first was the artisans' belief in engineering skill as conferring status and social power. This has suggested to some writers that the skilled stratum of 19th century workers was subject to an 'embourgeoisement' process, citing as evidence their assumed alignment with the Liberal party.

The second element was the artisans' claim that the apprenticeship constituted a form of technical education for most of the century.

Although much of the research on the 'labour aristocracy' in the 19th century puts a stress on the skilled workers' attempts to dissociate themselves from the unskilled, few accounts include analysis of the conflicts associated with machine tool implementation. This prompts a number of questions: What was the nature of the link between changes in machine tool technology and the conflict between artisans and unskilled workers, and between skilled workers and employers? How were the conflicts over the issue of machine manning using the new technologies

related to artisan attempts to retain the traditional craft apprenticeship system and become part of the technical education?

I therefore seek to examine in what ways the initiatives and strategies developed by the skilled workers in the course of their struggles with the employers may also be seen as part of their attempt to elevate the apprenticeship into a formal technical education system, against the wishes of the employers. Much of the antagonism generated by these conflicts of interest centred on the questions of machine technology innovation and machine manning.

My reading of the literature suggests first that existing accounts are constrained by a conventional model of historical analysis, which, while adequate within its given terms of reference, for my purposes does not provide entirely credible accounts. Much of the analyses is highly deterministic and, in the main, evolutionary in concept. It seems to me that there is a parallel between evolutionary accounts of technical education and deterministic notions of machine tool technology. Just as most accounts of technical education tend to treat it in isolation from other social forces and regard it uncritically as an evolution out of mass general education, existing accounts of technological change perceive it as self-determining.

Second, regarding technological development there is an undue emphasis on changes in the artefacts of technology, focusing on their significance for economic growth. Such accounts are limited , in my view, because of their characterization of technological developments predominantly in terms of their increasing sophistication and ease of operation. For me the analyses are set too narrowly within the confines of socio-economic history, in which machine tools are perceived as a kind of paradigmatic technology.

1.1.0.

Machine Tools as Evolutionary Developments: Historical Accounts of the Development of Machine Tool Technologies.

Many historical accounts of machine tools place emphasis upon their gradual evolution into more and more sophisticated and precise forms. Steeds(1970) and Floud(1976) favour such an approach and examine tool development from 1700. Steeds provides, as part of his analysis, an account of the modifications to the principal machine tool, the centre lathe. This is a machine for producing round and cylindrical work in metal and sometimes wood; a process called 'turning'. The centre lathe was the most common form of machine tool throughout the period [Smiles(1876),Spon(1882) Nasmyth(1883),Roe(1916),Jefferys(1945)].

Steeds(1970) argues that the main machine tool innovation in the period was the invention of the automatic lathe.The significance of this machine was that it could be operated with minimum skill on the part of the worker and most of metal cutting could be controlled by self-acting mechanisms built into the machine. He points up the advantages of this machine, focusing on the fact that it eliminated the need for skilled operators :

> 'This machine...known in England as the automatic lathe or 'auto' and in America as the 'auto screw machine,'is one that produces turned pieces <u>without any attention from an operator except occasional supervision and replenishment of the stock bar</u>.'(p.95).(my emphasis).

A further development in automatic lathes was the 'turret' lathe, so called because the actual cutting tools were fixed to a special hexagonal-shape device, known as a turret. Work rate was greatly increased on this machine due to the fact that up to six cutting tools, one on each face of the turret,could be fixed and precisely set for cutting before machining commenced. The tools could then be moved automatically into the machining sequence, as the job progressed. The general practice, before the introduction of the turret, was the all-purpose machine, the 'centre lathe', a machine in which only one cutting tool was used at a time and which required much skill in setting up the work and controlling the cutting process.[Singer et al(1965),Steeds(1970),Woodbury(1972),Floud(1976)].

Steeds' analysis of the turret lathe, centres on the potential this machine held for substituting unskilled labour for machinist artisans. He says,

> '...the most important advantage of the turret lathe in which all the tools were set to cut the required diameters and stops regulated the lengths turned (was) that subsequent operation of the machine required very little skill...'(p.122).(my emphasis).

My view is that this essentially descriptive account of the important modifications to the centre lathe exemplifies accounts which emphasise purely technolgical developments in the period. There is little reference to the effects on the workers who were clearly affected by the implementation of fully automatic machines. Both machines referred to by Steeds, for example, were characterised, not simply by their levels of automaticity, but also by the explicit use of unskilled labour.

1.2.0 The Issue of Social Purpose in Technological Innovation

I believe the evidence shows that the introduction of new types of metal-cutting machines, based on automatic principles, had both technical and social purposes : the pre-setting of machines to ensure fast, accurate reproduction of work; and the substitution of unskilled labour for artisan machinists.The stress in Steeds is narrowly technological; the social purpose is neglected.

A framework similar to Steeds is provided by Floud(1976) in his study of machine tools from 1850. He concentrates on the market-rational aspects of tool innovations; emphasizing the advantages of new classes of machines for greater economic efficiency. There were, he said, two sets of pressures generating new classes of machines :

> 'First, to carry out new processes, and to make old processes more efficient; second, to...produce new tools to take advantage in power generation in metals technology...'(p.20).

Thus in Floud's account modifications to the major types of machine tools between 1850 and 1914 were introduced in order to increase 'the capabilities and ease of operation'. Although he says his analysis is intended to 'discuss the relevance of the experience of the machine tool industry to a controversial period of British economic history...'(p.1), he sees no need to explore the major labour disruptions caused in the

engineering industry by the introduction of automatic machines, manned by unskilled workers, which culminated in the Great Strike of 1897.[The 'Engineer'(1898),Clegg et al(1964),Berg(1979),Zeitlin(1979)]. Social factors involved in technical change are unexamined.

In a later analysis Floud(1985) pursues a less-deterministic approach, by suggesting that new technologies induced, not resistance from workers, but recourse to re-training. This is framed in terms of human capital theory:

> 'The challenge of the new machine age was met by investment by individuals in their own education...a very high proportion of human capital formation took place...as a result of investment by the worker...in training on-the-job...' (p.83et seq.)

This interpretation of the interrelation between work and education fails to take into account the reality of the life of work for most young workers. In the main the evidence shows that part-time, evening class education alone was available and this has to be seen within the context of a gruelling work routine, involving an average of 57 hours per week from the 1850s. The evidence also shows that the employers' interest in systematic training declined as new technologies were implemented(Nasmyth(1856, Children's Commission(1864), Allen(1868), Robinson(1868), Bryce Commission(1895).

Rather than stimulating investment, the implementation of new technologies precipitated conflict. The conflictual nature of technological change seems to me to be manifested in consistent artisan resistance to the deployment of new classes of machines, using unskilled labour. This factor in social relations critically influenced the employers' attitudes to the notion of 'skill' and also determined their approach to the apprenticeship system and technical education.

Both Steeds and Floud over-emphasize the evolutionary development of machine tools, and take insufficient account of the conflict generated by technical change. As Samuel(1977) puts it

> '...resistance to machinery, though often opaque and only intermittently recorded...was an endemic feature of 19th century industrial life...'(p.10).

1.3.0 Work Rationalization and Skilled Worker Reaction

Some of the more contentious issues associated with the introduction of work reorganization are examined in Landes(1960) in his socio-economic account of technological development in the same period. In my view, he rightly addresses the social implications relating to the social effects of the reorganisation of work processes through the implementation of new technologies. He says, for example,

> '...the relationships of the men to to one another and to their employers were implicit in the mode of production; technology and social pattern reinforced each other.'(p.317).

In the socio-economic accounts I have read, this is one of the few references to the intereaction between technology and the social relations in which they are put to use.

But there is also an economic determinism in Landes which is highlighted in his reference to the inevitable course of rationalisation in the industry. He states initially,

> '...labour in the engineering trades, strongly organised, craft oriented, and fearful of technological unemployment, fought all changes in conditions of work...the very existence of this conflict, is evidence that... rationalisation was taking place'(p.316, and Ibid. footnote).

A narrower economism is evident when he locates the notion of craft skills in the context of economic 'efficiency.'

> '...skilled labour tends to be less efficient than directly supervised semi-skilled or unskilled labour, and this is only to be expected...'(p.306).

Landes' account is thus limited on two counts. First, there is a strong implication that the scope of 19th century industrial conflict was confined to the workers' reactions against material changes in working conditions imposed by employers. The ideology of production premised on new classes of machines seems to be taken for granted, and unquestioned.

Second, the fragmentation of workshop tasks, implicit in the use of semi-skilled and unskilled labour, is treated as self-evident in the drive to mechanisation and the rationalisation of production. There is no exploration of the nature of the conflicts he refers to, beyond a tacit recognition that they are imminent in workshop reorganisation '...labour is not a factor like other factors...it exists as well as responds...'(p.317).

Landes rejects notions of labour as an abstraction as the above quotation notes, but he does not make explicit the nature and course of the conflicts arising out of the reorganisation of workshops. What, for example, were the explicit causes of conflict? I suggest there were two. First, there was the resistance of the skilled workers against the employers' imposition of new technologies, particularly automatic machines, which artisans perceived as a threat to their skilled-worker status. Second, there was the generation of an inter-necine conflict between skilled and unskilled workers which derived from the employers' insistence that the latter could and should be deployed on the new automatic machines. [Children's Commission(1864), Robinson(1868), Nasmyth(1868), Noble(1893 Evidence to R.C.),Dyer(1897 EEF/ASE Negot.)

Focusing closely on work rationalisation by employers, Landes relies on a unilinear model of technological development. His relatively narrow conception of tool developments constrains his analysis and places too much emphasis on the employers' pursuit of profit and economic efficiency. There is a neglect of the implications the introduction of new technologies had for other social forces like the reproduction of skilled labour within the context of employers' intensification of control over the total labour process. His approach characterizes the approach found in most socio-economic accounts. Illustration of this may be seen in the work of Habakkuk(1962), and Woodbury(1972).

1.3.1 The Assumed Autonomy of Machine Tool Developments

Habakkuk(1962) provides a comparative study of 19th century technological developments in Britain and America. In his study machine tools seem to be endowed with self-generating properties. They assume a detachment from other social forces and are governed only by the internal characteristics of the technology itself :

> 'Technical progress has a logic of its own; one invention raises problems, intellectual and mechanical, which require time and effort for their solution.'(p.81)[my emphasis].

Habakkuk's thesis here clearly implies that technology is autonomous with respect to social change. The abstraction of technology from its social context divests this perspective of much of its precision. As Law(1987) states,

'...if we wish to understand the growth of technologies, then we should treat them as an end-product of goal-oriented system building...'(p.419).

The problem for me in Habakkuk's account is therefore the abstraction of technology from the workplace and the workers who actually operated the machines. I term this kind of model of technological development 'technicist'. Within this framework, narrow economic considerations allow only marginal consideration of some of the wider implications of implementing new technologies, such as reorganisation of work and changing labour practices.

He does however recognise that technology relates to a particular set of social relations in production; hinting that these relations might be conflictual:

'In the 1840s and 1850s workers in the engineering industry had opposed the introduction of planers and lathes; in the 1890s they attempted to impose conditions on the use of the capstan, turret lathe, miller and borer...'(p.198).

But earlier he argued that the predominant considerations in technological development were essentially technical and not social:

'...in the development of the internal combustion engine to the point where it became a practical proposition, technical considerations were the dominant influence...'(p.183).

Habakkuk's concern is to present a socio-economic analysis, and in this the argument is adequate. But, overall his argument appears to be too narrowly conceived in economic terms. For example in his discussion of the issue of machine manning his argument centres on economic benefits accruing from technolgical innovation. The question is, whose benefit? He fails to consider that technological innovations were also conceived as a means of diminishing worker power and control over the labour process. As Nasmyth put it, as early as the 1840s:

'...Machines from their automation power, no longer need regularly bred mechnanics to attend them...it becomes necessary...to reduce the subject...(to) within the range of...the ...inferior capacity of a humbler grade of men...'(1841,p.411).

Habakkuk thus underestimates other social influences at work when new tools were being introduced, despite his acknowledgement of the potential for conflict associated with new technologies:

'...English employers had been so long accustomed to cheap labour that their inclination was apt to be to get more work at the same money wage...and they were not prepared to concede to their labour

the higher money earnings which the new device warranted...'(p.198/9).

He does not pursue the implementation of new technologies as a possibl source of conflict; economic and social consensus seems axiomatic.

1.3.ii. The Consensual View of 19th Century Technology

Woodbury(1972) in one of a number of his specialist studies on machine tool developments argues within a similar economic perspective. He provides a comprehensive survey of the historical development of the most important machine tools: lathe , milling machine, planer, shaper, and slotters. As chronological studies they constitute a significant analysis of 19th century technological innovations. But his study displays a similar narrow economism and technicism. In its early stages it is also contradictory. On the one hand he argues :

> '...the historian of technology must keep clearly in mind that the most brilliant technological development can have significance only in a suitable economic and social situation...'(p.2).

But, on the other hand, technologies are conceived and developed independently of economic forces :

> '(there is) an inner compulsion of technological development which is quite independent of social and economic forces...'(loc.cit).

Woodbury's analysis is weakened by this technicist conception of technical change in which technological innovations are perceived as independent of the workers who put them to use. Like most other accounts in this field he appears to assume a consensual notion of 19th century technology, and ignores the labour process in which it was embedded.

Both Habakkuk and Woodbury provide insufficient explanation of the struggles induced by the interaction between technological developments and the way they were implemented by employers.

1.3.iii. Machine Tools as a Source of Employer-Employee Conflict

In more recent research, McGuffie(1986), in contrast to Woodbury and Habakkuk, provides an interactive model of technolgical development, locating it within specific social relations of production, in which the concept of skill was being radically re-shaped. Referring to the

implementation of 'standard' machines, such as lathes, milling and boring machines, he says,

> '...they became...multi-purpose mechanisms and their use allowed for a decomposition or simplification of the mental and manual faculties applied in direct production...this underlying principle of the decomposition of machinery and skills...affected all sectors of the labour process...'(p.152/3).

The significance of this view of technical change is the acknowledgement that technologies are not independent of the social and cultural context in which they find formulation. They also correlate with specific managerial strategies, which, in the context of 19th century technological innovation, implied increasing worker subordination. Employers deepened their qualitative and quantitative knowledge over all the technical and material aspects of production. According to McGuffie(1986), this process engendered,

> '...a more malleable workforce...more subject to management-inspired planning, control, direction and diktat...'(p.xvi).

The evidence I have examined shows that the basis for the employers' confidence in implementing new technologies, often against the resistance of skilled artisans, was the development of new methods of precision measurement i.e. metrology. From the 1850s employers and entrepreneurs such as Whitworth and Nasmyth were pre-eminent in this. The improved methods of controlling manufacturing sizes and limits were fundamental to the principle of interchangeablity upon which many of the techniques of automatic machining and mass-production relied. [Anderson(1854), Nasmyth(1854), Buckingham(1920), Galloway(1965), Roe(1916), Whitworth(1857) Wordworth(1905)]. I expand on the introduction of 'standards' in section 1.4.0. below.

Interchangeability is the process by which similar engineering components, which have been manufactured to precise measurements within prescribed limits of size, may be interchanged with each other without modification.

For employers implementing new machines, such as the turret lathe, 'standards'had great significance in that components could be made to precise sizes using automatic settings on the machines which themselves had been manufactured according to the same principles of precision and interchangeability. These machines could be operated by unskilled workers once the machines had been pre-set.I provide a more detailed analysis of the turret lathe in appendices 10 and 16.

Developments in metrology and machine building precision weakened the discretion allowed artisans over size and finish of components Automatic machines embodied labour-control properties, in the sense that many cutting operations, formerly directly controlled by the machinist were in-built through a system of stops, cut-off mechnanisms, size controls, speed regulators. The operator 'serviced' the machine. The evidence shows this embedded control became a source of conflict between skilled workers and employers, and also between skilled workers and unskilled workers: With the employers because the artisans forfeited their work autonomy; with the unskilled because the in-built control enabled employers to put unskilled workers to the machines.

Some writers address the issues relating to the early developments in interchangeability and the effect on 19th century machining processses. Cardwell(1972) focuses on the substitution of parts according to principles of interchangeability, and argues that late 19th century machine tools had reached

> '...such a high standard...that parts were interchangeable, accordingly, mass-production became feasible...'(p.146).

Cardwell's analysis portrays machine tool developments as an evolutionary process in which the technology becomes progressively sophisticated. Concentrating on the hardware of technology he does not consider the implications for both employers and workers of the implementation of work reorganization. In the period under discussion, for example, there were many localised strikes (in 1893 there were 615 disputes involving 634,301 workers); the engineering industry was involved in many local disputes and two national strikes in 1852 and 1897, both of which were connected with the introduction of new machine manning principles by the employers.(ASE Reports from 1850),Royal Commission on Trade Unions(1867), Shadwell(1906), Zeitlin(1979), Berg(1985). Despite these events Cardwell(1972) maintains,

> 'The age was rather a dull one of assured progress, evolutionary improvement and with few startling innovations...'(p.146).

Implicit in this kind of account is a separation of technology from the social purposes for which it was designed and implemented, and no recognition of the conflictual nature of much technical change.

A similar perspective is found in the 'official' biography of the Amalgamated Society of Engineers(A.S.E.) by Jefferys(1945).

Jefferys argued that the period 1850 through 1890 was a evolutionary one of consolidation, based on the development of technologies up to the 1850s:

> 'The spread of the processes and methods invented in the first half of the century rather than the development of new methods was a main characteristic of the years between 1850 and 1890...'(p.55).

The main focus of this account is the origin and development of the skilled engineering workers union,the Amalgamated Society of Engineers(ASE). Its limitation in my view is an inadequate analysis of the interaction between technology and work. There is an insufficient stress on the way engineering employers in fact used new technologies to lessen their dependence on skilled engineering labour and increasingly resorted to substitution of unskilled operators for skilled artisans. As I argued above, one of the principal means employers had to do this was new devices for precision measurement, which by-passed skilled workers' expertise in this area of work. But on this metrological development by Whitworth, Jefferys(1945) merely says,

> 'Whitworth's insistence on accurate measurement spread from the leading shops to become general practice...'(p.56).

Jefferys underestimated the degree to which employers were able to influence the concept of engineering craft skill through control over 'standards' and precision measurement. He also ignored the wider implications for labour control and workshop reorganisation.

1.4.0. The Introduction of 'Standards' and the Issue of Substitution

I believe employers such as Whitworth and Nasmyth brought about significant changes in labour and workshop control in the 1850s. Whitworth's work on metrology not only instituted new standards of exactness in measurement, but clearly paved the way for the substitution of unskilled workers for skilled artisans, particularly on automatic machines. His major contribution was the invention of 'gauges' which could be used by unskilled workers to check components as opposed to directly measuring them which required skilled application of fine measuring instruments [Smiles(1876),Spon(1874),Whitworth(1876)].

In order for this to be efective in the workshops a set of 'standards' had to be introduced. This entailed the establishment of

agreed limits on sizes over a range of the most common engineering components such as round shafts, where the diameters would be kept within defined limits of size. These limits were standardised and set and controlled by the employers and required the workers to work within them; the workers discretion over sizes, formerly in their province, was withdrawn. Systematic control over component sizes and limits was the essence of the principle of standardisation[Whitworth(1854,1856,1885)].

Whitworth thus advanced employer control over workshop processes by two significant innovations in metrology: The use of fixed, more or less universal, standards in the manufacture of common engineering components, and systematising the principles of interchangeable manufacture.

My appendix 9 shows the comprehensive system of gauges devised by Whitworth to cover most of the standard sizes met in the workshops.

Jefferys' account fails to elucidate the nature of technolgical change induced by Whitworth's innovations in the period; the underlying consensus in his work detracts from the potential new technolgies had for skilled worker subordination.

Versions of the consensual view are also found in Clapham(1938),Ashworth(1963),Chadwick(1965),Fleck(1965), Musson and Robinson(1969).

Clapham(1938) appears to accept the developments of Whitworth and,later F.W.Taylor, at face value. The evolutionary nature of technological development is again taken for granted. He says,

> 'It was natural that America with its well-established tradition of time-saving, labour-saving automatism, should blaze the trail for the entry of more and more quick-running and 'fool-proof' machinery into engineering workshops'(p.154).

The use of the term 'foolproof' in this context exemplifies a common assumption in existing accounts of technological development: the inevitability of the gradual elimination of skilled artisan labour in production prcessses where accuracy was necessary. There is acceptance of the transformation of machine tool technology, but only tacit acknowledgement that there was also a transformation of labour, requiring workers to adapt to the demands of the technology. There is a recurring notion of technology as something detached from working labour.

The implied neutrality and linear development of technology re-emerges in Ashworth(1963). In this account the displacement of

traditional engineering crafts by some form of machine is accepted as inevitable, subject only to the question of phasing:

> '(with) each improvement in machine tools...by the early years of the 20th century there were few handicraft operations for which machinery could not be devised as as alternative...'(p.27).

Chadwick(1965) offers a similar framework and argues that technological development meant improved machine accuracy and increased tool speeds:

> 'In the late 19th century the engineering arts advanced in scope and precision...with far greater quantities, at higher speeeds, and with increased accuracy...'(p.605).

Other writers, Galloway(1965), and Fleck(1965),link these developments in technology with market forces. They hold that these forces provided incentives which stimulated the employers' need to become more competitive and respond to increased demand for mass-produced products at home. Galloway stresses the boom in bicycle and sewing machine manufacture after mid-century:

> 'As soon as public demand for the newly invented devices grew large, means had to be devised for producing great numbers of components accurately and economically...'(p.640).

Fleck(1965)focuses on the methods used to improve economic competitiveness through the development of mass-production techniques in the 19th century. In the course of his analysis he concentrates on the hardware of production but also seems to me to unconsciously demonstrate the interpenetration of technology and the social relations in which it is used.

He traces, but does not question for example, mass-production technololgy back to the American, Eli Whitney in 1793. According to Fleck, Whitney's genius was to advance technology to the point where it could be '...ultimately mobilised to overwhelm an opponent...(p.819).

Musson and Robinson(1969) tacitly acknowledge the factor of changing strategies of labour control and imply that employers such as Nasmyth and Whitworth, apart from being inventors of genius in the period, sought to extend their control over skilled labour. They note, without evident consideration of the effects for skilled workers and power relations in the industry, that Nasmyth

> '...was a pioneer of 'scientific management'. In his ideas of factory lay-out, work-flow, standardisation, and mass-production, he was one of the leading creators of the modern machine age...'(p.509).

1.5.0. Human Labour and Machine Production: Workers' Resistance to Substitution

Exceptions to consensual approaches adopted by the writers I have so far examined are found in the work of Berg(1979,1982,1985); Roe Smith(1977); McGuffie(1986).

In a study of the machinery question and the growth of political economy in the 19th century, Berg(1982) argues that the increasing use of machinery met with variable, but determined worker resistance. This served to intensify the employers' control over labour:

> 'Faced with their resistance ...the industrial bourgeoisie and their associates adopted an attitude of increasingly aggressive...determination and optimism'(1982,p.2).

With reference to an earlier period,the 1840s and 1850s, she analyses the production process in which workers are perceived as being actively engaged with machines. She points up, in contrast to most accounts, the participation of human labour in technological innovation, and its reaction to changes in the organisation of work. She says,

> '(the workers) went beyond ...(criticism of the unplanned and rapid introduction of new techniques)...to challenge the uses and property relations of technology'(1982,p.16).

Technological change identified in more conflictual terms is also found in an American study by Roe Smith(1977). He examines developments in the methods of arms production in a national armoury, Harper's Ferry, in the 19th century. I quote this research to illustrate the kind of study which locates technological developments in a social and cultural context. He argues,

> 'Craft-trained artisans...increasingly found themselves isolated from employers, irritated by the growing intensity of production, and threatened by the machine'(p.20).

Commenting on Whitworth's visit to America as part of an official Parliamentary mission to engineering establishments,in the 1850s, Roe Smith points up the antagonistic relations which often accompanied technological innovations. Whitworth, he asserts, did not perceive workshop relations in this way:

> '(Whitworth)...did not perceive the many difficulties that attended building the factory and adopting new techniques, (nor)...the endless troubles encountered in getting workers to follow an industrial regime...'(p.22).

With regard to imposed technological change,it seems to me that a parallel may be drawn between English artisans, who struck often throughout the 19th century, and American artisans, such as those at Harper's Ferry. As Roe Smith puts it,

> 'Because so many...had been reared according to the conventions of the craft ethos, they found it extremely difficult to adjust to (the) increasingly specialised demands...they considered themselves artisans, not machine tenders...'(p.67).

In Roe Smith's perspective there is recognition of the potential for conflict in the introduction of new technologies, not often found in English accounts.

The implication for workers of technical change in Berg(1982) and Roe Smith(1977) is framed in terms of the interaction between reconstituted technology, skill redefinition and recomposition, and workers' reaction. As McGuffie(1986) in his critique of consensual approaches to technical change argues, they fail to recognize the emergence of competing groups accompanying technical change. Rather they assume an equilibrating system in which workers in which workers adapt to a changing industrial regime. He says,

> '...(in them) there is no sense of...one group tend(ing) to form itself around the labour of superintendence and management and the other around direct production...'(p.xxix).

These approaches are significant for me in highlighting the way in which more generalised accounts reduce labour to a factor of production, and tend to ignore the ways workers actively engaged in or actively resisted restructuring of the processes of production. The number of strikes throughout the 19th century clearly indicates that skilled workers frequently confronted employers on a number of issues; issues which tend to be ignored in histories of machine technologies.

In part, the artisans' rationale in opposing the employers on certain questions derived from their self-conception as an 'aristocracy of labour'. I turn next to a brief examination of this concept as it features in the literature.

1.6.0. An Aristocracy of Labour: Merely a Question of Status?

The concept 'aristocracy of labour' in general accounts of labour history usually refers to a minority of workers, all of whom were skilled and constituted a literate caucus of workers intent on differentiating themselves from the unskilled. They were frequently referred to as 'artisans'.**

The fact that some leading figures in the Liberal party of the 19th century such as Mundella, Huxley, Playfair had expressed active interest in working class education, has led some writers to link the exclusive, status-seeking skilled workers with the political ideology of the Liberal party.

Support from 19th century sources for this equilibrating model may be found in Wright(1871). In this work Wright fears the loss of status by skilled workers 'through democratisation of the labour force'. Artisans are men,

> '...by reason of the 'push' and energy which have enabled them to accumulate money or property are amongst the most influential of their class and with their class'.(p.134).

Engels(1882) argued that the skilled workers in Britain were a divisive element in working class solidarity, dominated by the Liberal party and participating in the domination associated with England's monopoly of the world market:

> 'English workers are...naturally the tail of the 'Great Liberal Party' which for its part pays them small attentions, recognises trade unions and strikes as legitimate...there is no workers' party here, there are only Conservatives and Liberal-Radicals.'(p.398).

The Webbs(1920) cited the mid-nineteenth century as the significant period for working class political change. According to their view the early part of the century had been characterised by radical socialist ideology. This gave way later to a more 'cautious and conciliatory approach (rendered) by a bourgeois economic philosophy'.

** The term 'artisan' often appears in the literature as synonomous with skilled craftsman. This seems to be its use in generalized accounts of the history of technology and labour history; or as part of a hierarchy of authority relations in the division of labour in sociological accounts. I make the point that the term can have a more precise connotation, namely, 'instruction in the arts'. In this sense artisans in the 19th century were craftsmen responsible for instruction in the /art

Such theories have a fairly long history and give credence to an embourgeoisement model found in some historical accounts. Saville(1954), for example, points to the collapse of Chartism as a watershed in working class political ideas. After the 1850s, he argues,

> '...there was an accommodation to bourgeois society by sections of the working class...'(p.156).

Roberts(1958) put the view regarding the 19th century unions,

> 'The trade union movement had embraced the doctrines of the Liberal party...'(p.94)

Tholfsen(1961) argues that the the most strikingly conservative characteristic of English democracy in the period from 1870 was the

> '...staunch loyalty of the working class elite to Liberalism and the Liberal Party'(p.2457).

Hobsbawm(1968) argues that the artisan groups were,

> 'an aristocracy of labour enjoying special privileges and therefore inclined to accept the views of the employers'(p.273).

This view is elaborated by Tholfsen(1971) and seems to me to characterise more recent perspectives which rely on a functionalist interpretation of skilled working class politics of the 19th century. The focus is on the artisans' reliability and stability, theorised within a structural functionalist framework:

> 'The whole system operated to internalise the dominant values...Shared values internalised, and institutionalised, constituted a powerful self-stabilising mechanism in a culture prevailed by social tension...'(p.61).

**

of engineering craftmanship, usually in relation to young workers. It also implied a kind of 'sub-managerial' function, a view put forward by Foster(1973), Brecher et al(1978), and Stark(1980). This function entailed the supervision of other, mostly unskilled, workers. The employer could not necessarily tell artisans how a job should be done; the artisan thus generally took responsibility for the instruction and supervision of unskilled workers and apprentices. There was often no other source of instruction available.

For the purposes of my study the term 'artisan' is used to suggest the dual aspect of skilled engineering workers' tasks: the manufacture of engineering products by hand and machine to relatively high levels of accuracy, and the supervision and instruction of young workers, apprentices. This was an historical from of craft development and training adopted by most trades and embodied in the articles of the Amalgamated Society of Engineers(ASE), the principal trade union of metal workers in the 19th century. The artisan-apprentice model of trade training was the only form of such training for skilled trades throughout most of the century.

Existing accounts thus emphasize the tendency of artisan groups to distance themselves from unskilled labourers,sometimes referred to in the period as 'handymen'.This particular stress points to their claim to exclusivity in labour and a possible connection between the artisans' demands for a retention of the apprenticeship system and recurring conflict within the engineering industry.

1.6.i. Artisan Exclusivity and Inter-Worker Conflict

Writers on the period have thus focused on the artisans' concern with maintaining an ocupational distance from the unskilled.

Hobsbawm(1954) stresses this aspect, arguing 'the artisan or craftsman was not under any circumstances to be confused with a "labourer"'. He quotes the Victorian craftsman-writer, Wright(Our New Masters,1873)

> '...labourers are an inferior class...they should be made to know and keep their place.'(p.204).

Hobsbawm's main argument focuses on the power 'labour aristocrats' held vis a vis the unskilled, which enabled them to receive relatively high wages and to make their labour artificially scarce:

> 'Only certain types of workers were in a position to make or keep their labour scarce enough, or valuable enough, to strike a good bargain. But the relatively favourable terms they got were...actually achieved at the expense of their less favoured colleagues...'(1968,p.322).

Neale(1968) adopting a similar perspective also examines the way artisans sought to distance themselves from the unskilled. He argues that the outstanding feature of histories of individual unions was 'the workers overwhelming concern with their own sectional interests'.

As far as engineering workers were concerned, this ideology was clearly evident in the policies of the 19th century Amalgamated Society of Engineers(ASE). In his history of the Union, Jefferys(1945) points out that the ASE did not claim that it was its duty to secure the objects of a 'class', but rather to 'exercise... control over that in which we have a vested interest'(P.20).

Gray(1973) argued that theories such as those initiated by the Webbs were contradictory and over-simplified. The new model unions of the kind referred to by the Webbs, composed entirely of skilled artisans, were often loathe to accept patronage and perceived their situation, relative to middle class groups, as 'bargaining rather than subordination'(p.450). The basis of the transition from subordination to bargaining was the skilled workers' exclusivity, which, according to Gray, was the source of 'social tension'(p.450).

His concern was to examine the extent to which one can detect an articulation of a cultural identity, a self-conscious exclusiveness by an 'upper stratum' of skilled workers. He argues that there was a transmission of middle class values, based on the cultural exclusion of less-favoured working classs groups, the unskilled.(p.451).

Hearn(1978) held it was the exclusionary characteristic of the labour 'aristocrats' which enabled them to move from a subordinate position to a bargaining status with the employers. He maintained this transition was strengthened by qualified support for skilled workers by the middle classes through the press (and government). Artisans were portrayed as exemplars of what was possible through initiative and determination. Hearn viewing this process as 'accommodation' argues working class values became circumscribed within an 'ethic of self-help; the 'labour aristocrats' were no longer perceived as 'challenging existing inequalities'(p.166).

Berg(1979) also identifies skilled artisans in terms of their exclusiveness and their ability to distance themselves from the unskilled(p.11). The distinction between the skilled and the unskilled and the appeal to exclusiveness depended, she argued, on the 'continued existence of a small number of important skills in basic industries.'(loc.cit).

I believe that status-consciousness on the part of artisans highlighted a significant source of conflict between skilled workers and the generality of labour. This skilled-unskilled labour dichotomy was exploited by the employers in the second half of the century, particularly over the question of machine manning.

A different perspective is found in Foster(1971). He argues that after the 1840s a new stratum of privileged workers, differing from the traditional labour aristocrats of the earlier decades, was created. This

labour elite combined high levels of skill with direct supervisory tasks under a 'piecemaster' system. He maintains,

> 'The industry's technological growth demanded a new structure of authority, one in which the skilled top one-third of the labour force acted as pacemakers and taskmasters over the rest...'(p.228 et seq.)

Foster seems to rely too heavily on a technologically deterministic view of 19th century industrialisation. For example, his argument that 'the technological demands of the industry... identified firmly the skilled worker with management...'(Ibid.), is not entirely supported by the evidence, which I produce in my study, of contradictions and conflicts within the social relations of production.

Melling(1980) also argues that in general sub-contracting and piecework were

> 'most prevalent in those occupations possessing little claim to craft expertise, or where the existence of a job control excluded the possibility of intensive management supervision...'(p.191).

Some accounts reject simplified and determinist notions of technological and labour control changes and attribute more assertive responses to skilled workers.

Clements(1961) dismisses arguments centred on the subordination of the working class, concluding that changes in trade union philosophy after Chartism were '...seldom the outcome of submissive obedience to orthodox economics...'(p.104).

Price(1973) in his study of 19th century working men's clubs comes out firmly against subordinationist theories. He argues that it was a 'nonsense' to suggest that middle class guidance was necessary for the working class to accomplish moral and social improvement(p.48). While Musson(1976) maintains that engineering employers, in particular, had little to gain

> '...from an increase in high wage differentials of skilled craft workers or to sustain a "labour aristocracy".(p.26).

Grossick(1976) also argues against an embourgeoisement thesis. He suggests that the process of ideological hegemony through which the middle classes contained section of the working classes was a far more subtle and ambiguous process than that allowed for by the orthodoxy of a labour aristocracy.

He also criticises theories which portray the working class as acquiescing in its own indoctrination into middle class values and ideals (p303).

What was the upper echelon of the working class, how was it appraised and to what extent was it an influential caucus? One particular designation, the 'Junta', seems to encapsulate the nature of a relatively small elite.

1.7.0. Technological Innovations: Some Implications for Skilled Workers with Special Reference to The 'Junta'

I believe most historical and socio-economic evidence indicates that much importance was attached by artisans to the maintenance of their power over workshop relations, particularly with reference to the control of apprentices and unskilled labour. This was a feature of artisan autonomy, plainly deriving from their strength as organized, unionized labour. The mass of the unskilled was non-unionized for much of the 19th century. Being part of a highly structured organization, the artisans, however, were equipped to protect their interests against expanding employer authority. Therefore decisions reached at Congress reflected only the concerns of the skilled workers, without necessary reference to the unskilled. It seems to me that this particular configuration of industrial labour was a significant context in which to locate an analysis of employer-employee relations from the 1860s. It also provides the framework for an examination of the status hierarchy of labour, whose upper echelon of administration, up to about 1871 was referred to as the 'Junta'. This group generated particular resentment within unskilled workers due to its persistence in distancing itself from the unskilled in order to maintain status and privilege. Unskilled worker reaction was articulated for a time through a journal, the Bee-Hive, and the through the personal antagonism of the editor, Potter.

Being members of craft unions was evidence that artisans were not in the business of promoting class solidarity; Conference resolutions represented a minority working class view. Hobsbawm(1961) has suggested,for example, that at no time in the Victorian period did this group exceed more than 15 per cent of the working class(p.104).

From the 1850s the ASE had been regarded as the archetypal craft union; highly structured and wide-ranging after amalgamation, well-administered and financed; and dominated by the skilled artisans, particularly the fitters.Artisan exclusivity may be thus illustrated with reference to the ASE. Allen, ASE secretary, in his evidence to the 1867 Royal Commission on Trades Unions, made clear the position of craft unions vis a vis non-unionists. Referring to a 'non-union' Trade Conference held in London, he said

> '...(those) that convened the meeting do not belong to any trade society at all...we refused to connect ourselves with them in any shape or form...'(R.C on T.U.(1867) Q.998).

Burns,secretary in the 1880s, was to re-present this view in stronger terms much later, making the point that technical education was the preserve of the skilled workers. There was a need, he argued,

> '...to impress upon the minds of the employers that unionists are indeed the pick of British artisans...'

This judgement was extended by the observation that 'unorganized labour was dangerous to social order...'(Burnett,J.(1886) p.36).

I believe the exercise of these forms of social organization, maintaining differentials between the skilled and the unskilled, typified the relations between the so-called 'Junta' and non-unionized workers. I do not consider it necessary to analyze too deeply the politics of the trade union movement here, but to highlight the anatgonistic relations between the Junta and Potter, and between the highly skilled and the labourers that seem to point up the contradictory elements active in the trade union movement about this time. They provide a significant focus for an analysis of a crucial development, the alignment of the unskilled workers and the employers, in the period preceding the Great Strike and Lockout in 1897/8.

1.8.0. The 'Junta': 'An Inner Cabinet

The 'Junta' was a name coined by the Webbs in referring to a small group of leading trade unionists of the period who constituted an 'inner caucus' of the movement. They were the general secretaries of the principal unions, and were bitterly opposed by the leader of a much smaller, relatively insignificant union, George Potter(the London Carpenters). The Webbs' account of this rivalry seems to me to point up

the nature of the distinction between workers of high status and labourers.

The Webbs argued,

> 'It is difficult to convey any adequate idea of the extraordinary personal influence exercised by (the Junta), not only on their immediate associates, but also as interpreters of the trade union movement, upon the public and governing classes...for the first time in the century the working class movement came under the direction, not of middle class sympathisers like Place, Owen, Roberts, O'Connor or Duncombe, but of genuine working men trained for the position...'[Webb,S.& B.(1907) p.221].

The group for whom the Webbs had such high regard were Allen(Engineers),Applegarth(Carpenters),Guile(Ironfounders), Coulson(London Bricklayers), Odger(Shoemakers).

Together these turned to the newly-established Trade Councils(local branches of the leading unions) to make them the political organs of the trade union movement. The Webbs held that between 1867 and 1871 this small elite, 'the effective cabinet of trade movement...'(Ibid.p.240), dominated trade affairs through meetings under the auspices of the 'Conference of Amalgamated Trades'. They exercised a distinctive combination of extreme caution in trade matters and 'energetic' agitation for political reforms.(Ibid.p.223).

It seems that it was this tendency, caution, which precipitated the major rift with Potter in 1865. Potter, through the Bee-Hive, advocated active support for striking North Staffordshire ironworkers; a policy which directly opposed the Junta's cautious control from the centre. The issue exemplified the conflicts over the question of trade union militancy[Kynaston(1976)p.26].

Potter represented the London Workingmen's Association, held by the Webbs to be, '...an umimportant society of nondescript persons...'(Webbs op.cit p.225).

Through his journal, the Bee-Hive, he maintained his personal and political opposition to the 'Junta'. The general secretary of the ASE,Allen, he said was '...full bodied, but empty headed...' Applegarth he referred to as '...the conceited, priggish secretary of the amalgamated carpenters...'(loc.cit). A recent analysis argues that Potter was intent on making a name for himself as a 'good Gladstonian Liberal'[Coltham(1965)p.53].

In the context of my thesis it seems to me that the mutual antagonism displayed by Potter and the 'Junta' symbolized the underlying contradictions in working class relations throughout the latter half of the century. It was significant, for example, that Burnett(ASE secretary), in his denunciation of the unskilled as 'a threat to social order', emphasized the growing fracture in working class solidarity by suggesting that technical education was the preserve of the skilled worker.

In a more pragmatic sense, the ineffectualness of the non-aligned unionists in confronting the employers was highlighted in the rivalry between Potter and the 'Junta'. This was brought out in the submissions made to the Royal commission of 1867 on Trade Unions.

In giving his evidence Potter was 'edgy and defensive in manner, leaving a poor impression', whereas members of the 'Junta', Allen and Applegarth 'shone almost continually'[Kynaston(1976)p.27].

Clearly, in the wider context of industrial relations Potter was less well placed to confront any anti-union tendencies on the part of employers. It seems to me however, that this period characterized by working class animosity, and Potter's attempts to challenge the power and influence of the 'Junta' underlines my argument that the employers, with control over new technologies, were able to exploit working class rivalries to weaken the historical status and privileges of the artisans. By the 1880s and 1890s this was to have a profound effect on the ability of the craft unions to challenge the widening hegemony of the employers.

Existing accounts of the 'labour aristocracy' suggest that two interpenetrating conceptions may be distinguished.

The first points to the idea of an 'aristocracy' of labour as a privileged group intent on self-elevation; a kind of moral category.

The second, suggests a self-centred political structure in which groups, such as craft engineers as represented by the ASE, sought to achieve and maintain power and status vis a vis other workers. The essential feature of this model was the privileged groups' exclusivity and conservatism.

It will be part of my case that many analyses focus on categories such as 'labour aristocrats' or 'labourers', without clearly locating them in defined, production relations. Because they also provide inadequate or ambiguous definitions of skill, the basis of the contradictions in power relations and the tendency for 19th century manufacturing to be characterized by industrial conflicts, is inadeqately examined.

I believe the interaction between two major groups in the principal manufacturing industry in the 19th century, and also within workers' groups, highlights the designation of groups as 'skilled' or 'unskilled' as part of a wider socio-historical process. These categories emerged from struggles within a long-standing system of power relations in industry.

These struggles were over control of the labour process as much as issues of economic or technical management innovation, or questions of wages or skilled worker status. I therefore make central the conflicts arising out of changes in the mode of production and reorganisation of the workplace.

Concepts such as 'labour aristocrats' have increased explanatory power if they extend to forces outside the production process, for example to the system of trade training and education, the apprenticeship. It was this system that produced a highly skilled minority of workers. Some accounts refer to this process, but produce models which are incomplete.

1.9.0. Summary and Discussion

In this chapter I have examined a number of accounts which have dealt with 19th century tool innovations; and examined the use of the concept 'labour aristocracy' in the literature.

Examination of these studies, in the main, confirms my original hypothesis that they are set too firmly within a specific discipline boundary set by socio-economic analysis and are restricted by orthodox parameters of the discipline. Technological developments within this framework which I have examined, therefore see no need to analyse machine tool innovations in terms of their relation to other developments, such as changes in the means of labour control, work reorganisation, or the possible implications for technical training and education.

The economistic perspectives in these accounts provide insufficient analysis of modifications to the division of labour which paralleled new 19th century technologies. This is exemplified in their treatment of the work of prominent Victorian engineer-employers such as Maudslay, Nasmyth and Whitworth.The invention of machines to cheapen parts is detailed, with much emphasis on the technical contribution of these eminent

engineers. A similar position is taken regarding the research into the metallurgy of cutting metals by the American engineer,F.W.Taylor, active in the first two decades of the 20th century. But the relation between the implementation by engineering employers of these innovations, and their reorganisation of work processes based on an increasing division of labour in the workshops is insufficiently explored.

My view is that the literature on technological development is restricted by undue emphasis on an evolutionary expansion of the hardware of machine tool technology. The transfer of control of new technologies is not perceived as part of a contested power struggle. The use of deterministic models of technology also precludes analysis of the inherent conflict in much 19th century technological innovation. There is need therefore to turn to other sources which might provide more insight into these factors of technical change.

In the next chapter I seek to extend the analysis beyond the artefacts and relate them to both the system of power relations in the workshop and to developments outside the workshops. I demonstrate that there was a relationship between the implementation of new technologies by significant employers, overseeing the devaluation of craft skills, and their declining interest in maintaining a structured system of trade training.

I offer an account of the development of 19th century machine tool technologies, with special reference to the work of Maudslay, Nasmyth, and Whitworth. I believe these Victorian engineer-entrepreneurs were more than inventors of genius, and may also be seen as effective employers in the sense that they accelerated the decline of the apprenticeship in the general workshops. They were charismatic figures of the age who indirectly, but crucially influenced the views of the generality of employers regarding technical education.

Chapter 2

VICTORIAN ENGINEER-ENTREPRENEURS AS EMPLOYERS: THE WORK OF MAUDSLAY, NASMYTH, AND WHITWORTH

Introduction

It has been well documented that important changes in the technical mode of production were intitiated in the 1850s, and earlier, by engineer-entrepreneurs such as Muir, Muaudslay, Fairbairn, Nasmyth, and Whitworth [Spon(1873), Smiles(1876), Roe(1916), Clapham(1938), Chadwick(1967) Galloway(1967), Steeds(1970), Cardwell(1972) McGuffie(1986)]. But it seems to me that most studies do not acknowledge that early technological innovations may have been also closely related to changing strategies of labour control. This may be illustrated with reference to Whitworth's work on precision measurement and standards** in engineering and manufacturing production.

In most accounts of the development of technology, technological factors such as Whitworth's research into metrology and machine tool developments are invariably treated as elements in the evolution of new classes of machines and of new metrological precision. For me his technological innovations also entailed the reorganization of technical and labour control in the workshops and may thus be considered as significant factors in changing employer-employee relations.

**

Standards' is the name given to a system of measurements which sets down limits within which certain component parts in engineering are to be manufactured; these limits are known as 'tolerances'. It was a characteristic of skilled workers to be able to work to 'close' tolerances,i.e. work within precise limits.

I believe it can be shown that the standards of measurement and gauging with which Whitworth was deeply engaged, were fundamental to the creation of new levels of workshop precision and his innovative work in this factor of production accelerated the demise of the apprenticeship system by encouraging the principle of substitution. The decline of the apprenticeship reflected the employers' increasing control over skilled labour and precision manufacture particularly. There are important parallels to be drawn between the substitution of parts (interchangeability based on fixed standards of measurement) and the substitution of labour (part of the process of 'de-skilling' of jobs and workers).

There is a need to explain how the specifics of engineering production, such as new techniques of precision measurement and control of rapid metal removal in cutting operations, were significant for employers in their attempts to control skilled labour. What did the changes mean for workers? What did 'de-skilling' mean in terms of the techniques used in cutting metal? How could employers gain by increasing their use of less-skilled workers? and what actually happened in the workshops when, as is argued, 'de-skilling' (or 're-skilling') took place; and why is this process perceived as such a critical element in existing accounts of technical change? Two further issues relating to these questions require elaboration and concern the nature of the skilled workers' resistance and subordination. Price(1983),for example, in focusing on the dynamic between resistance and subordination argues that

> '...the elements of subordination possessed an inherent dialectic...they would also react upon (those) traditions to create new forms of resistance...'(p.68).

On the one hand, therefore, were issues concerning the employers' attempts to extend their control over the planning and organization of artisans' work. Up to the middle of the 19th century it was the practice to view the self-activity of the skilled workers as autonomous, particularly with reference to the planning and execution of production processes. The artisan's traditional function of production control was increasingly curtailed by the employers' implementation and control of new tecnhnologies after the 1850s.

On the other hand, there was persistent artisan resistance to management reorganization of work. Historically, skilled workers demonstrated their 'indispensability' by working with reasonable speed

and accuracy. In practice this meant the employers were forced to rely upon artisans to produce work to 'acceptable' tolerances in a situation where there were no universal standards governing levels of accuracy.[Note 1 on p.75 below provides an illustration of the high level of expertise and arithmetical skills demanded of artisan machinist].In this area of work Whitworth's significant research on standards clearly affected the crucial element of artisan control over accuracy in the actual processes of production. Technical and social control of the workplace underwent fundamental changes, creating resistance from skilled labour.

An account of 19th century technical change can not be separated, in my view, from analysis of the major employers' concern to transform the organization of engineering work and extend their control over the planning and execution of the total labour process.

Technical changes can also be explained in a way which shows their importance in the understanding of at least two related factors: the demise of the apprenticeship system; and the foundation of a formal and separate technical education sytem based predominantly on a part-time principle.

This chapter, centering on Maudslay, Whitworth, and Nasmyth, begins with the development of the slide rest and cross-slide (a smaller slide to manoeuvre the tools, mounted on the slide rest). It is generally agreed that the slide rest was central to modern machining processes in order to more effectively control cutting tools, and improve precision. My case is that its extension to other machines also enabled employers to enlarge their control over skilled machine labour and have direct influence upon the method and pace of production. The artisan response was to challenge work reorganization based increasingly on substitution which new machine tool design stimulated.

2.1.0

The Slide Rest Principle and the Issue of Machine Tool Accuracy: The Work of H Maudslay

Overall design and construction of the common machine tools had remained fairly constant up to about the 1840's. There were a number of recurring production problems. First, general purpose machines, usually made of iron and wood, were often subject to errors of alignment i.e. parts of the machines were not always accurately located with other parts. Second, and of particular concern to employers, was reliance upon manual control of the cutting tool. This involved rigidly holding and guiding the tool as it moved along the metal being cut, the 'workpiece', in a way which removed surplus metal according to the required size and 'finish'. The 'finish' is the condition of the surface of the metal after being cut; it may vary from 'rough' to 'very smooth'. It was standard practice for the machinist on the most common machine tool of the day, the lathe, to hold the cutting tool in his hands against a 'rest' in order to cut the metal. [Spon (1874), Smiles (1878), Musson & Robinson (1969)].

The slide rest was designed by Maudslay to rigidly hold and guide the cutting tool. It was clamped to a sliding part of the machine usually a lathe, which fitted over the bed, or base, of the machine; this was called the 'saddle'. The more exact fitting of the slide-rest also refined the fitting of the 'saddle' on the machine for precision machining. The purpose of the slide rest was therefore to grip the cutting tool as it cut into the metal being machined, as the slide rest, on the saddle, moved precisely along the bed of the lathe, driven by a long screw. [Galloway, D. F. (1958) in Singer, Charles et al. (1958) Ch. 26. Woodbury, R. S. (1978) in Williamson, T.I. (1958) pt. II].

One innovatory development clearly associated with it, and, in my view, of particular significance to employers, was the application of this device on machines designed for the replication of machined parts in large numbers at a rate which superseded handcraft productions; and which enabled production costs to be more effectively controlled. Samuel Smiles (1876) writes of this development:

'The effect of the introduction of the slide rest were felt in all departments of mechanism ... all kinds of work could now be turned out in quantity and at a price that for its use, could never have been practicable ... various modifications were introduced ... the result of which has been that extraordinary development of mechanical production and power ...' [Smiles, Samuel (1876) p.214]

Important changes in machining practice, using unskilled workers had clearly been introduced through the work of Whitworth and Maudslay, particularly through the use of the slide rest concept. Originally designed by Maudslay for use on the centre lathe, the slide rest was later incorporated in a wider range of machine tools. Machining had been simplified and control of the cutting tools and finish became features of the machine tool and not the worker. Nasmyth said:

'... now that slide lathes and planing machines are becoming so very common in workshops ... and that <u>such machines, from their automatic power, no longer require regularly bred mechanics to attend them,</u> it becomes more than necessary to reduce the subject to those simple principles to which it is capable, so that the subject may be brought within the range of the supposed inferior capacity of a humbler grade of men, from whom we want no more than careful attention to secure the best results from these surprisingly productive machines'. [Nasmyth, (1841) p.411](my emphasis).

Engineering production methods in the second half of the nineteenth century were therefore profoundly influenced by the employers' development and implementation of new machines. From the 1890s they were increasingly used in mass-produced products such as typewriters, sewing machines, bicycles; and to accommodate increased demand for firearms, particularly small arms. I focus later in the chapter on small arms production, taking the example of Colt's factory in London as an illustration of the range and control possible with the new technologies.

2.2.0

<u>The Effect on Workshop Organisation of Self-Acting Machines: The Contribution of Maudslay and Whitworth</u>

The Slide Rest was the first mechanical invention of significance that literally removed the cutting tool from the craftsman's hand. As Evans (1986) noted:

'... after 1800 the lathe was a new animal ... the workman's hand no longer held the cutting tool. The tool moved left and higher, in and out, by turning long screws' (p.15)

That is, the cutting tool was located on the machine tool itself and was integral to it. As the slide-rest travelled, along the metal, the cutting took place. The setting of the tool relative to the metal being cut had always demanded high levels of skill, e.g. consistency of pressure in hand-held tools.

Nasmyth, a leading engineering employer of the day, said the slide rest was,

> '... of great importance ... and consists in substitution of a mechanical contrivance in place of the human hand, for holding, applying, and directing the notions of a cutting tool to the surface of the work to be cut, by which we are enabled to constrain the tool to move along or across the surface of an object ... with absolute precision ...' [Nasmyth, J. (1841) in Buchanan, R. (1841) p.395]

The main effect of the slide rest was that machining skills were mechanised and grossly simplified, and plain machine operations henceforth required less manual skill. It was thus the first major development in machine tool construction which facilitated the transfer of control by the worker over the actual process of tool cutting.

The saddle was moved along the machine bed by the action of long screws, called 'leadscrews'. These screws were originally designed and made by Maudslay and were precisely hand manufactured. Improved lead-screws were later developed by Whitworth and incorporated into the cross-slide; an innovation which also greatly increased the accuracy of the cut and finish.

2.3.0

Whitworth and the Principles of Workshop Gauging and Measurement

The machinist worked to given sizes, but he determined the accuracy of the finished size. There was a margin or error tolerated on any given size. This error was later called 'tolerance'. The tolerance was the total deviation, plus or minus from the size of the component, called a 'dimension'. The more accurate the work, the closer the tolerance on any given dimension.

Workers in workshops such as Whitworth's were given limits within which to manufacture any components. Working within 'limits' therefore presupposed acceptable levels of accuracy and finish, and was essential to what was to become known as interchangeability.

It was in this area that Whitworth made a highly significant contribution to workshop practice and labour control, from the 1840's. He regarded accuracy of size and finish on machines as an essential basis for the accuracy of work later produced:

> 'Every consideration combines to enforce accuracy, ... when it is considered that the lathe and planing machine are used in the making of all other machines, and are continually reproducing surfaces similar to their own it will manifestly appear of the first importance that they themselves should be perfect models.' [Whitworth (1840) p.8]

Whitworth argued that there were two crucial elements governing the construction of machines, these he referred to as the 'true plane', and the 'power of measurement', 'the latter cannot be attained without the former' [Whitworth (1856)].

Whitworth had joined Henry Maudslay in his works in London in 1825 and developed his system of 'true planes' during his time there. The principal virtue of the truly plane surface was that for all kinds of mechanisms which involved one surface sliding over another, as in many machine parts, frictional resistance could be reduced to a minimum. With this development a new standard of accuracy in mechanical construction and measurement became possible.

A sequel to the discovery of the true plane was Whitworth's introduction of a system of measurement of 'ideal exactness'. This was formalised between 1840 and 1850 by the conception and development of his measuring machine. [National Biographical Dictionary, p167]. As Whitworth said with reference to the discretion allowed to workers regarding sizes:

> 'What exact notion can any man have of such a size as 'bare sixteenth' or a 'full thirty-second' and what inconvenient results may ensue from the different notions of different workmen as to the value of these terms'. [Whitworth, J. (1857) p.49].

This observation by Whitworth shows workers were exercising control over the work being done to the extent of determining what levels of accuracy were possible. The quotation implies a wide latitude available to workers, with imprecise limits: 'bare sixteenth' or 'full thirty-second'. That is, they worked to a given dimension within a sixteenth of an inch or a thirty-second of an inch, of that size. The final precise measurement rested with the worker. Whitworth argued that no form of standardisation was possible with such imprecision in manufactured work. His point of departure was the true plane from which, he derived much

closer control over accuracy, i.e. he developed closer 'tolerances'. This control also meant he was able to remove the discretion over the final size from the worker. The artisan was required to work to prescribed limits, set by the employer.

The concept of 'tolerance' was incorporated into agreed standards. That is, instead of expressions such as 'bare sixteenth', a consistent set of tolerances would be specified relating to an acceptable margin of error within a given range of common sizes in engineering practice. Thus the larger common sizes in standard engineering practice would have a bigger tolerance than smaller common sizes; but they would remain constant and thus, more or less, replicable.

This was the foundation of the principles of standardisation in sizes, and interchangeability.

2.3.1.

Whitworth's Research into Precise Measurement

The basis of measurement in the 19th century workshop was the Imperial inch, and the most common instrument was the ruler, graduated down to a thirty-second of an inch or a sixty-fourth. That is, the closest limit was a sixth-fourth of an inch.

Whitworth was convinced that no system of measurement depending on sight was suitable for accurately determining the size of engineering components. Where exact size or good fitting was required he argued that a sense of touch was far more reliable. [Whitworth (1857) p.48] Thus he devised a new measuring machine, the basis of which was a system of parallel blocks of polished metal, so arranged that of two parallel surfaces one can be moved nearer or further from the other by means of a screw. The movements of the screw could be measured for each turn or part of a turn and hence the distance moved by the moving plane.

The screw thread on the machine had 20 threads to an inch; attached to the screw was a wheel, called a micrometer wheel, with 500 graduated divisions. With one division of movement of the wheel, the screw would advance or retard 1-500th of a turn, that is by 1-10,000th of an inch. Whitworth subsequently showed that the movement of a fourth part of a division, being 1-40,000th of an inch, was 'distinctly felt and gauged'.

By 1859 the measuring machine had been refined to the stage where

> 'movement of the micrometer wheel through one division, which is the millionth of an inch, is sufficient to cause the feeling piece to be suspended or to fall by its gravity'. [Whitworth, J. (1876) p.66]

2.3.ii

The Standardisation of Screws and Screw Threads

Whitworth's metrological research had convinced him of the importance of accuracy and informity in the area of screw threads. Before his work in precision measurement, screws had been manufactured on an ad hoc basis with no recognised principle or system; each workshop manufactured a type of its own. Individual variations in screw thread sizes indicate another source of control in the workshops, exercised by artisans. Smiles (1876) noted in his description of screw threads;

> 'There was an utter want of uniformity. No system was observed as to "pitch" ... nor was any rule followed as to the form of ... threads. Every bolt and nut was a sort of speciality in itself ... to such an extent was (the) irregularity carried, that all bolts and their corresponding nuts had to be marked as belonging to each other; and any mixing of them together led to endless trouble, hopeless confusion, and enormous expense'. [p.226]

The value of the screw thread and its application as a means of transmitting linear motion for a given rotational movement was realised in machine tool production. It is in this sector of machine tool building that Whitworth's contact with Maudslay seems to have been so influential. As Evans (1986) has argued, with reference to precise measurement in the early 19th century, with Maudslay's 'beautiful screws' it was possible to measure with great accuracy.

> 'Our modern precision machining and measurements are descendants of their patriarchal Maudslay screw' (p.15)

The micrometer wheel principle on Whitworth's measuring machine was employed in conjunction with accurately made screws. It was also used on hand wheels of machine tools so that the worker could determine precise movement of sliding machine parts he was controlling.

The use of screw thread principles was early recognised in screw bolts to join certain parts of machinery. The screw bolt had power, strength and durability:

> '... it is peculiarly adapted for (this) purpose by the compact form in which it possess the necessary strength and mechanical power'. [Whitworth, J. (1841) in Spon. E & F.N. (1882) p.19]

The importance of accurately made screw bolts improved the location and fitting of machined components. The other common forms of joining were riveting and welding. The advantage of bolted components was that they could be subsequently separated with relative ease.

The lack of uniformity of screw threads generated a wide range of threads with varying pitch (the distance from a point on a thread to the corresponding point of the next thread), and thread angles (the slope of the thread relative to the axis of the bolt or screw). Whitworth as early as the 1840's observed that the "... economy and manifold advantage resulting from uniformity ... must be sufficiently obvious'. [Whitworth (1841), in Spon (1882) p.18]

Whitworth collected an extensive assortment of screw bolts from different English workshops, and deduced as a compromise an average pitch of thread, for different diameters; and also a mean thread angle of 55°, which he adopted all through the scale of sizes. By 1860 the Whitworth system was in general use. [National Biographical Dictionary op.cit.p165] The system came down into modern workshop practice as the British Standard Whitworth system; threads incorporating his standard specifications being designated B.S.W. Whitworth's denomination of standard gauges were approved by the Privy Council in 1881, as standard under the Weights and Measures Act 1878. [Whitworth (1876) Appendix]

2.3.iii.

The Development of Gauges for Checking Work Sizes

Whitworth argued that a system of standardised parts, made to high levels of accuracy, was essential to interchangeability. The evidence shows he was clearly aware that the maintenance of manufacturing precision rested with the artisan's measuring skills. He therefore concluded that if a means of replacing those particular skills could be found, the employers' dependence on the artisan could be reduced or eliminated, and some kind of uniformity or 'standard' introduced. Using his own advanced measuring machine he developed a system of workshop gauges designed to check, rather than measure, specific components over a range of common workshop sizes (Whitworth(1856, 1883).

Thus in the production of close fitting parts of machinery, precise measurement was indispensable to ensure accurately fitting work. Whitworth illustrated the importance of very small differences of size

with gauges (devices for checking, within closely prescribed limits or tolerances) ...

> 'I have ... as internal gauge having a cylindrical aperture .5770 inch diameter, and two external gauges or solid cylinders, one being .5769 and the other .5770 inch diameter. The latter is 1-10,000th of an inch larger than the former, and fits tightly in the internal gauge when both are clean and dry, while the smaller .5769 in gauge is so loose in it as to appear not to fit at all ... it is therefore obvious both to the eye and the touch, that the difference between these two cylinders of 1-10,000ths of an inch is an appreciable and important quantity'. [Whitworth, J. (1857) pp. 44, 50]

The standardising of common engineering elements was thus based on the assumption that quantitative variations, within a given range of common components, could be realistically controlled within fine tolerances. The basic workshop structure of these standards was established with the development of ring and plug gauges available in standard sets of various dimensions. [See Appendix 9].

A system of ring and plug gauges was refined by Whitworth in 1856 in order to introduce a form of standardisation of sizes across a wide range of engineering components[Appendix 9 gives details of these gauges]. The concept of standardisation had impressed Whitworth on his visit to America (as a member of an official delegation to report on the latest developments in arms manufacture; one of the results of which, was the remodelling of the Enfield armoury). This took place two years before his later, definitive work on gauges. After a visit to the leading arms factory, the Springfield armoury, he noted that:

> '(The) complete musket is made (by putting together the separate parts) in three minutes. All these parts are exactly alike that any single part, will, in its place, fit any musket'. [Whitworth, J. (1854) p.27]

This is a clear, concrete definition of the principle of interchangeability.

The case for a means of fixing an accurate stable measure, or standard, over a controlled range of engineering components such as shafts, bolts, screws, was thus effectively argued by Whitworth, and in this his contribution was outstanding. A more or less universal range of standards was developed and related directly to replication of components in large quantities. This was the principle of mass-production. As he said,

'It is of great importance to the manufacturer who makes parts of machines in large quantities to have a means of referring to an accurate fixed measure ... errors in standards are not only reproduced in the copies, but are superadded to the errors in workmanship, which will occur in the course of manufacture; and this is especially likely to occur in cases where one manufacturer supplies parts of machines for the use of another'. [Whitworth, J. (1857) p.52]

The advantages to employers of manufacturing according to a standardised system of parts may be illustrated in this extract from the submission of evidence to the 1854 Small Arms' Select Committee by Anderson, the Superintendent of Woolwich Arsenal. The basis of this system as fundamental to interchangeability is shown in the reference to the employment of unskilled 'assemblers' as opposed to skilled 'fitters', i.e. artisans who worked on components by hand to make them fit.

'Have you any doubts that the parts of a musket can be created by machinery so perfect that the assembler will take so short a time as 10 minutes in putting them together? - After a little experience ... there will be very doubt on that point.
Was it not the object with this improved machinery to reduce the amount of wages; to employ fewer persons, very few skilled labourers, but to employ a number of unskilled persons to manage under them the machinery? - Yes, I hope it will come to that'. (My emphasis). [Anderson, J. (1854) Qs. 371, 794]

Such evidence shows that the substitution of parts also implied a susbtitution of workers. The relation between machine operations and hand-work incorporating these principles was further demonstrated by Whitworth. He reproduced for the Royal Commission an American working schedule showing the production of a complete musket from raw stock, completed in thirty-one minutes. This involved a series of 16 separate operations, representing a total manufacturing time of 28 minutes and 45 seconds taken from machine work, and 2 minutes and 17 seconds for hand operations. [Whitworth, J. (1854) p.27]. This illustration lends support to the view that an interchangeable system of manufacture was regularly pursued by gun makers:

'... Of the typical articles, such as firearms, bicycles, typewriters, sewing machines and the like, now produced by interchangeable system, guns and pistol are the only one which antedate the system itself'. [Roe, J.W. (1916) p.128].

The introduction of advanced systems of interchangeable manufacture was a revolutionary development. In the period after the visit to America by the government commission, the Small Arms factory at Enfield was thoroughly reorganised and production of rifles, requiring 700 separate

operations, was 2000 per week: 'The parts of each rifle being completely interchangeable'. [Galloway, D.F. (1958) p.638]

Anderson noted in 1880 the way new machines embodied higher levels of precision and replication:

> 'one of the most suggestive characteristics was ... the growth of simple machines ... into a higher stage of development with almost human intelligence permanently embodied in the mechanism for its own self-preservation.' [Anderson, J. (1880), p.38]

The new machines referred to by Anderson were modified forms of the basic lathe, the machine mainly used for producing round bars of metals. The main development was the 'turret' lathe which was an automatic, i.e. self-acting machine which was developed from the significant work on the cross-side by H. Maudslay.

2.4.0

Self-Acting Machines and Interchangeable Production: An Illustration in the Manufacture of Small Arms: Colt's Factory

The simplified machining practices particularly noted by Nasmyth [Nasmyth, J. (1854) Q.1353] were demonstrated in evidence before a House of Commons Select Committee in 1854. In that year the chief engineer of the Royal Arsenal at Woolwich, J. Anderson, had inspected the Colt factory in London with a view to appraising the level of machine automation in firearm production. (Military arms production provides an interesting case of engineering processes in which components have to be made in very large quantities, with precision, in replication for easy assembly. Highly accurate, semi-automatic machines were necessary for long production runs of this kind). Anderson's conclusions suggest that as early as the 1850's advances in automatic principles in machine tool operations in small arms manufacture had been brought to a level where the requirement of skilled-machinist labour had been very much reduced. Skilled workers who remained in work were engaged in setting the cutting tools in the machines, 'tool setting', for machine operations by unskilled workers.

> 'The work in this manufactory is reduced to an almost perfect system; a pistol being composed of a certain number of distinct pieces, each piece is produced in proportionate quantity by machinery, and as each piece when finished is the result of a number of operations (some 20 or 30) ... and each operation being performed

> by a special machine made on purpose, many of these machines requiring hardly any skill from the attendant beyond knowing how to fasten and unfasten the article, the setting and adjusting of the machine being performed by skilled workmen; but when once the machine is properly set it will produce thousands'. [Anderson, J. (1854) Q.341] (my emphasis).

The significance for relative cost factors of substituting unskilled workers for skilled artisans may be seen in an illustration in which work which formerly took four days by hand, was performed in a fraction of the time by machine, using unskilled workers;

> '... every part (of a musket) ... if made by machinery ... would be made with thorough accuracy, and very much more quickly ... a machine is used for planing cannon between the trunnions; formerly this was chiselled by hand and then filed, and there was at least four days' work in it; now, by means of the machine ... it is put in and taken out again within an hour; the lad that watches this machine has to turn the trunnions of another cannon, so that it is produced for less than ten minutes of wages'. [Anderson, J. (1854) Qs. 343, 347]

Further evidence from Anderson demonstrates the processes of a division of labour within automated machine production. As production became increasingly automated the range of skills tended to become less differentiated. The areas of work reserved for the highly skilled were increasingly circumscribed by what Braveman(1974) referred to later in his critique of the employers' control of the labour process, as a separating out of planning from execution. The tendency in places such as Colt's London armoury was toward a mass of undifferentiated labour; the key to the explanation of this phenomenon was the introduction of automatic machine processes and new levels of precision measurement.

An arithmetic expression comes from Anderson; for a production run of 150,000 firearms a recommended workforce of 1,000 would be envisaged of which

> '... about 150 would be men of considerably skill, and the remainder ... of moderate skill, labourers, boys and girls taken on without skill, but being trained to a simple operation become highly skilful at that particular process ...' [Anderson, J. (1854) Q.379]

The structure may be more clearly revealed by analysis of the proposed wage differentials;

> '... one man at 5 £ per week; two men at 3 £, five men at 50s; twenty men at 2.2.0.; twenty-five men at 36s; twenty-five at 30s; fifty at 24/6; seventy-two at 18s; one hundred at 15s; one hundred at 12s; one hundred and fifty at 10s; one hundred and fifty at 8s; one

hundred and fifty at 6s; one hundred and fifty at 4s (the latter would be of course, boys and girls) ... amounting to 621 £ 11s or annually to 32,339 £'. [Anderson, J. (1854) Q.380] [My emphasis].

Marx (1978) in his first volume of Capital, published at the time workshop transformations were increasing, put forward what he considered a three-fold division of labour which appears to parallel Anderson's model and that of the Colt factory: As Marx put it: there were, those who were actually employed on the machines; attendants (almost exclusively children); and a third, numerically unimportant group,

> 'whose occupation it is to look after the whole of the machinery and repair it from time to time: such as engineers, mechanics, joiners etc. This is a superior class of workmen, some of them scientifically educated, others brought up to a trade ...'
> [Marx, K.(1887) (1978) p.970]

This division of labour Marx referred to as 'purely technical'.

Colonel Colt, an American from Connecticut, had opened his arms factory in London in January 1853, [S.C. on Small Arms, (1854) Q.1150] - and evidently conceived a division of labour more or less similar to that envisaged by Marx. Embodying an employers' perspective of the concept of skill required for machine work, his view illustrates his attitude regarding training for general engineering work:

> 'The more ignorant a man was the more brains he had for my purpose ... they first come as labourers at 2s per day ... in a little time ... if there be a machine vacant, I put them on it ... the best get 8s per day ... Do not bring me a man who knows anything if you want me to teach him anything'. [Colt, R. (1854) Q.1152]

Were such employers redefining engineering skills through the reorganization of work?

Colt's preference for unskilled workers for machine manning suggests that the level of technology was sufficiently developed by the 1850's and 1860's for employers to consider training for machinists to be redundant or at least minimal. Nasmyth held a similar view. He employed former agricultural labourers in the machine shops:

> '... the most trustworthy men I have were originally ... taken from the fields in my neighbourhood'. [Nasmyth (1854) Q.1436]

I believe the evidence shows that technological development was inseparable from social development and control in the reorganised workshop: Control over technology meant control over the labour process. Instead of craft training, employers such as Colt and Nasmyth placed

emphasis on the workers' ability to familiarise quickly the operation of repetitive machine operations:-

> 'I select those that are the most intelligent, and in the course of one week I have them producing three or four times the amount ... of a legal hand ...' [Colt, R. (1854) Q.1437]

Although the concepts 'intelligent' and 'stupid' employed in the context of Colt's evidence appear contradictory, they appear rational in the sense that both categories satisfied the employers' demands for unskilled labour. Work reorganisation made them less dependent on artisan machinists, and freed them from union prescriptions on machine manning. The A.S.E. was exclusive to skilled workers, and the employers use of non-union men enabled both variable costs in the form of wages, and rates (and methods) of production to be more effectively controlled by them. As Colt expressed it,

> 'If labour is not raised in price, I know what a person can do in a day on all the details of operation done upon my arm (firearm), and I could tell you as to the very operation of boring that hole ... the cost of it per 1,000. There are hundreds of machine operations on that arm, and there is not one of them the detailed price of which is not upon my books, what it costs per 1,000'. [Colt, R. (1954) Q.12627]

The organisation and control of metal-machining provides a clear illustration of the way employers were able to implement new technologies and rationalise their resistance to craft training in the traditional form of apprenticeship.

It also seems to me to illustrate how the specific deployment of a machine tool by an employer acts to redefine the nature of the worker's skill assigned to a particular machine. Often there was a shift of designation from 'artisan machinist' to 'machine minder'. The assumption here was that having 'set' a machine fitted with a self-acting mechanism, the machining could take place without further attendance on the part of the operator, beyond checking the progress of the cut - the notion of 'minding'.

Related to the concept of 'machine minding' is 'idling time'; a notion which had its origin in the machine shops. In brief, it referred to the time during a cutting operation on a machine when the tool was automatically moving along the work being cut. The machinist was not actually 'working' while the cut was under way; this period was referred to as 'idling time' by employers, some of whom attempted to capitalize on this by giving the worker more than one machine to tend.(I give

practical, numerical examples of how this operated in the workshops in appendix 6.i).

Nasmyth provides a striking illustration of this form of intensification of labour with the boring machine. This was a machine used for cutting accurate holes in heavy-sectioned or irregular shaped components. He said:

> 'I have a machine for boring cylinders, a process that requires very great accuracy and care and found, after the cylinder was put in the machine and set to work by self-action, that here was a man at 32s a week standing by for nearly a week looking at the machine; ... and I thought the best way to keep him fully employed was to give him another machine to fill up his time, and he then said he would not do so ... the best thing you can do is walk out (I answered) ... I then took the very labourer who used to assist him in putting the cylinder into the machine and said, now you have charge of this machine and the other that this man refused to work; and for every additional machine that you manage I will give you an additional shilling a week. That man now manages six machines, and he has plenty of time to spare'. [Nasmyth, J. (1854) Q.1437] (My emphasis)

The machine operation boring referred to by Nasmyth was used for cutting internally - 'bores', and might be called internal turning, the cutting operation being almost identical. But it was difficult machining operation, requiring great care on the part of the machinist.

> '... for the action of the tool cannot be watched as in turning being as a rule out of sight, the dimensions are more difficult to gauge, while cored or interior surfaces are both harder and more irregular than outside surfaces'. [Spon's Dictionary (1874) p.2322]]

Machines of this calibre were capable of boring cylinders 90" diameter, 11 ft long, (Buchanan & Co (1864) p.81] indicating the magnitude of the machining task in this form of heavy engineering.

Evidence of employers such as Nasmyth also shows that accurate work of large dimensions could be attained with new kinds of automatic machines using unskilled operators. The machines were capable of producing precise work, independently of the skill of the operators. For example, by 1877 it was possible to report that

> '... in the automatic machines of modern times, tools have assumed a far higher relative position because in them, (the) mental faculties, the skill and craft are permanently embodied ... and many of them are qualified to transmit their virtues or vices without assistance". [Anderson, J. (1877) p.2127]

The self-acting mechanism in machines was thus highly rated by employers such as Nasmyth, Whitworth and others, and, for them, constituted a 'great

feature' by which 'brute force is completely set aside'. [Nasmyth, J. (1868) Q.19133] Whitworth, expressed few reservations regarding the advantages of self-acting mechanisms, as the following extract from his testimony to the Parliamentary Select Committee shows:

'Are you a manufacturer of machinery? - Yes.
Is the class of work that your machines produce required to be accurate? - Yes, great accuracy is required.
Do you make what are termed self-acting machines? - Yes
Is there much advantage in having machines self-acting?
Very great.
Is the work performed by them likely to be as accurate as it would be if the agency of an attendant were constantly employed? - Yes.
Will you explain for what reason? - Not requiring the attendance of a man, the work is often of a superior quality and more regular than it would be if moved by hand.
Do you consider the employment of self-acting machines as a general principle to be economical? - Undoubtedly'. [S.C. on Small Arms, (1854) Qs.1920-1928] (My emphasis).

Employment of boys and other less-skilled labour for the superintendence of machines, in my view, was directly related to the development of the semi-automatic function of the machines:

'All that the mechanic has to do now ... is to sharpen his tool, place it in the machine in connection with the work, and set on the self-acting motion, and then nine-tenths of his time is spent ... not in labouring, but in watching the delicate and beautiful functions of the machine ..." [Nasmyth, J. (1865) Q.19133]

One of the leading automatic machines brought into limited service from the 1860's was a type of lathe, called the Turret Lathe: Its principle features were the special mechanisms, 'chucks' used for gripping the metal being cut, and facility for up to eight cutting tools to be brought into operation at speed.(In sub-section 2.5.0. and appendix 10 I give a detailed description of the turret lathe, including the designation adopted by the Institution of Mechanical Engineers).

2.5.0

The Turret Lathe: Its Influence in Changing Definitions of Machine Shop Skills

Anderson, Superintendent of the Woolwich Arsenal, praised the new turret lathe principles in manufacture as early as 1867. He drew attention to the turret lathe in his reports as a juror in the machine tool section of the International Exhibition of that year. He also criticised the slow uptake by employers of other mass production

machines, including the milling machine (In Appendix 3, I provide a description of the milling machine and a note on its introduction into England). Anderson (1867) said of the milling machine:

> 'This class of tool is a great feature of the Enfield Small-arms factory, and it is much more used by engineers in America than it is in England". [Vol. XXX, pt. II, pp.373-4]

But I believe the most significant machine tool development sponsored by figures such as Anderson and Whitworth was the turret lathe. It was an innovatory machine tool which had a highly significant effect on integrated production i.e. methods based on standardisation.

The turret lathe used the basic principle of the cross-slide as in ordinary lathes. In addition to clamping one or two cutting tools to the slide rest, this machine had a hexagon-shaped block fitted to a second 'saddle' mounted on the base. On each of the six sides of the hexagonal block one or more cutting tools could be fitted. The saddle and hexagon block, called a 'turret', could be moved back and forth by a large hand wheel. As the hand wheel was turned clockwise the turret would automatically swivel one-sixth of a turn round to the next side; it was possible therefore to bring at least six different cutting tools into action simply by turning the hand wheel one part of a turn. Two further cutting tools could be mounted on the cross-slide itself.

The advantage for employers of this machine was that the six 'turret' tools could be 'set' in the correct cutting position before the start of the cutting. Normally no further adjustments were necessary after the setting. The skilled workers who remained after workshop reorganisation were usually employed as 'tool-setters'; the actual machine operation was left to unskilled machine operators. The skill was in setting the six tools accurately in relation to work being cut.

The deployment of this particular machine became central to the employers' attempts to reorganise metal machining using unskilled labour. The introduction of this kind of automatic machine had three important influences:

a) it led to the decline in the number of skilled artisans employed in machining;

b) the turret lathe was ideally suited to replication of large numbers of components and fitted the employers' strategy of promoting labourers to machine manning in conjunction with a new kind of wage-payment system, the piece-work system;

c)it supported the employers' justification in virtually abandoning craft apprenticeships.

According to one source automatic machine tools ensured conformity to rigid, pre-determined production schedules, irrespective of the technical or social background of the workers:

> 'In the workshops there was an extraordinary admixture of different nationalities, and this was an advantage to the employers as it enabled them to control their men much better than they could otherwise do. The system of work was almost universally piece work ... in some cases the engines were running from Monday morning until Saturday night without stopping, and it was not uncommon to see men working all through their meal times, and eating their food as best they could'. [Report of a visit to American Workshops by the Iron and Steel Institute (England), in *The Engineer*, 12th December 1890]

By the 1890's some of the influences of a mass market system particularly in the demand for products such as cycles was evidently having effects in supply and on the use of high-production machines based on the turret principles. The dominating influence remained American in this sphere, for by the last decade of the century new machines imported from the United States demonstrated the operational effectiveness of manufacture using fully automatic principles. Crucial developments were made through the use of wire-feeding (automatic feeding of the material to be cut to the cutting position), and the automatic revolving turrret (dispensing with the hand wheel). [Horner,(1900) p.121]

Production rates were increased through the employment of more than one cutting tool simultaneously:

> '... it becomes possible to use ... two turrets to be brought round in succession for the forrmation of a single piece of work ... some of these tools are operating on 2, 3 or 4 different faces and diameters at once ... the chief feature (in the production of 6,000 screws per day - BC) was the fact that four screws were being operated on at one time in revolving vertical turret'. [Ibid.]

A critical feature for employers was the ease with which the new turret lathes could be operated by unskilled machinists:

> '... a large amount of work <u>now done by skilled men is to be shortly done on the turret machine by comparatively unskilled attendants,</u> who will eventually beat the trained turners to output, accuracy, and uniformity ... <u>the great advantage in the modern turret machine lies in the possibility of using operators, who,</u> in a few weeks <u>can turn out accurate uniform work in competition with lathe hands who have served several years' apprenticeship ...</u>' [Orcutt, H.F. (1902) p.28] [My emphasis].

Before the end of the 19th century the advantages of automatic production and its generalisation to other forms of machine tool practice were recognised. The Northampton Institute in Clerkenwell was opened and classes were started for the training of "engineers" in the use of automatic machine tools for making inter-changeable parts. [American Machinist, Nov. 9, 1899, p.1071] A contemporary English journal, *The Engineer*, argued the case for automatic machines as a benefit to management:

> '... The English manufacturer is at length beginning to recognise that the restriction in the way of their use being now removed, automatic machine tools are of great importance ... the automatic tool has arrived at such a state of perfection that no longer need any hesitation to be felt in adapting it'. [The Engineer, 2nd Dec, 1898]

This journal also advocated the adoption of another technique for use with automatic tools, 'stock piling'. This was a system of production in very large quantities of a relatively small range of standardised parts, manufactured at speed which were put into store. Potential customers were notified that high turnover of products might be possible if they restricted their demands to high-productivity components over this given limited range:

> 'Much of the (American) success is due to the fact that they do not wait for their customers to tell them what is wanted, but show how much more can be done than was deemed possible ... they lead and do not follow manufacture'. [Ibid.]

2.6.0

Employers' Attempts to Change Definitions of Enginering Skill: Workers' Reaction to New Designations.

The evidence of employers such as Whitworth, Nasmyth and Robinson points to the substitution of skilled labour as a managerial priority. The employers' attempts to overcome skilled workers' resistance to the deployment and implementation of new technologies therefore needs to be seen as a part of the search by employers for more efficient means of work and labour control. Further evidence from the first official enquiry into trade unions in the nineteenth century clearly shows that some engineering employers insisted upon non-union labour wherever possible, invoking retaliatory action by the unions:

> 'After the strike of 1851-2 we required every man who came into the works to sign a declaration that he did not and would not belong to a union...' [Robinson, J. (1868) Q.9005]

On this kind of interaction,Penn(1983) remarks,

> '...the history of the (last) 100 years revolves around the successive attempts of the employers and management to develop machinery and subdivide tasks in order to eradicate the need for skilled craftsmen...'(p.46).

A precedent had also been established by other employers with the publication of a 'black list' of Society (A.S.E.) members after they had struck in 1855. [Allen, W. (1867) Q.876]. In justification it was argued on behalf of the employers at the Royal Commission that there were few formal associations of employers, and those which had been formed were instituted

> 'for the ordinary regulation of their respective trades, for the purposes of obtaining labour upon the most favourable terms, and for self-defence against the proceedings of the trades unions'. [R.C. on T.U. (1868-69) p.XVI para.43]

But this emphasis on a defensive position by employers tends to obscure more aggressive policies. As McIvor(1984) argues with reference to the period from the 1880s,

> '...there were hundreds of lockouts(from the 1880s)...and the lockout was the most feared and most devastating of employers' strikebreaking tactics...'(p.31)

On the question of whether the employers' federating tendencies were merely contingent upon union activity, a minority report by three members of the Royal Commission, Lichfield, Hughes, Harison, acknowledged that the employers' views, as represented by testimony to the Commission were"... entirely similar to the rules of the unions". [R.C. on T.U. (1869) (b) p.X]

In the event, A.S.E. rules of the time did not categorically preclude unskilled men being employed on machines, although there was a tacit understanding that society men would generally be employed in that capacity. (R.C. on T.U. (1867) Q.641]. Although machine-minders were recognised as 'society men' in some provincial towns, [Ibid. Q.643] they were differentiated on grounds of skill and length of service, i.e., they were not regarded by A.S.E. members as being 'legal hands'. The union was evidently conscious of the legality attaching to the exercise of restraints over the introduction of what it regarded as unskilled labour. The union constitution reiterated the need for a protective association concerned with the maintenance of the boundaries between 'skill' and 'non-skill', but operating within discrete and legal parameters:

> 'Our object is not to do anything either indiscrete or illegal; but if constrained to make restrictions against the admission into our trade of those who have not earned a right by a probationary servitude, we do so knowing that such encroachments are productive of evil, and, when persevered in unchecked, result in reducing the condition of the artisan to that of the unskilled labourer, and confer no permanent advantage on those admitted. It is our duty, then to exercise the same care and watchfulness over that in which we have a vested interest as the physician does who hold a diploma, or the author who is protected by a copyright'. [Rules of the Amalgamated Society of Engineers, Machinists, Millwrights, Smiths and Pattern Makers (Revised May 16th, 1864) as submitted to R. C. on T.U., (1869) (a) p.246]

However, the criterion of skill used by Society members would seem to be less rigid than the term connoted, for it referred to

> '... a man who has been five years in the trade, whether apprenticed or not, is capable of earning his livelihood at it and has become a competent workman'. [R.C. on T.U. (1867) Q.631]

I believe the evidence shows that there was a link between the introduction of new technologies such as the slide rest and innovatory techniques in metrology, and the employers' power to reorgnise work patterns and control strategies, often against the wishes of the workers. Through standardisation and inter-changeability of parts, the interaction between skilled worker and the object of his labour changed. No longer

requiring a process of traditional craft training, the skilled workers' job which was formerly characterised by precision, speed and manipulative skills, was gradually reorganised.

The actual construction of machinery was modified. This was done by the process of fitting. By producing components of improved accuracy and finish, the need for subsequent work by 'fitters' was lessened, but not entirely eliminated as Whitworth's evidence below shows. I turn briefly in the next section to the craft of fitting because, it was and remains a highly regarded practical hand-skill in engineering practice. It was difficult to completely mechanize the process of building machines, i.e. the actual process of fitting components together.

2.7.0

The Importance to Employers of "Assembly" as Distinct from "Fitting"

With more generalized use of standardization employers sought to reduce their dependence upon individual fitting skills, which were used to rectify minor errors and facilitate construction, by 'assembly' of accurately dimensioned and finished machined components, using less-skilled or unskilled 'assemblers'. Nasmyth, breaking with tradition, even argued that standardization of parts made the employment of girls on assembly in fitting shops a viable proposition. He thus held that the bulk of the work in the engineering trade could be carried on by boys, and that

> '... the day will come in which steam engines will be made by girls. There is as much mechanical skill required in superintending a power loom or a spinning jenny with its thousands spindles as a steam engines'. [Nasmyth, J. (1868) Qs.19190, 19194]

Whitworth also envisaged a wider application of the use of making standard components 'fool-proof' as regards size and finish which enabled assembly to be accomplished with little or no skill. The evidence concerning metrology has shown that it was the more or less 'foolproof' nature of control of production precision that was the essence of both standardisation (manufacture to pre-determined standard sizes); and interchangeability (the ability to interchange components - made to pre-set standards of accuracy and finish).

Whitworth argued

> 'Fifty years ago thousands of spindles in a cotton factory had each to be separately fitted into a bolster in which it had to work. At the present time all these spindles are made to gauge, and are interchangeable ... it cannot be impressed too forcibly... that accuracy of measurement is essential for good and efficient workmanship, and that it tends to economy in all branches of manufacture, so as to have the parts interchangeable. [Whitworth, J. (1876) p.68][My emphasis].

An examination of the process of 'fitting' amplifies the thrust of Whitworth's argument here.

2.7.1. The Processes of 'Fitting' Explained

Fitting may be regarded as a primary engineering craft skill. Fitters were skilled engineering workers employed in the construction of machine tools, and the fitting and maintenance of general purpose and specialised machinery. Fitting was, and remains, a highly regarded occupation in the engineering industry embodying not a single, but a number of generally recognised mechanical skills.

Fitting skills may be briefly outlined as 'marking out' (the translation of dimensions of engineering components from technical drawings). These are usually laid out in what is termed first-angle or 'English' projection, i.e. drawings, to scale, representing a component viewed in three directions to encompass the complete article). This process required geometric precision, the ability to 'read' technical drawing ('blueprints'), and facility for working to close tolerances (within specified, close limits of dimension).

The preparation and execution of a variety of smaller machining processes was a fitter's main task and this entailed the use of general machine shop tools, drilling, shaping, milling, turning, and grinding; together with the fabrication (putting together) - 'fitting' - of components previously prepared. The preliminary work was carried out by the fitters or executed on machines.

The complex and varied nature of the job requirements generated a high regard within the A.S.E. and also with engineering employers; fitters thus constituted a pre-eminent group among society members. They were the most highly represented group in the A.S.E., and remained so despite the increase in the use of machines. A.S.E. admissions indicate that fitters outnumbered turners (lathe workers, the other principal artisan

group) in the period up to 1889. Up to 1869 there were 54 per cent fitters and 24 per cent turners, in the period 1875-79, 57 per cent and 25 per cent respectively, and in 1885-89, 58 per cent and 27 per cent respectively. [A.S.E. Annual Reports]

This class of worker was rated by the Society, and employers, as essential to engineering production. The requisite fitting skills were of such an eclectic quality, embodying both fabrication and machining abilities, that it is realistic to argue that they would not have been easily replaced by less-skilled workers. The important assumption here is that it was very difficult to manufacture components in the forge or machine shop preparatory to fitting, to a level of precision and finish that would rule out further work by fitters. Whitworth, for example, concluded that, despite advances in machine tool processes, the skilled fitters' work remained crucial. The following extract illustrates this point. This comes from his evidence to the 1854 Royal Commission on Small Arms:

> 'Would the application of these inventions (gauges invented by Whitworth for checking components) render the parts of a musket more nearly alike in diameter than at present they are? - Yes, it enables a person to make them of the exact size, whereas he has not exact means of ascertaining whether they are so or not.
> Then it is your opinion that it is possible to produce the several parts of a military gun with sufficient accuracy by machinery, so that they shall fit together, and require comparatively little finishing by hand labour? - it is hardly possible to do that; they do require hand labour.
> What amount? - That would depend upon the care that was taken in attending to the machines, and in their quality.
> You think that it is not possible to make them with sufficient accuracy, but that some hand labour would be required? - Quite impossible'. [S.C. on Small Arms, (1854) Q. 1943-1946]

Despite this kind of qualification by Whitworth, the effect of new technologies on precision assembly was marked by the 1870s and 1880s.

The combination of the production of precision machines tool work based on more or less nationally-agreed standards, and assembly of components using unskilled labour, was therefore well established by 1878. It was reported at that time that

> 'Where the machine tool system of construction has been introduced in its entirety ... the several parts of (the) structural skeleton are so planed or otherwise shaped by accurate machine tools that, when the several parts are brought face to face for the first time, they fit each other exactly without adjustment ...' [Anderson, J. (1880) Vol.II p.296]

By the beginning of the 1900s it appears that interchangeable manufacture in the machine tool section had achieved almost universal acceptance among production engineers. Evidence from America confirms its incidence there:

> 'Thus the advantage to be gained ... by the use of up-to-date machines and special tools and fixtures are obvious, as the cost of the machines and the amount expended in the designing and constructing of special tools will be quickly balanced on the profit side when the increased output and the efficiency of the parts produced though their use are compared with the results under the old methods. Another advantage ... is the almost total elimination of the obtainable results depending upon the degree of skill and intelligence possessed by the workman; thus allowing of employing less expensive help in the manufacture of the required parts'. [Wordworth, J. W. (1905) p.513]

Another source has argued that by the end of the 19th century the development of assembly as distinct from fitting in the engineering workshop characterised more definitively the contrasts between the old and the new technology;

> 'In the new (technology), accuracy and interchangeability of dimensions are maintained by a suitable equipment of gauges and the establishment of limits; in the old, there is a variety of sizes depending upon the skill and judgement of individuals ... In the new method, machining is done accurately to dimensions; in the old, machine and tools are mainly used...'(Orcutt(1902).

Organized artisan resistance to work reorganization was gradually weakened by gradual dilution of craft skills, including fitting which had hitherto been difficult to rationalize to employers' satisfaction because of the varied nature of fitting skills. The process of craft decomposition was accelerated through the progressive application of automatic machine tool developments. The piece-work system of wage payment may be seen a a significant innovation introduced as part of an increase in the hegemony of the employers and to encourage the workers' acceptance of the implementation of the new tools and in order to widen the deployment of labourers on automatic machines against the skilled workers' resistance. In the next chapter I turn to an analysis of the piece-work system, and examine some of the implications for the employment of children.

2.8.0 Summary and Discussion

American, and increasingly English, 19th century engineering practice was reorganized through a combination of relatively highly developed automatic machine tools; and accurate controls over measurement through the metrological and machine tool innovations of entrepreneurs such as Whitworth, (and F.W.Taylor in America). In terms of control of the labour process the new technologies entailed different management strategies. Direct workshop supervision of unskilled labour was carried out by a small number of highly trained skilled workers. Overall, the nature of workshop management also moved from the machine shop and fitting shop to a separate location within the factory called the 'toolroom'.This ensured centralisation of control. An English engineer noted:

> '...(the) practice is to construct nachines so automatic in their nature that it has become possible to employ practically unskilled labour to a large extent, engaging at the same time highly skilled and thoroughly educated foremen and managers to superintend the setting and keeping in order of the automatic machines which can then be left in the hands of unskilled men, who can only command a low wage...'(Amos,E.C.p.274).

The base for this kind of control became increasingly centred on the 'toolroom'. This method of work control and supervision of labour was the benchmark of the system developed by F.W.Taylor in America. Taylor had this to say about management problems of labour control:

> 'The first duty which lay before...engineers was that of counteracting the blighting fallacy which rested upon every one of their workmen, and which was paralyzing their energies, that it was to the best interests of the workmen to go slow instead of going fast, to do as litle as possible for the money they were getting instead of as much as possible...'(Contribution to a Meeting of the I.Mech.E. in July 1910, in Proc.I.Mech.E. Vol 79,1910,p.1002].

Additional refinements such as multiplication of cutting tools with automatic feeding of the work made it possible for these machines to outstrip all competition in quantity and quality despite the fall in the number of skilled workers employed in the workshops.[HornerJ.G.op.cit., Benjamin(1906), Woodbury(1967),p.628]

The development and use of automatic machines, and the implementation of new levels of precision manufacture was characterised by a number of distinct features which can be related to employers' attitudes to the craft apprenticeship and training.

Increased production rates were clearly possible using unskilled labour, fostering a growing reluctance by employers to continue the apprenticeship scheme in its historic form. This tendency was further encouraged by the availability of undifferentiated labour, particularly children and young adults, combined with a new system of wage payment, the piece-work system

I believe the evidence also shows that, by and large, employers' control in the 19th century was never entirely complete, despite the highly significant contributions of pioneers like Maudslay, Whitworth, and Nasmyth. Control was limited by three factors: a) the mechanical and metallurgical limitations of machine cuting tools, a problem not adequately resolved for management in England until about 1903 with F.W.Taylor's major innovation of High Speed Steel.b) The organised resistance of unionised labour against indiscriminate labour substitution on machines.c) The limited craft capablities and endurance of unskilled and child labour. The next chapter examines a key strategy used by employers to counter artisan resistance and encourage intensified employment of children in a capacity other than apprentices: the piece-work system.

Note 1

A simple example will illustrate the kind of problem facing a centre lathe turner(i.e. not a turret lathe operator who had automatic features which eliminated calculations). The turner had to calculate which gears (of a given number of teeth) would be required to connect 'in train' to cut a given pitch of thread. Assuming the lathe had a lead-screw of 6 T.P.I. (threads per inch) to calculate the gears required to cut a thread of 3/32 in. pitch:-

$$\frac{\text{Pitch to be cut}}{\text{Pitch of leadscrew}} = \frac{\text{Number of teeth in driver}}{\text{Number of teeth in driver}} = \frac{3/32}{1/6}$$

(6 T.P.I. means 1/6 pitch)

$$= \frac{3/32}{1/6} = \frac{3 \times 6}{32 \times 1} = \frac{18}{32} = \frac{9}{16}$$ multiplying top and bottom by 5

$$= \frac{45}{80}$$ = 45-tooth gear driving directly an 80-toth wheel.

A range of gears, known as 'slip' wheels or 'change' gears available for each particular lathe as standard.

Fig. 1

Example of a Calculation Carried Out by a Machinist in Setting Up a Machine for Cutting a Screw Thread.

Note 2

Joseph Whitworth [1803-1887, Baronet, Mechanical Engineer, worked under Maudslay, Holtzappfel, Clement; President of Institution of Mechanical Engineers 1858: elected to Royal Society in 1857. (National Biographical Dictionary ...)] a leading figure in work in these areas for a large part of the nineteenth century.

Note 3

Nasmyth an influential engineering entrepreneur and employer of skilled labour at Patricroft near Manchester; he invented the steam hammer and made several modifications to many standard machine tools.

CHAPTER 3

THE TRANSITION OF APPRENTICES TO CHILD LABOUR: THE SIGNIFICANCE OF THE PIECE-WORK SYSTEM

3.0.0

Introduction

I have argued that one of the main advantages for employers of an expansion of automatic tools was manufacture according to principles of interchangeability. Large numbers of components could be made at one time, each within specified limits of tolerance and interchangeable as required. I cited the Small Arms industry as typifying this method of engineering production.

There were two important management assumptions concerning these methods of production in the 19th century. The first was that the method and rate at which specific detail components could be manufactured came under stricter employer control than had been previously possible, before standardisation of parts. Second, the sequence in which various machining and assembly operations were carried out was more systematically developed with less dependence upon skilled labour.

The increase in production rates based on the extension of automatic principles supports these assumptions. In the last quarter of the nineteenth century the demand for mass-production consumer goods such as bicycles and sewing machines stimulated research in techniques for accelerating production rates. [For example, by 1913 Britain exported 150,000 cycles, Germany 89,000; and the rest of the world none. The Singer Sewing Machine Company was producing 8,000 machines a week by 1885, reaching 13,000 per week at the turn of the century, with a U.K. workforce of 7,000: (Saul, pp.125, 160]

In this chapter, in order to point up its main characteristics, I make a detailed analysis of the piece-work system, which usually accompanied mass production with automatic machines. I take as a case study its operation under a leading engineering manufacturer of the period, Rowan and Co., employing a variation of the piece-work system, the Premium bonus system. This will be followed by an examination of the use

of the Contract Note as a means of controlling the limits of discretion exercised by machine workers.

An analysis of the attitude of employers and the response of the unions, and an examination the 'Piece-Master' or 'Butty' system is the subject of the next sub-section, followed by an analysis of the incidence of child labour in the engineering workshops.

My hypothesis is that the combination of automatic machines and a piece-work system of wage payment was a product of the employers' overall strategy in extending their control over the labour process. Because of its attraction for employers in the employment of children as cheap labour, piece-work particularly influenced employers' attitudes to technical training and education, which was given low priority, at best being 'tolerated' as a part-time system only.

3.1.0

The Piece-Work System of Wage Payment

The evidence I have examined suggests that the remodelling and reorganisation of significant centres of production engineering such as the Armstrong Whitworth Works, the Rowan Company, and the Enfield Armoury may have been instrumental in the adoption by English workshops of new high-production methods(Jefferys(1945). These methods, employing semi and automatic machine tools, had their English origins in the mid 1850's. The developments in machine technologies and new methods of measurement control also made it easier for employers to extend the system of payment 'by the piece'. That is, wages paid according to the number of components produced to a predetermined schedule. It served to justify increased child employment, in capacities other than as apprentices. A number of questions arise from these developments:

What was the rationale behind the employers early and persistent attempts to establish the piece-work system?
What was the effect on power relations in the workshops?
Were there any new mechanisms of social control associated with piece-work?
Does the evidence support the hypothesis that the piece-work system accelerated the decomposition of traditional trade practices?
In what ways did the system interpenetrate with the organization

and control of the labour process; and what particular effect did it exercise over young workers?

The American influence in the new wage system was marked and was clearly evident in a House of Commons report as early as 1853:

> "In the government and private enterprises of the United States, piecework when applicable is universally preferred to day-work, as this arrrangement yields the greater amount of work at the least possible cost to the employer ..."

This report strongly recommended acceptance of a piece work system in arms production. It gave three reasons for this recommendation:

a) Payment by the piece stimulated the economic interests of the workers, and encouraged the development of labour-saving devices

> "... that may occur to them as likely to increase the production of the machines they attend". [Ibid. P.]

b) Fewer supervisors were necessary as 'time-wasting' or inefficient work on the part of workers entailed loss of wages and 'no loss upon his employers'. c) Men paid by the piece could be held financially responsible for any work they may spoil through carelessness; particularly important with the manufacture of replicated parts,

> "... any workman who may be employed in some trifling operation on an article that is almost finished, by carelessness in looking after his machine may spoil and render useless a large number of parts on which a great deal of careful labour has been already bestowed". [Ibid. P.]

The recommendation by the 1853 Mission to America and its support for the adoption and extension of a kind of premium system of payment of wages seems to have been clearly related to the introduction of automatic tools. It is my view that the combination of automatic machines and a piece-work system of wage payment was crucial to the employers' overall strategy of extending their control of the labour process.

As the 1853 evidence suggested, variants of schemes for paying by the piece reputedly encouraged the economic interests of the workers and protected employer interests through a relatively simple expedient of sanctions and penalties attaching to the worker for components incorrectly manufactured or exceeding production times.

Payment for work by the piece was generally by 'time' or by 'money'. In the former, work was allocated on a 'floor-to-floor' time, in hours or days; the latter implied a set sum of money accredited for the job. [My

appendix 15 and tables 1,2,3 below provide data illustrating this system of production]. In both 'time' and 'money' systems the incentive for the worker was to cut machining and assembly times in order to increase bonus rates.

There was a self-correcting principle embodied in these schemes which ensured that faulty components manufactured in any part of a production sequence would be passed back by a 'receiving' worker to the preceding stage for correction. This procedure incurred a loss of bonus for the worker responsible and appears to have been a constant factor in piece-work systems throughout the latter half of the century. Engineering-employer Robinson, for example, in his evidence to the 1868 Royal Commission on Trade Unions, argued thus:

> Q."You are satisfied with the quality of work which is produced under the piece work system?"
> "Yes, and there is a check in this way. A smith, for instance, does his work by piece work, a turner or fitter comes after him, and if the piece of work is bad, it is sent back to the smith to be replaced without cost. The man in the after process is always ready enough to find fault with the man in the previous process if he has not done his work well". [R.C. on T.U. Report X, op. cit. Minutes of Evidence. Q.19090]

3.2.0.

Illustration of the Piece-Work System in Operation: The 'Premium'System'

Evidence from a prominent engineering employer and leading proponent of the system, R. J. Rowan (1901), shows that following its introduction into his works in 1898, his control over the labour process was not only simplified but the overall effect was 'revolutionary' in terms of work reorganization:

> "It has resulted in a largely increased output from the machines for the same labour cost ... To prevent any chance of scamping or bad work, a strict rule is enforced that if any part of work, however small, done under contract, is not right, the man loses his whole premium under the contract". Rowan (1901)p.898]

The advantages to the employer were cumulative, particularly regarding increased productivity of labour. In the period 1898 to 1903, the times taken by machinists on standard machining jobs had, on average, been reduced in the succeeding years by 20, 23, 31 and 37 per cent respectively. [Rowan (1903), p.218]. The method was generalised to fitting and assembly with equally satisfactory results:

> "Up to this point the system has been treated as applied to the machine shop, but it is equally applicable to the erecting and other departments ... if erectors are to actually lose money by the carelessness of a machine man, as they would on premium, they rebel, with the result that great care is taken by the men and foreman that work when it leaves the machine is correct". [Ibid. pp 219, 220]

The reorganisation of labour using Rowan's 'premium system' produced, a complete revolution in (the) shop". [Rowan (1901), p.884]. For example, on its introduction it was found that it began to show up discrepancies in the performance of certain machine tools; investigation led to the replacement of under-powered machines with heavier, more powerful tools, "... all along the line". [Ibid, p.887]

Rowan's production schedules show how these new working principles affected the rate at which work was produced. I show on the next page an example of three common types of machine work: Turning (lathe work); slotting (for making square or rectangular slots in metal); hole production (drilling and boring). I focus on these operations as being the most common workshop machine processes.

A typical workshop time schedule, using a premium system of payment:

Same Machines throughout

Description of Work	Time taken under old Time System Hours	Time taken on Introduction of Premium Bonus	Record Time taken Hours
1. Turning connecting rod. 1 off	43½	36	29
2. Slotting conn. rods 3 off	31	24½	20
3. Crank Webs (finishing holes) 1 off	7 2/3	5½	3½

TABLE 1

[Rowan (1901). Extracted to illustrate three different machining processes, turning, slotting, hole production, from Table 1, p.886]

In the application of this particular form of piecework the practical considerations were such that in no case were the operations carried under a premium contract of longer duration than 50 hours. [Rowan (1901) p.897] The system paid a premium of 50 per cent on the time saved. This principle is shown in a further example:

Part	Operation	Time in Hours Allowed	Taken	Saved	Rate of Wages per hr.	Workman's earnings
10-inch) cast) iron) pump)	) Boring) out	40	24	16	8d	24 hrs.at 8d. + 16/2 at 8d. = 21s.4

An Example of Earnings Under the Premium System

TABLE 2

Source: [Rowan (1901) p.898]

However there was a tendency for advantages to accrue to employers at a faster rate than wage increases earned by the piece worker.It will be noted that under the premium system there was a 40 per cent saving in machining time, and 33.3 per cent increase in workman's earnings. A second example illustrates this regressive tendency:

Taking the first machining operation from Table 1 above, turning connecting rod; assuming time allowed was 43½ hours, and machining completed in record time of 29¼ hours, at rate of 8d per hour, the rates become:

i) $\frac{\text{Time saved (hr)}}{\text{Time allowed(hr)}} = \frac{14\ 1/4}{43½} = 32\%$ saving of production time

ii) $\frac{\text{Premium Wages}}{\text{Normal Wages}} = \frac{½ \times 11 \times 8}{29\ 1/4 \times 8} = \frac{57}{234} = 24\ 1/3\%$ increase in wages

The second operation, slotting connecting rods, produces the following figures:

2. i) $\frac{\text{Time saved}}{\text{time allowed}} = \frac{11\ \text{hrs}}{31} = 35\%$ saving on machine time

ii) $\frac{\text{Premium wages}}{\text{normal wages}} = \frac{½ \times 11 \times 8}{248} = \frac{44}{248} = 17\%$ increase in wages

<u>Comparisons of Wages Earned and Production Increases under the Premium System</u>

<u>Table 3</u>

<u>Source: Rowan Ibid.</u>

The claims by management for the system may be summarized thus:

a) Largely increased output from the machines '... for the same labour cost'.

b) Increase in workmen's average wages of from 10 to 40 per cent.

c) The practically compulsory maintenance of their machines in '... the highest state of efficiency'.

d) Greatly increased interest of the men in their work, machines, and equipment, and a '... fair amount of co-operation in all the schemes for improving the factory'.

e) It has given the foreman a field for the choice of men they never had previously, resulting '... in the employment of only the best class of steady workmen'.

f) It has caused a change in the foremen's function from task-masters to providers of work and inspectors of that work. [Ibid. p.899]

3.3.0. Piece-Work: The Use of the Contract Note as a Form of Labour Control

On completion of a contract i.e. a specific job to be wholly or partially completed, a note (a standardised 'contract note' detailing operations to be carried out, with appropriate times, issued from a 'premium office') was checked-punched by the inspector. Either the inspector or the foreman of the department, thus certified that the job was done correctly and the full operation denoted on the card had been carried out. [Ibid. p.898]

Time allowed for any job was fixed by management; clearly curtailing one of the principal job characteristics of skilled labour. This time allowance was not restricted to actual machining of the work but also included all the time necessary to procure tools, set up machine and obtain material for doing the job. This was a critical condition, for setting-up or locating the work in a machine was an essential pre-condition for accurate machining. It was also time-consuming if the workpiece was irregular or heavy. [Rowan (1903) p.211]. Another employer ([Wigram (1893)], estimated that in his works

'... probably one-quarter to a fifth of the time of a machine is occupied in setting the work up on it". [R.C. on Labour, 3rd Report, 1893, minutes of Evidence Q.25767. (Wigram, of John Fowler, Engineers, Leeds)]

The imposition of a close time schedule directly influenced premium earnings in cases where the work to be machined was in any way irregular. This particular factor became more regulatory and exploitative when considering the condition that

"... the time taken on a job will include all working hours between the starting time of the job, and the starting time of the next job". [Rowan (1903) p.212]

The rate at which the work was set-up, and the accuracy and speed with which it was machined therefore interrelated with and determined bonus payments. Under the principles of the system adopted by Rowan, articles that turned out defective while being machined and condemned due to a flaw in the material resulted in loss of premium. [Ibid.

If completed components did not pass inspection, premium would be paid only if the work was made good within the time allowed. Considering the 'total-time' schedules referred to above, this imposed a significant restraint, for time used in correction would have had an effect on the time allowance for the next job.

A type of gang system also operated in this works and a time allowance was fixed for the complete job. If the total time taken by the squad was less than the time allowed, a premium was paid to each man in the squad. This premium had the same relation to the time wages (ordinary rate) for the job, as the time saved by the squad had to be time allowed. [Rowan (1903) p.213]

The operation of the system clearly shows a significant increase in the employers' control over the implementation of new technologies and highlights the articulation between technology and work.

3.3.1. The Practice of "Rate Fixing": A Variation on Job Control

A critical component of the system was 'Rate Fixing', the establishment of job time comparisons by management who used existing production data. When sufficient data had been gathered for a particular manufacturing process, a card bearing "lines" was prepared and given to each man working a machine, [Rowan (1903) p.215]. These were drawn up by the Rate-fixing Department, issued to the foreman, who gave them to the men. They were card devices for keeping checks on work progress; the card being designed to show as a quick reference, the daily progess of each man, workpiece, hours allowed and taken. The relevant data arranged in columns indicated machine number, time allowed for each, number of articles on "line" or in the batch, the times the workman had been working on the job to 10.30 a.m. on the date on the card, and finally the record time, i.e. the shortest time in which each job had been done previously. [Ibid. p214]

On completion of the job the worker handed his "lines" to the foreman who noted the time the work was completed and indicated if he was satisfied with the quality of the work. This was then handed to the Rate-fixing department and cost of the work and wages, including premium if earned, were calculated.

Using this system, oversight of individual workers by management in effect, became easier and, for management, more efficient. The use of gauges and similar instruments, developed by Whitworth were significant in controlling finished sizes. A new principle of 'work control' was available to employers with the introduction of the system of gauges developed by Whitworth:

> 'If the operative has a standard article beside him, from time to time, he can apply his gauges, and see what the progress of the work going on is, and he may detect anything is wrong at a very early period. [S.C. on Small Arms, (1854) Q.1569]

The increased control by management in penalising 'inefficient' workers derived directly from these new production principles. As early as the 1860s employers therefore recognized and generally welcomed the control elements associated with the piece-work system:

> "... piece work is the fairest mode of securing the payment of a workman, in proportion to his skill and industry, since in our business it is easier to watch the quality of work produced than to watch the efforts of every workman in the establishment ... the

profitable result ... depends upon the amount of exertion used in executing the work". [Robinson, J. (1868) p.55]

The evidence suggests that the economic and labour-management strategies of some leading engineering employers in the second half of the century were a product of the innovation and control of new production technologies and, the use of a wage system involving payment by the piece. They were also a major source of contention in engineering employer-employee relations in the 1850s and 1860s. [Allen, W. (1861) Q.841]

3.4.0. Employers' and Unions' Views on the Piece-Work System

A.S.E. secretary, W. Allen argued that as a general rule, piece-work was inferior, contributed to the degrading of skilled labour and 'injured the trade'. Work rates essential to the piece-work mode were determined by employers based on the work patterns of an expert workman, a procedure that proved less beneficial to the ordinary machine worker because the rates were commensurate with high skill:

> "The wages of piece work are generally settled by an expert workman; that is employers generally give a piece of new machinery or whatever they want doing into the hands of an expert workman, so that if he gets what may be considered a fair wage, those who are not such good hands come down to almost a starvation price ... there have been instances in which a workman has been obliged to go with less than his ordinary wages would be ... so we endeavour to destroy the system wherever we possibly can". [R.C. on T.U. 1st Report, 1867, op. cit. Qs. 674, 675, 698]

The A.S.E. therefore resisted piece-work principally on account of its exploitative character, and the divisive nature of its operation in the workshops:

> "... piece work (even in its best features) is without doubt the worst evil we have to contend against, for under the most favourable conditions it is utterly selfish in its operation, and is calculated to set man against man, by tending to benefit those most opposed to our Society ... the Conference cannot too strongly condemn the system; further we recommend the members generally to use their utmost infuence in putting an end to piece work ..." [Allen, W. (1872) p.15] [Extract from Resolution (passed unanimously) at the Manchester Conference of the A.S.E., 24th July 1872].

This was a challenge to the employers over piece work, at least as the system was articulated by a prominent employer, Robinson at the 1868 Royal Commission on Trades Unions. The piece-work system was regarded by

the unions as a management strategy to dilute craft skills in engineering workshops, leading to the decomposition of the labour process which historically had at its centre the autonomy of the skilled worker. The employers on the other hand favoured the system on the grounds of its 'normalising' effects in terms of providing work opportunities for different grades of skill. Robinson said,

> "... the abolition of piece work I look upon as another mode of keeping down the skilled and industrious workman to the level of the idle, incompetent, and careless one, since a good man working by the piece simply earns a higher amount of wages in a week than an indifferent man, and in exact proportion to his ability and industry, but if hindered from doing so his employer as well as himself is prevented from reaping the advantage of his superior skill, and so from producing the work as the lowest possible price". [Robinson (1868) p.56]

This evidence exemplifies the nature of production policy advocated by employers, against worker resistance throughout the second half of the 19th century. Melling(1983) has argued that

> '...(premium) bonus was pursued by employers...(for)...rigorous supervision was far more popular with them than improved working conditions...'(p.67).

Captain A. Noble (1893) as vice-chairman and managing director of Sir Wm. Armstrong & Co. (Newcastle-upon-Tyne), provides a contemporary perspective of this view towards the end of the century. He maintained that piece-work generated higher rates of pay, and accordingly, differentiated workers according to ability. He also asserted,

> "If you have a large piece of work put in a large machine, the foreman knows the rate at which the machine should go, and ... he can ascertain without much trouble whether the proper amount of work is done or not ..."

He also maintained that where precise labour control was not possible, piece work still remained viable, as a means of: "... knowing that you are getting a proper amount of work out of the men employed". [Noble (1893) Q.25207]

The significance here is that the direction of the manufacturing process under this method of work control was centred on the foreman or leading hand, not the artisan machinist. To quote Melling(1983) again on the increasing strategic importance of foremen,

> '...it is clear that Victorian foremen were pivotal figures in many of the staple industries. Their status often depended upon the degree of technical knowledge required, with craft trades selecting supervisors on the basis of superior expertise and creative imagination...'(p.1910).

The rate and quality of production was therefore, to a large extent, determined by the foreman's ability to calculate and determine the method of production and also to fix cutting and feed rates.

This clearly affected 'floor-to-floor' times, i.e. complete machining practice including 'setting-up' and the subsequent machine work. The implication of this technical input from foremen was that the machinist could be reduced to machine tending; a break with traditional practice. A recent view by Littler (1978) in his commentary on the American system of 'scientific management',Taylorism, put it like this:

> '... (Taylorism) represents the historical switch-over from traditional effort-norms to the creation of new social mechanisms for constituting effort-standards". [Littler, p.198]

The key to the understanding of the piece-work system is that it was realisable only under certain conditions of machine and authority control. The essence of this control was direction of workers by foremen, through the use of reliable machine tools of predictable performance, and standardised quality control methods. This kind of organisation has been characterised in another recent commentary as a means of consolidating the authority structure of the workplace:

> '... capitalism (uses) the new 'technical basis' offered by the passage from the preceding stage to that of high mechanisation (and automation) in order to perpetuate and consolidate the authoritarian structure of factory organisation". [Panzieri (1980) p.52].

But some 19th century employers regarded the social relations of production under this kind of organisation as limiting and contradictory: This is brought out in this reference to a group system of working:

> '... individual piece work I think is very bad. Dick has a piece of work set him, and he does not care a bit what Tom and Harry are doing, and he will break his tools to get his piece through. There is ... constant fighting ... whereas if you make the whole responsible, each one produces more than if he had not been working himself alone". Hills, A. F. (1893)

An employer tactic designed to overcome this kind of objection was the encouragement of the Piece-Master or "Butty System".

3.5.0.

The Piece-Master System or "Butty System"

Labour control under the piece-master system is significant for my analysis as I believe the evidence shows that, as with foremen generally in the engineering industry, those controlling piece-work schedules were emerging as an influential group within the changing social relations of production. Later in the century, for example, foremen became key figures in deciding whether boys could be released early from work in order to attend evening classes.The part-time day release system was a tediously slow feature in the development of technical education and then only after the turn of the century. I provide a more detailed analysis of this particular aspect of work organization in chapters 7 and 9.

At this juncture I hypothesize that the structure of technical education was to become increasingly tied in with the prevailing work patterns. The majority of students attended evening classes and were heavily dependent upon the goodwill of their immediate supervisors, the foremen, for release from work. Burgess(1986) argues, with reference to the Great Strike of 1897, that the ASE's claim that its members were responsible for training workmen, was rejected outright by the employers on the grounds that this function was 'the responsibilty of foremen...'(p.224).

The tactic of group or 'gang' working provided an important variant of the piece work model, the "Butty" or piece-master system, and illustrates how young workers could be closely integrated into dominant work patterns.

The piece-master system entailed a specific job organisation in which a gang of skilled men, labourers, and boys worked under the direct control of a skilled artisan foreman, the 'piece-master'. In a large factory there might be up to five such gangs each under their respective piece-master.

Three features may be noted about this system. The first was the control of the wage bill through labour substitution within the gang, boys or labourers replacing skilled men; a policy under the direct control of the piece-master. [Jefferys, M. & J.B. (1947) p.45] Whilst in the majority of cases the piece-master had no right of hiring and firing or responsibility for payment of his 'gang', they did use their influence with employers to keep wages down. [Ibid.] Evidence from the Children's

Commission suggests that a system approximating to the "Butty" method did, in fact, operate covertly in some instances, and, in others with employer connivance (see below 3.6.0.).

Second, there was a tendency for piece-masters to 'drive on' the men, for bonuses were gained for working within prescribed limits.

The third, concerned the payment of such bonuses. This process known as "settling" concerned the sharing out of bonuses and inevitably involved decisions by the piece-master as to the relative worth of the contribution of different members of the gang.

Considerable criticism, focusing on these main concerns, was generated against the piece-master system. The A.S.E. criticized the unfair distribution of accrued bonuses; workers were frequently in debt to their employers as a result of not meeting production schedules; wages generally were brought down by the process, to the lowest possible point. [Allen, W. (1867) Q.675]

This view was supported much later by one employer who considered the gang system very undesirable. The comments in this particular critique crystallise the more generalised criticisms of the system.

> 'I found that the men were grinding each other; sweating each other ... when the balance was paid (over and above the flat rate) we paid it to the leading hand of the gang, and we left him to divide amongst his mates; we found he did not divide amongst his mates ..." [Wigram (1893)R.C. on Labour, Q.25740]

The incidence of the 'Butty' system tended to be disguised by its generally uneven distribution throughout the industry. But two sections of the industry were prominent, railway workshops specialising in wheel and axle turning jobs; and arms manufacture particularly in the arsenals at Woolwich, Enfield and the W. G. Armstrong's workshops in Newcastle. These government establishments employed relatively high levels of piece work; the former at 60% and the latter, 'a very high proportion'. [Jefferys, M. & J. B. (1947) p.39]

In Coventry, working by the piece was practically unknown in 1861; by 1891 83% of A.S.E. members were working by the piece. During the same period in the West Midlands and the eastern counties there were 30% and 36% increases in the practice, respectively. [Ibid. p.43]

Although sporadic the piece-master system was increasingly used throughout the century and the evidence shows there was systematic use of children within it. I turn now briefly to the employment of children because it seems to me to highlight how new social mechanisms of control

were reflected in the employers' attitudes to children as a form of cheap labour rather than as young workers under training.

I take a number of illustrations of children in engineering as case studies. The source of this evidence is the Children's Employment Commission of 1864.

3.6.0 The Use of Child Labour in the Workshops

A screw bolt works, in Darlaston employed 35 women and girls, and 26 boys in the works. The boys were from nine years of age upwards and were principally employed at 6d to 10d a day from 6 a.m. to 6 p.m. as 'blowers' (operating heating systems for making metal red hot). The lowest earnings the girls received was 3/- per week and it was suggested that any amendment to the existing Factory Act would seriously affect their earnings as,

> 'They work piece-work, and one girl can earn twice as much as another in the same time". [Parliamentary Papers, Vol.XXII, 1864, Children's Employment Commission, Third Report, Appendix and Evidence, 1864, p.24 (Evidence of F. N. Cotterill of Cotterill's Screw Bolt Works)]

A machine-maker of relatively larger capacity employing 563 workers, included 13 boys under 13 years of age, 110 boys between 13 and 18 years of age, and 3 girls under thirteen. The large number of young people present in the works was accounted for by the owner as a consequence of a strike in the foundry; the result of which evidently entailed the sacking of men and the employment of boys as substitute labour. They were paid by the piece, through the men,

> '... in all cases in fact, where we can get a fair measurement of the work produced". [Ibid. p.182.. Evidence of John Hetherington]

Another screw bolt works worked machinery non-stop from 6.30 a.m. to 6.30 p.m. All the men and women were on piece work, the youngest girls received 2/6d. per week, the others 3/- and 4/-. It is clear some of the children were at risk on the machines.

> 'In one case ... a girl had her arm broken ... (she) let it throw the bolt out before she ought to have done, and the bolt hit her arm. Another girl had her wrist put out in the same way". [Ibid. p.24 Evidence of George Noreton, Manager of Horton's Screw Bolt Manufactory, Darlaston]

Responsibility for hiring and firing sometimes rested with adult workers rather than management; this required the building up of a team or gang, usually children, often workers' own children.

> 'Three-quarters of the feeders are girls and young women. They were hired and paid by the fitter". [Ibid. p.24. Evidence of W. Elkington, Manager of The Crown Nail Company, Volverhampton].

Littler (1978) focused on this kind of labour control in his critical essay on Taylorism

> '... management control in many industries was based on some form of internal contractor, who in large part ran the shop floor'. [Littler, Craig ...]

It seems that some firms which had set limits to child employment but tolerated informal hiring procedures, a strategy that enabled management to benefit from their labour:

> '... no boy under 14 had any business there at all; all that were below that age had been 'smuggled in' by the parents or overlookers. Whatever their age and length of service, they were not recognised as having any position in the place, and were put on the footing of an apprentice till they were 15, that is, would receive only 3/- a week, the wages of an apprentice at 14 ..." [Ibid. p.87. foreman at Messrs. Walker & Hackney, Bury]

The children were evidently conscious at times of the effect of this type of employment on their own, and others', health.

> 'Am 14 years old, have been here 17 months working at grinding iron; began that work at 10 years old ... the dust makes my chest bad at times. Father used to grind here too; he died of it; he was 35 when he died ..." [Ibid. p.183, Nathaniel Shaw, of John Hetherington & Sons, Machine-Makers, Manchester]

3.6.1.

Children Employed in Work Teams

A common work practice known as 'integrated work processes' in which boys worked as a member of a team with adult workers, placed further constraints on some children. Analysis of this method of working suggests that release before completion of a 12-hour shift for education or training was discouraged and likely to be a hindrance to employers:

> 'It was thought that a limitation of the labour of the young persons under 18 to 10½ hours a day would not work well, for the men would be at a standstill, when, as was very common, they worked on for 12 hours, if the boys did not work equally long to keep them supplied with the articles they wanted. Such a restriction would involve an increase of tools, of room and of young persons to one-fifth beyond the present state of things, and would thereby be extremely distasteful to the adults ..." [Ibid. p.187, Mr. Walker of Walker & Hackney, Bury]

Evidence also shows that wage incentives encouraged children to remain in repetitive, low-status jobs. A machine manufacturer in Lancashire employed 44 boys under 13 years, and 354 between 13 and 18 years. Some of the 15 year olds were employed in the glazing and grinding shed

> '... that is unhealthy work, but not nearly so bad as the cutlery grinding in Sheffield; still for the reason of its unhealthiness, they are the best paid of any Superintended by one man to six boys; their wages 6/- per week on average. All paid by the piece, and we settle every seven weeks with them". [Ibid. p.184 W. Madeley, Partner in Messrs. Parr, Curtis and Madeley]. Others were machine minders."

Any form of 'part-time' release, i.e. being allowed off early, was subordinated to work schedules, as this evidence shows. A concession to 'education' was effected by certain firms, one of which allowed half of its under 13 years old to leave in time to go to night school. But this could have been a problem for the children, for the hours worked normally were 57½ hours in the week, from 6 a.m. to 6 p.m. on four days, and on Mondays from 7 a.m. to 5.30 p.m., with occasional overtime of two hours four days in the week. Any suggestion of limitation of work to 10½ hours in the day was perceived by the foremen and adult workers as fragmenting for '... men and youths work in sets, and the work of one is dependent on that of the other". [loc. cit.]

It is clear that the concept of machine tending by unskilled workers and boys was well established by the 1860's and became generalised practice in a wide range of engineering and engineering-related firms. Among the largest, substitution of juvenile labour for artisans' work was related to machine tending and piece work.

> '... by far the greater part of what may be called the preparing work, - drilling, planing, slotting, and turning, and the like, - is done by lads under 18." [Ibid/ I/156 (Evidence of Mr. Palmer, partner in Messrs. Platt, Brothers & Co., Oldham, employing a total of 4471, including 115 under 13 years, and 778 13 years to 18 years)]

Boys were paid about 3/6 per week at 11 years, but the preferred age at the Platt Works was 12 years, after which they are put to drilling and turning; <u>'none are apprenticed'</u> [loc. cit][my emphasis]. The need for overtime working was obviated by two factors at Platt's: a recent completion of the extension of factory space for which extra hands were always available 'for a pressure'; and piece work which provided sufficient incentive for children to make '... as much in 10½ hours, as they do when they know they have two hours longer". [loc. cit.]

Breaks in a production run precluded payment by the piece and other work strategies were employed. For example, in a firm such as Messrs. Iver and Hall in Bury, if a particular job was difficult to cost under a piece-rate, they favoured overtime work. Normal hours were 6 a.m. to 6 p.m., extended to 8 p.m. 'when times are good', and occasionally till 9 p.m. or 10 p.m.; and at times 'all night'

This firm was not concerned to investigate the age of children employed,

> '... if a boy looks from his appearance up to the work the foreman lets him come on;" [Ibid. p.187]

It employed 40 children under 18 years, 13 under 13 years, one between 10 and 11, and one under ten. Starting at 2/3d a week, those that were

> '... at all sharp get promoted to the machine room, and become screwers, drillers, turners, and so on". [loc. cit.]

The largest railway carriage makers in the country, the Ashbury Railway Carriage and Iron Company, employed 1367 workers, 23 under 13 years of age, and 149 between 13 years and 18 years of age. The youngest boys were employed as errand boys and the 'brightest were promoted' to drilling machines at about 13 at a wage of 6/- per week, paid by the piece in common with 'nearly all (the) hands' [Ibid. pp. 191, 192 (Johnson of the Ashbury Railway Carriage and Iron Company, Openshaw, Lancs.)] Some of those aged 12 assisted in the foundry at 4/6d per week; whilst in the trimming department girls were employed at about 4/- per week. About 45 boys were operating machines such as lathes and screw-bolt making:

> "Am 12. What I am at is 'tapping' (putting the screw in an iron nut with this machine). Have been here three years; was 'pulling out' for one year at a furnace on the other side there. Went to day-school for a year, before I came to work here. Go to Sunday-school now. Can't read ..." [Ibid. p.192. Evidence of John MacEwen (to investigator H. W. Lord)]

Pressure for orders often meant working long hours particularly in the wheel and axle department,

> '... we are celebrated for wheels and axles;" sometimes involving day and night turns of 12 hours for as much as... 10 months out of the last 12". [Johnson Ibid.]

Boys of ten were not exempt:

> "Am 13. Have been here two years in the smithy; before that was working at rope walk. Went to that at 10 years old; used to work there from 6 a.m. till dark, that was till 8 and nearly 9 sometimes in summer. Have never been to day-school. Go to Sunday-school, but

don't read; they read to us there; I don't know what it's about". [loc. cit. Evidence of James Alcock]

The generalised practice of employment of child labour, particularly on machine tending, did not seem to have been a singular focus of attention for the A.S.E. But as a component of the piece-work system it was clearly perceived as an element of exploitation. There was a resistance to payment by the piece, and systems based on pre-scheduled production times.

The employers' views were based on the notion that rigid demarcation in job practices based on skill differentials hampered production efficiency. The employment of 'unskilled' workers, such as children, on machines, paralleled the use of the piece-work system of payment. The evidence shows that in deploying self-acting machines, employers stressed the simplicity of operation of such machines, and the logic of employing marginally skilled labour to man them. The unions challenged these assumptions.

The substitution of skilled machinists by unskilled workers in machine manning, and the operation of more than one machine tool by a single operator as demonstrated by employers Whitworth (1854) and Nasmyth (1868) seems from the evidence to have been a form of increasing intensification of labour and a category of labour exploitation. This factor in the social relations of production became a particular focus of dispute between engineering employers and skilled labour during the period fromthe 1850 [Allen, W. (1967) Q.841]

An example of the kind of reaction to the practice of intensification of labour came from A.S.E. Secretary, Willian Allen's testimony to the Royal Commission on Trades Unions in 1867. He argued that machine shops and tool-making establishments were particularly vulnerable to the effects of employment of unskilled labour vis a vis skilled machinists,

'... there are a large number of boys employed, and in some instances they (employers) have introduced boys to what we think an alarming extent, and result is that the men have objected to it". [Allen, W. (1867) Q.846]

Allen also referred to a diffentiating grade of machine tool operator that marked off the traditionally trained machine artisan from unskilled operatives, who were known as 'machine men' ('machine minders'). They were regarded by the Society (A.S.E.) as labourers because they

'... were not in receipt of what we call ordinary rates of wages ... and members must be in receipt of the ordinary rate of wages". [Allen, J. (1867) Q.895]

3.7.0. Summary and Discussion.

I believe the evidence points to a relatively widespread practice of the piece-work system, although its incidence throughout the industry was uncoordinated and piecemeal. The employers who used the system in well organized structures clearly gained both in terms of productivity and marginal cost of labour.

The introduction of accurate, automated tools with sophisticated means of measurement control, simplified many production processes to the extent that children could be employed more systematically. The unions' objection to this was not motivated by humanitarian concerns for factory children, but revolved around two factors: the intensification of existing labour with increasing use of child labour, and the accompanying decomposition of machinists' skills.

New mechanisms of control were available to employers; one was built into the system of piece-work itself. The self-correcting checks on workers in serial production was significant not only for quality control, but it also clearly simplified labour control. Variations on the basic principle of piece-work, such as the 'piece master' or 'Butty' system tended to consolidate the exploitative aspects of work control, particularly for children working within 'integrated working processes'.

I have suggested that the implications for children of working under the piece-work system were twofold: Firstly, other than marginally elevated wages, the system militated against young workers gaining any realistic advantages either in terms of work or education. Secondly, tied in to a 'production by the piece' system, it was increasingly difficult for individual workers to break the pattern of production by seeking access to education requiring time off work. In the next section of the thesis I shall elaborate on this and put the case that young workers' access to technical education, based predominantly on a part-time principle, was critically influenced by the employers' pursuit of short-term profits. Employers were reluctant to forego the contribution of young workers integrated into a work pattern designed to depress costs.

Underlying productive processes such as the piece work system was the continuing conflict stimulated by the employers' attempts to redefine engineering craft skills against the resistance of the artisans' union, intent on revitalizing the apprenticeship system.

These issues warrant further analysis of the craft apprenticeship system and its decline throughout the century. This will be taken up in the next section. The section begins with an analysis of labour process theories in order to explore the contribution they might offer in illuminating the interrelation between industrial and educational change.

SECTION 2

CONTROL OF THE LABOUR PROCESS AND TECHNICAL EDUCATION

Introduction

My focus in this thesis, engineering employers, as principal buyers of labour power, were concerned in a number of ways with the processes by which labour power was reproduced. (I use 'labour power' in the sense that it was a capacity to work for a given period of time, and it was this potential for work which was 'bought' by the employer, and 'sold' by the worker). I believe the evidence also shows that a primary concern of employers thoughout this period was maintaining current production needs and not planning future skilled labour requirements. Time allocated to production was considered crucial by employers and other considerations, among them education for young workers, were secondary to the maintenance of production [Nasmyth(1856), Robinson(1868), Royal Commision (1909). Therefore my view is that any explanation of the emergence of and changes in technical education has to take into account the interests and purposes of those who controlled 'technical labour power' for a great part of the time.

I aim to show that the principle of part-time technical education became firmly established in the 19th century for ideological reasons, based on the employers' uncompromising insistence on young workers doing a full working week to meet the demands of production.

In this I am at variance with a writer such as Floud(1985) who argues that the part-time system of technical education offered a means of vertical mobility for the workers in Victorian Britain, and it was

> '...an essential ingredient in the British approach to (technical education)...which had to base its appeal on personal motivation...(of)...those employees who were anxious to improve themselves...(that) technical schools were a successful means...of obtaining promotion or higher wages is clear from the Report of the Royal Commission on Techncal Instruction in 1884...'(p.92).

The fact that the part-time system was subject to constant criticism because of its heavy demands on young workers, even from its inception, is alluded to but not developed by Floud. As late as 1935, the Association of Teachers in Technical Institutes (ATTI) was pressing the

Board of Education to make even the part-time element of technical education compulsory; a policy that had still not been implemented by 1983 [(C.A.and P.L.R.Horn(1983)]. On the persistence and prevalence of the part-time principle, Stephens and Roderick(1982) have also argued,

> 'Firms were not interested in the education of their employees, and the few firms involved were only interested in part-time evening instruction...'(p.25)

I have shown in my previous chapters that changes in the organization of work were part of a set of labour control strategies which included the substitution of unskilled labour on jobs traditionally carried out by artisans. My examination of the skilled workers' resistance to work reorganization, based on substitution, shows that the ensuing conflicts centred mainly on the apprenticeship issue which was also related to the artisans' demands for some form of technical education.

My hypothesis is this. After their defeat in the strike of 1852, artisans in the mechanical engineering industry were concerned with the way the deployment of new technologies was being initiated; they perceived it as accelerating the process of substitution. At the same time as introducing new technologies, most engineering employers manifested a declining interest in maintaining the traditional mode of craft training and education, without proposing any substantive alternative model to replace it. The employers' interest and influence extended beyond changing the configuration of the labour process by radically modifying the conditions governing the apprenticeship pattern of training. Not only did they resist the claims made by artisans for a retention of their status as skilled, autonomous workers based on the traditional apprenticeship, but they also resisted any notion of a technical education system which they perceived to be discordant with the pattern of production structured on the employment of unskilled labour, working automated machines.

Artisan demands for a retention of the apprenticeship system and continued recognition of their status as skilled artisans were articulated as part of a set of ideas on education being developed by them. The precedence for working class interest in education other than as a 'provided' system, may be traced to the Sunday School system going back to the previous century (Lacqueur(1976),Joyce(1977). In this respect I include examination of some of the artisans' first formal initiatives in a parallel development, the Artisans' Insititute as an off-shoot of the Workingmen's Club and Institute Union. This examination also seeks to

show that these kinds of initiatives embodied tensions and contradictions because, a) the skilled workers insisted on negotiating independently of unskilled workers in any discussions with employers. b) Artisans sought active support from certain public figures from the employer-class, such as Lord Elcho(Lord Weymss), and scientists such as Lyon Playfair and Thomas Huxley. I believe that both of these influences acted against the long-term interests of the artisans and the apprenticeship system as a form of technical education. It was to the employers' advantage to encourage unskilled workers to man new machines; and clearly the employment of unskilled workers suited the emerging ideology of production.

My exploration of the attitudes of the skilled workers on these issues includes analysis of workers' proposals advanced from the first Congress in 1868; at this inaugural conference a motion was passed calling for a system of technical education to be set up and that the apprenticeship system be recognized as central to any such technical education scheme[TUC Congress 1868 (Microfilm)].

I begin this section with chapter 4, an analysis of Labour Process theories and the interaction of work and technology.

CHAPTER 4

LABOUR PROCESS THEORIES AND THE INTERACTION OF WORK AND TECHNOLOGY

4.0.0

Introduction

In this chapter I examine sociological accounts chiefly concerned with analysis of the labour process, and, within it, the issues of labour control. They are significant for my purposes for they have inserted, within a broad framework of industrial processes, analyses of such issues as job fragmentation, homogenisation of labour, and the effects on labour of increasing mechanisation.

I thus turn to this literature, first to see how analyses of the transformation of factory work highlighted in it may illuminate an understanding of changes in the use of machine technologies in the 19th mechanical engineering industry. Second, I explore how these accounts may provide a basis for tracing a link between industrial change and the origin and development of technical education.

Whilst they do not necessarily provide explanations of the interpenetration of control within the labour process and 19th century technical education; unlike histories of technical education and historical accounts of technology, they do stress conflicts within the labour process and the relation between technological development and labour control.

They have focused, with varying degrees of emphasis, on the nature of changes in the definition and use of skilled labour, the increasing domination of managerial control,and the transformation of work. (Braverman(1974), Marglin(1976),Friedman(1977), Berg(1979, 1982),Lee(1979),Zimbalist(1979),Whalley(1986),Wood(1988).

I shall examine three broad areas:

First, more general accounts of industrial management. Although not providing theories within a labour process framework, they are a significant part of the orthodoxy in the field of mangement and organisation studies. The main writers in this tradition are Woodward(1965),Blauner(1973),Kerr et al(9173).

Of the labour process theorists, Braverman(1974) has provided significant contributions to the debates on changing concepts of skill, job fragmentation, and work reorganisation. My second area is an examination of his work, and the critiques that his theories have generated.

Thirdly, I analyse accounts which focus more or less directly on technical education.

4.1.0.

Work Organization, Labour and Technology: Some Early Significant Theories

The achievement of the work of writers such as Woodward(1965), Blauner(1973), Kerr and Dunlop et al(1973) during the 1960s and 1970s has been to put organization and technology 'on the agenda' in their attempts to explain the nature of the relation between technology and organizational change.

Woodward(1965) focuses on the relations between technology and management organization. Her main thesis is that management varied its style and method of formal work organization in accordance with available technology. As technology became more complex and sophisticated the chain of organizational command tended to increase,

> '...in firms where large batch production had been superseded by continuous flow production, the command hiearchy had lengthened, and the span of control of the chief executive had widened, and the ratio of managers and supervisors to total personnel had increased...'(p.73).

The main thrust of her argument is that technology is a pre-determining factor in industrial change(p.75). She characterizes the development of technology on a typology from unit and small batch production, large batch and mass production, through to process production(p.39).

Blauner(1973) adopts a similar perspective and asserts that there is a tendency for technology to 'evolve' from 'single-piece' production as in specialized, highly skilled, work to 'continuous process' type of the kind found in the chemical industries. In relating work to technology he maintains that this evolution leads to a reduction in worker alienation.

Like Woodward he advances the view that technology is a determining factor in industrial change:

> '...technical changes involving changes in the production system were followed by a fundamental organizational change..'(p.72).

According to this view the imperatives of technological change dominate the productive process, as Blauner(1973(put it,

> '...employers and their organizations are relatively uninfluential...'(p.10).

The problem for me is that both of these writers present a limited analysis, constrained by their use of an historicist model of technology. The studies assume an autonomous development of technology, i.e. technology independent of other social and cultural forces. Such a model of technology resides in a consensual framework grounded in normative integration:

> '...technology more than any other factor determines the nature of job tasks...skill distribution...and normative integration...'(Blauner,p.8).

Thus for Blauner, technology has significant functional properties; for normative integration is defined as 'consensus between the workforce and management...'(p.25).

The functional perspective is to be found in Woodward who argued earlier that the industrial enterprise is,

> 'a small but complete society of individuals bound together into a functioning team...'(p.74).

The unifying characteristics of technology emerge in the work of Kerr et al(1973). A convergence model is put forward, in which it is argued, industrialization develops 'consensus whenever (it) is successful...'(p.266).

Industrial organization is also assumed to be integrative, breaking down differentiation:

> '...(occupation) takes the place of class...(with) no really clear-cut dividing lines visible to all...'(p.266).

In addition to the uncritical acceptance of an evolutionary model of technolgy, it seems to me these theories rest too readily on the assumption of the workers' passive acceptance of the authority structure of industry:

> 'An industrial labour force...must conform to a pace of work established by the dictates of new masters rather than their own inclinations or traditional standards.'(Kerr et al p.172).

The overall perspective seems to exemplify consensual models in which the potential for conflict associated with the reorganization of work seems to be unrecognized and thus remains unexamined. There is also the assumption of a link with a particular ideology of education; for example, basic literacy for workers is necessary,

> '...to enable the bulk of the population to become literate enough to receive information (and) follow instructions...'(Kerr et al,p.267).

4.2.0

Alternative Models of Work-Technology Interaction

There are few studies which critically question the assumed linear development of technolgy and its operation within a consensual framework of technical change. Two studies which articulate the potential for conflict, not found in consensual theories, are Roe Smith(1977) and Berg(1979,1982).

Roe Smith, in an American study, examines the response of skilled workers to work restructuring at Harper's Ferry Arsenal. He argues

> 'Because the element of individuality loomed so large in their lives (artisans) prtoved to be a fiercely independent breed who baulked at any attempt to regulate, systematize, or depersonalize accustomed work procedues at the armory'(p.334).

Berg(1979) holds that new management strategies of control often met worker resistance and thus technological innovations embodied control strategies designed to overcome skilled workers' reluctance to forfeit their autonomy:

> '...technical strategies (were) designed to allow industries to escape the grip of ambitious and highly skilled workers... these technical changes were often accompanied by new management strategies.'(p.13).

These latter studies are significant for me in so far as they acknowledge the potential for conflict in industrial change, and unlike consensual models, avoid a deterministic model of technical change. Technology is not seen as an independent and integrative force but located as part of a specific set of social relations, often characterized by conflict between employers and workers rather than a functioning equilibrium. As Berg(1982) expressed it, organizational changes early in the 19th century were met by 'rising working class militancy'(p.5.). With reference to the 'labour aristocrats', she argues,

> 'Although accorded distinct status by industrialists and middle class reformers...(the aristocrat) was still subject to the discipline of the labour force(p.217).

These views contrast with more orthodox models such as Woodward, Blauner, Kerr et al, in which technology is presented in an unproblematic way with highly circumscribed views of the conflictual nature of much technological change.

Figuring prominently in consensual accounts is the notion of technology as a prime determinant in the organization of work and industrial change. This view is carried over in more recent studies in industrial sociology. I quote Hirszowicz(1981) as an illustration of this kind of approach:

> 'it is clear...that the nature of workers' tasks is moulded by technological development; the division between machines and aggregates of machines is the decisive factor in shaping human work, structuring social relations and affecting the whole rhythm of individual life...'(p.30).

It seems to me there are two parallel and questionable assumptions in many studies, exemplified by those I have referred to here. The first relates to the prime determinancy given to technological change. Second is the assumption that labour responds passively to the imperatives of technology, which is said to embody its own logic. Blauner(1973), for example, writes of the workers' 'powerlessness, meaninglessness, and self-estrangement...'(p.15,34).

The orthodoxy in these kinds of studies appears to accept at face value a linear develolpment of technology and worker compliance, as an inevitable consequence of increasing mechanization. The crucial significance and influence of employers who controlled and deployed particular types of technologies as part of a wider control of the total labour process is underestimated. This approach seems to follow from a shared perception of technology as an independent variable.

I now turn to accounts which see the processes of industrial change more in terms of employer control over the labour process. These are embodied in the debates concerning the labour process theories.

4.3.0

The Centrality of Work in the Labour Process: Braverman and the Issue of De-Skilling.

A number of studies have focused on the centrality of work in the labour process, and its reorganization which paralleled changing technological imperatives. Highly significant among these has been Braverman(1974). Thompson(1983) says,

> '(Braverman's) analysis played such a pivotal role in later debates because he combined a renewal of Marx's categories with an explanation of the dominant trends in the world of work...'(p.67).

Empirically limited to the American situation Braverman, however, provides a useful focus for my study because one of his main arguments stresses that under a capitalist system of production there is a tendency for labour to be displaced in those occupations where technological progress is most rapid. The mechanical engineering industry in England from the 1850s was characterized by rapid technical and social change, and labour substitution was a key feature of the conflicts between management and labour.

Braverman's argument puts machinery at the centre of such a process:

> '...in addition to its technical function of increasing the productivity of labour...machinery also has in the capitalist system the function of divesting the mass of workers of their control over their own labour..'(p.193).

In what ways was it possible for the employers to appropriate artisan skills and thus radically reorganize work?

One of their crucial strategies was located in the deployment of new machines instituted as part of an increasing division of labour, which relied more upon unskilled workers than artisans. This was highlighted in the employment of child labour, especially boys. Children illustrate the point in so far as they were clearly not autonomous and had little, if any, control over their work. Two consequences may be said to stem from this. First, this kind of labour was suited to the sub-division or fragmentation of work, with an emphasis on the replication of many parts on automatic machines which could be pre-set. Groups of these machines could be set up and supervised by a single skilled worker who would then oversee up to six machines and unskilled operators (Nasmyth(1856), Parliamentary Papers, Children's Commission(1864), Robinson(1868).

Second, employers accustomed to employing children in the capacity of 'machine minders' were ill-disposed to both the apprenticeship system and technical education in a form which interferred with job specialization or work fragmentation.

On the question of job fragmentation Braverman holds that,

> '...labour power may be purchased more cheaply as dissociated elements than as a capacity integrated in a single worker...'(p.81).

For 19th century artisans, a combination of innovative technologies and new means of labour control rendered it unnecessary for them to understand anything concerned with their work except that required for their immediate tasks. As Braverman expressed it,

> Technical capacities are henceforth distributed on a strict 'need-to-know' basis...'(p.82).

I believe the data show that significant changes in specific areas of work, for example metrology and automatic machining, accelerated the rate of job fragmentation and labour substitution. These processes, largely dependent upon increased use of child labour, weakened the employers' interest in training young workers according to traditional patterns, or any newly conceived system which they perceived as incongruent with their redesigned production needs.

4.3.i.

The Question of Workers' Resistance to Work Re-Organization

Some writers have emphasized the place of substitution in the reorganization of work. Larson(1980), for example, says

> 'The massive degradation of industrial skills by modern machinery creates a new labour market, one in which the supply of labour is enormously increased by the influx of unskilled and therefore eminently replaceable workers'(p.18).

But, in my view, the notion of employer dominance in Larson, as in Braverman, is so complete as to preclude any recognition of resistance on the part of the workers. This seems to me to be an ambiguous position for, as Wood(1982) says, the essence of Braverman's argument is that work is geared to the creation of profit and,

> '...this locates a fundamental conflict of interest between workers and capitalists...for workers cannot be relied upon to work in the best interest of capital in a context of antagonistic relations...'(Wood(1982:13).

This perspective has been theorised in a number of recent studies as the transition from formal to real subordination of labour. (Palmer(1975), Coombs(1978), Cutler(1978), Lazonick(1978), Elger(1979), Burris(1980), Walkers(1981), Littler and Salaman(1982), Thompson(1983).

I hold, in common with most of these writers, that Braverman(1974) not so much overstated the case of employers as a dominant class developing a clear, untramelled ascendancy over a passive working class, but that he underestimated the nature and extent of skilled working class reaction to new technologies and management ideologies. This was plainly the case with engineering workers in England.

Palmer(1975) argues that Braverman focused on control within the labour process but failed to to acknowledge working class reaction to the emergence and consolidation of the process:

> 'Braverman arbitrarily separates vital and complex relations that formed part of a basic unity...(and) he inhibits his analysis by refusing ot consider the working class response to this unity...'(p.32).

This failure by Braverman to acknowledge the active resistance of workers to imposed changes is questioned in a number of other critiques. Cutler(1978) holds that employers were motivated by factors other than increasing profits, and that consolidating control had a significant influence on their organizational behaviour. He says,

> 'It is a universal that 'labour' resists its insertion within the capitalist production process and that the primary object of capitalist calculation, is to break down this resistance...'(p.75).

Coombs(1978), Elger(1979), Stark(1980) also make the point that Braverman's historical account of the reorganization of work is flawed in ignoring the workers' appraisal and resistance to work reorganization.

For Coombs, Braverman presents the reshaping of the labour process as a kind of 'blueprint' for action drawn up by the employers without consideration of possible reaction from those most actively involved with its outcomes. Accordingly Braverman is said to view reorganization as

> '...the outcome of conscious design rather than as the product of the struggle of contending groups..'(Coombs:92).

Elger(1979) focuses on the manner in which Braverman conceptualizes the relationship between capital accumulation and the degradation of work, arguing that Braverman 'forgets that the working class remains an active agency in the capitalist relation...'(p.24).

Braverman, he maintains, gives insufficient stress to the relationship between employers' initiatives in the reorganization of the labour process and the broader 'ideological and political conditions of capitalist hegemony..'(p.44).

He also questions Braverman's analysis of 'scientific management', and the assumptions regarding working class conformity in labour reorganization. Braverman, he says,

> '...produced little indication of the manner in which this, and related initiatives, arose out of any crisis...'(p.40); or the mannner in which capital was,
>
> '..compelled to increase its scale and intensify its control over the labour process and create a complex corporate apparatus in an effort...to transcend these constraints...'(p.40).

I believe Elger's argument has a particular relevance for my study in this respect. Nineteenth century engineering employers in England did in fact create a 'complex corporate structure', the Engineering Employers' Federation (EEF), during the course of the century in order to confront the militancy of skilled workers: A process of management of such specificity finds no parallel in Braverman with his assumption of worker passivity.

4.3.ii

Other Contributions to the Labour Process Debate

Burawoy(1979,1985) centres on the way employers came increasingly to dominate modern organizations in the form of bureaucracies, characterized by control, 'dependent more on rules rather than coercion...'(1979,p.64).

He argues that one of their strategies in confronting workers was through 'manufacturing consent' inside the relations of production. This entailed encouraging 'horizontal forms of conflict': workers directing conflict against other workers rather than against management.(p.94). He writes

> 'English workers are acutely aware of differentials...conflict on the shop floor often arises from attempts by specific groups to maintain their position relative to other groups, rather than an implacable hostility to management'(1985:134,135).

This notion of the deflection of struggles between employers and workers to inter-worker conflicts provides an important insight into power relations in industry. It has significance for me in questioning the way employers asserted their 'right to manage'. The evidence plainly shows that they resorted increasingly to the use of unskilled labourers on new classes of machines. A critical outcome of the strategy was increasing antagonism between artisans and unskilled workers particularly over the question of machine manning. (This was one of the main issues in the strike of 1897, and the subject of chapter 8 below).

This perspective is also found in Edwards(1979), for whom bureaucratic control was the 'most imortant change wrought by the modern corporation in the labour process' (p.1320)

Such writers suggest, by and large, that employers later in the 19th century embodied a less coercive approach to workers' resistance. But Edwards (1979) dismisses revisionist theories paralleling the earlier models of Blauner, Woodward and Kerr et al which postulate a consensus located in bureaucratic controls. His model of industrial organisation recognizes potential disunity rather than passive adherence to a hierarchical structure. He writes of the organisation, coordination and assignment of work tasks embedded in a 'larger structure of work '(p.109) which could be conflictual, in fact a 'contested terrain.'

I find Edwards' argument plausible but ambiguous at certain points.For example, in his reference to work organization he implies a possible separation of technical and bureaucratic control. He writes

> '...the control mechanism could be embedded in the technological structure...or it could be embedded in the socio-organizational structure...'(p.110).

This seems to represent a dualism which also appears in Burris(1986). She argues,

> '...technical control is the blue collar/production counterpart of bureaucratic control; both are forms of structural control which serve to veil and legitimate control by embedding it in the structure of either the machine technology or the organizational structure...'(p.173).

My case is that the technical and social aspects of production are inseparable, and may be clearly illustrated in the work of the American engineer F.W.Taylor as I have previously intimated. The interpenetration of the technical and social elements of production was a basic principle

of 'scientific management', which Edwards also maintains, had as one of its most direct influences

> '...the addressing of the issue of power relations in the workplace..'(p.104).

Wood(1983) holds that Braverman as well as neglecting the issue of worker conflict, attributes an homogeneity to the employers while ignoring crucial differences between workers arising out of changing patterns of power relations:

> '...(Braverman) underplays the differences between sections of the working class. By contrast, he treats the dominant class as a totally organized and united force(p.15).

I seek to show that my analysis, particularly with respect to the strike and lockout of 1897, demonstrates that the employers were, to paraphrase Burawoy, 'maunfacturing consent'. They encouraged unskilled workers to collaborate and engage in substitution; indifferent to the accompanying demise of the artisan class and the deterioration in industrial relations this kind of 'consent' generated.

4.3.iii

The Issue of 'Scientific Management': The Influence of F.W.Taylor.

On the question of the status of 'scientific management' as propounded by F.W.Taylor, I hold Braverman's analysis relies too implicitly on this feature of Taylor's work, and the effect of these principles on workshop control and management. He says of the equation between Taylorism and work organization:

> 'It is impossible to overestimate the importance of the scientific management movement in the shaping of the modern corporation and indeed all institutions of capitalist society which carry on labour processes'(Braverman:86).

The labelling of 'scientific management' as a 'movement' seems an exaggeration of a relatively limited management strategy. The application of 'Taylorism' was not universal as implied in Braverman; in any event, it was controversial in America, based only in two hundred firms at its peak (Littler(1980). It made little impression in England as a 'science of management' vis a vis Taylor's highly significant innovations in cutting tool steels, which had their first cutting trials in England in 1903.

These had a profound effect on metal machining. (Proceedings of the Institution of Mechanical Engineers,1903)

Thus 'Taylorism' was to be found in England in a modified version known as the 'Bedaux System' in the 1920s and 1930s(Littler(1980). One of the first 'science of management' texts in England suggested that 'Taylorism' failed to take hold in British industry because,

> '...the industrial milieu presented an infertile soil...(of) sceptism and apathy - an incapacity to understand that anything other than technology was of consequence...and the opposition of organized British labour...'(Urwick and Brech(1946:89,92).

Despite his over-reliance on Taylorism it seeems to me that Braverman also takes technological development at face value. He gives insufficient analysis to the precise way Taylor systematically used technology, particularly metallurgical innovations such as cutting tool steels and new machining processes, to overcome skilled workers' resistance to work reorganization.

For Braverman, technology and technological knowledge were readily appropriated by employers as an ineluctable part of a process of 'de-skilling':

> 'The break up of craft skills and the reconstruction of production...have destroyed the traditional concept of skill and opened up only one way for mastery over labour processes to develop; in and though scientific, technical and engineering knowledge. But the extreme concentration of this knowledge in the hands of management...has closed this avenue to the working population...'(p.443).

Braverman fails to adequately explain how it was possible for management to divest artisans of their skills within an innovatory 'science of management', in the way he suggests. It seems to me Taylor's major contribution to the employers' ideology of production lay, not so much in 'scientific management', as in bringing the seminal work of engineer-entrepreneurs such as Maudslay, Whitworth, and Nasmyth in the 18th and early 19th centuries into contemporary engineering practice.

The technologies developed and implemented by these engineers were designed to operate in a specific set of social relations in which the worker had minimal autonomy; the technologies were factors of labour control. In other words, the machines were not technologies which required new forms of management expertise but were conceived with the subordinate position of the worker in mind (Nasmyth(1856), Whitworth(1854,1856), Taylor(1911), Hoxie(1918), Littler(1980,1985).

From the 1880s Taylor researched a new cutting steel, High Speed Steel, which was capable of cutting metal at much higher speeds than ever before; hence the rate of metal removal was commensurately greater [Iron and Coal Trades Review (1903), 'Engineering'(1903), Benjamin(1906), Taylor(1910,1911)].**

Taylor's tool steel developments embodied a further means of neutralizing worker resistance by undermining the skilled workers' exclusivity regarding preparation of cutting tools and machine setting. He achieved this through the introduction of his high speed steel tools that could 'tolerate' heavy loading, i.e. they were able to stand rough treatment during the cutting process, a characteristic well-suited to use by unskilled workers(Taylor 1906,1910).

His innovatory machining techniques were based on a principle of 'roughing', machining with high rates of metal removal, where the condition of the finished surface was relatively unimportant. This kind of practice was instituted by Taylor for use with his new tools, employing predominantly unskilled labour. Subsequent machining was done by the more skilled workers, who could work accurately at much faster rates because the bulk metal removal had already been carried out in the 'roughing' process [Usher(1895), Taylor(1906,1910,1911), U.S.Eleventh Special Report(1904), Hoxie(1918)].

This seems to me to be the essence of Taylor's work and is clearly undervalued in Braverman because the technology is taken as given, and the workers' reaction to its implementation is ignored.

It is my case therefore that in an important sense much of the technology introduced by employers from the 1850s was never 'in the hands' of the artisans as argued by Braverman. From its inception it was an employer-dominated technology, and not appropriated later. This chronology of technological innovation is over-shadowed in Braverman by his insistence on seeing the process in terms of 'de-skilling', a process in which the employers extracted 'skills' from artisans.

** In Appendices 6b,11,11(a) I provide details of some of the more significant research by F.W.Taylor in the field of metal machining and his metallurgical studies contributing to the development of new tool steels.

4.4.0.

Control of the Labour Process and Labour Reproduction

Some labour process theorists have attempted to extend the analysis beyond the confines of the production process. For example, some have explored the relation between education and the labour process, focusing on the employers' need to reproduce a particular kind of labour force [Davies and Broadhead(1975), Gorz(1976), Bowles and Gintis(1977), Edwards(1979), Lazonick(1977), Burns(1980), Whalley(1986), McGuffie(1986).

Although much of this work is American I find it provides relevant and useful sources because of the way the analyses is moved from direct concerns with the productive process and its control, to cultural and institutional considerations outside.

I now turn to an examination of these kinds of analysis.
Lazonick(1977) argues that in order to locate the essence of the capitalist mode of production in terms of the way emplolyers appropriate labour in the labour process, analysis must move outside the sphere of production. He appears to argue a case for considering education as part of an analysis of work organization and control. Such an analysis, he holds, focuses on political and cultural institutions

> '..that are fundamentally shaped by the need to reproduce labour in a manner that conforms to the goal of appropriation..'(p.111).

Gorz(1976), turning to the process of certification, argues that formal education leading to technical qualifications, is also concerned with controlling the social condition in which production is carried out. He says,

> 'All those whose job it is, because of their technical qualifications, to supervise the smooth running of production in fact work to reproduce the hierarchical division of labour and capitalist relations of production...'(p.175).

Burns(1980) reflects Braverman's notion of the appropriation skills and their acumulation in the hands of the employers:

> '...the obverse of the degradation of labour is...the emergence of a highly privileged stratum of highly qualified technical and supervisory personnel in which the skills and knowledge once held collectively by the working class are concentrated and employed in a manner which...perpetuates the subordination of the immediate [producers...'(p.26).

Thompson(1983) argues similarly that there was a need on the part of the employers to combine coercive forms of control with elements of education which,

> '...create a new breed of workers appropriate to the discipline of the factory...'(p.56).

Whalley(1986) implies that a differential education was significant in so far as,

> '...workers who supervise are separated from the working class by political relations since the managerial control of labour reproduces within the factory the political dominance...that exists...(outside)...(p.8).

The importance for employers in favouring a differentiated system of technical education, which, I argue, had its English origins in the late 19th century, is argued in Whalley thus:

> 'As technical education becomes more arcane and less susceptible to acquisition by experience, workers will be less able to challenge management's legitimation of their decisions on technical grounds...'(p.10).

These theories provide some insight into the way employers perceived technical education in the 19th century. I have argued that in the earlier phases of technololgical development in the 19th century, i.e. before the 1880s, skilled artisans were responsible, through the apprenticeship system, for craft production and also for the training of young workers. In the chapters which follow I shall elaborate on this and propose that with the development of technical education from the 1880s under the Society of Arts, and subsequentlty the City and Guilds of London Institute, the traditional artisanal role was fragmented and a division between workers and between managers and workers became institutionalized and replicated: Very small numbers of students attended courses at the Central Institute of the City and Guilds, the bulk of students attending evening classes only at the Institute's technical college at Finsbury(C.A and P.L.R. Horn(1983,1984)

Davies and Broadhead(1975) are among a number of writers who identify a relationship between productive and non-productive forces and link education to aspects of control within the labour process. They emphasize the cumulative role of new groups of 'managerial specialists' who receive a specialized education. Their view is that technical education in the U.S., for example, gave rise to to new groups, scientists

and 'professional engineers', whose function became increasingly linked with the 'design of the labour process'(p.80). As Armstrong(1986) says

> 'The (engineers') approach to the physical process of production grew out of the engineers' previous experience of machine design. Workers' movements were analyzed and redesigned so as to achieve the most economical sequence, an approach which inherently presupposes the subordination of manual to mental labour..'(p.24).

A more specific analysis of education and its relation to control in the workplace may be found in Bowles and Gintis(1977). They provide a 'correspondence' theory in which they maintain the education system produces differentiated manpower for the economic system. It reproduces, they argue, the relations of production; functioning to assist the capitalist economy in preventing subversion of the production process:

> 'Different levels of education feed workers into different levels within the occupational structure and, correspondingly, tend toward an internal organization comparable to levels in the hierarchical division of labour'(p.132).

My intention is not to support a 'correspondence' (or conspiracy) theory, but to suggest that Bowles and Gintis' theory represents one of the most recent variants of the consensual approach found in earlier English and European writers such as Cotgrove(1958), Musgrave(1962), Tholfsen(1971). Although these writers do not offer accounts within the labour process debate their work points up the functionalist orientation of much of the research on education and industry, such as exemplified by Bowles and Gintis.

Cotgrove's (1958) account serves to strengthen the rationale found in most historical perspectives of technical education, by assuming a functionalist model of industry, education and society. This may be seen in his view that,

> '...the dead hand of tradition has hindered the adjustment of the educational system to the changing needs of society...'(p.205).

The holistic approach in Cotgrove is coupled with a highly deterministic view of technology which is itself equated with science. He says,

> 'It is the application of science, that is to say technology, which has brought about transformations (of society)...'(p.1).

Musgrave(1962) argues an equally deterministic account of technological and social development, predating in its emphasis the correspondence theory of Bowles and Gintis(1977).

He maintains,

> 'The inherent logic of industry tends to drive the industries of different countries to the same destinations...(and)...education is vital to the process...a broad general education helps adaptability...this should ensure that at all levels workers can switch to meet innovation with more ease...'(pp.256,259).

The underlying ideology of the holistic approach of Cotgrove and Musgrave to education and technology, is paralleled in Tholfsen's(1971) thesis. His focus is on the self-regulatory mechanisms of a shared value system, characterized , for example, by skilled workers:

> 'the whole system operated to internalize the dominant values within the basic personality structures of individual workmen. Shared values, internalized, and institutionalized, constituted a powerful self-stabilizing mechanism in a culture prevailed by social tension...'(p.61).

Bowles and Gintis(1977) seem to be extending Marx and share with Cotgrove, Musgrave, and Tholfsen a functionalist perspective, which does not square with the evidence I shall produce in later chapters. I believe it shows that the conflictual nature of much of the interaction between powerful employers and skilled workers significantly influenced the type of education workers were offered.

4.5.0. Summary and Discussion

In the main, I believe 19th century employers' ideology of production was dominated by an overriding concern with maintaining current production needs and advancing their control of the labour process. They were not concerned with 'forward planning' of skilled labour requirements. The conflictual nature of employer-employee relations associated with much of this management process is ignored in mainly functionalist accounts. A thesis such as Braverman's plainly underestimates the potential for conflict in work reorganization and the implementation of new technologies. I hope to show that the development of the CGLI from 1878 reflected this kind of ideology.

In relation to 19th century England, I believe the evidence shows that not only was there no neat interlocking of education and the 'needs' of industry, but suggests first, that technical education was conceived as part of the 'free-market' enterprise; on a much more ad hoc basis. Second,

the form and structure of technical education from the 1880s was related, not in a form of 'correspondence' inducing some kind of functiong equilibrium, but was contingent upon increasingly antagonistic power relations in industry.

My examination of the literature suggests that there are two common strands in theories of the labour process which seem to parallel models of education in which technical education is institutionalized, separate from practical work. First are those which postulate a separation between technical and bureaucratic control; second those which focus on the distinction between 'conception and execution' as articulated by Braverman.

This has led me to centre my analysis of the origin and development of technical education on the employers' ability to unify control over the total labour process and thereby significantly influence, but not necessarily wholly determine, the form and content of technical education.

I believe the debate on the labour process has highlighted a neglected area in existing accounts of labour and technological history in the 19th century, viz the critical interpenetration of work and technology. Artisan reaction to the imposition of work reorganization, based on new technologies, has been neglected by writers associated with Braverman and neo-Marxist approaches. Subsequent critiques of this model of technical change have reopened the crucial issues associated with the implementation of new technologies and the employers widening hegemonic control over the labour process. Central to this control in manufacturing industry was machine tool technology and changes in the basic metal-removing properties of the new tools. In order to offer an explanation of the changing relation between control of work and the use of specific technologies I turn to an examination of the apprenticeship system, for it was the crucial question of the reproduction of skilled workers which became the focus of many conflicts during the period.

CHAPTER 5

THE CRAFT APPRENTICESHIP FROM 1850: THE POLITICIZATION OF APPRENTICES

5.0.0 Introduction

In my study thus far I have suggested that the essential features of the traditional methods of trade training were being radically changed from the 1850s. What was the nature and extent of these changes and how were they influenced by the recasting of the ideology of engineering production, through the use of innovative technologies and new management strategies? In order to address this question it is necessary to provide a brief analysis of the development of the apprentice system. My short historical survey** shows that artisan-apprentice relations were based essentially on paternalism. By this I mean such relations were characterized by a 'master' being 'an authority' (in a traditional craft); the apprentice was in a learning situation and adopted the role of 'pupil'. This was at the centre of the historical English craft system of technical education; and the only form for much of the 19th century.

In this chapter I examine the hypothesis that the retention of the craft apprenticeship, or some model based on it, was central to the skilled workers' resistance to work reorganization and underlay many employer-employee disputes from mid-century. The unions regarded skilled status as more than a vehicle for occupational recognition, it was also crucial to their self-conception as 'respectable' scientific artisans, superior workmen.

My theoretical position draws upon my critique of what I have referred to as the technicist ideology of engineering employers. Therefore in exploring the centrality of the apprenticeship question I hope to show

** As this is not an extensive historical analysis I offer a review of the Craft Apprenticeship System in the form of appendices [14,14(a)].

that there was a critical interdependence between innovative technologies, struggles over power relations, and employer attitudes to work control and technical training and education.

This raises further questions: What was the interrelation between the employers' attitudes towards the implementation of new technologies and the reorganization of industrial work?

Why were engineering employers reluctant to maintain the traditional craft training system, the apprenticeship? In what ways did a belief in the linear development of technology influence the employers' attitude towards the apprenticeship? What, if any, alternative model of craft training had the employers envisaged? My belief is that the key to these questions lies in an examination of the nature and development of craft expertise.

Here I first examine the notion of 'skill' and the treatment this concept is given in the literature. Next I shall explore the assumed autonomy of skilled labour and as a form of investment in human capital; and how artisans and employers perceived it in relation to the traditional craft apprenticeship system of training. I go on to examine the relation between the employers' control over a system of trade training, and their ideology of production which seems to me to hold as paramount the domination of new technologies as essential precondition for control of the labour process. I shall follow this with an exploration of the changes in the attitudes of employers and skilled workers towards the apprenticeship system, as control of work was gradually transferred to employers from its traditional location in skilled workers.

5.1.0. The Concept of Skill

The literature as a whole reveals little in the way of clear definitions of skill. The debate since Braverman's(1974) analysis of the labour process and his articulation of the process of 'deskilling' has tended to focus on the negative aspects of 'skill' in the sense that it is a quality in human work performance which is diminished or eliminated as a result of increased mechanization. But few explicit definitions exist of what it is that is actually affected in the process of 'deskilling'. As Thompson(1983) says

> '..in most cases skill is measured less by formal definition than by historical context and comparison...'(p.92).

The main contentions between 19th century employers and workers frequently related to the credibility afforded definitions of 'skill', and the implications it had for the struggle over workshop control and the experience of young workers learning a trade. The main focus of this as I see it is the way the skill content in certain classes of work was defined in the 19th century. The artisans argued that many classes of work required a generalized expertise which could only be acquired through systematic training. Discussing the notion of generalizability in terms of 'flexiblity', Rainbird(1988) makes the point,

> '...the unions' ability to claim new skills and to obtain formal recognition for them will be fundamental to the (re)definition of skilled work...'(p.176).

Employers regarded the artisans' rationalization as exaggeration and held 'skills' were often no more than mere 'defensive' categories used by the workers to maintain status(Nasmyth 1868, Robinson 1868)

Recent analyses of the nature of skill may be summarized in terms of a broad dichotomy. First, there is the notion of skill as learned attributes, abilities, and knowledge developed over a period of time by training and experience. Pollard(1978) for example notes,

> '...(skill) traditionally involved manual dexterity, acquired after many years of practice, but it also included knowledge and judgement of processes and materials...a degree of literacy and other abstract (e.g. mathematical) knowledge...'(p.118).

Oxhey(1981) largely concurs in this definition, but also distinguishes the highly transferable, generalized skills of the craftsman and the product- or process-oriented skills of the 'operator'(p.580). The latter is characterized by the need to work to explicit instructions and under close supervision. This particular distinction is also made by Gulowsen(1988) who characterizes general skills as those acquired through apprenticeship, and company-specific skills which are related to an individual firm and not readily transferable(p.162). The former types of skills provide a 'sheltered labour market' for the worker. The latter have restricted mobility being almost entirely limited to the company; they are 'company-dependent'(p.164).

Skill may be defined then as a multi-purpose concept in as much as the worker is able to demonstrate the degree to which he has a mastery over certain manual operations. It could involve planning and decision-making, flexibility and dexterity in performance, competence and manipulative sophistication in various aspects of work; and the ability to work at reasonable speeds within prescibed limits of size with minimum supervision.

Second, there is the approach to skill which rests primarily on labelling; an approach which emphasizes the social construction of skill as opposed to explicitly defined technolgical categories of human performance. More(1980) distinguishes social and technological definitions of skills, arguing that if workers are sufficiently strong, they attempt to formalize skills, and resist changes of definition and status. Such attempts correspond to a social defintion of skill.

This dichotomy is highlighted by Lee(1981) in discussing the 'de-skilling'/'en-skilling' debate. He argues that there is a need to make a distinction between de-skilled jobs and de-skilled workers. He says,

> '...Where craft workers are recognized as 'skilled' their jobs will not have been technically de-skilled, though they may have been re-defined...'(p.71).

Clearly, a specific 'skill' which embodies learned characteristics of expertise and methodology, under 'normal' circumstances, is inviolable in the sense that it is embedded in the personality structure of the individual. As Polyani(1975), in an analysis of 'tacit knowing' and apprenticeship, says,

> 'By watching the master and emulating his efforts in the presence of his example, the apprentice unconsciously picks up the rules of the art, <u>including those which are not explicitly known to the master himself...</u>'(p53)(my emphasis)

The notion of tacit knowledge is found also in Manwaring and Wood(1985), Jones and Wood(1985), Sorge and Streeck(1988), and Granovetter and Tilly(1988). Manwaring and Wood refer to 'tacit' skills which relate to the 'feel and discretion which form the basis for subjectivity in even unskilled workers and are vital to efficient performance in all work situations...'(p.117). They argue that an important implication of the conception of tacit skills is that the exercise of skill should not necessarily be seen as a 'conscious activity...'(p.179).

Sorge and Streeck(1988) argue similarly in distinguishing 'qualificational' factors in the organization of work and work skills. They define 'qualificational factors' as denoting skills and knowledge embedded in a person for the 'achievement of a task'(p.21). Granovetter and Tilly(1988) stress skilled workers' capacity for productivity and their indispensablity, maintaining that a skilled person, a) has a personal capacity that adds to a firm's productivity, b) would be expensive to replace by another worker. Drawing upon Jones and Wood(1985) they further argue that skill involves 'tacit knowledge' that

is difficult to articulate. Stressing the dual nature of skill they locate it within the social relations of the workshop:

> '...since the skill the workers display is neither a well-defined trait of worker or of job, but emerges from interaction and bargaining among workers, employers and one another, technological change can not automatically impose deskilling and employers' control...'(p.210).

This latter perspective is a useful corrective to views which perceive technological control in a mechanistic way and stress 'deskilling' as an inevitable consequence of mechanization, ignoring the interaction of work on technology and the response of workers to technological and organizational change (Woodward(1965), Blauner(1973), Kerr et al(1973), Braverman(1974), Goss(1986).

Skill characteristics may of course fall into disuse, be 'unlearned' or forgotten, but in the context of 'de-skilling' it seems to me more likely that the skill requirements for particular jobs would be changed, or re-defined. Lee(1981) therefore makes an important distinction. The experience of 19th century engineering developments suggests that jobs could be, and were, technically 'de-skilled', as my analysis of the issue of precision measurement taken up by Whitworth(1854,1856.1876,1885) shows.

Hobsbawm(1984) presents a classical approach to skill definition when he argues that the division of workers into 'artisan' and 'labourers' represented, from the men's point of view,

> '...a qualitative superiority of skill so learned...'(p.358).

He also stresses that 'skill' required a formal structure for its realization, a process he refers to as the 'professionalization of craftsmanship'(p.358). This model fits with his notions of 'labour aristocracy', the structure of which reinforced the status differences between the skilled and the unskilled.

Morris(1981) points up the interdependence of socially constructed skill and economic conditions, both market and technological(p.23). In this he criticizes More(1980) who put forward the view that the concepts of economically rational and socially determined skill were mutually exclusive and independent.

More rejects the notion of skill as a social construct, and particularly the place of unions in determining skill:

> 'There is no...evidence that engineering unions were strong enough to impose apprenticeship on their employers...(and) in the social

construction model, technology and therefore skill are infinitely variable...'(p.146/7).

Lee(1981) argues similarly that unions exercised limited power regarding the social construction of skill. He says,

> 'Neither at local nor national level have craft unions been able to impinge successfully on the employers' 'right to manage' industrial training and enhance the content or status of apprenticeship...'(p.271).

Another approach which differentiates the social and technical characteristics of skill is found in Goss(1986). He argues that skilled status needs to be conceptualized as incorporating a 'social dimension' capable of being constructed or destructed independently of the objective "technical" content of a particular job(p.425)

In his study of skill in the printing industry he puts the view that the conferring of the label 'skill', whether by management or workers, does not necessarily signify 'the essential possession of genuine knowledge, but may...be socially constructed...'(p.428).

I find unsatisfactory the separation between the 'objective' "technical" content of a particular job and the social dimension of skilled status. It is not clear what the 'objective technical content' of a job implies. This seems to me to reflect a technicist view of technology which disregards the human input and social purpose underlying all technological developments. Littler(1982), drawing upon Hinton's(1973) notion of the traditional craftsman as capable of working from start to finish on a job without employer interference, makes a similar point:

> '...in practice it proves difficult to find an objective basis for the labour quality of jobs... Changes in skill levels are linked to the modes of work control. This means...it is not possible to define skill independently of organizational and control processes...'(p9).

Jon Clark et al(1986) concur in the approach of Lee(1981) and Manwaring and Wood(1985), but go beyond a simple dichotomy regarding craft skill. They particularly question the notion that the exercise of control by workers over their own labour is synonomous with job or task control. They first distinguish skill as 'rooted in the content of work tasks...' Two other other dimensions of skill are then proposed: Skill in the person, i.e. 'skills possessed by individuals accumulated from a variety of sources (training and experience and so on)'; and occupational skill which is said to depend on the ascription of skill status by groups, for example, trade unions, employers, workgroups.

With their typology Clark et al seek to challenge the mechanistic link they see often characterized between technology and 'de-skilling or 'up-skilling'(p.90).

The interpenetration of economic, technological and social factors is brought out in Penn and Scattergood(1985). They reject the notion of a unilinear transformation of skills or of production relations, necesarily paralleling technical changes. They stress the critical interdependence of trade union organization, the relative power of skilled labour, and market conditions, as determinants of the conditions under which new technologies were applied. They then argue,

> 'Occupations are organized around the identity of "skill" and a whole range of norms and practices focus on the preservation of such skill...'(p.612)

Joyce(1984), focusing on the dynamics of technical change, challenges existing accounts which assume radical modifications to workshop management determined by technological and organizational changes. He suggests that in order to effect a smooth transition during such changes 'skill' needs to be re-defined, and '...renegotiated, carrying with it a marked degree of control over the immediate work situation...'(p.69).

However, in the case of 19th century engineering it would be difficult to sustain the notion of 're-negotiation', rather, the evidence suggests the imposition of redefined job skills by employers intent on diminishing skilled worker status. My case has been that in order to put this into practice the employers required an alternative to the artisan skills upon which they had been so reliant. Technologies developed by entrepreneurs such as Maudslay, Whitworth, and Nasmyth in the late 18th and early 19th centuries were outstanding in that they introduced new classes of machines and tools in which 'skills were embedded'. I believe it has been shown that the essence of this technology was the reproduction of engineering components made to close tolerances, i.e. components finished to pre-determined limits of accuracy.

Penn(1983) in his analysis of skill in the cotton and engineering industries from 1850, also focuses on the question of accuracy as a prime factor in the drive for increasing mechanization and the eradication of the need for skilled craftsmen. The productive emphasis was on '...interchangeability of parts rather than perfect accuracy...'(p46).

This view is shared by Knox(1986) who argues,

> 'the growth of a system of interchangeable parts made for greater tolerances; hence there was less need for a precise and lasting fit...'(p.174).

Penn(1983) and Knox(1986) provide a critical focus on the production process with their assertions regarding interchangeability. My analysis of Whitworth's work from mid-century has shown the highly significant contribution made by him in his attempts to regulate workshop accuracy. It seems to me however that they misinterpret a vital interrelation between the two concepts of accuracy and interchangeability: Accuracy is the essential precondition of interchangeability, which means parts made so that they may be substituted for each other without modification. There was little chance of interchangeability without precision and a recognized set of 'standards'. This was ably demonstrated by Whitworth.

Evidence from America also points to the significance of this aspect of workshop processes. F.W.Taylor in his research at the Bethlehem steel plant in the 1880s concentrated the areas of work requiring close accuracy into a small department within the workshops, the 'toolroom'(Taylor 1906, 1911, 1912). It was here that non-production components were made such as jigs, fixtures, dies, templates, models. These and other aids were used to determine and monitor accuracy in mass-production in the general workshops. In this way oversight of the critical factor of accuracy was removed from general practice and strictly controlled by supervisors and management rather than being left to the discretion of the artisans (Taylor 1906, 1911); Zeitlin(1983).

However I would argue that Zeitlin's(1987) particular position that employers did not transform the division of labour in the 'direction of standardization'(p.173) is not entirely supported by the evidence. Although his assertion that there was no breakthrough into a new 'Taylorist' mode, based on the notion of 'scientific management', seems to me to be correct, his idea that the traditional employers' strategies of work control were merely intensified, states only part of the case. The evidence shows that 'Taylorism' did not manifest itself to any great extent in English workshops, but Taylor's metallurgical research and development into new cutting tools and techniques of machining metals were essential preconditions of innovatory workshop processes and were concomitants of standardization(Taylor(1906,1911). Thus the new technologies embodied direct control over both the production process and

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Penn(1983) and Knox(1986) provide a critical focus on the production process with their assertions regarding interchangeability. My analysis of Whitworth's work from mid-century has shown the highly significant contribution made by him in his attempts to regulate workshop accuracy. It seems to me however that they misinterpret a vital interrelation between the two concepts of accuracy and interchangeability: Accuracy is the essential precondition of interchangeability, which means parts made so that they may be substituted for each other without modification. There was little chance of interchangeability without precision and a recognized set of 'standards'. This was ably demonstrated by Whitworth.

Evidence from America also points to the significance of this aspect of workshop processes. F.W.Taylor in his research at the Bethlehem steel plant in the 1880s concentrated the areas of work requiring close accuracy into a small department within the workshops, the 'toolroom'(Taylor 1906, 1911, 1912). It was here that non-production components were made such as jigs, fixtures, dies, templates, models. These and other aids were used to determine and monitor accuracy in mass-production in the general workshops. In this way oversight of the critical factor of accuracy was removed from general practice and strictly controlled by supervisors and management rather than being left to the discretion of the artisans (Taylor 1906, 1911); Zeitlin(1983).

However I would argue that Zeitlin's(1987) particular position that employers did not transform the division of labour in the 'direction of standardization'(p.173) is not entirely supported by the evidence. Although his assertion that there was no breakthrough into a new 'Taylorist' mode, based on the notion of 'scientific management', seems to me to be correct, his idea that the traditional employers' strategies of work control were merely intensified, states only part of the case. The evidence shows that 'Taylorism' did not manifest itself to any great extent in English workshops, but Taylor's metallurgical research and development into new cutting tools and techniques of machining metals were essential preconditions of innovatory workshop processes and were concomitants of standardization(Taylor(1906,1911). Thus the new technologies embodied direct control over both the production process and

labour; it seems to me implausible to make a separation. Zeitlin(1987) however says

> '...employers in many British industries remained reluctant to assume direct control over the production process through the introduction of deskilling technology or more systematic management...'(p.173).

Penn and Scattergood(1985) take a different perspective and argue that there are dangers in trying to identify changes in skill 'simply at the level of employees of a company...'(p.625). This proposition, similar to that of Oxhey(1981), raises the issue of generalizable skills as opposed to company-specific skills.

The case of the A.S.E. in the 19th century illustrates the case put by these writers here. One of the common practices of the period was that of 'tramping', whereby artisans (journeymen) would tramp for work from place to place. The local union office supplied details of work available in the area on arrival, and the 'skill credentials' of the worker were attested by local union members (Hobsbawm1974). In this way the 'general' engineering craft skills were 'identified' and accredited. To quote Zeitlin(1987) on the notion of craft control by unions, he says

> 'The very notion of craft control implied the formulation of a set of rules which reached beyond the individual workplace...craft unions sought to protect the market value of their members' skills...standardizing...working conditions...to ensure that they encountered similar conditions in each workshop...'(p.172).

There is an implication of skill as an investment in Zeitlin's argument. Evidence from T.U.C. sources in the 1860s points to a general concept of skill regarded first as an investment, second as a means of differentiating the journeyman from the labourer. An assumption frequently associated with skill formation was that it was an investment by both employers and workers. In terms of human capital theory the most efficient training system will be that which allows each participant to capture the value of his investment (More 1980, Floud 1985). Another assumption in human capital theory is that the employee would receive training from the employer in the detailed processes of the trade, and would become manually proficient.

5.2.0.

The Nature of Skill and 'Human Capital as Investment'.

The craft unions first put forward a conception of skill as investment in 1868. During the Congress of that year it was unequivocally argued that 'skill and labour' in the working man was his 'capital' over which the 'employer had no right of interference' [T.U.C. 1868]. In spite of the uncompromising nature of this declaration the A.S.E. was not extravagant in its formal claims regarding skilled status. It held that its membership was limited to men who were

> '... possessed of good ability as a workmen, (be) of steady habits, good moral character ...' [R.C. on T.U. 1868(b)]

ASE rules on the definition of engineering-skill were of long-standing, but they do not seem to have been over-rigorous, and were generally accompanied by the kind of admonitory qualifications common to unionists. Allen, the ASE secretary outlined in 1867 what was deemed by the Society to be the social effects of amalgamated unionism on the skilled worker. The salient points revolved around the maintenance of status of the skilled worker:

> 'I think it (the Union) has been a means of decided improvement to them in the position and character generally; for we have a controlling power over them ... we have the opportunity of dealing with them, and we do our best to keep them up to the mark so far as regards their position.' [R.C. on T.U. 1867, Q.644]

Another specific, engineering-artisan's view was given by ASE member, John Burnett. He argued the engineering craftsman was characterised by skill and intelligence,

> '... their work (engineers) requires both skill and intelligence, and the best workmen are really scientific artisans, working under conditions which require the exercise and very highest faculties of brain and hand' (Newcastle Weekly Chronicle, 3 July 1875 - John Burnett - A Model Trade Society).

He later formulated his ideas on artisan exclusiveness in terms of 'skill as property', emphasizing the concept of skill as an investment in capital to be protected; the hence need to distance the artisan from the unskilled labourer. For him the skilled man was a bearer of economically valued capabilities:

'Skill is the only property of the artisan ... (it) is in perpetual danger from competitive struggles of society ... the union is his only hope of security ... (non-union men) to the common cause contribute nothing; on the contrary they hang like a millstone round the neck of their more thoughtful and courageous fellows who have to make the fight and find the means for all.' [Burnett, J., 1886, p.18].

In order to attain status an engineering craftsman had to produce proof of his ability as a workman before entry to the Society. This was attested by fellow-workmen of the candidate who were already Society members. In addition he was to be a man of fair moral character, and in tolerable health, as minimum levels of social conduct were expected in the workshops, commensurate with the status of skilled workers:

'... a man shall conduct himself properly while at work, and if he be thrown out of employment by reason of misbehaviour, he is disentitled to his benefit.' [Burnett, 1886, p.16]

In the light of the constraints imposed by employers over areas such as machine manning, this was a considerable sanction, as the chances of re-employment receded as the worker grew older and labour substitution by employers became an increasingly viable proposition.

The qualifying time for membership of the A.S.E. was five years in order that the Society 'may be satisfied that the candidate is a competent workman.' [R.C. on T.U. 1868(b) Q.985]. I have previously discussed, in this context the notion of the 'aristocracy of labour' (my analysis above, Chapter 1, sub-sections 1.6.0 and 1.6.i). It is clear that the conception of skill held by nineteenth century artisans had a broad connotation. Not only did it imply high occupational status ('good ability'), but also qualities of moral rectitude ('steady habits'), and 'influence' as members of a respectable stratum of the working class. The differentiation from the unskilled seemed an imperative. George Lowell well-known as secretary of the Operative Bricklayers Society and Secretary of the London Trades Council (1861-2) emphasized the exclusiveness of the artisan groups. He despised and feared the onset of the new unionism which encouraged the inclusion of inskilled workers; he gave '... sincere assurances that he wanted to have nothing to do with the dictatorship of the proletariat.' [Quoted in Harrison, R., 1974, p.98] A later, more centralist ASE secretary, Barnes, urged the union to accept 'specialization and open the union to the less skilled.(Zeitlin(1983:43).

Union sources thus suggest that artisans were separated from the unskilled both in terms of identifiable workshop skills and the most pervasive of Victorian social concepts, respectability. This phenomenon was manifested in the life style of artisans, which derived from their ability to bargain for a minimum level and regularity of earnings, and the facility to live outside the slums. [Hobsbawn, E. J., 1954]

Wright(1871) observed artisans manifested thrift, sobriety, and drive; they were

> '... well-to-do workmen, who own their houses, have shares in building societies; men also who, by reason of the 'push' and energy which have, as a rule, enabled them to accumulate money or property, are among the most influential of their class and with their class. [Wright, T., 1871]

Wright condemned aspring labourers;

> '...any clever or ambitious labourer who shows a desire to get out of his place...by attempting to creep into a 'trade'...is guilty of of a deadly sin, and deserving of the abhorrence of al right-thinking members of the craft...'(Ibid p.6).

'Respectability' was thus highly regarded by artisans and held to be a kind of moral attribute, one which also provided a common link beween the various skilled trades. Artisan leaders such as Howell (Bricklayers), Allen, Burnett (Engineers), and Applegarth of the Carpenters' amalagamated union, agreed that craftsmen embodied norms and values which emerged from a relatively respectable position in the hierarchy of the capitalist social relations of production.

Their views also show that they considered they had most to lose as a result of substitution. Allen in his evidence to the Royal Commission on Trades Unions (1867) clearly intended to dissociate his members from the ranks of the unskilled. He reaffirmed union opposition to any amalgamation with the unskilled when recalling his union's refusal to attend the Trades' Conference in London in March 1867, on the grounds that

> '... a large number of what is called the Working Men's Association, which convened the meeting, do not belong to any trade society at all, and we were determined not to identify ourselves with parties who do not belong to unions.' [R.C. on T.U. 1867, Q.998]

There seems to be little doubt that historically there had been a marked distinction between skilled and unskilled workers, in terms of wage differentials, autonomy over work procedures, control of labour including apprentices,living standards.(British Labour Extracts (1978),

Hobsbawm(1974,1984),Census of Production(1908). At the centre of contemporary artisan definitions of skill was their perception of skill as a set of learned attributes and attitudes to job performance, and also a socially determined category through which they were differentiated

from the unskilled, via the apprenticeship system. Penn(1983) reflects this model and conceptualizes labour categorization in terms of a 'skilled divide'. As he says in his critique of existing accounts of the labour process:

> '...there has been no structural analysis of the extent to which the British working class has been organized around a skilled divide between the 1850s and the mid-20th century. nor crucially, of the precise chronology of this skilled structure...'(p.38).

5.2.1.

The Notion of Craft Exclusivity: Some Criticisms.

Criticism of union attitudes to employer-employee relations centred on the wider, political effects of skilled workers' exclusivity. In an early critique, Engels (1889) argued, for example, that working class zeal had been sapped by artisan quasi-alliances with the Liberal party; promoting a lethargic and undemonstrative sub-stratum, intent on extending and consolidating those attributes of respectability that marked them off from the unskilled:

> 'The most repulsive thing here is the bourgeois "respectability" which has grown deep into the bones of the workers. The division of society into a scale of innumerable degrees, each recognized without question, each with its own pride but also its native respect for its "betters" and "superiors", is so old and firmly established that the bourgeois still find it pretty easy to get their bait accepted.' [Engels, F., 1889]

Commenting on this aspect of working class life, Marx held that the accommodation and de-radicalisation of the working class had been continuing since 1848. He spoke of the demoralisation of the English working class which had

> '... got to the point when they were nothing more than the tail of the great Liberal party, i.e. the henchmen of the capitalists.' [Marx, K., 1878]

He also maintained that artisans were a privileged group, and

> '... an aristocratic minority, excluding the unskilled and enrolling in the East End of London one worker in ten.'[Quoted in Collins, H. and Abramsky, C., 1965, p.51]

Such criticisms suggest there was a skilled working class obeisance in its attitude to the employers. On the one hand, this perspective seems to discount much of what was happening among skilled workers within certain sectors of a principal industry of the period, machine tool and machinery production, who consistently challenged the employers from the 1850s. On the other, the criticism appears to add weight to the view that skilled workers were not over-concerned with notions of a 'working-class' solidarity at this time. As a recent commentary expressed it,

> 'The archetypal independent-minded radical working man of the 1860s owed allegiance to a personal, not a collective, morality ... (they) aspired to an individual ideal in order to show that they were not as other men.' [Shepherd, M., 1978, p.61]

The fact that unionized, i.e. skilled workers, constituted a small proportion of the workforce lends credence to the idea of exclusivity. The first T.U.C. meeting of 1868 was itself unrepresentative for it did not include representatives from all 'eligible' unions. It has been argued that the Trades Union Congress up to the 1890s was representative of little more than half a million skilled workers [(Cole,G.D.H.(1937),Roberts(1958].

Parliamentary Committees rarely took into account the concerns of the mass of the unskilled who had no apprenticeship system and demarcation rules to control the flow of applicants for their jobs. [Roberts, B. C., the Trades Union Congress, 1868-1921, London 1958; Roberts, B.C. 1951, p.128].

5.2.11

The Apprenticeship Viewed as a Source of Conflict

From mid-century engineering employers increasingly recognized the potential for resistance embodied in artisan exclusivity. This may be seen in the aftermath of the first national engineering strike in 1852. The employers insisted that on their return all workers sign a declaration that they would not belong to a union [R.C. on T.U. 1968(a)]. They focused on artisan autonomy perceiving it as a block on efficiency and productivity, and as a prime source of organized resistance. The union's ability to exercise sanctions over the members was regarded as '... an impediment to trade' [R.C. on T.U. 1868(c)].

I believe other evidence shows that artisan exclusivity also had wider-ranging political consequences for worker solidarity later in the century. This skilled/unskilled divide was exploited by the employers in the 1890s when they actively encouraged the unskilled, i.e the non-unionised, workers to take up skilled postions and press for union recognition. I shall examine this aspect in Section Three of my thesis in my analysis of the events leading up to and including the Great Strike of 1897.

One of the pragmatic grounds for the employers' case against the A.S.E. was that its restricted membership increased production costs and 'weakened the competitive capacity of the industry". [R.C. on T.U. 1868(c), p.56]

I believe the evidence shows that despite claims to exclusivity and autonomy in the workplace, based on the formal apprenticeship, artisanal notions of 'skill as an investment' were increasingly subsumed by the employers' attempts throughout the century to extend their controls over the labour process. This was not merely an extension of employers' control over the hardware of production, but also a re-shaping of their ideology of production. The ideological changes had important implications regarding technical education and training which seem to me to stem from this and need to be addressed in this thesis.

Employers perceived their domination over new technologies, using unskilled workers, as a pre-requisite to their widened hegemony. I have previously argued that most new machines, particularly the self-acting or automatic, were specifically designed for operation with a minimum of skilled labour, not new species of machine requiring more advanced skills. In this I take issue with deterministic notions such as More(1980) who, in his analysis of skill in the 19th century, argues that

> '...the technology of the industry demanded the skilled, all-round worker, and the all-purpose lathe which could be switched about to different types of production...(p.154).

To a large extent, the implementation of new technologies premised on conceptions of skill which were being redefined as part of a new production ideology, precluded serious consideration of systematic craft training and education. It seems to me therefore that the key to an explanation of the employers' perception of the interdependence of technology and work lies in an analysis of the struggles between

unionised workers seeking to retain autonomy through the craft apprenticeship, and employers, intent on witnessing its demise.

5.3.0.

The Employers' Challenge to Artisan Control over Trade Training

The challenge to the exclusivity and assumed autonomy of skilled, unionised labour was formally reasserted by employers at the Inquiry into trades unions in 1867/8. Because of its place in the traditional practice of reproducing skilled labour the apprenticeship system was a prime focus of contention. Nasmyth, a leading employer and engineer, in his evidence to the Royal Commission derided the appenticeship system as the

> '... fag end of the old feudal system'. [R.C. on T.U. 1868(c), Q.19201]

At this time he employed 1500 workers [R.C. on T.U. 1868(c) Q.19137] and could be regarded as a representative of substantial engineering employers of the period.**

The model which was the object of Nasmyth's derision was the traditional craft apprenticeship system, dating from the Elizabethan Statute of 1563. In terms of the relationship between the development of skills and increasing mechanisation and sub-division of labour his evaluation was firmly based on the principle of substitution. The logic of his and other engineering employers' apparent indifference to the decline in the traditional method of craft training, the apprenticeship system, becomes more clear if this is recognized.

He argued that, given the current developments in machine technologies, artisan skills were clearly dispensable:

> 'When I began to introduce these mechanical contrivances that facilitated the production of work, independently of dexterity, enabling me to do the work with boys and labourers, I reduced the numbers fully one-half [R.C. on T.U.1868(c), Q.19138].

** In my appendix 1, I analyse the structure of the nineteenth century mechanical engineering industry. It may be seen that the industry was fragmented, and on average, the company workforce engaged in machine tool manufacture was in the region of 650 workers. [Appendix 1, p.ii].

The use of the term 'independent of dexterity' in this context is significant. It pointed to a reorganisation of engineering work in which dependence upon skilled labour had been superseded by machines operated by unskilled workers.

Another leading engineering employer, Beyer, of Beyer, Peacock & Co. of Manchester argued in his evidence to the Commission that the A.S.E. ruling on apprenticeship and the five-year rule was 'degrading'. He stated that employers would resist the 'implementation of such rules in the workshops'. [R.C. on T.U. 1868(c), Q.18887].

Other evidence suggests this kind of attitude prevailed throughout the period from the 1860s to the 1890s and beyond. Prominent in the dispute of the 1890s, for example, were directors the company whose representatives also gave evidence at the Inquiries and Commissions beginning in the 1860s, one of whom, Robinson, of the Altas engineering Company, provides an illustration of employer attitudes. At the 1868 inquiry he challenged the A.S.E. over the rationale underlying the apprenticeship as a mode of training. [Robinson's company employed about 1,600 workers at the time]. He particularly questioned the A.S.E. notion of the traditional apprenticeship system as creating an area of work autonomy for skilled labour. He maintained that limitations on apprenticeship conditions 'were an intrusion by union upon management prerogatives'. Thus in his company the question of apprenticeship was 'resolved' by debarring the union from discussions between the company and the men. On the crucial issue of limitation of apprentices he stated

> 'We have fought a battle with them (the A.S.E.) and beat them.' [R.C. on T.U. 1868(c), Q.19058]

Regarding the training of young workers, his company evidently used an informal method, the operation of which even management seemed to be unclear. In reply to the question:

> '(And) you have retained the privilege of educating apprentices to any extent you think right?'

Robinson replied,

> 'So far as we know that is so, but the foreman sometimes do things that we are not cognisant of ...' [R.C. on T.U. 1868(c), Q.19059]

5.3.1.

Increasing Mechanisation and Changing Conceptions of Skill.

It seems to me therefore that for skilled workers, there was a greatly increased possibility of dequalification and 'downgrading' particularly in last decades of the century and which existed in two forms. The first was explicit: displacement and even loss of employment.

> 'In times of depression the journeymen are generally the first to lose their employment as the employer fancies ...' [R.C. on Labour 1893, Q.26149]

The second implied a gradual loss of status for the skilled worker:

> 'When a man gets to a certain age he is not able to do quite the same amount or perhaps class of work. There is a great deal of work that he may do, and usefully, but it becomes the interest of the employer to get rid of that man altogether, whereas in former years he would have been kept on at some class of work, although possibly at a reduced wage.' [R.C. on Labour 1893, Q.25248]

This suggests that the concept of 'skill' was being redefined both in terms of quality of individual performance and skill content of the job. What then was the nature of the interaction of new technologies and management strategies and the influence on work organization? I have argued earlier that new standards of metrology instituted by Whitworth embodying the principles of standardisation and interchangeability were highly significant factors in rationalising production based on redefined skill requirements. Skills, in terms of engineering workers' technical competence to perform generalised functions with accuracy and fluency, were radically modified by the use of gauges and templates, diminishing the employers' historical dependence upon this aspect of skill.

Management therefore reorganised engineering craft work through a new system of 'quality control' hitherto unavailable, until the research on metrology was brought into practice, and which also had the effect of changing the balance of the skilled/unskilled ratio in the workshops. The employers' perception of skill by the employers altered as technology made substitution of skilled labour by the unskilled more viable; thus the apprenticeship lost much of its purpose for employers. Engineering employer Noble's evidence in 1893 underlines this development and shows that the large engineering concerns drew upon partially trained labour, paticularly boys, as substitutes for skilled workers. The scale of this enterprise may be gauged by the fact that his company had 15,000 workers on its books, including an Italian subsidiary at Possuoli; and at the time

of the 1893 Royal Commission had a U.K. Workforce of 12-13,000. [R.C. on Labour 1893, Q.25229]

Boys and apprentices were traditionally exempt from strike call, thus Noble stated:

> "During the last strike we caused our boys to carry on such of our machines as could be carried on by moving the apprentices, and these apprentices were advanced a little sooner than they would have been under ordinary circumstances ... when the strike terminated I refused to put back those lads who had advanced and distinguished themselves, by putting them back to their old machines, or to their old work. In fact their old places had been filled by new lads ... unfortunately ... an immense number of men were left without employment ... in our works we have somewhere between 1500 and 2000 men less than we had before the strike' [R.C. on Labour, 1893, Q.25217]

Clearly, the immediate issue here, the enforced unemployment of between 1500 and 2000 workers, demonstrated the relatively weak position of workers in a system of power relations in which employers had a reserve pool of labour, and control over new technologies.

Another employer distinguished between 'apprentices' who were sons of farmers, 'or people of that class', who were taught a trade '... as well as we can'; [R.C. on Labour 1893, Q.25777] and those who were '... ordinary workmens' sons, what we call boys. The boys are moved into different departments, i.e. provided they will show themselves anxious to learn, they are moved forward in two or more shops.' [R.C. on Labour 1893]. The concept of boy labour, as distinct from 'bound' apprentice, characteristic of the traditional 'master-pupil' relationship, therefore, seems to have gained more currency with employers as expanded technology came into production.

This form of reductionism may be illustrated by Noble's reference to the Wm. Armstrong company in which most of the apprentices were not bound:

> 'We take boys as boys, first they go to small machines, if they are found competent they are advanced to be apprentices ... if you put them to the proper class of work <u>they are unquestionably cheaper</u>.' [R.C. on Labour, 1893 Qs 25217, 25218] (my emphasis).

The evidence has shown, the artisans' case for a retention of the craft apprenticeship was weakened by the employers' success in the 1852 strike and their subsequent insistence that new technologies should be no longer dependent upon protracted training characteristic of the traditional apprenticeship system. In effect the artisans' workshop autonomy was

clearly undermined by pressure from new technologies and the increasing volume of non-artisan labour operating new classes of machines.

In the course of the employers' effective rebuttal of the A.S.E. defence of the apprenticeship system the influx of untrained workers, with no tradition of militancy, not only altered the division of labour but also affected power relations in the engineering industry.

Zeitlin(1985) sees such a process throughout the latter part of the century as a serial development having its origin in employer-employee conflicts:

> 'The division of labour which prevailed in most engineering workshops during the second half of the 19th century was itself the product of a prior wave of technical change and industrial conflict during the 1840s and 1850s...(that) might result in the eventual elimination of skilled craftsmen as a significant component of the engineering workforce (pp.198,199).

One of the direct effects of the conflicts was the almost total abandonment of a training period of 'apprenticeship.' Being no longer controlled by statute, the situation was formalised as a result of the Terms of Settlement which concluded the Great Strike of 1897/8 and were ratified in 1907. These Terms imposed conditions which clearly diluted any attempt by the unions to restrict the number of "apprentices" that might be employed as a proportion of journeymen in mechanical engineering.

As Zeitlin(1985) holds, despite its defeat in 1852 the A.S.E. sought to enforce an informal ratio of apprentices to journeymen of 1:4, but in parts of the country it reached 6:1 and there,

> '...was an accelerated subversion of apprenticeship into a form of cheap labour...'(pp.202/3).

The Children's Commission revealed that in 1864 a well-established routine of child labour was operating in the factories, continuing a decline in indentured and premium apprenticeships which lasted well into the next century. One of the largest companies in England, Messrs Platt Bros of Oldham, with 430 workers under 18 years of age, and 95 under 13, in its evidence to the Commission argued,

> '...we like them to be 12 years old...but many are brought at 11...they earn 3/6d per week...<u>none are apprenticed...</u>'(p23) [My emphasis].

A submission by an engineering firm on the North-East coast in 1915 highlighted a related social factor. This showed that some employers used the non-binding agreement as a disciplinary measure: 'The unbound

apprentice is more amenable to discipline'. The employer was in a position to discharge the young worker without fear of redress through the breaking of a covenant:

> 'We may explain ... that the apprentices are not indentured and no written agreement is come to...' [H.M.S.O. 1915, p.55]

Another inquiry noted that unapprenticed learners obtained by promotion from adult unskilled labour were found in relatively greater numbers in large machine shops with highly specialised or self-acting machinery. [H.M.S.O. 1915, p.57] It is clear that by the first decades of the twentieth century the ranks of journeymen were being constantly recruited from those who received an irregular training. [R.C. on Poor Laws, 1909, p.241](H.M.S.O. 1928,p.12)

Recent analyses, for example McIvor (1984) and McKinlay(1986), have focused on the interpenetration of control of work and the changing structure of trade training, which the evidence from this period has highlighted.

McIvor(1984) has rightly argued in my view that the workers' lack of immunity to replacement stemmed from the employers' control of new technologies and their ability to rationalise production against skilled workers' resistance in pursuit of a new production ideology:

> 'This lack of immunity of skilled personnel to replacement in strikes can be partially explained by the ferocity of the employers' counter-attack in the 1890s and partly by the penetration of essentially de-skilling technology and new management techniques...'(p.16).

McKinlay highlights the breakup of the traditional 'artisan-learner' situation which characterized late 18th and early 19th century trade practices. He says:

> 'The cumulative effects of mechanisation, skill fragmentation and increased managerial interest in work organisation was to divest the relationship between "master" and apprentice of much of its former moral obligations so that it corresponded more closely to the instrumentalism of an employer-employee reltionship')(p.3).

There is support for the 19th ASE view that boy labour was often used by employers to ameliorate the effects of strike action by skilled men. It was also clearly used as a lever to gain more purchase in attempts in the longer-term aim of labour substitution in machine manning:

> 'I have known at one time, while all the machines were occupied at one particular factory ... at least 300 or 400 boys were on the books waiting for their turn to get in, and when we were on strike they took these boys in all at once.' [R.C. on Labour, 1893, Q.23235)

This evidence shows that some of the leading engineering employers subverted the apprenticeship into a form of cheap labour. Some imposed carte blanche the new production ideology on the workers, suggesting the absence or disregard of any legal restraints.

5.4.0

Repeal of the Statute of Apprentices: Some General Implications.

The law of apprenticeship in England reflected its traditional character. It was based, in the main, on the paternal or fiduciary character of the relationship existing between employer and apprentice, and also on the apprentice's status as a minor.(H.M.S.O(1928 p.19).

This paternal character is revealed in the written indenture, common in the traditional pattern of apprenticeship, under which the 'master' exercised a wide responsibility, beyond trade training.

> ' The said (company) will at all times during the said term provide for the apprentice board, lodging, clothing, and all other necessaries...'(Indenture,1904).

The statutory requirements of such covenants were generally recognized as binding at Common Law. The rule under Common Law that contracts made by an infant were voidable at his option, i.e. were enforceable by but not against him, was waived in the case of the contract of apprenticeship. This implied that it was binding on the young worker.(H.M.S.O.1928,p.18).

Where there was an agreement by an employer to teach an apprentice, as in traditional written arrangements, the evidence has suggested that employers protected themselves with various strategies. They often repudiated the concept of the 'bound' apprentice which was frequently revoked and boy-labour substituted under oral agreements(R.C. on Labour 1893). The ASE-EEF agreement in 1907 provides an illustration of how employers could by-pass obligations. The agreement stated:

> An apprentice shall be afforded facilities for acquiring a practical knowledge of the branch of trade he adopts, and shall be encouraged to obtain a theoretical knowledge thereof as far as circumstances permit)((ASE-EEF Agreement 1907) [My emphasis (my appendix 2(b)).

Clearly the wording of this condition allowed a loop-hole for any employer to exploit when 'circumstances' were unfavourable.

Evidence from T.U.C. sources shows that what remained of legal sanctions failed to deter employers intent on circumventing statutory obligations relating to apprenticeship. It was argued at the 1880 Congress that some form of statutory obligation, approximating to the old statutes might be reintroduced (appendix 14 outlines this background). A motion was passed proposing that

> '... parents should be able to sustain an action in a court of law for the non-performance of the covenants of an indenture, the failure to instruct the apprentice in the mysteries of his trade being a breach of the covenants. [T.U.C. Report 1880]

In 1882, the T.U.C. reiterated the view that there was both a local and more general need for the reorganisation of a conventional apprenticeship model of craft training. They argued

> '... it is to be deeply regretted that a growing tendency exists in many trades to discourage the employment of indentured apprentices, thereby deteriorating the quality of skilled labour and inflicting serious damage upon our industrial progress'. [T.U.C. Report 1882]

Shortly before this, during a House of Commons debate, a motion was put calling for legal sanctions covering the employer-apprentice relationship:

> 'The law of apprenticeship must be amended and employers must be made responsible for the fulfilment of the contracts entered into by them when they took apprentices into their firms ... Apprentices, not uncommonly, were employed in unskilled labour in order to save grown up labour.' [Hansard, 1881, col.546]

The increasing specialisation of craft skills in production to which I referred in my earlier analysis (above, chapters 1,2, and 3) was being brought about. I identified two main contributory factors: the drive for cheaper production, with new technology using unskilled labour and increasing use of a premium system of wage payment. This development prompted criticism during the 1881 Commons debate, where it was put that there was a tacit if not direct, relationship between a decline in skilled craftsmanship and the seeking of more profits:

> 'We have gone in too much for cheapness at the cost of quality, and that had tended very much to degrade our handicraft skill ... the apprenticeship has broken down here ... (and) cannot much longer be maintained.' [Hansard, 1881, cols.527, 537].

The interest shown by the House of Commons on this occasion, served to highlight the inertia associated with attempts to challenge the prevailing economic short-termism of the Victorian period. Parliamentary reports show that the debates on this subject were initiated in 1868 but were fragmentary; between 1884 and the passing of the Technical

Instruction of 1889, there were seven attempts to pass a Bill on the subject of 'technical education'.

However, the evidence shows that as a general concept the apprenticeship system was virtually inoperative by the last two decades of the nineteenth century. The repeal of the Act in 1814 controlling the training of craft apprentices clearly underpinned the engineering employers' attitudes concerning the definition and implementation of skills. They increasingly adopted a more laissez-faire attitude to the conditions governing the employment and training of young workers, consolidating a process which had begun much earlier in the century.

5.4.1.

The Concept of the Free Contract in Apprenticeship and the Politicization of Apprentices.

I have examined some of the legal aspects relating to apprenticeships above in appendices 14 and 14(b). At this point I refer to the notion of being 'bound' as an apprentice as one which entailed a legal and moral obligation on the part of an employer to teach a young person a specific trade, for a set number of years, formerly, on payment of a premium. 'Boy-labour' carried no such obligation for employers. During the critical period both leading up to and following the E.E.F.-A.S.E. confrontation of 1897 the traditional patterns of trade training were being gradually weakened by employers either through deliberate obstruction or through omission. Accelerated changes in the character of the apprenticeship model of training were a product of the interaction between increasing mechanisation and more substantive employer control over the labour process, plus the constraints imposed upon engineering artisans after the 1852 and 1898 settlements (my appendices 2,2(a), and 2(b)). It became a 'free contract' differing in essential features from the traditional mode of apprenticeship agreements. As Knox(1986)put it

> '...the relationship was one of "mutual agreement", with the employer enjoying the right to dispense with apprentices in slack periods and the latter being allowed to "turn over" for better pay...it signalled the emergence of the proletarian apprentice by removing his social-legal status...'(p.172).

The question of nomenclature appears superficial, for both T.U.C. and E.E.F. sources show that as a consequence of the "free" contract, young workers were engaged under various labels, one of which was loosely termed 'apprentice'. This suggests a convenient designation for it did not necessarily imply a regulated period of systematic training. This was revealed as early as 1864 in the Children' Employment Commission(1864). This showed, for example, that none of the machine makers in its inquiry had formal apprenticeship agreements. One employer summed up the situation thus:

> '...apprentices...(are not) legally bound to us, that practice is now rare in the trade, but the name is still maintained whenever the lads are being taught any process that involves using their hands, except as common labourers, and results in skilled as opposed to working with a self-acting machine...'[Thomas Heatherington of the Heatherington Machine Company],(Children's 1864 Commission).

By 1894 it was reported that the old system of apprenticeship had 'almost died out', and that, in certain industries such as some branches of engineering,

> '... lads, though not indentured are still "for all practical purposes", apprentices, but it is a very loose system at present ... and there is no guarantee either that the lads shall serve for a proper period, or that, during that period, they shall be properly instructed.' [Evidence submitted to the R.C. on Labour, 1894]

In trades where boys' labour was found to be relatively more expensive than men's due to their lack of familiarity with machines and inexperience in certain processses, there was a tendency to do without apprentices altogether, or to confine their training to certain specialised areas of work. Other sectors of industry revealed an opposing tendency, the over-recruitment and exploitation of boy labour. In either case a constant factor may be distinguished, the abrogation of responsibility by employers to educate and train apprentices and young-workers in various trades. This was highlighted by the 1894 and subsequent inquiries, and referred to

> 'This absence of responsibility on the part of employers as to the instruction of the lads in their employ, combined with the fact of the excessive numbers of apprentices (in some cases "the very foremen do not know how many apprentices there are"), results in a lowering of the standard of efficiency.' [R.C. on Labour (1894),R.C. on Poor Laws(1909),H.M.S.O.(1915)]

Engineering employers such as Nasmyth, Robinson, and Noble whose evidence to the public inquiries I have discussed above, intent on

dequalifying skilled labour, used the 'free contract' to draw non-unionised labourers into machine manning. Two related developments may thus be noted: a) unskilled labour was increasingly used to man new classes of machines; b) power relations in the workshops, based on the historical artisan-labourer ("helper") structure and the employers, were radically altered. Labourers were no longer perceived by the employers solely as 'helpers' but, more significantly, as potential machine tenders. The social relations between artisans and labourers consequently changed; and the labourer was seen as a threat to the status of the journeyman, whose continued existence depended so crucially on the apprenticeship system or some system approximating to it. The fears expressed by union officials such as Allen and Burnett of the ASE seem to have been justified by the course of events. These changes were central to the ideology of control based on a principle of what I termed substitution, later known as 'craft dilution'.

It seems to me that the changing properties of the apprenticeship system involving a new concept of the 'free contract' were more than labels of convenience but constituted important structural devices for engineering employers. The traditional 'master-pupil' relationship was substantially broken. The evidence from employers regarding apprenticeship suggests that its deregulation was perceived by them as the key to their struggles with the artisans. As Mckinley(1983) notes, for example, the employers' refusal to permit union regulation of the skilled labour supply through the operation of a fixed apprentice-journeyman ratio was

> '...an integral element of the managerial prerogatives they defended in the Lock-outs of 1852 and 1897...(and)(1922)'(p.1).

Apprentices may thus be seen as acquiring a political role in the social relations of production. Knox(1986) argues they became an important bargaining factor in disputes:

> 'Changing technologies not only specialized the labour of the apprentice...but they also enhanced his strategic importance in the occupational structure of the industry..'(p.179).

Employers were by-passing the traditional agreements on apprenticeship, and employing young workers both as substitute labour and as a counter to artisan workshop power, as the evidence shows. The politicization of apprentices radicalized the relation between work and technology, and restructured the interrelation between apprentices, skilled workers, and

employers. The basis of power relations in the industry also changed to a new level beyond economic considerations, evidence of which emerged strongly in the strike and lockout of 1897. It seems to me that the political character of the relations of production is often unrecognized by writers on apprenticeship in the period. In this respect, Penn(1983) seems to characterize a common 'non-political' approach. His view is that the introduction of more semi-skilled labour was 'far more serious than the four major issues of 'systematic overtime', 'piece work', 'apprentices', and 'illegal men'(p.47). I find this fragmentary for it fails to locate the issue of substitution in its socio-political context.

Unlike the semi-skilled with no tradition of resistance to work reorganization by employers, primarily because they were non-unionized, the fulcrum of the skilled workers' long-standing struggle, i.e. from 1852, was the defence of the apprenticeship. Resistance to work reorganization came from skilled workers; notions of 'semi-skill', 'illegal' men, derived from the concept of 'skill', which traditionally depended on a formal institution, the craft apprenticeship.

The history of the apprenticeship from mid-century is also the history of the skilled workers' struggle to maintain traditional power relations in the workshops; it thus has a significant political dimension. One of the few writers to acknowledge this aspect is Price(1983) who says,

> '...unlike the semi-skilled, the key problem for the skilled was the challenge to the traditions of resistance they had erected since the 1850s...'(p.68).

With the repeal of the Statute of Apprentices is seems clear that the employers' control over the labour process grew in inverse relation to the strength of the apprenticeship.

5.5.0.

Some Arguments for Survival of the Apprenticeship

The evidence has shown that some substantial employers had disregarded the traditional agreements on apprenticeship from about the middle of the 19th century, and in some cases even before that, the Repeal of the Statute of Apprentices in 1816 being the crucial date in this respect. The implementation of new machines, although generally ad hoc, became a significant factor in the transformation of work, paralleling redefinitions of traditional skills. It plainly specialized the workshop tasks of young workers:

> "Apprentices ... are very frequently working on classes of work which they are not fully qualified to perform ... in many instances they are kept upon particular classes of work, and they do not become generally acquainted with all the details of the trade ... as a result those apprentices turn out rather inferior workmen. [R.C. on Depression of Trade, 1885]

In the light of this kind of evidence it is difficult to support the views of writers such as More(1980), Hobsbawm(1984) and Buchanan(1986) regarding the survival of the apprenticeship. More argues, for example, that employers favoured the continuation of the apprenticeship because it was a cheap and effective form of reproducing manual skills(p.219). But, he holds

> '...there is no evidence that there was widespread exploitation of apprentices in the sense of using them as cheap labour..'(p.84).

From More's position it seems that the apprenticeship, rather than being in decline, retained much of its traditional skill-acquiring characteristic to the extent that he perceives it as an alternative to technical education. Employers, he argues, were reluctant to support technical education, for unlike the apprentice system, there was no guarantee of a 'payback' for their investment in training, '...unless they were paternalistic or highly specialized organizations...'(p.219). Drawing upon human capital theory, he also argues that there is prima facie evidence that there was no decline in apprenticeship as a means of acquiring skill. The apprenticeship survived

> '...where it could earn the apprentice a decent return on his initial investment, which he made by forgoing the higher wages earnable as a juvenile in other trades...'(loc.cit.).

I view this position as unrealistic since it assumes that the kind of young workers who were the subject of the inquiry in 1864(The Children's Commission), for example, were sufficiently informed and capable of making economically rational choices in terms of opportunity cost. There seems to be little evidence of 'enskilling', the raising of levels of skill due to the implementation of advanced machinery, as implied by More's thesis. As McGuffie(1986) argues in his critique of More(1980), knowledge and intelligence for most engineering groups were not rising, but were being

> 'specialized and fragmented on one hand, and on the other, recomposed and subordinated to a managerial hierarchy...'(p.143).

Buchanan(1986) adopts a different perspective and argues the apprenticeship provided a pragmatic means of fulfilling the need for 'professional recruits'(p.43). Buchnanan here seems to use an alternative definition of apprenticeship, one relating to the practical training for professional engineers as opposed to the acquiring of manual skills for arisan work in the factory. But the essence of his model, however, is that the traditional mode of craft learning survived the century, invalidating criticisms, he says, of

> '...authors...giving insufficient weight to the strength of the traditional modes of instruction through apprenticeship and pupillage...'(p.59).

Hobsbawm(1984) argues that the specialization of labour and the introduction of new technologies 'largely failed' to displace skilled workers from their privileged positions(p.356). Thus by 1914, 60 per cent of the workforce of the E.E.F. were still regarded as skilled (p.367).

This raises the issue of skill perceived as an identifiable ability acquired through training and instruction or as a socially constructed 'label' used to distinguish certain grades of workers from others.

In another, related, perspective, Mckinlay(1986) suggests that apprenticeship also implied a 'rite of passage', a pattern of socialization into the ethics of the craft community. This, he argues, was not entirely disrupted because,

> '...skilled workers remained almost completely responsible for teaching apprentices "the mysteries of the trade"(p.4)

A similar rationale for the survival of the apprenticeship is found in Knox(1986). He also focuses on the importance of the element of 'craft mystery' in trade training, suggesting that it formed an indispensable part of artisan development:

> 'The element of "craft mystery" was still in many trades a tangible factor in the production process, giving the tradesman a measure of craft control...'(p.173).

The evidence shows that both the form and content of the traditional apprenticeship had been radically transformed: The artisan machinist's role was clearly modified by the implementation of new technologies, as the evidence of Nasmyth, Noble and Robinson confirms. I believe the essence of new technologies developed from the 1850s was the stripping away of much of the 'mystery' surrounding manual and machine skills. Of particular significance in this respect was Whitworth's research which centred on what he regarded as one of the 'mysteries' of the trade, control over measurement. His gauges and methods of narrowing tolerances were specifically designed to eradicate discretion over sizes of work by individual workers.[Whitworth 1854,1856,1876].

McGuffie(1986) commenting on this feature of engineering production, says,

> '...though in both old and new methods, sight and touch were used by the worker, (later)...the ultimate standard was not the worker's judgement of divisions on a rule, but rather the precise dimensions...'(p.153).

An important source of evidence regarding the nature of the changing apprenticeship pattern is to be found in the first major study by a metropolitan authority - London. I shall examine this in the next sub-section.

5.6.0.

The London Employers: A Case Study: Sidney Webb and the London County Council Technical Education Committee

By the late 19th century the process of skill substitution had become a significant factor affecting general employer attitudes regarding labour control and the traditional apprenticeship system in engineering. Sidney Webb, chairman of the London County Council Technical Education Committee, commissioned the first major study into the provision of technical education in London. A report was published in 1897 after

extensive research by a Committee member, Llewellyn Smith. It has been widely quoted as being the first comprehensive study of technical education carried out by a metropolitan area.

The findings of a further London County Council report in 1906 offers evidence in support of the general conclusions of the first survey. In the main, employers had abrogated their responsibility with respect to the training of young workers in skilled trades. It was reported that the old system of indentured apprenticeship had for many years been falling into decay,

> '... In the majority of the industries it has almost entirely disappeared.' [L.C.C. Report 1906]

From this report Webb was to argue that many London employers not only refused to teach apprentices, even for premiums - they often refused to have boys on those parts of their establishments in which anything could be learnt. This practice, according to Webb, was coincident with the increasing scale of engineering enterprises which discouraged the master-apprentices relationship. As Webb expressed it,

> '... the village blacksmith can take an apprentice, but a large engineering firm does not take anything like a proportionate number of apprentices.' [R.C. on Poor Laws (1909) Q.93031, 93035]

The L.C.C. reports considered the sub-division of labour, the introduction of 'machinery'; and the development of mammoth factories as contributory factors in apprenticeship decline. It is not clear in the report what kind or species of machinery is referred to - for the purpose of this illustration it may be assumed that the reference is to machines embodying self-acting devices and automatic principles based on the machine tool concepts I have analysed above. These factors, the Reports argued, tended to render the old practices of apprenticeship either undesirable or impracticable.

> 'The large employer does not care to be troubled with boys if he is compelled to teach them the whole trade. He prefers to divide his processes into men's work and boys' work, and to keep each grade to its allotted routine.' [L.C.C. Report 1906, p.1]

It was further argued that employer reticence over the traditional craft training processes was well established by the first decade of the twentieth century. The routinisation of the labour process based primarily on advanced machinery in the engineering and allied trades thus seems to have proved a disincentive to employers regarding apprenticeships. The advantages to the employers of using boy labour rather than apprentices outweighed the incentives to be derived in the form of grants from outside agencies. Data show that the aggregate of endowed charities that

might be employed in apprenticing children was nearly £24,000, of which not more than one third had been used for that purpose.It was contended that the trustees of the charities had considerable difficulties in their attempts to revive the apprenticeship system in London. [L.C.C. Report 1906)

The case of the London employers is significant in my view. Statistical returns of children, young persons and adults working in factories and workshops, in 1904, indicate that of the total industrial population of England and Wales, thus employed, London contained one-seventh. The proportion of children entering any form of skilled training at this time was about one-third. The remainder drifted into unskilled occupations. [L.C.C. Report, 1909, p.415; London Statistics,Vol xviii, quoted in The Economic Journal,Sep.1909,p.408].

The number of boys covered by L.C.C. returns was 8756, of which 27.1 per cent entered occupations categorised as skilled; and 64.2 per cent entered unskilled occupation. Just under 3.8 per cent were reported as having 'higher education'. [L.C.C. Report, 1909] A further 2028 boys included in the census were returned under' non-provided'. Of these 34.7 per cent entered skilled jobs, 63 per cent unskilled, while 2.3 per cent were returned as entering higher education. The total for this survey of boys shows that of 10,784 boys, 28.5 per cent and 67.9 per cent entered skilled and unskilled job respectively. Those entering higher education averaged 3.6 per cent.

Findings based on more general research for the same period in the U.K. confirmed that there was a regular drift by young workers into the low-skilled labour market. In the case of London the trend was attributed to the enormous growth of the city as a distributive centre. A Royal Commission put the level of drift at between 70 per cent and 80 per cent of boys leaving elementary schools entered unskilled occupation. [R.C. on Poor Laws, 1909, para.136].

London presented innumerable 'dead-end' openings for errand boys, milk boys, office and shop boys, bookstall boys, van, lorry boys, street sellers.

> 'In nearly all these occupations the training received leads to nothing; and the occupations themselves are, ... destructive to healthy development, owing to long hours, long periods of standing, walking, or mere waiting, and, morally, are wholly demoralising.' [R.C. on Poor Laws 1909, para.137]

The majority report of the Royal Commission on the Poor Laws noted that in addition to the 'blind alley' labour of boys in the streets as messengers and errand boys, as noted above, there was systematic exploitation within the factories where they were taken on as "process workers":

> They were '... put to machinery, and, while becoming expert in one operation, learn nothing of the fundamental principles of the trades in which they are engaged.' [R.C. on Poor Laws, para.590]

The Poor Laws Commission of 1909 implied that some employers of child labour were exploitative in character and '... get more than they ought of the physical and moral capital of the rising generation.' [R.C. on Poor Laws, para. 545]

The interaction between the patterns of recruitment of boy labour and the growing exploitative character of the productive process, was again reiterated in a minority report of the Poor Laws Commission. This put the view that a mass of unemployment was continually being sustained by

> '... a stream of young men from industries which rely upon unskilled boy labour, and turn it adrift at manhood without any general or special industrial qualification ...' [R.C. on Poor Laws, 1909]

Clearly there were sectors of the economy of an exploitative character, to which many young workers were drawn, particularly in metropolitan areas. Three features may be distinguished as relevant to my analysis. First, without apprenticeship into trades, but attracted by relatively high wages, boys often remained as unskilled labour until they were too old to enter any other regular occupation. Second, if this tendency is put against the work-life expectancy of the time it becomes highly significant. It has been argued, for example, that in 1894 the average age at death for manual workers was 45 years. The number which, according to union sources, continued at work after that age was so trifling that it was argued that for practical purposes, there were no men available after 45. [Inglis, J., 1894, p.7]. Taking twenty-two as the age at which a journeyman's life began, the duration of his working life would therefore be taken as twenty-three years. Third, the availability of a mass of undifferentiated young labour, unprotected by bound agreements, proved a disincentive to employers regarding apprenticeships. This represented an almost total collapse of the apprenticeship system in the Capital, and signalled a corresponding disregard for technical education.

5.7.0.

Summary and Discussion: Employer Attitudes to Apprenticeship After the 1897 Strike

The evidence, particularly from official sources, reveals a general criticism of employers regarding the apprenticeship system: The Childrens Commission of 1864, Inquiry into Trades Unions in 1867, the 1886 Inquiry into the Depression of Trade, the 1893 Poor Laws Commision, and the 1894 Royal Commission; as well as criticisms arising out of the direct challenge to their ideology from specific unions.

In the case of engineering the evidence has also shown that there was a clear conflict of interest between the A.S.E. and engineering employers regarding the training and education of young workers. On the question of the apprentice-journeymen ratio Inglis(1894) deduces a ratio in the order of 3-4 per cent. Figures from EEF sources for the turn of the century show for the Federation as a whole,the following proportion of apprentices to journeymen. Fitters 12.17 per cent; turners 5.88 per cent; planers , borers and slotters 0.412 per cent; smiths 45.5 per cent (EEF Minutes 1906). At a corporate level the engineering employers were expressing concern over the apprentice situation, their minutes for 1903 and 1904 stated:

> '...(the Committee have directed that the combined attention of the members be drawn to the great importance of training apprentices and of maintaining an adequate proportion to the number of men employed...'(EEf Minutes 1903/1904)

There were clear disparities between concerns expressed at a corporate level and what was happening in the workshop. The evidence I have examined above shows the conflicts between engineering employers and workers on the subject of apprenticeships turned chiefly on the question of who was going to man the new machines; and on the more general issues of limiting the number of 'apprentices' in the trade. These issues were also the focus of the 1881-4 Inquiry specifically instituted to examine provision for a national system of technical education. This was the first of its kind. I shall examine this Inquiry in detail in Section Three.

After the 1897 dispute the engineering employers, acting as a federated body, continued to modify the conditions governing the apprenticeship. This may be seen as one of a number of strategies

developed by engineering employers to consolidate their control of the labour process.

Cronin(1987) has argued that during the course of the 19th century employers became more adept at devising new methods of labour control:

> '...the employers' side took the initiative in evolving new forms of organization with which to prosecute their aims...engineering employers gave the lead in organized strike breaking...'(p162).

Of particular importance was their ablility to minimize the effects of strike action by militant artisans; the politicization of apprentices being highly significant in this regard. The evidence has shown that enlarged employer controls and modifications of the apprenticeship acted against the long-term interests of skilled workers. The implementation of late 19th century changes in technology or management did little to advantage artisans or apprentices, and clearly worsened the relations between the skilled and the unskilled workers. Traditional legal restraints governing apprentice-employer relations were so diluted as to be meaningless, strengthening employer controls over skill definitions and the employment of boy labour and machine manning.

The decline in apprenticeship was uneven and the Charity Commissioners annual report of 1897 shows that vestiges of the old system remained in twenty-seven engineering trades [PRO files 1897]. On the other hand, the evidence I have produced demonstrates that as a general concept the apprenticeship system was in rapid decline, particularly in London; and craft training was no longer perceived in terms of an historical 'master-pupil' relationship. Thus, Noble, director of one of the largest engineering concerns of the country, was able to argue in 1904, that due to their employment policy, which, the evidence shows, meant the employment of cheap, 'defranchised,' boy labour, it was possible to maintain production of his Elswick works during the 1897/8 dispute. This was carried through with no less than 10,000 men,

> '... while nearly all the engineering works in Newcastle were stopped ... we had ... hundreds of machines at work ... and at <u>not one of these machines was there a turner or a high class machine-man employed.</u>' [R.C. on Trade Disputes, 1906, Q.2415] [My emphasis].

Noble's evidence to the earlier 1893 commission has been referred to above [R.C. on Labour, 1893, Q.25217], and from this it is clear that the policy of his company was to employ, as far as possible, boy labour as opposed to bound apprentices. The consequences of this policy were threefold: a) machines were increasingly manned with unapprenticed

labour, b) skilled labour resistance was circumvented, c) the re-definition of "apprenticeship" was altered to foster the aims of management rather than labour. This represented three of the clauses of the 1898 Terms of Settlement, following the 1897/8 conflict, which directly confronted the principle regarding apprenticeship put forward by the Amalgamated Society of Engineers. This principle held that tradesmen maintained areas of autonomy over methods and pace of work through a structured craft apprenticeship system, or a system approximating to it. Clearly large employers such as Noble, and Armstrong had successfully challenged the unions over this issue.Such evidence strongly suggests that the traditional mode of craft training, the apprenticeship system, had been allowed to languish from the 1850s.

I have attempted to show in this chapter that, against the background of increasing employer control over the organisation of work, there was a decline in the historical form of trade training and a corresponding redefinition of craft skill. This decline reflected the employers' increasing dominance over the total labour process: Any ideology or traditional practice perceived by them as challenging their hegemonic control over the disposition of labour power and machines was vigorously confronted. It has thus been my argument that the decline of the apprenticeship system has to be seen against a background of struggles over power industrial relations and attendant political considerations.

In Section Three I seek to extend this argument by showing how this aspect of the employers' strategies of control related more concretely to the development of technical education. I believe the evidence shows, first, that the Technical Instruction Act of 1889, the first piece of legislation specifically designed to promote some form of national technical education, made little impact on employers in the engineering industry, who resisted ideas or initiatives which they perceived to be contrary to their ideology of production. This situation was crystallized in the 1897 confrontation in the engineering industry, the effects of which lasted well into the next century. For example, H. A. L. Fisher, responsible for the 1918 Education Act, argued that industries

'... have done little towards helping to improve the system of training, while they have offered no adequate reward to those who have been trained. The system of organized technical instruction had, in practice, been organized from outside industries, ... whose full interest and cooperation it has never succeded in securing.'[PRO 1919].

Second, incipient forms of technical education derived from models put forward by agencies outside engineering trades, for example through interested parties associated with the Society of Arts, in addition to those argued by craftsmen and other workers from about 1868, were also perceived by employers as threatening. By and large, these kinds of initiatives were generally undervalued, and criticized in the Press as presumptious. But the more serious issue for workers were contradictory elements in the case put forward by artisan groups which were compounded by their ambiguous relations with influential employers. In the next chapter I examine some of the implications of these contradictions for workers' education within the context of general educational provision from the 1860s.

CHAPTER 6

CONTRADICTIONS AND STRUGGLE IN IDEAS ABOUT EDUCATION FROM 1867 to 1897.

6.0.0.

Introduction.

My aim in this Chapter is to examine some of the developments in education which were taking place about the same time as the technical developments I have discussed. I explore some of the proposals for a system of technical education made by artisans, concerned with the prevailing inadequacies of educational provisions. I make the point that in proposing models of technical education based on existing mass education provision, artisans were seriously compromised by the contradictory nature of their position with respect to employers and non-skilled workers.

First there is a need to locate the various definitions of technical education held by different groups within a broader concept of general education. Second, offer an explanation of how these definitions were used and were related to 'science' education in the period 1860 to the end of the century.

Two main questions are addressed: What conception of technical education was held by the State and influential public figures? How did this particular view of technical education relate to the attitudes and understanding of the principal 'target' groups, artisans and their employers?

To set the context I shall briefly examine the provision of general education, and the nature of state provision in the period from the 1860s.

6.1.0

General Education Provision

Most authorities agree that growth in educational provision in England and Wales from mid-century was not continuous or coherent. Often, agencies responsible for various aspects of education appeared to be not only independent of others, but also operated with little regard to their existence. For example, there was a Committee of Council with two departments running side by side: the Elementary School Department which was independent of, and received no aid from, the Science and Art Department; both under the President of the Council. Official reports show that in the 1860s administration of these two principal agencies of state-provided education was imperfect. [R.C. on Secondary Education 1895 p.9]

In 1868 the teaching profession principally concerned with servicing both elements controlled by the Committee of Council, was regarded as almost entirely unorganised; its members isolated with few common aims. [Ibid. p.14].

There was also a third body involved in state education, the Charity Commissioners. This institution had little to do with the Education Department at Whitehall, and hardly any contact with the Science and Art Department at South Kensington. The Charity Commission however, seemed to have an important relation to certain aspects of the apprenticeship system. It was the responsible organisation for the administration of various charities' funds, including the financing of apprentice schemes e.g. those concerned with children 'under care' such as paupers.

Another agency, the Endowed School Commissioners, was loosely aligned to the administrative structure of the others, but also seemed to act independently. In 1874 this Commission was merged with the Board of Charity Commissioners. Subsequent Acts modified the function of this body giving it wider powers regarding endowed schools. But later, the Bryce Report considered its significance weak and powers inadequate. [Ibid. p.9]

Other Government schools existed outside the Education Department. There were Union and Workhouse Schools under the Poor Law Board; Military and Regimental schools under the War Office; Naval and Ship schools under the Admiralty; Factory and 'Industrial schools' under the Home Office.

The administration of this disparate group of educational agencies was poor; one view being that it was in

"... a state of chaotic confusion". [Playfair, 1871, p.61]

An historical review by the Bryce Commission, shows that in the period from the 1860's through the 1890's the organisation and development of provided education, and its administration was neither logical nor consistent. [Bryce Commission, 1895, p.17].

The lack of coherence and organisation in general education was reflected in the early attempts to develop a national system of 'technical education'. Both suffered similar problems over funding. After the 1889 Act, technical 'instruction' grants (the 1889 Act referred to technical 'instruction' not technical 'education'), were being made with little regard to parallel grants being made by the Science and Art Department. The overall effect seems to have generated needless competition and overlapping of effort.

I argued in the previous chapter that artisans, in advocating the need for technical education provision, based on the apprenticeship system, had concluded as early as the 1870s that such a model would require State funding. But the evidence shows that it was ill-equipped both in administration and funding to control a universal system of technical education. This could account for the prevailing tendency of educational administrators at the time to consider 'technical education' narrowly as an extension of 'science education'. The agency responsible for 'science' in schools in the 1860s and 1870s, was the Science and Art Department. I now briefly examine this agency and its function.

6.1.1

The Science and Art Department at South Kensington

The Department of Science and Art was formed in 1853 under the direction of Henry Cole. He was joined in 1856 by the chemist, Lyon Playfair, who was Professor of Chemistry at the School of Mines from its inception and played a leading part in organising the Great Exhibition of 1851. He represented the Universities of Edinburgh and St. Andrews as a Liberal from 1868 to 1885. It has been asserted that despite the overwhelming success of Britain in the 1851 Exhibition, Playfair was among the few critics who seemed to realise that this was to mark the

end of industrial pre-eminence for Britain, not the beginning. [Williams, T.I. (Ed.) 1969 p.421].

Playfair assumed responsibility for the 'science' aspects of the department. One of the primary objectives of the Department was the administration of a system of grants for the provision of science teaching in schools. Clearly, this provision was limited in the period from the 1850s and 1860s. In 1860 there were 9 'science' schools, with 500 pupils; in 1867 212 schools with 560 classes and 10,230 pupils. [Privy Council (1867)]. Official data for the period 1855-1878 demonstrate that government expenditure on elementary education, and science and art increased from 1.26 per cent to 4.88 per cent in absolute terms. But the relative disposition of funds specifically for science and art, fell 14 per cent in the same period. [British Association (1879) p.466]. Other official data for the period 1871-2 to 1878-9 confirm the decline in expenditure on science and art: total expenditure for education in Great Britain, £1,107,430, expenditure on science and art, £211,083 (19%) (1871); with figures of £3,732,534, and £305,324 (11%) respectively for 1878-9. [PRO Ed 23/71, Appendix A. 1889].[My appendix 23 provides detail].

Data on the relative growth rate in science teaching in schools, indicate in my view that in this early period, 'science' education tended to be equated with 'technical' education [See appendices 17 and 19]. This equation partly explains government's apparent reluctance to distinguish and take responsibility for 'technical education'. The problem with the Directory's concept of technical education, as an extension of science teaching, was that 'science' itself was underfunded and provision generally inadequate.

That the Directory at South Kensington considered 'science' and 'technical education' to be more or less synonomous may be inferred from a Science and Art minute of 1867:

> "In order to assist the artisan classes who may show an aptitude for scientific instruction, My Lords resolve to aid local efforts ..."

And later the rule covering the award of exhibitions for Science in Schools/Colleges stated

> "... The exhibitioner must be of the artisan class or a poor student, as defined by the Science Directory". [Privy Council (1867)a]

Pressure for 'technical education', from whatever source, was perceived by the Directory as proposals for the extension of existing provision rather

than demands for a new form of education. But the evidence also shows that existing provision for science teaching in schools was not meeting the needs as perceived by certain groups of workers such as skilled workers i.e. related to the craft apprenticeship system. There was no change in structure or content in the Directory's scheme for at least thirty years.

It may be reasonably deduced that in terms of administration and funding, science and art education was a relatively low government priority over this period.

It seems to me that the reluctance by the State to extend its financial and administrative responsibility in this area of education was paralleled by the static nature of the curriculum in the same period, through to the 1890s. Therefore apart from the issues of government priorities regarding funding and administrative responsibility, there was the issue of what was taught under the heading 'science' and to whom it was directed. A Select Committee set up in 1868 provided an initial focus for these questions.

6.2.0

The Paris Exhibition of 1867, and the Select Committee on Science Instruction.

The Select Committee on Science Instruction was appointed following critical reports from observers at the Paris International Exhibition of 1867. Of these, I cite two. They were written by Lyon Playfair and another well-known scientist of the period, John Scott-Russell, who were jurors at the Exhibition. They focused attention on the relatively poor placing of British industrial contributors in the Exhibition. Playfair suggested that the 'failure' of British manufacturers vis à vis Continental countries was primarily due to a lack of 'technical education'. Writing to the Chairman of the Select Committee, Lord Taunton in 1867 he emphasised that

> "... (continental countries) possess good systems of industrial education for the workers and managers of factories and workshops, and that England possesses none ..." [Playfair to Taunton, 1867]

Playfair initiated the first public discussion of this issue by criticising the lack of technical education provision in England through

the columns of the Times. Fellow Exhibition jurors, and others, supported his arguments.

Frankland, scientist and Paris juror, for example, argued that the lack of science education was a defect in school and college education

> "... (which) affects the masters and managers of our factories even more deeply than the workman themselves ..." [Engineering' 19th July 1867, p.48]

His contention was that lack of scientific training, in physics and chemistry especially, prevented them from 'originating inventions and improvements'.

In the machine tool section another Paris juror argued that the lack of technical education would lead to increasing costs and a lowering of quality of work turned out by artisans. [McConnell, J. (1867)]. Scott-Russell added to his previous comments in the official Exhibition reports by advocating some form of 'technical training' for

> '... all youth destined to skilled trades and occupations'. (Engineering, Ibid. p.49]

The evidence taken by the Select Committee was used to evaluate the system of science instruction in schools and other institutions and of the aid granted to it. This evidence fell under two heads, giving some indication what 'science' was held to be, and to whom it was presumed to be of value. Science teaching was thus reviewed under

> i) the state of scientific instruction of a) the foremen and workmen engaged in manufacture, b) the smaller manufacturers and managers, c) the proprietors and managers-in-chief of large industrial undertakings.
>
> ii)the relation of industrial education to industrial progress.

The division between the groups was clearly identified in the Report and seems to reflect in its structure the specific views of the relation between science and industry held by scientists. The influence of Continental systems, although treated with circumspection, was reflected in a call from an engineer juror for the setting up of an institution like the Arts et Metiers of Paris. [Ibid. p.48]. This, it was argued, would be valuable not only to working men and their 'superiors' but to engineers.

6.2.1

Technical Education as an Extension of Science Teaching.

Playfair and the Select Committee focused on factors which they assumed were inhibiting productive efficiency. The lack of science education was identified as one factor which they perceived as appropriate to those engaged in the manufacturing industries.

The underlying assumption seems to have been that their definition of science education as technical education could satisfy not only technical requirements but also the perceived social needs of industry. On this latter point Playfair noted in his letter to Taunton that

> "... (industry) suffered from the want of cordiality between the employers of labour and workmen ..." [Playfair to Taunton,1867]

The Select Committee supported this view and outlined an educational scheme in its proposals. Particularly emphasised was the need for efficient elementary schools (for foremen and workmen); and the reorganisation of secondary schools (for the smaller manufacturers and managers). The 'proprietors' and 'managers-in-chief' were considered the group to benefit from the other principal recommendation that

> '... there was a claim upon national funds for grants in aid of the provision of superior colleges of science and superior schools for technical instruction requiring costly buildings and laboratories'. [S.C. on S.I. (1868)]

It also accepted that the range of sciences offered under the Directory suited the various grades of industrial worker and management in manufacturing industry, provided elementary and secondary education were improved:

> 'foremen...by reason of their superior natural aptitude, steadfastness and industry were unable except rarely, to take advantage of scientific instruction ...' [S.C. on S.I. p.iii]

The Inquiry also noted that second only to the defective elementary instruction of the student was the scarcity of science teachers:

"... science teaching is scarcely followed as a profession ..." [Ibid. p.v]

The clear implication was that a scarcity of science teachers and the depressed state of general education was linked to the inadequacies in industrial 'efficiency', as suggested in critiques by Playfair, Scott-Russell and other Exhibition jurors. It was Playfair who raised the issue of the parlous state of science teaching in the House of Commons when he revealed that at the time of the Select Committee of Inquiry,

there were no science teachers under training anywhere in England. [Hansard (1869)].

The Directory's science scheme however reaffirmed the theoretical emphasis of the sciences and a narrow interpretation of their function:

> 'The object of the grant is to promote instruction in Science especially among the industrial classes by affording a limited and partial aid or stimulus towards the funding and maintenance of Science schools and classes'. [Privy Council (1868) Appendix D]

But the laissez faire ideology underlying science grants was evident. They were subject to market forces and not intended to encourage gratuitous provision. Local funds were to be used for providing suitable premises. If these were not found, it was inferred

> '... that there is no (such) demand as the government is justified in aiding for instruction in the locality ...' [Ibid. p.43]

At the time the Directory at South Kensington co-ordinated and organised a mainly theoretically-based examination structure of twenty-three subjects. Included under this structure were some subject areas that might be termed 'technological': Mechanical drawing, mechanical, plane and solid geometry; mechanical and machine drawing; theoretical mechanics, applied mechanics; magnetism and electricity; elementary and higher mathematics. [Privy Council (1867) p.18].

Thus the limited aid and theoretical bias of the Directory's scheme continued, the structure and content remaining intact with the approved list and examination procedure unchanged until 1898, when two further subjects were added, hygiene, and agriculture. This may be seen in the Directory's approved list of sciences taught in establishments under its jurisdiction.[Appendix 19].

Few engineering courses existed at the time, but a proposal was put at a society of Arts meeting in 1868 by Scott-Russell for a course for 'the mechanical engineer and machinist'. [Journal S.O.A. July 1868) p.628]. In content it was similar to the subject elements contained in the Directory's approved 'science' list. The table gives the course outline:

THE MECHANICAL ENGINEER AND MACHINIST

A THREE YEARS' COURSE

[Proposed by J. Scott-Russell]

First Year

(Mathematics
Pure Science (Physics
(Chemistry
(Descriptive geometry
Applications (Elements of mechanism
of Science (Strength of materials of construction
Practical work in laboratories and drawing offices and museums to accompany each study.

Second Year

(Mathematics
Pure Science (Physics
(Natural history
(Constructive geometry
Applications (Prime movers and steam engines
of Science (Nature and raw materials
(History of inventions
(Elements of mechanism
Practical work in laboratories and drawing office and museums to accompany each study.

Third Year

(Mathematics
Pure Science (Ultimate mathematical physics
(Political economy
(Statics of Machinery
(Hydraulic machinery
Applications (Prime movers
of Science (Electro-magnetic mechanism
(Engine tools
(Metallurgy
(Design of factories

Practical work to be carried on in laboratories, drawing office and museums, and collections of machinery during the Session.
Practical work in factories and workshop should, if possible, alternate with study in periods of six months.

At the end of apprenticeship a course of travel, with work and study, should be recommended. [Source: Journal Society of Arts, 24 Jul 1868 p.628]

Table 4

The concept of a six-month 'sandwich' was clearly novel as was the 'course of travel...' Neither seems to have become the norm in the late 19th or early 20th century.

The theoretical bias of the sciences offered by the Directory and Scott-Russell suggests a high level of expectation, despite prevailing criticism that elementary education was at a poor level. It also suggests a degree of over-optimism, given that in 1867 any person wishing to be recognised as a science teacher was free to do so provided he "... offers himself for examination once a year ..." (Privy Council (1867)]

A science 'school' or class was quite simply any place where one or more of the Directory's sciences was taught; and teachers in such a situation received payment according to results. [loc.cit.]

However, arguments put forward for 'technical education' by Playfair, T. H. Huxley, and to a lesser extent, Scott-Russell, in the main were clearly proposals for an extension of existing science education provision. For example Huxley argued

> "... the great thing wanted (in technical education) was scientific instruction to artisans ..." [Huxley, T. H. (1868) p.199]

His view appears to have stemmed from his close connection with the Mechanics' Institute at the time. As external examiner in the sciences to the various institutes, he was receiving an annual average of two thousand sets of papers, mainly from artisans. Other examiners in these fields could expect three or four times that number of papers [Hansard (1869)]. As principal of the School of Mines, he was also aware of the practical interest shown by artisans in the series of science lectures put on by that institute. The six hundred tickets issued for artisans in connection with the series were regularly over-subscribed. Privy [Council 1868 col.160].

Scott-Russell's research into Continental technical education on behalf of the Samuelson Commission of 1868 led him to a similar conclusion:

> '... the teaching of science was indispensable for youths intended to be craftsmen ...'

He was convinced that the reported advantages in European industrial efficiency were due to systematic scientific education. [Journal S.O.A. (1867) 7th June].

Playfair had long been an active supporter of state-provided education. His earlier comments to the 1868 Select Committee have been noted. In 1888, he could still argue that

> 'the object of technical education is to give an intelligent knowledge of the sciences and arts which lie at the basis of all industries ...' [Nineteenth Century, (1888) p.327]

He asserted that because industry had become more scientific its management became more 'professional': 'Industrial occupations are acquiring the dignity of a profession, because they are now based on a knowledge of science'. [Ibid. p.332]

There is an interesting parallel here with Marx's views. Writing with reference to the revolutionary technical basis of industry, Marx argued,

> 'by means of machinery, chemical processes and other methods, it is continually causing changes not only in the technical basis of production, but also in the functions of the labourer, and in the social combinations of the labour-process'. [Marx. K. (1887,1977) p.457]

My point is not to reveal assumed congruities between the theories of Playfair and Marx but to suggest that the emphasis on 'science' characterised in the work of these commentators of the early period concealed an ambiguity in their contribution to educational thinking of the period.

Scott-Russell had reservations about the 'science-technology' relation and put forward a dissenting note regarding the assumed close alignment between science and technical education. He was concerned about the separation of theory from practice, and argued,'... the divorce of practice from science has been the great misfortune of our generation ...' [Scott-Russell, J. (1869) p.349]. 'Students', he said, 'should be exposed to the best examples of craftsmanship'. [Journal of Society of Arts p.351]

He maintained that the separation generated a division between management and labour. The former, lacking skill abrogated responsibility to a 'middle-man' and becomes '... a buyer and seller of other men's work'. Skill, he asserted disappeared under the 'reigning maxim of 'cheap work' to be sold dear'. [Ibid. pp.119, 126].

He advanced this view in the Journal of the Society of Arts in which he had also introduced what seems to me, to be the first use of the concept of 'Further Education'. He described it as follows:

> '... a schooling midway between the elementary day school and the workshop, which the youth should enter after he knows his reading, writing and counting, in order to learn to apply his reading, writing and calculation to his purpose of requiring such knowledge of mathematics, mechanics, numerology, chemistry, drawing etc., ...'[Journal, S.O.A. 7th June 1867]

The implications for the long-term development of English technical education of Scott-Russell's notion of 'further education' in my view, have been underestimated in existing accounts. His proposition added weight to the views of employers I examined in my analysis of the piece-work system and the apprenticeship above, that demands for technical education were best met, if at all, on a part-time pattern. If 'further education' implied evening classes, then such a system suited a conception of technical education which made few demands on production time. The evidence shows other models, such as 'day-release' or full-time periods of education of short duration were not seriously considered as alternatives. A possible reason for this was their lack of correspondence with the changing patterns of technological and organisational innovation being implemented at the time.

Scott-Russell later broadened his views on further education in his definition of the technical college as an institution of continuing education:-

> 'Technical Colleges have a special duty to those who leave education at 18. They are to be shown how all the abstract science they have learnt leads up to the work they are about to do'. [Scott-Russell (1869) p.347]

Despite Scott-Russell's criticism of the separation of theory from practice implied in the models of nineteenth century scientists, he, together with others such as Playfair, Huxley, and Frankland, retained the conviction that 'science' education was a means of improving industrial efficiency. They seemed to have underestimated the critical influence of strong industrial employers. Almost by definition, the institutional

context of technical education was conceived in a way which abstracted it from the organization of work and actual industrial work practices. They showed only limited recognition of the possible interaction between work, technology, and technical education. Skilled workers involved in the production process viewed the situation from a different perspective.

6.3.0

Artisan Views on the Issue of Technical Education: T.U.Congresses from the 1860s.

In the 1860s and 1870s the Directory's science provision and the Society of Arts' technical examination scheme were the only available sources of what could be loosely called 'technical education'.

Evidence relating to artisans' views from the period, shows that they held a different conception of 'science', which appeared to challenge the prevailing orthodoxy.

Throughout most of the century from the 1860s the trades unions consistently reiterated their belief in the strengthening of the relationship between traditionally-acquired craft practices and some form of technical education. The TUC, from its inception, in 1868, passed formal resolutions to this effect. This also coincided with the first Society of Arts meeting on the same issue.

This first T.U.C. conference, sensing the need for adequate primary education as a pre-condition of technical education, referred to these issues as follows:

> '... this Congress, recognising the immense value of education, primary and technical, recommends the trades of the U.K. to aid by all means in their power every effort to advance national education'. [T.U.C. Minutes (1868)]

Apart from their own, independent sources, such as the Artizans' Institute, the Workingmens' School Union, and the Trades Guild of Learning(which I discuss below), these views thus found expression at a corporate level, the T.U Congresses in which the old system of apprenticeship was regarded as constituting technical education:

> '... the genuineness, and the superiority of British manufacture was built up under the old system of apprenticeship, which, though rude, and often tyrannical <u>was a sort of technical education'</u> [loc.cit.][my emphasis].

This view was restated in the year following Forster's Elementary Education Act of 1870 was passed. The relationship between primary education and technical education was clearly reaffirmed:

> '... primary education should without delay be applied to every child in the kingdom and that in addition to this a good technical education should be open to every person engaged in connection with the industry of the country'. [Ibid. (1871)]

In 1874 the Congress argued that their deliberations should take some concrete form, adding that further independent action might be appropriate to their needs:

> "... the time has come when it would be well for the workingmen's organisations to actively take up the question of technical education, with a view to developing skill and that with this object, schools for technical instruction ought to be established in every centre of industry, supported by grants from the Education Department". [Ibid. (1874)][My emphasis].

The term 'further independent action' is intended to highlight the fact that a number of working class initiatives in this direction had previously been attempted in 1867-1869.

This was a new concept of technical education which embodied a notion of its relation to the acquisition of 'skill', as the 1874 resolution shows by its reference to 'technical education' and 'technical instruction'.

A number of crucial issues for artisans were embodied in these resolutions. First, the T.U.C. clearly recognised the artisans' need for technical education based on universal primary education. Second, there was an acknowledgement that such provision would require government support and could not be over-dependent upon voluntary provision.

It is clear that union thinking on technical education throughout this period was premised on the idea of the inseparability of a structured craft training system, the apprenticeship, and some form of technical education. Thus in 1880 it was resolved that

> '... a regular system of indentured apprenticeship extending over a stipulated period is the best means of furthering the development of technical knowledge and increasing the skill of workmen in the United Kingdom'. [Ibid. (1880)] (Congress at Dublin). My emphasis.

Such a proposition appears far-sighted, but was utopian for it demonstrates a mis-judgement of the prevailing industrial situation. It was evident that neither sustaining the apprenticeship in its historical form nor supporting a national technical education system underpinned the

employers' industrial policies. It was also plain that from 1852, skilled workers were being drawn increasingly into a struggle against the prevailing philosophy, held by both State and employers, that British industry was fairly well adapted to current needs and demands. Spurred on by the strength of their belief in free-market policies, employers adhered to essentially short-term measures, which contradicted the longer term expectations for training within British industry held by skilled workers. As one employer put it,

> 'We have to train for today's jobs and today's requirements...we should have to train for those jobs which already exist and not worry that these jobs may not exist in 10 years time...'(Smith, of the Sturmey-Archer Company, quoted by Carroll(1979)

Artisans failed to appreciate that technical education had become tied to market forces, despite the fact that, for all practical purposes, its control had devolved upon ad hoc strategies administered by local authorities.

6.3.1

Problems Underlying the T.U.C. Case for a Retention of the Apprenticeship System as a Basis for Technical Education

It was central to the union argument that it was only through systematic training that the craftsman could effectively resist skill dequalification and decline to a 'mere appendage of the machine'. In 1885 it was therefore argued that through the appenticeship system:

> '... (the) workman would become the controller of the mechanical forces; (and) instead of being part of a machine he would supply the knowledge, the skill, and the artistic taste". [T.U.C. Minutes 1885]

My examination of the 1897 strike will show that the engineering unions viewed the employers' increasing use of unskilled labour through machine technology as a threat which originated in managerial strategies to weaken their workshop autonomy. The reaffirmation of the need for retention of the apprenticeship system was one of the responses to this threat.

The unions expressed these ideas within a framework of resistance to the employers' increasing control over the reorganisation of work. As my discussion on this has shown the engineering union's tactic was to project their rules, such as those covering apprenticeship and trade

training, as constituting important elements of control over skilled engineering practices:

> 'Every artisan following a given occupation has an interest in common with those similarly engaged in forming rules by which that trade should be regulated ...' [R.C. on T.U. (1869)]

Employer control over the labour process clearly had significant implications for the attitudes and policies on technical education the artisans were attempting to put forward as part of the general aim to preserve the apprenticeship system.

T.U.C. propositions on technical education, apparently unambiguous in their intent, however, obscured the social and technical significance of a fundamental principle in union policies: their craft and social exclusivity. The historical pattern of trade practices rigidly excluded non-apprenticed workers from negotiations with employers. In presenting a case for some form of technical education, artisans persistently attempted to distance themselves from unskilled workers. They were prepared to align themselves with the employers over certain isues, i.e. improve 'industrial efficiency' in order to secure their skilled status vis a vis the unskilled. This indirectly stiffened the employers' position regarding craft training and education, for, as I have argued the employers were implementing new technologies which relied less on skilled workers and made substitution viable and more profitable. Hence any basis for skilled employee-employer interdependence was undermined, weakening the case for a technical education system based on the apprenticeship of trade training. The question of artisan status and privilege became one of the central issues in the 1897/8 conflict in engineering.

In Chapter five I put the case that employer control over production varied in inverse relation to the strength of the craft apprenticeship system. If the unions claimed the apprenticeship system to be central to technical education, it would follow that employer control over apprenticeship was construed as also control over incipient technical education. In this way I think it is possible to argue that a) employer control over production processes paralleled their strong ideological and political influence over technical education. b) It is possible to trace a link between two apparently unconnected events: the debates on technical education in the 1860s and the engineering strike and lock-out nearly forty years later. What strategies regarding technical education were open to artisans, given the structural strength of the employers?

As part of their challenge to the employers' strategies on new technological implementation, artisans turned to alternative propositions on technical education provision, through which they attempted to strengthen their independence and exclusivity. A number of educational initiatives were put forward from the 1860s which were out of the mainstream of educational thinking. But closer examination of these initiatives again reveals certain anomolies in the artisans' perspective.

What then was the basis for the workers' belief in a quasi-autonomous education? Was there any precedence for working class groups proposing 'self-help' educational provision? I believe it is possible to locate the beginnings of 19th working class ideas on technical education in the previous century.

6.4.0.

Skilled Workers and Contradictions in Attempts to Establish a Technical Education System.

I believe the evidence shows that the concept of education embodied in government thinking from the 1860s regarded work as the dominant feature of working class lives. Ideas coming from certain sections of the working class, the artisans, seemed to concur in this and accept, for example, a notion of 'secondary education' based on the principle of evening classes.

A motion formalizing this particular ideology was put by an artisan representative at a Society of Arts Conference(1868) which read:

> "That as the demands of labour make it impossible that children of the working classes shall be retained at day schools until their education is complete, and as their attendance at evening classes is essential to the completion of their education ... provision should be made ... (for) support for systematic instruction in evening classes". [S.O.A. Journal (1868) 31st Jan., pp.185-6]

This resolution, which was passed, portrayed children of the working classes in a certain light: they required education which would facilitate their adaptability and accommodation to the demands of the prevailing system.

But just as in the previous militant phase such as Chartism, workers were also engaged in a more or less constant struggle to improve their working environment. In an analysis of 19th century skilled workers, for example, E. P. Thompson(1977) argues that the first half of the nineteenth century must be seen as a period of chronic under-employment, in which the skilled trades

> "are like islands threatened on every side by technological innovation and by the inrush of unskilled or juvenile labour". [p.269]

Therefore the articulation between education and work, embodying a principle of evening classes as the 'means of secondary education' for the masses, had significant implications for working class ideas of 'technical education'. Artisans presented a case for technical education which, on the whole, did not challenge the prevailing orthodoxy on education. The de facto situation did not radically alter throughout the century. After the Cockerton Judgement of 1900, School Boards could only conduct, out of

the rates, elementary schools, and in these schools, whether day or evening, only elementary education could be given. This clearly implied that the upper age limit was 14 years. The situation was legalised in 1901. [Memo. on the new scheme of Regulations for Evening School and Classes under the Board of Education. Statistics and Returns, 1894-1901. P.R.O. Document ED24/831 Working class dependency in education was not always normative as the evidence I discuss below shows.

6.5.0

Pre-1850 Notions of Education: The Influence of the Sunday Schools on 19th Century Ideas of Technical Education.

The notion of non-state educational provision has had a relatively long working-class history, going back at least to the 1780s. At that time it was an activity engaged in by a fairly broad stratum of the working class; sometimes at considerable cost. Thompson (1977) refers to an 'intellectual culture' of the working class, in which the 'articulate consciousness of the self-taught was above all a political consciousness' [p.781]. Segregated, the working class institutions according to this view, generated a toughness and resilience, in which class acquired a significance:

> "... everything, from their schools to their shops, their chapels to their amusements, was turned into a battleground of class". [Thompson,p.914]

Lacqueur (1976) also argued that the period 1780-1850 was significant in terms of education perceived as part of a working class culture. In particular, he related this to Protestant Christianity, arguing that this religious ideology provided the language of radicalism. This radicalism found expression in the later conflicts between the trade unions and employers. Applegarth, a leading trade unionist, retained some of his evangelical zeal in his work with the carpenters union, in the 1860s. He insisted, for example, on union meetings being conducted in temperance halls rather than public houses. This working class ideology was also an integrative force in England particularly through the working of the Sunday Schools. [Ibid. p.24 et. seq.] Lacqueur maintained that these schools mirrored

> "... the comparative strength of cohesive over disintegrative forces in society, an aspect of working class not often registered". [Ibid]

It seems to me that 19th century pleas for general and tchnical education, by working class groups such as artisans, reflected the seriousness and persistence of the workers' educational thinking referred to by Lacqueur. But, this is not to argue that the later ideas on technical education were similarly autonomous or independent. I have previously discussed T.U.C. resolutions which recognized the necessity for some kind of state or employer funding for technical education as well as general education (my discussion, above sub-section 6.3.0.). However, there would appear to be a sense of continuity in later developments of the 1860s and 1870s, although there were important differences in working class cultural expectations reflecting the changing relations of production. For as I have previously argued, there was plainly a change in technology in use from the 1860's as social and technical relations came to be characterized by the increasing dominance of industrial employers and the artisans' resistance to work reorganization. (In a sense, artisans colluded with employers in supporting the prevailing profit-seeking ideology).

Working class attitudes to education thus came to be modified. Their demands for education, framed by a transformed social and ideological structure, which made greater demands on their time and energy, were not so readily met by a self-serving system such as the Sunday School System. After the mid-19th century the educational self-sufficiency engendered by and within the Sunday School movement and beyond, identified by Lacqueur, was influenced by the changing relations of production. The Artisans' Reports, produced in 1868 arising out of their observations at the Paris Exhibition of 1867, provided a case in point. Regarding the change from a fundamentally religious ideology to a more secular view,the interference of institutionalised religion was unequivocally rejected by artisans.. One artisan argued for example:

> "Government in effect now says Education is all-important, it is essential to your welfare ... if you are to have education you must take my dogmas with it ..." [Randall, J. (1868) p.297]

This view was reiterated in the following year at an international working men's congress by Applegarth, despite his evangelical convictions, anxious to separate education and religion:

> "We are in want of education and the State must give it free from religion". [Applegarth, R. (1869)]

The voluntary Sunday School system had been concerned with basic literacy and numeracy in addition to religious studies. But, demands for a universal primary education system on a broader scale, as a preliminary to technical education, of necessity presupposed a more universal, 'provided' system. Briefly, the two systems may be characterized thus:

a) the Sunday Schools were staffed predominantly by working class people and funds came from working class communities;

b)If self-help' initiatives proved inadequate, technical education required a 'sponsored' system through a secular organ, the government, or employers vis à vis a system like the Sunday Schools, 'sanctified' through a religious ideology.

I believe the common factor in the two developments was an ideological one: a combination of a skilled working class intrepretation of the Protestant ethic and demands for secular education that coalesced in one period in a pressure for technical education. This is not to undervalue the more generalised force of the earlier religious ideals but to reaffirm their presence in some working class thinking in the 1860s. As Lacqueur said,

> '... a highly developed culture of self-help, self-improvement and respectability, which nurtured many of the political and trade union leaders of the working class, emerged from the ... Sunday School'. [Ibid. p.155]

(Marx was to note the same tendency, from a different perspective:

> 'Odger and Applegarth** are both possessed with a mania for compromise and a thirst for respectability'. [Marx. (1869), p.278]

The earlier evangelical Christian idealism was evident in some of the later working class educational developments in the period between the 1860s and 1880s. The alignment with organisations sponsored or organised by a religious denomination illustrates the point.

**[Odger and Applegarth were prominent members of the 'Junta']

6.6.0.

The Working Men's Educational Union

The Working Men's Educational Union, founded in 1852, might be said to be one of the descendants of the Sunday School Movement. The combination of the religious and the secular may be identified in its aims:

> "... the leading feature of this ... organisation was the attempt to unite Christian men ... (and) furnish them at the cheapest possible rate with the material requisites for popular, entertaining, and instructive learning".[W.M.E.U(1853)p.24].

There were other illustrations of a non-religious kind of development, such as the Co-operative movement which put forward plans to provide and encourage, through education, 'partnership in industry' [Ludlow, J. M. & Jones, 1867, p.24].

But I believe one of the clearest illustrations of 19th century Evangelism at work in working class politics was the Working Men's Club and Institute Union (W.M.C. & I.U.). This organisation was founded ('sponsored') by a Unitarian Minister, Henry Solly, in 1862. Solly, maintaining that the 'integrity' of the working man should be constantly upheld, asserted that the W.M.C. & I.U. should be autonomous institution:

> "No working man will go near a club if it is not their own". [Solly, 1866]

However, later he seems to have lost confidence in the abilities of workmen to organise their own affairs:

> "... any committee of working men or a committee chosen by the members would be fatal to the movement". [Ibid, 12th May, 1875]

In the mid-1870 Solly's attitude to working men was condemned as patronising and authoritarian:

> "Mr. Solly's attempts (at authoritarian control) have not recommended him to the working man. He has never worked unless allowed the entire lead as well as good pay. And he has never been over-scrupulous in obtaining his ends". [Weiler, A. (1875) p.131]

Despite criticisms it was to this institution that certain artisans in London first turned in order to stimulate the development of some kind of technical education system. As one metal-working artisan expressed it:

'I should like to see a number of institutions, they might be called colleges, or any other name, I would have them fitted up with a number of workshops for different trades, and one large room to be used as a lecture room. ... There should be schools attached ... Working men in large towns have a great difficulty in finding convenience to do anything for themselves by way of improvement'. [Winstanley, T. (1867) p.165]

Another illustration from a worker in the carriage trade, the nearest equivalent to modern motor-body building, argued:

'It is of the greatest importance to the workmen that they should possess an intimate knowledge of drawing and mechanical appliances. And I regret to say ... in the great City of London there are no classes or instruction ... I must confess that our French fellow workmen have greater facilities for obtaining (a) more scientific knowledge ...' (McGrath, T. (1867) p.169].

Plainly, these present a clear, if deterministic relation between technical education and 'economic' and 'technical efficiency'. They differed from the scepticism shown in the employers' journal, Engineering:

'We are now aware that any student of our technical schools, and we have several of them, has yet given us a valuable invention ... technical education was useful, but limited ... and received by those who would otherwise be valueless members of the industrial community ...' [Engineering Vol. 4, 2nd Aug. 1867][My emphasis].

Technical education lacked universal appeal as another contemporary journal noted:

'We entertain the greatest doubt...as to the wisdom, in any sense of trumpeting those very generally weak and jejune productions of half educated men, seeing in a country where most of them were ignorant of a word of the language spoken round them, things necessarily understood but imperfectly ... and attempting to make the world believe that the Society had elicited and discovered superhuman talent in their workmen...' [Practical Mechanics Magazine, April 1868, p.19]

The bias against a cultural perspective generated within a working class group, was clear.

6.6.i.

The Formation of the Workmen's Technical Education Committee

There were more favourable responses to artisan initiatives than the criticisms imply for one of the outcomes of artisan approaches made in the Artisan Exhibition Reports, and to the W.M.C. & I.U. was the organisation of a conference, sponsored by the Society of Arts, held in March 1868. Arising from this was a proposal to form a Workmen's Technical Education Committee. Its terms of reference included a brief to promote technical instruction in workshops and 'manufactories'; to relate the instruction to existing educational provision in accordance with artisans' perceived needs. In particular it was to ascertain how far existing institutions in London particularly, could be made available for the instruction of

> '... apprentices and artisans in the principles and practices of their trade'. [Report, W.T.E.C. (1868)]

Its inquiries in London found that there was no provision in the metropolis adequate to the wants of workmen, that is at such hours and at such terms that would place such provision within their reach [Ibid. p.6]. This confirmed the criticism made by the various contributors to the artisan reports on the 1867 Exhibition.

The Committee's recommendations included a call for the provision of technical schools for instruction in the details of the various handicrafts similar to the 'ecoles d'apprentissage in Paris' and a

> 'Great Central School for foremen like the Ecole des Arts et Metier in France'. [Ibid].

A number of innovatory ideas emerged from this meeting. There was a proposal for the establishment of suitable training schools for technical teachers. Another, in the final clause of the proceedings recommended that the law should empower employers to release apprentices

> 'for a certain portion of their time in obtaining technical and scientific instruction relating to their calling'. [Ibid. p.8]

Thus two factors may be distinguished in skilled working class educational thinking of the period: A recognition of a need for specialised training for technical teachers; and one of the first proposals for part-time day release; a proposition put in the following

year by Scott-Russell in his Systematic Technical Education(1869), who also made reference to an 'F.E.' concept on a part time day basis.

The W.T.E.C. seems to have anticipated one of the principal provisions under the City and Guilds system by some twelve years. After 1878, the Central Institute at South Kensington for example, provided academic technical courses, and also introduced systematic training for technical teachers (my analysis Chapter 9).

The Committee recommended, in addition to the more radical proposals for 'day-release', an extension of existing science and art clases. The argument here was that the Jermyn Street classes (School of Mines) were not accessible to artisans during the day; and the evening classes at Kings' and University Colleges were too expensive[Ibid]. Apart from the issue of allocation of time the question of funding was a critical and recurring factor whenever working class educational issues such as this were discussed. In this context I examine below the legislation that followed the 1889 Technical Instruction Act, much of which was concerned with issues of the proper authority for funding technical education generally. Thus twenty years after this recommendation by the Workmen's Technical Education Committee, it was being argued in the House of Commons:

> '... there was a want of funds and the fees are so high that the working classes cannot avail themselves as much as is desirable (of evening classes B.C. ... very few boys from the elementary schools are able to attend, consequently very little good is done ...' [Hansard, 1889, Col.1252]

Money was eventually found from an unexpected source, within the aegis of the Customs and Excise Act of 1890. But in 1869, the first annual meeting of the Workmen's Technical Education Society (W.T.E.S.) was held in the theatre of the Royal School of Mines in Jermyn Street. Under the chairmanship of Lord Elcho, it was resolved that a permanent organisation be established with the name 'Workmen's Technical School Union'. [Times 25th June 1869]. It was further resolved that

> '... trade societies be recommended to establish schools, classes, and museums for the children and apprentices of their members...' [Ibid.]

The Educational Times noted the recommendation that large companies ('manufactories') be requested to open schools for technical education in their respective establishments. [Educational Times, 19th July, 1869]. Again this deliberation would seem to anticipate provisions through the City Livery Companies in 1879.

The evidence therefore suggests skilled workers were attempting to generate some form of technical education provision in the decade before the establishment of the City and Guilds of London Institute in 1878. The beginnings looked promising. In the first year of the W.T.E.C's. existence, in addition to the research into technical education facilities, nine lectures on related topics were arranged and delivered between 26th May and 23rd June 1869 (Report of the Proceedings, op.cit.) But the life of this particular initiative was, in fact, short-lived; the committee disbanded in 1869.

In political terms the Workmen's Technical Education Committee was relatively ineffectual. It was, in the event, too late to submit its views and recommendations to a government Committee of Inquiry under Samuelson (S.C. on Technical Instruction, 1868 (Chairman - Sir Bernhard Samuelson)).

There are a number of possible explanations for the demise of the Workmen's Technical School Union after only one year. There was clearly the question of funding, which was a problem at local and national level. It seems to me that a further explanation lies within the political and ideological framework of these artisan proposals. Two issues may be distinguished.

The first points to ambiguities associated with artisan claims to exclusivity as I analysed above (1.6.0, 1.6.1,1.8.0)). One of the problems here was the question of 'technical efficiency' and the place of skilled workers in the hiearchy of production and their position vis à vis other workers and employers. The alignment of skilled workers with non-working class people, such as Solly and Lord Elcho (discussed below), seriously compromised skilled workers whenever employers' and artisans' views were incompatible or irreconcilable. This ideological position was highlighted by artisans responsible for the Exhibition Reports.

In 1868 they issued the following invitation:

> 'To commemorate the issue of a somewhat novel undertaking (the publication of the artisans' reports on the Paris Exhibition in book form), and at the same time to mark their sense of the honour conferred upon the working classes by the Society of Arts, the workmen authors have invited Mr. William Hawes, the Chairman of the Council, and the executive officers of that body to a public dinner ...' [Times, 23rd April 1868]

Thus artisans' relations with employers, and their representatives need to be examined in terms of 'sponsorship' sought by a minority of workers in proposing educational provision of the kind associated with the Workmen's Technical School Union.

6.6.ii.

The Trades Guild of Learning, and the Artisans' Institute

Solly's interest in working class education was continuing. In 1873 he proposed the formation of a Trades Guild of Learning. His intention was that the guild should promote

> '... the delivery of lectures and the formation of classes, to assist members of Trade Societies and other skilled workmen in acquiring a knowledge of history, political economy, and technical education ...' [Solly, H. (1873)]

This was also presented as part of a paper read by Solly to the London Trades Council in an effort to encourage their ideological and material support. The response from the Council was to affirm the principle

> 'without pledging delegates to anything further'. [Minute Book, London Trades Council, 8th April 1873]

This cautious response seems to have been justified in the light of subsequent events as the development of the Artisan's Institute reveals. This Institute was an important off-shoot of the Trades Guild of Learning. It was formed under Solly's direction in 1874. Initially it appeared a substitute for the defunct Workmen's Technical Educational Union in the promotion of technical education, in terms of a 'demand from below'. At its inaugural meeting there were representatives from at least twelve skilled trades, including two from engineering branches.

Solly at this stage put forward his views on technical education for artisans. The Artisans' Institute was innovatory in the sense that through Solly it was proposed to conduct classes staffed by teachers who were themselves tradesmen:

> '... we regard as a fundamental axiom for any real improvement in Technical teaching ... that we must look among skilled workmen for Technical teachers ... we must give them the means of instructing their fellows'. [Solly (1873); Solly (1878) p.11]

My view, is that these perceptive ideas on technical education were overlaid by his patronising attitude towards workers. On the one hand was his advocacy of having workers conducting classes. On the other,

was the prescription for a change in the workers' social attitudes and beliefs:

> 'A change in the habits and an improvement in the tastes of some workmen, with a willingness on the part of the steadier and more educated shop-mates to help them "onwards and upwards"'. [Solly (1873)]

There was also what seemed to be a missionary or reformist ideology behind his proposals. He argued for

> '... the substitution of Trades Halls and Clubs for public houses as places of business, social intercourse and recreation'. [Ibid.]

In this he was supported by a member of the 'Junta', Applegarth of the Woodworkers. Carrying over, perhaps, some of the evangelical zeal of the Sunday School system, he was a fervent believer in promoting sobriety and order in union affairs.

Like the Workman's Technical Education Committee, Solly's initiative was also short-lived. Within three years it was in financial difficulties. The Science and Art Department refused a request for a grant in 1876. [The Globe, 30th May 1876]. This action reinforces the belief that government was reluctant to commit public funds to this form of technical education at this time. The 'amateur' status of Solly's movements clearly made no appeal to government regarding funding.

But at least one journal considered the Artisan's Institute an important factor in the promotion of technical education of the period. The Globe wrote that

> '...at the present moment this institute...contain(s) probably ... whatever germ there is of hope for the survival of English trade'. [The Globe, 30th May 1876.]

The Trade Societies, composed mainly of local skilled workers' representatives, were approached again for help by the executive of the Artisans Institute in 1877. [Minute Book, London Trades Council, 11/12, 1877] The Secretary Hodgson Pratt, and an executive member, M.P. Samuel Morley, after an initial appeal made a further approach in the following year. They proposed that the

> 'trades should take over and conduct in their own way the Artisans' and Mechanics' Institute in St. Martins Lane'. [Ibid. 12/2/1878]

This proposal was considered at length, and finally rejected in June 1878. [Ibid. 15/6/1878]. In the following year Solly resigned. [Solly (1878)].

6.6.iii.

Ambiguities in Skilled Workers' Educational Initiatives

This brings me to the second major issue. A problem for skilled working-class groups in this period, seeking sponsorship for educational strategies, was the political and ideological position of prominent political figures associated with them. I have referred to the ambivalence regarding working class initiatives in relation to Solly's work with the W.M.C. and I.U. In the case of the W.T.E.U. the connection with Lord Elcho seems to warrant further consideration.

In the light of his views on trade unions generally, it appears to have been a questionable decision to invite an aristocrat to chair what was, in effect, a workers' meeting. It is speculative to suggest that it was intended to promote the respectability and credibility of the venture. Some evidence provides justification for the decision. During the course of a Commons debate on the Master and Servant Act in 1867, it appears Elcho supported an amendment relating to the 'operative classes'. They responded positively to his support:

> 'thanks and gratitude for the great interest and sympathy exhibited by you on all occasions where the social conditions of the industrial millions of your countrymen is involved'. [Elcho (1868)]

But, other evidence shows that Elcho had a very circumspect view of trade unions. At best he seems to have been ambivalent:

> '...trade unions are doing great good, as benefit societies ... (they) are the means of keeping men off the poor rates'. [Elcho (1867) p.12]

In 1866 he had written of his mistrust of trade unions. He was arguing the case for an inquiry into the trade union movement, maintaining that it would

> '...show the danger of trusting these men with the uncontrolled power which they are seeking...the tyranny of the unions is such that I see an anti-union union is being formed in Derbyshire...' [Letter Elcho to Walpole (1866)]

Coupled with this mistrust were his views on the ideology of socialism and his belief in the unequivocal 'laws' of laissez-faire economics. He made this clear in his speeches and writing in the period from the 1860s through the 1880's.

At the time of the Workmen's Technical Education Union initiative he was arguing '... the laws of political economy are. ... clear and defined ... as those of nature herself'. [Elcho (1867) p.10][My emphasis]..

But in my view it was his evident distaste for socialism that highlights the ambiguity of his former association with the Workmen's Technical Education Union and working class groups generally. '"State socialism", he argued, 'saps the qualities of self-reliance and originality which have been pre-eminently the characteristics of our race'. [Elcho (1885)]

The ambivalent nature of Elcho's association with working men's movements notwithstanding, the assumed need for sponsorship on the part of certain elements of the skilled working class continued. In 1870 Elcho was approached to attend a public meeting on technical education to be held in July. The invitation clearly spells out the sentiments surrounding the relationship between two apparently disparate groups of people:

> 'We can only hope to stimulate the latent energies of the artisan population by continued endeavour and there is no doubt that one way of moving them is by showing that noblemen like yourself and gentlemen ... take an interest in their permanent well-being'. [Murphy (1870)]

But, the London Trades Council had had different ideas and expressed a clearly opposed view earlier:

> "The general conduct of Lord Elcho was such that the Council had no confidence whatever in him". [Minute Book, London Trades Council (1868)]

Elcho's relation with the workers was clearly tenuous. His response to an invitation by Holly to chair a meeting indicated this. In his reply he questions whether it was wise

> '...to keep at these working men's clubs a staff of Dukes, Lords and authors ready to take the chair, lecture and speak in the way now proposed...' [Elcho to Solly (1865)].

He continued, however, to exercise his influence on working class affairs through Parliamentary activities, particularly sitting on Select Committees. He was a prominent member of the 1868 Commission of Inquiry into Trade Unions. Later, in 1893 he was associated with employers in an aggressive counter to unionism. In this context he was active in the National Free Labour Association of 1893. This was an organisation founded by an ex-trade unionist, William Collison. Its avowed aim was

the crippling of the power of the unions and to provide a reserve of 'blackleg' labour for employers. In action it took two forms: systematic importation of 'blackleg' labour; the other was legal action against what was considered 'intimidating' picketing. Both elements were involved in the protracted engineering strike and lock-out in 1897. [Kynaston (1976) p.153; Roberts(1958)p.153]

6.7.0

Summary and Discussion: Artisans and the Concept of 'Technical Culture'

I believe the evidence shows that there was a 19th century working class definition of technical education which acknowledged a distinction between science and technology. A metal worker expressed the concept in this way:

> 'A knowledge of geometric forces would be invaluable to the artisan, and lift him from often only being an imitator of others, doing so and so because it has been the custom to do so; but measuring on principles would make him in the highest sense of the word a master of arts ...' [Bramhall, W. (1867) p.164].

At an organisational level, this concept was reiterated at the 1874 T.U. Congress. In the debate on technical education, working men's organisations were urged to

> '... actively take up the question of technical education with a view to furthering skill, and ... schools for technical instruction ought to be established ... supplied by grants from the Education Department'. [T.U.C. Minutes, 1874]

Thus the idea of 'technical knowledge' was linked to the central notion of craft apprenticeship, a combination which was later argued to be

> '... the best means of furthering the development of technical knowledge and increasing the skill of workmen ...' [T.U.C. Minutes, 1880]

Skilled-working class educational initiatives represented the only attempt of substance I have seen recorded to promote a concept of technical education as part of a 'technical culture' in the 19th century. By this I mean technical education portrayed as a feature of a working class culture characterised by interaction between practical activities in the workshops and the theories and social relations embedded in these practices. It posited the notion of technical education which rejected an

emphasis on wholly manual craft practices, and yet avoided the abstractness and esotericism of the purely theoretical.

The evidence suggests the existence of an alternative to the prevailing notion of technology as a logical extension of science, as conveyed by Huxley, Playfair, Randall and other established public scientific figures.

I believe influential and education-minded scientists in the period assumed a deterministic model of science, in which science promoted 'technical and productive efficiency' through its incorporation into manufacturing processes by skilled workers: the notion of technology as 'applied science'. But at the time the apprenticeship, the basis of skilled craft production, was clearly in decline. Its demise was accelerating with the transformation of work organization and increasing employers' control over the labour process. Mechanistic views of science and technology failed to take into account the ideological nature of industrial reorganization and the implementation of new technologies. Thus for the 'science establishment', the social relations in which science and technology were embedded were assumed to be given, unalterable and an essential pre-condition of modern production. The relation between work and technology was regarded deterministically, and was therefore unquestioned. The events in the engineering industry, such as numerous strikes following the major confrontation of 1852, were not perceived by Playfair, Huxley et al as significant factors in the deliberations about technical education, despite the fact that engineering employers and their employees were principal target groups for technical education.

Control over the labour process by employers had crucial implications both for employers' and artisans' policies and beliefs about technical education. Artisan attempts to initiate independent sources of technical education through working class orgnizations such as the Artisans' Institute and the Workman's Technical Education Committee, failed mainly in two respects. First, they were unable to convince a cautious and vacillating government of the viability of their proposals; funding therefore remained crucially significant to development. Second, the artisans' contradictory relations with the employers and unskilled workers continued to subvert their ideas for a national technical education system. The contradictions were highlighted by the erosion of the historical dependence of employers on highly skilled labour. New technologies were proving more and more an indipensable condition for

profit-seeking vis a vis expensive artisan expertise. Skilled workers, seeking to preserve their autonomy and consolidate their exclusivity though a newly-formed technical education system, failed to perceive the inherent difficulties associated with these developments: The impulse on the part of employers, encouraged by State adherence to laisez-faire economics, to maximize short-term profits whilst attempting to initiate a national system of technical education based on long-term projections for skilled labour.

These ambiguities were to have serious repercussions for the development of technical education in the last decades of the century. The evidence suggests that this became manifest in the period up to the Great Strike and Lockout of 1897 in the engineering industry. The strike itself and its ramifications for technical education will be a principal focus of Section Three of the thesis.

SECTION 3

CHANGES IN THE CONTROL OF WORK AND THE INFLUENCE ON EDUCATIONAL CHANGE.

Introduction.

In this Section 3, consisting of three chapters, I examine in detail the events from the 1860s, which I believe highlight the conditions affecting the consolidation of employer power, particularly in the latter part of the century, in relation to the reorganization and control of the labour process. The social and technical developments from the 1850s had profoundly influenced both the concept of skill and the historical method of skill acquisition, the apprenticeship system. The apprenticeship and machine manning issues provoked frequent industrial conflicts. McIvor(1984) suggests that in the thirty year period from 1880 there were 'hundreds of lockouts...the most feared and most devastating of the employers' strike-breaking tactics...'(p.16). My case is that at the centre of most of these disputes were questions of the reproduction of skilled workers and the implementation of new technologies.

Artisan attitudes to the apprenticeship and technical education had been made clear from the 1860s, especially after the first TUC resolution on technical education in 1868. Concern was expressed over the way the employers' extension of their control over the labour process intruded into early technical education developments, which they believed should embody the apprenticeship system as a central element. Employers, reinforced by their increasing power over the implementation of new technologies which no longer relied upon skilled craftsmen, effectively combined to challenge the leading artisan union, the ASE.

Disputes erupting throughout the 19th century culminated in the strike and lockout of 1897, with machine manning and the question of substitution as a main contention, and not the issue of technical education per se. But the structural position of strong, federated employers at that time was such that they were able to impose their ideas concerning trade training and education upon the skilled workers, and indeed crucially influence policies for a national system. I seek to

establish that the principles behind the employers' transformation of the workshops underpinned their attitudes and beliefs about technical education. Thus, I believe questions concerning the development of technical education can not be separated from the broader issues of the reorganization of the workplace.

The conflict of 1897 therefore seems to me to provide a watershed in industrial relations in the period. Furthermore, the events leading up to the strike and lockout paralleled the first important pieces of legislation on technical education.

In my analysis here I shall question the predominant evolutionary model of technical education, and the assumption that it can be viewed as an extension of general education. I shall also question the existence of a 19th century technical education 'movement' or 'cause', which I believe implies a coherence and rationale based on an identifiable educational philosophy of technical education.

I show that technical education was not simply an evolutionary development from general education, but was largely influenced in structure and form by the attitude of both the state, intent on minimizing national expenditure on education, and significant employers, such as those in the mechanical engineering industry. In what ways did employer influence manifest itself? How was it possible for employers to be such a force in incipient educational devlopments when the evidence suggests they rarely made public their views on educational affairs?

I believe a key to an understanding of these questions lies in an examination of the processes which gave rise to the predominantly part-time pattern of technical education which was embodied from the outset in the 1870s. Does this suggest that this particular mode fitted industrial work norms of the time?

This Section begins with chapter 7 in which I examine how existing accounts treat the origin and development of technical education and technical developments associated with it.

This will be followed in chapter 8 with a detailed analysis of the Great Strike of 1897/8. I show how the development of the strike and the events leading up to it revealed hitherto obscured employer attitudes to technical education.

In chapter 9 I analyze the foundation of the City and Guilds of London Institute from 1879, and how this particular development interrelated with government legislation on education in the period up to the close of the century.

Chapter 7

HISTORICAL ACCOUNTS OF THE DEVELOPMENT OF TECHNICAL EDUCATION and SOCIO-ECONOMIC RESEARCH RELATING TO TECHNICAL EDUCATION

7.0.0. Introduction

Historical accounts of 19th century technical education I have examined are characterised by a combination of the following predominant components in one form or another.

Foremost, is the recurrent idea that in the second half of the of the 19th century there evolved a technical education 'movement' or 'cause'. It is held that this 'movement' was initiated and led by far-sighted industrialists and philanthropists who were motivated by the need to counter foreign economic competition.(Clapham1938; Ashworth 1960; Barnard 1963; Adamson 1964; Argles 1964; Armytage 1964;Ashby 1965; Simon 1965; Musgrave 1966; Sims 1981.)

Second, there is a strong emphasis on the attitudes of the trade unions and employers towards technical education and the apprenticeship system. Trade unions are said to be motivated by self-interest and are portrayed as indifferent or opposed to technical education. This perspective, if the apprenticeship system is considered at all, views trade union attitudes regarding apprenticeship simply as archaic and a means whereby skilled workers sought to restrict entry and protect their artisan status.

The majority of employers, it is argued, were also indifferent, if not actively hostile to technical education, and motivated primarily by the need to maintain their economic competitiveness.

These theories tend to be one-dimensional. The idea that employers were solely concerned with economic efficiency and profits, without evaluating the implications of the prevailing laissez faire economic doctrines seems to me to be simplistic. It also crucially underestimates their influence on technical education through the reorganisation of industrial work and the introduction of new methods of labour control. It is also too simple to assert that the trade unions were opposed to technical education.

The third set of ideas links trade union attitudes on technical education with an unquestioning acceptance of the separation of technical education from the workplace. This is reinforced by a notion of technical education as an extension of 19th century general schooling. (Jefferys 1945; Cotgrove 1958,1970; Argles1964; Armytage1964; Ashby1965; Simon1965; Musgrave1968; Parker et al 1975; Le Guillou1980).

There is therefore an emphasis on the evolution of a technical education 'movement,' separate from industrial work and the apprenticeship system. Some writers argue the 'movement' provided an alternative to the traditional craft apprenticeship mode of training due to the apprenticeship being in decline.(Cotgrove1958; Musgrave1966). The general argument is that the 19th century apprenticeship system had changed its traditional character and had little technical educational value . (Webbs 1902; Cotgrove 1958; Liepmann 1960; Turner 1962; Clegg et al 1964; Flanders 1964,1970; Zeitlin 1979; Lee 1981; Sims 1981; More 1982.)

Most accounts, in varying degrees, stress the importance of the relationship between technical education and economic efficiency. Some also embody two further variants. First are those which focus on the role played by a small number of employers who provided what were known as 'company schools'. These were training schools set up within companies to provide general and technical education for their own young workers(Robertson 1974; McGuffie 1986).

Second are those which view technical education as a factor in socialisation. In this version it is argued that technical education served to engender company loyalty in young workers and reinforce the authority structure of the factory.(Robertson 1974; Joyce 1980; More 1982; McGuffie 1986.

The main aim of this chapter is to confront these recurring ideas in existing scholarship by exploring in detail the actual interests of different groups, the State, employers, and skilled artisans in the development of technical education.

I turn first to accounts which stress the influence of prominent people, sincere and at times philanthropic, but primarily motivated by the fear of foreign economic competition, who instigated a technical education 'movement'.

7.1.0.

The Idea of a Technical Education 'Movement': 'South Kensington' and the Great Exhibitions.

Historical accounts of the origin and development of technical education invariably focus upon the significance of 'South Kensington' on the origins of such development. The government department responsible for education in schools was located in South Kensington. After 1878 the City and Guilds of London Institute was also centred there in the form of the Central Institute which began operations in 1880. Thus a common argument is that a technical education 'movement' had its origins in this source.

The period from 1851 was presumed to have marked the beginning of the 'movement' and was characterised by the Great Industrial Exhibitions. Two Exhibitions in particular figure in accounts of the development of technical education, those of 1851 and 1867.

Cotgrove(1958) cites the 1851 Exhibition in London as a main stimulus for a technical education 'movement', and argued:

> '...the threat to Britain's industrial pre-eminence (was) first apparent at the 1851 Exhibition ...(and) provided one of the strongest arguments for supporters of technical instruction...'(p.19).

Argles(1964) asserting that the Department of Science and Art at South Kensington was the 'cradle of technical education', maintained that the 'spirit of South Kensington has shone over technical education for over one hundred years'(p.12).

He also held that after the Great Exhibition of 1851 a technical education 'cause' evolved and gradually gathered momentum in the second half of the century:

> '...the cause of technical education in England made more rapid strides forward than it had done in any period so far'(p.31).

Thus the 'movement' got under way and the stage between 1881 and 1884 was heralded by the 'trumpet blast' of the appointment of a Royal Commission in 1881 to inquire into the provision of technical education in England (Argles op.cit.).

Adamson(1964) also locates the origin of technical education in Soul Kensington with the formation of the Central Institute of the CGLI. Afte its foundation, he argues there was a ripple effect,

> '...the movement in support of this kind of institute (spread)...(it was taken up by Birmingham, Manchester...and other cities in the industrial areas'(p.42).

Armytage(1964) and Adamson(1964) single out the 1867 Exhibition in Paris, and emphasise the way it stimulated the foundation of provincial institutions of technical education. One of the consequences of the Exhibition, Armytage argues, was that it forced a technical education 'movement' into being. There was, he said,

> '...a movement that stirred following the convulsive therapy of the 1867 Exhibition...'(p.163).

Another writer, Haines(1958), had previously provided a more specific focus. In the two decades up to 1887, the impetus for the foundation of institutions of 'technolgy and education' in England stemmed principally from German economic competition, the direct effect of which was to focus the employers' attention on the 'more...immediately and discernibly profitable technical education...'(p.236).

Ashby(1965) also argued that it was the fear of economic competition from Europe that proved the

> '...mainspring of educational reform in England...'(p.784).

According to Ashby, this stimulus from Europe prompted certain industrialists to take an active interest in technical education,

> '(industrialists)...raised their voices in advocacy of technical education...'(p.785).

Accounts which focus in this way on technical education development substantiate the prevailing orthodoxy and attribute the rise of technical education to a response to the political pressures of economic decline. A main source of these pressures was the Exhibition jurors' reports covering the various industrial categories exhibited by the competing nations, and published a short while afterwards.

Cardwell(1972) stresses how a technical education 'movement' in England evolved in response to criticisms from English jurors, the main focus of which was that by the 1860s Continental countries were technologically 'superior' as shown by the exhibits at London and Paris. As Cardwell put it,

'...the Great Industrial Exhibition of Paris in 1867...revealed a state of affairs highly discreditable to England...as a result there was...near panic and a movement was initiated...this was the technical education movement'(p.111).

Herward(1980) maintains the Department at South Kensington was one of the most far-reaching developments which followed the Great Exhibition of 1851. But she also argues, correctly in my view, that a concentration on increasing State intervention and an emphasis upon legislation and administration has led to ' a neglect of intellectual movements and voluntary organizations...'(p.103)

The Society of Arts, according to one source, provided the forum for one of the most influential independent groups associated with the technical education 'movement'(Bailey 1983):

'During the 1880's the movement became more recognized as a group...'(p.57).

The main impetus for the 'movement' after the 1860s and 1870s came from a group of people who were associated with the Royal Commission on Technical Instruction in the period 1881-4: Magnus, Swire Smith, Woodall, Slagg, and Samuelson. I examine the effects of this Commission later in the chapter.

Thus existing scholarship, influenced by evidence from the Great Exhibitions, emphasizes the growth of a technical education 'movement' impelled by the lack of economic competitiveness on the part of British industry during the second half of the century. It assumes a clear relation between science, economic performance, and technical training.

Critical to these studies, stressing economic competitiveness, is a consensual notion of technical education structured solely to meet the needs of industry through the improvement of labour efficiency. Adamson(1964) argues,

'The aim of (technical education) is not culture but ability...technical schools must be carefully suited to the particular trades resorting to them...'(p.405).

Musgrave's(1966) position seems to extract technical education from culture:

' The demand for transmitting a society's culture through technical education as such is almost non-existent...'(p.173).

From another perspective, Roderick and Stephens(1978) suggest a cultural bias against technical education which may be partially accounted for by the composition of the governments in the period:

> '...men... steeped in the...tradition and ideology of the Public schools and Oxbridge...'(p,167/8).

They assert that the exclusion of professional scientists and technologists from the essential decision-making processes

> '...meant that the last word was with the amateur...'(p.169).

7.1.i.

The Nature of the Influence of Prominent Public Figures on the Origins of Technical Education

Most accounts, in the main, emphasize economic 'efficency' models of technical education, and stress the way force of foreign competition stimulated the interest of key public figures,

> '...who have spoken for technical education...(providing)...the two main stimuli towards technical education throughout the 19th century'(Musgrave(1966) p.177).

The association of prominent people with the rise of technical education pervades most of the literature. It permeates accounts which emphasize the evolution of a technical education 'movement'.

Cotgrove (1958), presents such a model and writes of an unambiguous development of technical education. Accordingly, technical education evolved steadily throughout the century, and by 1851 'many important features of the system had already emerged'(p.15). By 1882 the broad outlines of the development were 'largely determined'(p.15).

There seems to be little doubt in Cotgrove(1958) that the main stimulus for the 'movement' was direct and came from scientists and philanthropists. He argues,

> 'Most support for technical education seems to have been forthcoming from scientists- men such as Huxley and Spencer...'(p.22).

The influence of public figures on technical education development was strengthened by the imputation that from the 1880s the 'movement' gathered momentum and progressed, despite inertia and opposition. For example, writers such as Argles(1964),Ashby(1965), Musgrave(1966) and Checkland(1977), maintain it evolved thoughout the century, regardless of indifference and opposition.

Argles(1964), without specifying the 'tide' of opposition, refers to a '...handful of prophets', Lyon PLayfair, T.H.Huxley, Bernhard Samuelson,who

> '...campaigned ceaselessly (for technical education)...against the tide of the time...'(p.136).

Armytage(1964) argues the 'movement' was stimulated by figures such as Matthew Arnold who was,

> 'ceaselessly pointing... to the growing demand for technical training for the lower classes'(p.163).

Focusing on resistance to technical education Ashby(1965) puts the view that technical education was hampered in its progress throughout the century. There was, he said,

> '...one frustration after another...there was a massive inertia against all educational change...inherited from the 18th century...((p.794).

Musgrave maintained 'there was a constant hinderance to the advance of technical education throughout the period...' (Musgrave(1966)p.180).

While Checkland makes the point:

> '...the resistance to...a technical education system was...powerful...'(p.91).

He also refers to influential industrial figures who promoted technical education, adding that these industrialists, or

> '...rather an innovating minority among them, had provided both the initiative and the resources for the inventions that underlay economic growth ...'(p.91).

Even Simon(1965), who usually takes a more radical position on the development of 19th education and technology, adopts this perspective. He highlighted what he maintained was the connection between economic considerations and the technical education initiatives of prominent people,

> 'It was an awareness that industries on the continent benefitted materially from...higher education that led advanced industrialists such as Ironmaster Bernhard Samuelson, scientists of the calibre of Lyon Playfair, T.H.Huxley, and H.E.Roscoe (to) cooperate in urging the extension of scientific and technical education...'(p.165)

Simon further argued that in continental countries educational developments paralleled technological developments. The poor quality of English education, he said, 'worsened the country's industrial position' vis a vis Europe.(loc cit).

According to many accounts therefore the interest of key figures such as Playfair, Huxley, Roscoe and Samuelson was central to the technical education 'movement'. Musgrave(1966) said they kept the 'movement' before the public eye, when, but for them,

> '...it might have been forgotten...'(p.177).

Some writers argue that the passing of the 1889 Technical Instruction Act set the seal on the 'movement's' bias towards a part-time pattern. Barnard(1963) takes this view with reference to the 'movement' receiving a boost as a result of legislation:

> 'The Technical Instruction Act (allowed) technical instruction in day and evening classes to be provided...the movement received assistance.'(p.179).

Ward(1973) held that pressure from influential people had a broader function than advocating the provision of extra classes for technical education; it also generated political support for the 'movement', such that,

> '...the Liberal identification with cause of technical education was complete in 1881(p.34).

Clearly these views discount much of the influence of voluntary organizations such as the Sunday School system, and artisan educational initiatives earlier in the century.

7.1.ii

Problems of 'Short-Termism' and Projections for a National System of Technical Education.

Ashworth(1963) and Gowing(1978) offer a variation on the economic-efficiency models. Ashworth(1963) advanced the view that the fear of foreign competition was adequately met without a technical education system:

> 'With all its technical shortcomings and its retention of many practices that were not the last word in modernity, British industry seems to have been fairly well adapted to current needs and practices'(p.107).

Gowing accepts an orthodox position regarding the relation between education and economic performance. But she also argues that while 'objective economic factors' were important in Britain's industrial decline, industrialists

'...wanted neither to pay rates nor dip into their own pockets...to pay for technical education'(p.6).

Gowing's argument here differs from other economic accounts for she maintains that the position taken by English employers was economically rational. She says,

'Britain had achieved so much in the early 19th century with so little education that she felt no need to create the educational infrastructure which her potential competitors were building in advance in advance of their industrialisation'(p.14).

Such a view provides a partial explanation for a loss of impetus in the technical education 'movement'; but more common is the view that it was a lack of direction. Cardwell(1972) holds that after its initial boost the 'movement' began to waver, due, it was argued, to the lack of clear directives on the part of the leaders of the 'movement'. There was,

'...a curious vagueness surrounding the ideas of the leaders of the movement that makes it dificult to specify...'(p.187).

The explanation of this imprecision on the part of the leaders, according to Cardwell, was linked to the problem of the definition of technical education:

'It seems to have been the case that many enthusiastic advocates (of technical education) reduced themselves to proclaiming "we cannot say what technical education is, but we must have it"' (p.158).

These rationalizations seem to me to beg a number of questions: If the maximization of profits represented rational economic behaviour, how can the apparent irrationality accompanying the decline of the skilled artisan class be explained? Was it possible to articulate clear objectives for technical education if the context of technical education was unclear and unformulated?

In addressing these questions I have shown that the evidence from the 1850s demonstrates that the employers' desire to maximize profits was pre-eminent in the organization of work [Whitworth(1854,1868), Nasmyth(1868),Anderson(1884), Donnelly(1868,1884)]. I believe it has also been shown that control of the labour process was inextricably linked with profit seeking.

Writers such as Asworth(1963) and Gowing(1978) point up the issue of economic rationality on the part of employers by focusing on the employers' singular pursuit of profits. But they omit to explain the decomposition of skills underscoring the contraction of skilled artisans. My view is the development of technical education needs to be seen

against the background of this apparently contradictory economic behaviour and also against the government's position on mass general education from the 1870s.

Over twenty years after the complusory education Act of 1870 the State was still slow to accept that it had a significant role in mass general education. The Bryce Commission of 1895 reported on the lack of clear objectives, administrative fragmentation, disorganization and frequent overlapping of educational resources. Government however plainly believed that technical education, despite the prevailing conception that it was an extension of general schooling, was more consistent with management under market forces. It also believed that employers embodied laissez faire policies congruent with its own. This assumption proved correct as employers sought to boost production, increase profits, and extend control of the labour process.

The ambiguity of the government's position lay in the assumption that short-term rational economic behavior by individual employers would be consistent with a national policy for technical education.
The rationale behind this ambiguity is not difficult to discern.

Evidence from the 1850s and 1860s on (Small Arms Commission(1854); R.C on T.U(1868); and the later R.C on Technical Instruction 1884) points to the government's belief in the workings of the market with respect to technical education. According to this logic, demand for technical education would call forth appropriate supply; if demand was not forthcoming supply would respond accordingly [The Times(1868), Playfair 1869), Forster(1870), Lord Armstrong(1872,1888),the Times(1896/7)]. I expand on the relation between market forces and educational development in chapter 10 below, where I examine the various pieces of legislation relevant to technical education up to the turn of the century and in the first decades of the 20th century.

A commitment to laissez faire economics, a dominant feature of Victorian Britain's affairs vis a vis rising industrial competitors, therefore precluded State intervention in technical education developments. At the same time there was active encouragement of employers in terms of profit seeking through labour substitution and implementation of new technologies.

Consensualist accounts of technical education development, in the main, do not consider the economic and wider social implications of work reorganization. They thus ignore the significance for technical education

that laissez faire economic behaviour in the market, of which technical education was assumed to be part by government, was essentially short term. But the goverment's position was that the national interest demanded long-term projections for skilled labour (R.C.(1884), R.C. on T.I(1892), Bryce(1895). In the period from the 1850s, well into the next century, there was no perception (is there now?) that a neglect of technical education, by the State and employers, arose out of 'short-termism'; clearly a by-product of laissez faire economic policies.

7.1.ii(a)

The Concept of a Technical Education 'Movement': Problems of Definition

Cardwell's (1972) case that pioneers of 19th century technical education were not entirely clear what was meant by technical education, parallels definitions implied in existing accounts.

Definitions of 19th century technical education invariably framed in terms of economic competition, seem to me to be tautological. With their emphasis on economic efficiency, the need for which is considered self-evident, there is an assumption that the technical education 'movement' continued throughout the century, even against opposition, because economic competitiveness demanded it.

There is too much reliance in these accounts on the apparent self-generating properties of the prevailing education system in 19th century England. Questionable also is the assumption that the formation of the City and Guilds of London Institute in the 1880s, logically fitted an expanding school system under the Science and Art Department at South Kensington.

As I shall show later, in chapter 10, the CGLI was basically an examining body with a structure inherited from the Royal Society of Arts. I believe it unreasonable to assume that it should effectively constitute a body responsible for technical education on a national scale. The CGLI was formed out of the old Livery Companies, with a tradition of monitoring craft standards in the various artisan trades. The predominant historical influence was naturally the individual crafts which they represented. Existing accounts of technical education, in not fully acknowledging the historical traditions and relatively narrow perspective

of the Livery Companies, overstate the case for a technical education 'cause' or 'movement', rooted so firmly in the foundation of the CGLI.

The evidence leads me to the view that the Science and Art Department at South Kensington was neither ideologically nor financially committed to technical education ; relying, for example, on funding from external sources such as the 'Whisky Money'in the 1890s. The Department could not be said to be fundamentally aligned with a technical education 'movement'.

With the exception of the lobby exercised by the initiators of the 1881-4 Inquiry, the generality of 19th century employers is mainly regarded in existing accounts as apathetic or hostile to technical education. A combination of factors therefore seem to me to undermine the case for the origin and development of a technical education 'movement': The inadequacy of technical education definitions, an apparent inherent inertia against technical education, the questionable assumption that technical education evolved simply from existing school provision, and the 'indifference' and 'hostility' of trades unionists and employers.

With regard to the 'movement' therefore, it must be concluded that the influence of prominent figures, scientists and philanthropists, appears to have been over-dramatized when considered against the educational and industrial developments of the period.

The particular emphasis on the influence of prominent public figures in these accounts has a certain logic however, if the assumed resistance of major groups such as the trade unions and the hostility of the majority of employers against technical education are further analyzed.

I next examine the attitude of the craft unions and employers to technical education as argued in existing accounts.

7.2.0.

Employer and Trade Union Attitudes to Technical Education: A Case of Reluctance and Obstruction?

Accounts which include examination of the inter-relation of trade unions, employers and technical education argue, with some notable exceptions, that both the employers, and the craft unions were apathetic,indifferent and even hostile to technical education. This attitude serves to justify the accounts' acceptance of the inevitable separation of technical education from work and, in particular, the

apprenticeship system.This, in turn, strengthens the argument that technical education was an evolutionary development arising out of the existing school structure.

Cotgrove(1958), for example, attributes the slow growth of technical education from 1851 to '...the apathy and hostility of industry in general towards technical education...(p.30).

Later he states,'...there is evidence of distinct apathy towards the technical education of the worker'(p.81).

Liepmann(1960) in her comprehensive analysis of the craft apprenticeship system argued that 19th century employers had a very limited view of technical education which they also carried over to the next century. She attributed this to the basic economics of training costs :

> 'Employers bear the cost of training and tend therefore to confine the training of apprentices to the skill required for the job which each is intended to do in the firm's service'(p.192).

The implication of Liepmann's view is that employers were not necessarily committed to a general notion of technical education, but inclined to limited training within a relatively narrow range of skills appropriate to individual companies: company-specific skills.

Armytage(1961,1964) enlarges on such a theory and represents a common perspective in technical education histories embodying a narrow, economistic approach. But he also argues that most employer were actually opposed to technical education on the grounds of preserving company sercrets, '...even though they should have profited by (it)...'(1964 p.167). He goes on to argue,

> '...the fear (that) trade secrets... exclusive to a company... could be revealed in class discussions... was a real stumbling block to any effective system of technical education'(1961,1964, pp.230,168).

A rational economic approach, in which employers are portrayed as over-zealous in their attempts to protect their trade secrets and restricting the training of workers to a narrow range of skills, is taken up by other writers. Robertson(1974), for example,in his study of 19th century shipyards holds that employers were reluctant to support technical education because,

> '...the industries...were highly dependent upon skilled trades which could best be learned through on-the-job training'(p.222).

Furthermore, by concentrating on the cultivation of a limited range of manual skills only, the employers were able to avoid the cost of providing technical schooling and to 'obtain a more productive workforce'(p.223).

The perspective presented here is different from most accounts in that Robertson argues the apprenticeship-type training was an alternative to technical education.

Zeitlin(1979) in a comparative study of the 19th century engineering and printing industries similarly argues that employers were circumspect regarding education and training for skilled work and used skilled workers only as long as they perceived a need for them.

Focusing on the employers' calculative approach to technical training he maintains they were not concerned with technical education or long-term planning with respect to labour, so much as reproducing sufficient labour to meet immediate production needs.

With reference to machine manning, for example, he holds that employers' sought the most economical use of machines rather than providing systematic technical training for skilled machine tool operations:

> '...the employers believed the use of less skilled and lower-paid labour essential to the profitable operation of the (new) machines...'(p.268).

Lee(1981) emphasizes the employers' narrow, instrumental approach to skilled labour reproduction, arguing what survives of the apprenticeship system is due to the fact that it 'had the tacit support of the employers over the years...'(p.68).

He also stresses the employers' primary concern with immediate production, an approach which clearly influenced their attitude towards technical training:

> '...the content of training has essentially been fixed by the immediate production needs of individual firms...'(p.72).

Justification for this kind of perspective also rests upon the assumption of the obstructive attitude of the trade unions to technical education. I examine next accounts which perceive the unions' attitude in this way.

7.2.1.

Accounts of Trade Union Attitudes to Technical Education.

Trade union attitudes to technical education are often portrayed as indifferent or actively in opposition. The unionised workers, i.e.the skilled workers, are said to have been concerned only with their own sectional interests.

The Webbs(1902), despite their advocacy of workers' education, provide one of the earliest illustrations of this kind of approach:

> 'Notwithstanding their almost infinite variety of technical detail, trade union regulations may be reduced to economic devices: Restriction of numbers and the Common Rule,'(p.704).

Clapham(1938) held that trade union interest in trade training was narrow and embodied little notion of technical education. Trade exclusivity was the hallmark of the unionists; they were intent on restricting access to jobs traditionally done by artisans:

> 'For a whole generation, from the fifties to the eighties, the A.S.E (the Amalgamted Society of Engineers), had tried without effect to exclude unapprenticed men. After that the attempt was abandoned.'(p;.326).

Liepmann(1960) argued that union attitudes were related to the way skilled workers perceived the effects of increasing mechanisation on their artisan status. Two effects were said to issue from the restriction of entrants to the trade: 'First it checked the substitution of cheaper labour for the craftsman's. Second, it regulated entry into the skilled trade.'(p,17). According to Liepmann this emphasis on restriction by skilled workers was also influenced by the employers' reorganisation of work which created a situation in which,

> '...the old type skilled craftsman has disappeared and been replaced by a man who is essentially ...semi-skilled.'(p.21).

She thus argued that the educational element in the traditional apprenticeship became increasingly redundant through progressive mechanisation of production. As she put it,

> 'Fifty or sixty years ago...skilled workers required considerable... intelligence, a very high degree of trained sensitivity of certain senses, highly efficient eye-hand coordination...together with literacy and an acquaintance with arithmetic...the increased degree of automaticity of machines, greater standardisation...have rendered obsolete some of the craftsman's specialised knowledge...'(p.19).

Turner(1962), presenting, in my view, a limited perspective, maintained workers were skilled or unskilled,

> 'according to whether or not entry to the occupations is deliberately restricted and not according to the nature of the occupation itself'(p.84).

Clegg et al(1964) also put much emphasis upon the unions' restrictive practices. They argued,

> 'It was the first objective of the Societies to turn this custom (traditions of apprenticeship) into a universal and uniform rule so as to exert a firm control over the size of the labour force...'(p.184).

Flanders(1964) also argued that the apprenticeship controlled not standards, but numbers:

> 'For craft unions the main purpose of an apprenticeship was to regulate entry into the trades they organised. It was one of the buttresses of their basic device...'the restriction of numbers'(p.184).

He held the same views later arguing union interest in the apprenticeship was, '...mainly directing entry to the trade...'(p.284).

Musgrave's (1967) position was that trade unions were 'never wholeheartedly in favour of technical education' (p.106); being over-concerned with the supply of labour, they neglected the educational aspects of the traditional apprenticeship system. He said,

> 'The influence working against technical education was the attitude of the trade unions towards the apprenticeship... to the unions the apprenticeship carried few educational implications'(p.71).

Many accounts of technical education and studies of apprenticeship and union apprenticeship policy, thus present a view of 19th century unions as oppposed to technical education and over-concerned with protectionism.

My analysis has revealed another picture. The unions were not indifferent to technical education but were actively debating it as part of the issue of apprenticeship, particularly the ramifications of its decline, as early as 1868 (T.U.C 1868 Reports). The evidence also clearly shows that throughout most of the 19th century the unions were on the defensive, engaging in a series of struggles over the employers 'labour control strategies, particularly the substitution question. Their case against the continuing decline of the apprenticeship system was that technical education should be regarded as an extension of the apprenticeship and not abstracted from it.

Arguments relating to union opposition to technical education serve to justify theories that any form of technical education evolved separate from the workplace. The main assumption is that technical education was an extension of general schooling.

In view of its separation from the workplace and its location in the school system, for example, in the 'continuation' school, it was clear that technical education, on this basis, would evolve on a part-time, evening pattern. The practice of 'day-release' to enable young workers to attend classes outside work,during working hours, was virtually non-existent in the 19th century.

Existing accounts unquestioningly accept the inevitability of a part-time, evening class pattern of technical education from the 1880s.

7.3.0.

Technical Education as Separate from the Workplace.

In support of this theory many accounts draw upon evidence relating to prominent figures associated with its early development. Huxley, one of the inaugural committee members of the CGLI, for example, clearly advocated a part-time pattern. He argued the demands of industrial work took precedence over theoretical classes:

> '...if they were not to tap the reservoir of labour needed in the great manufactories...the only way was to augment the apprenticeship with evening classes, but these would have to be local'(Quoted in Lang (1978)p.17)

An early 20th century version of this theory is provided by Sadler(1907), who equated evening classes with 'continuation schools'. According to this view these types of schools were favoured as a means of technical education, particularly in towns where small workshops prevailed. He said,

> 'The main impulse to the (technical education) movement for the increase of technical continuation schools, has come from towns in which the small workshop has held its own against the advance of the factory system...')p.532).

A Board of Education report of 1909 confirmed this view :

> 'The usual combination of workshop and school in the preparation for industrial work assigns the evening only to school and requires the young worker during the day to give full-time attendance in the workshop...evening classes have provided an open avenue for talent...'(para.98,p.83).

Cotgrove(1958) accepts these early interpretations and argues:

> '...it is difficult to see how, under the circumstances...technical education could have developed other than as an extension of night school'(p.66).

Cotgrove's case is that the 'circumstances' in question were the 'apathy' of industry and the indifference of the workers towards technical education, and a lack of technical qualifications among anagers:

> 'It is the position of the scientist in the management hierarchy which is the key to the apathy shown towards science and technology...only a minority of the total directorate were technically qualified'(p.93/99).

I find this argument restricted. Other factors that might also have been equally crucial to the 'circumstances' governing technical education provision and management attitudes to science and technology are unexamined. I have shown above that the implementation of new machine technologies by the employers, and their widening of control over the labour process, to be highly significant developments, representing radical changes in labour control and training.

Generalized accounts of technical education provide no disussion how new technologies, increasingly based on automatic principles, largely eliminated the employers' historical dependence upon highly skilled workers; and how the pattern of training was changed following the introduction of new types of machine tools. They thus fail to acknowledge the significance of the fact that employers were well placed, for the first time in the history of metal working, to perform complex operations, with accuracy, on machines using unskilled labour.

Unlike many accounts Cotgrove does address the fundamental issues of the nature of employer control, but he provides insufficient analysis of how their control over the development of advanced technologies radicalized their attitudes towards the whole question of technical education. I believe the evidence shows that it reinforced the majority of engineering and general employers in the belief that technical training and education were irrelevancies in the drive to improve production and thus, a small minority excepted, technical education was marginal to their concerns.

This prompts the question how was it possible for employers to adequately transform (decompose) machine production, maintain and even increase, production with a minimally trained labour force?

A recent analysis suggests that the innovative companies in the period were, in fact, directing technical education at an upper echelon of employees who would,

> '...undertake more stringent and scientifically-based supervisory duties...(thus) adapt(ing) to the new economies of fixed capital investment and to the need for a more intensive utilisation of labour-power in direct production...'[McGuffie(1986)p.141]

McGuffie's analysis is one of the few I have read that acknowledges an interrelation between developing technologies and the development of 19th century technical education. But his main thesis seems to me technologically deterministic; there is an abstraction of the use of technologies from the ideology of the employers implementing them. He writes, for example, of the '<u>underlying impulse</u>(my emphasis) of technical change'(p.152), as being the breakdown of general or 'standard' machine tools into 'Multi-purpose mechanisms'. This is critical for his analysis, for he says,

> '...(multi-purpose mechanisms)...allowed for a decomposition or simplification of the mental and manual facilities applied in direct production...'(p.152).

The inherent technicism in this analysis is evident when the interrelation between technologies and technical education is articulated. At one point he says,

> '..the underlying principles...affected all sectors of the labour process and made their impact on the entire engineering industry...'(p.153).

At another, is his assertion that technical education provision, represented a serious and successful attempt to provide for the future skilled workforce;

> '...(it) represented a concerted effort to integrate and develop the private and public dimensions of the capitalist regulation of skill...'(142).

But the main thrust of McGuffie's own argument is that only a very limited number of companies displayed more than a passing interest in technical education. These, in the main, were concerned not with reproduction of generalized work skills, but company-specific skills(pp.139-144). One imputation to be put on "the private and public dimensions of the capitalist regulation of skill" suggests, not so much employers' interest in training skilled labour, as management actively

seeking ways to replace it with cheaper labour and automated machines, in order to extend control and further increase profits.

7.3.1

The Rationale Underlying the Part-Time Principle in Technical Education

I have shown in my previous chapters on the development and implementation of new technologies the regulation of skill was contingent upon management strategies, particularly their persistent attempts to replace skilled labour through a policy of substitution. The evidence I have examined thus leads me to a different conclusion from McGuffie(1986). The implementation of technology was a political as much as a technical phenomenon; and the relation between technology and technical education clearly interrelated within the framework of skilled labour reproduction. In the light of McGuffie's assertion about technical education being 'successful', the question arises, 'successful' for whom?

Technical education was 'tolerated' by employers in so far as it remained isolated from workshop procedures. The location of technical education in evening classes was a logical extension of the employer-imposed condition that production should remain uninterrupted. The organisation and structure of technical education is thus accepted in consensual accounts as part of the continuation school, which, in turn, functions to meet the needs of the wider social system. A pattern of technical education, based on a part-time principle fitted the needs of employers seeking to prevent loss of labour time through absence of young workers at classes.

Cotgrove(1958) recognized this development in part and drew upon evidence from a 1911 survey to substantiate the view that 'part-time' technical education actually meant evening classes. According to the survey, in 1911 there were just over fourteen thousand day students in technical institutes, and 765 thousand evening students(Cotgrove p.68).

> '...technical education in Britain is ...predominantly part-time in nature, mostly in the evenings.'(loc.cit).

Robertson(1974) examined employer attitudes to technical education during the period 1863-1914. He concluded that employers favoured a part-time system because it would not interfere with the development of basic skills for their workers; and would not incur extra costs:

> 'They were unwilling to believe that there were any benefits to be gained by making any significant adjustments in established patterns of work organisation.'(p.223,224).

This encapsulates the views put forward in more generalized accounts which embody a consensual notion of both education and technology, perceived as evolutionary developments.

The prevailing assumption is of a neat interlocking of technical education and the social system and is evident in writers such as Cotgrove, and Liepmann:

> 'The demand by industry was matched by the output of the colleges...'(Cotgrove p.78).

For Liepmann(1960) technical education was theoretical and examinable, something carried on outside the factory:

> 'Technical education for craftsmen had developed since the middle of the 19th century under the influence of examinations conducted by the ..Science and Art Department and by the City and Guilds of London institute.'(p.38).

Curtis(1963) adopts Sadler's(1902) model of continuation schools in the period. He also maintained that technical education was moulded by the examinations of the Science and Art Department and the CGLI:

> 'Evening technical schools were developed side by side with evening continuation schools.'(p.500).

More recent studies focus on the separateness of technical education in this way, emphasising its abstraction from work. Parker et al(1975) take this approach:

> 'Technical education is extremely heterogeneous and is carried on in <u>a variety of educational establishments...</u>'(p.34).

I acknowledge that Parker et al examine the current (1975) situation, and do not provide an analysis of 19th century mechanical engineering employers. But their argument that the apprenticeship, '...changed little since the Middle Ages...'(p.35), exemplifies a common distinction found in existing accounts between craft apprenticeship and technical education:

> 'The apprenticeship system (is) a makeshift, class-ridden, inadequate, anachronistic contract which perpetuates master-servant relationships...'(Quoted on p.35).

Most accounts concur in the view that by 1902 the part-time, evening pattern of technical education had become institutionalised.

Le Guillou(1981) holds that,

> 'Technical education at that time remained largely concerned with part-time education provided for the lower wage earners...'(p.181).

This is similar to Sims(1981) who argues,

> 'In late Victorian England...it was commonly accepted that engineering was for the artisan...who was catered for in evening classes'(p.146).

Roderick and Stephens(1970) provide a singular note of criticism when arguing that the part-time system of technical education represented its main deficiency. They maintain,

> 'Technical education was bedevilled by the 'evening class' complex which persisted well into the 20th century.'(p.103).

With few exceptions existing accounts of technical education accept without reservation or qualification that, by the turn of the 19th century, it had been consolidated into a part-time, evening pattern. The dominant notion is technical education abstracted from the workplace and the apprenticeship system. There is a narrow concentration on its evolution as part of general education, conceived as a limited form of education undertaken outside the workplace. The apprenticeship is not regarded as embodying any educational character, technical or otherwise. The essential characteristic of technical education is perceived as theoretical and examinable, and by definition, exclusive from work.

7.4.0.

Technical Education Viewed as a Factor in the Socialisation of Young Workers.

The main emphasis in much of the research on technical education develpoment is on the influence of concerned philanthropists and 'enlightened' industrialists who initiated a technical 'movement' during the 1870s and 1880s. The motive for this innovation was said to be the need for economic efficiency and the fear of foreign competition.

Some also stress the socialising effects of technical education. This is illustrated with reference to 'enlightened' employers who provided technical education for their young workers in the form of 'in-company' education, or the 'Company School'.

The main source for this approach is the Royal Commission on Technical Instruction of 1884 which highlighted the work done in this respect by certain employers.In the final report it referred to:

> ' The schools established by Sir W. Armstrong at Elswick; by the London and North Western Railway Company at Crewe; and those of Messrs Mather and Platt of Salford in connection with their engineering works, testify to the importance attached by employers to the theoretical training of young mechanics...'(p.513).

In some firms attendance at the Company School was a condition of employment. This was the case at the Salford Ironworks of William Mather, also a Liberal M.P. The school was founded in 1873 and was the first of its kind (R.C.on T.I.1884).It continued until 1905, and during that time instituted its own certificates, 'the Salford Ironworks Certificate'.(Cowan (1969,p.41).

Although this kind of employer initiative was noted with approval in the 1884 Inquiry it would appear that the incidence and spread of the company schools was very limited. By 1884 the only schools of the kind were those mentioned specifically in the Inquiry and one school in Scotland, at the Denny shipyard in Dunbarton.(R.C.on T.I.p.514). However, the notion of the moralising effects of technical education finds a place in more generalized accounts.

In an early study Dobbs(1919), advocating a later familiar theme, argued that the 'movement' for technical education, which began with the Mechanics' Institutes, had a moralising rather than an educational underpinning. He said,

> 'What gave the movement its initial impulse, was not so much the thought of commercial expediency, as a desire to cultivate the minds of the artisan class...'(p.173).

A government paper of 1926 observed that one company welcomed the social effects of technical education :

> 'One great firm which definitely promoted the technical and scientific instruction of its employees, found that the classes developed thought and intelligence, fostered steady and studious habits and raised the tone of the students...'[Board of Education, Pamphlet 49,p.4].

Cotgrove(1958) also argued that technical education involved a socialising element :

> 'The extension of technical instruction in the polytechnics and elsewhere was the outcome of efforts to elevate the working classes rather than any concern with the contribution of education to industrial efficiency...'(p.65).

Thus the expansion of the polytechnics in London after the 1880s, Cotgrove continues, was motivated by the evangelical Christianity of philanthropists such as Quinton Hogg.(loc.cit.).

A further illustration of the way some employers viewed technical education in the works, such as those referred to in the 1884 Inquiry, comes in a modern biography by Koss(1970). In this account of the work of Liberal M.P. and industrialist, Brunner, Koss argues that for this particular employer, technical education had an integrating and moralizing influence :

> ' Education as (Brunner) saw it was designed to impart moral values as well as technical training...'(p.41).

Robertson(1974) points to the practical benefits for employers of the socialising effects of some kind of technical education:.

> ' In all, technical education for skilled workmen was deemed beneficial because it discouraged vandalism, promoted moral strength, and broadened a man's outlook as well as giving him a better grasp of his job...'(p.227).

The most recent account, McGuffie(1986) argues some employers were quite successful in their attempts to solve the problem of technical training by devising their own schemes. So much so he claims that, to a certain extent,

> 'British employers in the metal industry were anticipating by a good 10 years American training methods...'(p141).

He cites a number of companies: Clayton and Shuttleworth of Lincoln, The Great Western Railway works at Swindon, Andrew Barclay of Kilmarnock, Barr and Stroud, and Westinghouse (pp.139/140).

The influence of organised religion emerges in another study, Joyce(1980). Seeking to show how the relationship between work and religion reinforced the employers' attitudes to technical education, he examined the relationship between the 19th century factory system, and the social structure to which it gave rise in the north of England. There were, he maintained, close links between employers and organised religion. In 1892, for example, the majority of Bolton's seventy-seven churches were built with employer aid, and this was held by Joyce to be, 'representative of factory towns in general'(p.174).

Joyce further argues religion, although limited in effect on popular life, was more successful in attempting,

> '...to cement the chain of authority in the factory and to bolster the hold of the factory regime on the workpeople...'(p.176).

The authority of the factory was reinforced by the integrated nature of the workers' lives, dominated by paternalistic employers. Accordingly, the employers were also influential in the provision of secular education :

> 'As with all aspects of factory life, with secular and religious educational provision the integration of the majority occurred because so much of what was an integral part of daily life...took place, within the territory of the factory...'(p.172).

The focus in these studies has moved from considerations of technical education as an alternative to the apprenticeship or as a necessary, contributory factor in improving economic efficiency. The emphasis has shifted to the ways employers sought to use technical education as a means of reinforcing social control. But they are variations of the common view of technical education that it was primarily instituted to improve economic performance. These specific accounts emphasize the indirect influence technical education was said to have had through innovations such as the company school. Within this framework technical

education is presented as a means of rationalising the workers' acceptance of the factory regime.

My view is that despite the claims made for the 'Company School', this kind of provision featured in existing accounts, represented only a small fraction of the total situation. The importance of this sector of technical education, has been exaggerated in the accounts which make reference to it.

7.5.0

Summary and Discussion.

I opened this chapter with an examination of accounts of 19th century technical education which stress the significance of prominent people initiating a 'movement' or 'cause' in technical education. Inspired by concerned people's perception of the impact of foreign competition it is presented as a necessary part of economic development.

International Exhibitions, for example those in 1851 and 1867, are held to be the source of initiatives instigated by people such as T.H.Huxley, Lyon Playfair, H.E. Roscoe, who responded to criticisms coming from the Exhibitions concerning Britain's failing competitive economic performance.

The Inquiry instituted in 1881 and published in 1884 confirmed the negative views expressed by jurors at the Exhibitions. This evidence appears in most accounts as justification for their belief in a 19th century technical education 'movement', based on the two institutions at South Kensington, the Science and Department, and the City and Guilds of London Institute. Both institutions are said to have been a response to pressure from prominent people for a national system of scientific and technical education.

It is further argued that the 'movement' evolved from the 1870s, against the apathy and hostility of a generality of employers and the indifference of trade unions.

Trade unions figure largely in most accounts as being indifferent to technical education and holding a narrow, sectionalist interest in the apprenticeship system. It is argued they perceived the apprenticeship simply as a means of controlling entry to the trade, in order to protect their artisans' status.

With notable exceptions, such as McGuffie(1986), employers are portrayed as apathetic and having only limited regard for technical education, with a calculative and instrumental interest in the apprenticeship system. But there is no examination of the underlying rationale of the employers' attitudes; rather, most accounts adopt the orthodox view that technical education evolved as an extension of general schooling.

Some accounts focus on the socialising effects of technical education. These approaches come within a general economic framework which views technical education primarily as a means of improving workers' industrial performance. Two variations of this approach were discussed, the Company School, and the generalised notion, found in some accounts, of technical education fostered in order to strengthen social control of the workers.

Overall,the predominant model of technical education presented is one which evolved on a part-time, evening pattern, and, in the main, separate from the workplace.

An unquestioning belief in this model is reinforced by the common assertion that technical education was an extension of general schooling. The apprenticeship therefore is not considered part of technical education in the 19th century, for by definition, it was something which took place outside the factory. Because it was viewed in this way it is assumed in these accounts that technical education could have functioned only as a part-time, evening class system.

I believe the evidence is clear that the employers' influence on technical education justifies more thorough analysis than existing accounts acknowledge. The extent and nature of their control over the labour process, and the ambiguous position of the state relative to employers and to mass general schooling, has not been fully explored.

Employers were not restricted simply to controlling the new technologies. They critically regulated both access and time available to young workers who were to be the main technical education catchment.

It is too simple to dismiss the Trade Unions' attitude to technical education as being soley motivated by sectional interests and concerned only with controlling numbers entering the trade.

TUC evidence has shown that as early as 1868 the leading Union of the day, the Amalgamated Society of Engineers(A.S.E.) was advocating the retention of the apprenticeship system and inviting the creation of a structured technical education system. There is also evidence of independent artisan initiatives in the 1860s, such as the Workmen's Technical Education Committee and the work undertaken by Solly in the 1870s.

I believe it has been shown that central to an analysis of technical education in this period is a detailed exploration of the interests of the three groups which constitute the focus of my study: the State, employers and the skilled workers. At one level both the skilled workers and the employers perceived the working of the market as consistent with their own aims. The employers were committed to profit maximization and pursued this through the implementation of new technologies and the use of unskilled labour. At another level Government failed to perceive the contradictions relative to both the employers and their workers in pursuing a laissez faire policy, which, being essentially short-term, fostered a neglect of technical education, with its long-term implications. The factor of laissez faire economics was deeply rooted in Victorian life, often manifested under the 'self-help' philosophy; I shall analyze more fully the implications of these policies for technical education in chapter 9.

The common idea in most accounts, of 19th century technical education as an extension of general schooling, clearly reinforces the belief in the abstraction of technical education from work, and its institutionalisation outside industry.

Accounts in which technical education is regarded as an evolutionary development out of mass general schooling are unable to consider the significance of influences other than prominent scientists such as Huxley and Playfair. They do not take into account that people involved in the reorganisation of factory work were also those involved in the development of technical education.

Existing theories of the origin and development of technical education are therefore inadequate for me in three principal areas of analysis.

First, there is little substantive evidence for the belief in the existence of a national 'movement' in technical education from the 1870s. By and large, technical education initiatives were fragmented, localized

and often independent, with ad hoc administrative arrangements. The 1884 Inquiry, the first formal investigation on a national level, revealed a disparate and fragmented technical education development.

Second, the unquestioned assumption that the Science and Art Department at South Kensington, in conjunction with the CGLI, was in a position to assume responsibility for a national system of technical education, appears to be at variance with the evidence regarding the specific roles of these institutions. The former was responsible for the administration of a relatively new and weak national school system. The latter was restricted, as were the Livery companies from which it originated, to an examining and monitoring role over a narrow range of crafts.

Third, the assumption that it was inevitable that a technical education should develop on a part-time, mainly evening class pattern, is too readily accepted without qualification. Most accounts agree that 19th century industrial employers were indifferent or hostile to technical education, but few question why employers persistently held negative atitudes, well into the next century.

I believe that in order to provide an adequate explanation of the distinctive pattern developed in English technical education it is necessary to look beyond educational policies and administrative strategies. The evidence strongly suggests that employer power was not confined to the workshops, but that it crucially extended beyond the factories. It therefore seems to me that an examination of one of the most significant political and industrial events in 19th century industrial struggles, the Great Strike and Lockout of 1897/8 could provide insights into the way technical education was influenced by events outside the educational world.

In the next chapter I therefore analyze the political and ideological background to the consolidation of engineering employers' power. I examine in depth the culmination of employer-employee struggles,the 1897/8 conflict, and investigate whether this dispute provides the framework for an explanation both of employer power and the way it influenced technical education development, well into the next century.

CHAPTER 8

EMPLOYERS AND THE IDEOLOGY OF ENGINEERING MANAGEMENT: THE GREAT STRIKE OF 1897/98.

PART A: Engineering Management and the Ideology of Engineering Production

8.0.0.
Introduction

In my previous chapters I have argued that new technologies such as screw cutting, milling machines, and the turret lathe, represented a crucial part of the essential technical conditions for the dequalification of skilled engineering labour. (My analysis above, Chs. 3,4,5).

The process of dequalification was characterised by skill substitution also dependent upon a pool or reserve of unskilled labour composed, in the main, of unskilled adult labour and children, particularly boys, and increasingly displaced skilled labour. In this chapter I argue that this specific reserve of labour underpinned employer management strategies from the 1860s, and to suggest that from this period the ideology of engineering labour control centred particularly on the exploitation of these groups. The increasing use of unskilled workers, in course, radicalized the political nature of machine production and machinery assembly. The unskilled workers came to be aligned with employers' attempts to weaken the solidarity and resistance of the amalgamated unions.

The evidence I have produced has shown first that artisan exclusivity and its historical near-monopoly over certain trade practices were necessary points of employer pressure as they pursued their attempts to extend and exploit the advantages derived from 19th century expanded machine tool technology. Second, employers perceived technical developments as a means of pre-empting the traditional functions of skilled craftsmen, which enabled them to deploy unskilled labour more effectively and further increase the pressure on skilled labour autonomy. The demise of the apprenticeship system paralleled these developments.

I aim to show therefore that the 1897 strike and lockout was the culmination of a series of struggles throughout the century and became a conflict over power relations centring on employer and artisan interests regarding control over certain workshop practices such as machine manning, and the training of young workers. I shall examine the nature of the strike and lock-out, and explore the following hypotheses:

First, as the first major conflict in the engineering industry between employers and skilled artisans, after the engineering strike of 1852, it represented a major challenge to employers' dominance in a principal manufacturing industry. Second, it was the first major industrial strike to be primarily concerned with principles of labour substitution. Third, the 1897/8 conflict was concerned with the changes in the system of power relations that developed as the structure of work control altered. And finally the strike and the Terms of Settlement which concluded it highlighted the way engineering employers perceived technical training, and thus influenced the development of technical education.

8.1.0

The Challenge to Skilled Workers' Workshop Autonomy

I argued in Sections one and two above that employers, in defining certain areas of engineering practice as independent of craft skills and artisan direction, e.g. with machine tool operations using automatic principles, rejected the historical patterns of training skilled craftsmen, and promoted the widespread use of non-artisan labour. As Cole(1937), in his discussion of trade unionism in the latter part of the nineteenth century argued, there was a clear division between the skilled and unskilled workers, a division that employers were always seeking to break down.

> "... at particular points, by employing cheaper men to do work claimed by the craftsmen as their monopoly". [Cole, G. D. H. (1937) p.5]

Marx(1887) had also argued that

> "... the less the period of training, therefore, that any work requires, the smaller is the cost of production of the worker and the lower is the price of his labour, his wages. In those branches of industry in which hardly any period of apprenticeship is required, and where the mere bodily existence of the worker

suffices, the cost necessary for his production is almost confined to the commodities necessary for keeping him alive and capable of working. The price of his labour will, therefore, be determined by the price of the necessary means of subsistence". [Marx(1887), (1976) p.26]

The aims of 19th century unskilled engineering workers came to be increasingly allied with the employers by their cooperation in the process of substitution, and taking up some skilled workers' functions in machine tool operations.. As early as the 1860s an important objective of employers was to break skilled artisan monopoly, and to promote the cause of non-unionised workers,

"The interests of the operatives, in their ultimate development, are identical with those of the employers, inasmuch as if the restrictions on labour sought to be imposed by the unions result in increasing the cost of the products of their labour to such an extent as to allow foreign competitors to obtain orders ... (and) the country loses the trade, and the workman his share of the wages which might otherwise have been his". [Royal Commission on Trade Unions(1868)p.56].

The employment of non-union workers in jobs formerly the exclusive property of ASE artisans, could therefore be said to advance the cause of both the unskilled workers and their employers. By the 1890s engineering employers were arguing that the skilled workers' claim to autonomy within the labour process extended beyond the exercise of traditional practices. They maintained it constituted interference with output, restriction on overtime working, control over access to certain machine tools, and unwarranted intrusion into the management of the shops. [Times, 6th Nov. 1897].

Employer hostility towards traditional workshop practices may be illustrated by the case of the London firm of Daniel Smith & Co. The firm had been challenged by the A.S.E. over the placement of labourers on mechanics' work, and for employing a driller to operate a boring machine. The reaction was unequivocal:

"In consequence of the inconsiderate, selfish, uncharitable, and uncalled-for interference of a small section of our employees endeavouring to enforce us to inflict an injustice and deprive other men of their liberty or right to progress in a higher branch of our trade, we consider it necessary to make the following announcement:
It is our firm intention from this date to have whomsoever we choose, put them to whatever kind of work we think fit, and pay such wages as are initially agreed, without any dictation or interference on the part of our workmen.
'No discussion or interview relating to Society's rules will be allowed during working hours". [Quoted in Engineering, 12th Nov. 1897]

Another large company provides further illustration. Two copying lathes were rated by the A.S.E. at 35/- per week, or 70/- for the two. As a result of a strike a labourer was put in charge of both machines, and received 24/- per week, which was "... a large increase on his former wage". [Times, 6th Nov. 1897]

The firm maintained that output was increased and, in this single machine function, 46/- per week was saved, arguing that interference by A.S.E. men was manifest in this case by insisting on a one-man-one-machine operation. They refuted this A.S.E. claim and held to the view that both machines "... can be easily and capably worked by a single 'handy' man". [Ibid]

Labour-substitution was a critical factor in the case of a northern firm which reported a marked reduction in the amount of wages paid on individual machines, compared with similar machines before the strike. On one special lathe an A.S.E. man had 35/- per week for turning a certain class of pulley taking 26½ hours. On the same lathe a 'machine man', at 24/- per week was turning slightly larger pulleys in 22¼ hours, after being 'advanced'.

> "There has been a much better turn out by the non-union men since the strike than there was before it". [Ibid]

A promoted labourer in a Manchester firm was producing work on a large planing machine in 135 hours; an A.S.E. man took 190 hours for the same class of work. The firm took the view that increased production rates were possible as a result of supervision being carried out by a non-union shop foreman. Disputes over work control by non-Society foremen were common; the evidence shows that it was significant in the employers' tactics of substitution. This was clear in the particular case of a firm on the Clyde.

The firm concluded that in the period from 1895 to 1897, production times for engines had increased by 20 per cent, due, it was contended, to A.S.E. shop steward interference, which had become "... simply intolerable". [Ibid] . The firm offered 'low-class' mechanics 5/- per week increase if they would work any machine to which they might be put; the alternative to this was that of 'leaving the works'. Ten immediately left, refusing to work machines vacated by A.S.E. men. The relations of production were unsettled:

"Even non-society men who have tried to work in our place since the commencement of the strike have been persecuted out of it by the pickets during meal hours and at night ... driving away even our new foremen over the machines".

8.1.1

Relations between Engineering Employers and Unskilled Labour

Evidence shows that in the period following the strike of 1852, employers were increasingly prepared to challenge the skilled workers over historical work practices. They responded to skilled worker resistance to work reorganization by questioning the basis of traditional artisan autonomy and particularly ASE influence with respect to machine tool operations. By the 1890s they felt confident enough to confront the unions directly. A mechanical engineering journal argued that 'capitalists are absolutely justified in trying to smash Trade Unions as they exist'. [Engineering, Sep. 1897] ASE reaction was regarded as a direct challenge to management prerogatives,

> "It has ... come to this: Trade Unionism as now practised in the British Engineering trade has to go ... it is the duty of the employers to smash the union". [loc.cit]

The issue for skilled enginering labour had revolved around the critical question of how and to what extent employers were to develop the potential of the new classes of machine tools, and the use of undifferentiated labour.

As distinct from previous employer-employee disputes, from the 1890s the employers were gaining political confidence, emanating from two sources. First, was their control over important new classes of tools, which stiffened their reaction to ASE demands for exclusivity regarding certain classes of work. Second, ASE and EEF sources show that more employers were rejecting individualism and veering towards a form of federation. This combination was crucial in the changing political and ideological structure of union-employer relations from the 1880s. As the Spectator put it:

> 'The owners of capital have for the moment control of the markets in their hands, and if they learn to combine and make common cause they will be as powerful as ever the feudal barons were...'(25th Sep.1897).

This injunction was supported by the claim that a reduction in the numbers of skilled workers in the factories was possible because of

> '...the use of machines still more nearly self-acting or "alive"...'(lo.cit.).

8.2.0

Trade Unions and Federating Employers: Early Developments

Movements towards a national engineering employers' federation were fitful and had started about the mid-1880's, with Colonel Dyer, Chairman of the William Armstrong Company, Newcastle, as a prominent figure. This development was the outcome of engineering employers' continued awareness of the unions' potential for national collective action, which despite trade rivalries, was showing signs of increasing solidarity.

This is not to imply a solidarity in class terms, but related to a relatively narrow stratum of the working class, skilled artisans. At one level, combinations of tradesmen such as the London Trades Council alone constituted a federation of organised trades consisting of 49 societies, 35 districts and 15,480 subscribing members [R.C. on T.I. (1884) Q.3854].

At another level, the Amalgamated Society of Engineers (ASE) itself had evolved by the 1890s into a highly eclectic but relatively cohesive organisation; the diverse number of engineering trades eligible for membership indicating its comprehensive character.

The society consisted of craftsmen in the following trades or branches: smiths, fitters, turners, pattern-makers, highly skilled machine woodworkers who manufactured precision patterns for use in moulds for the casting of metals, millwrights, skilled fitters and machinists responsible for machine installation and factory lay-out; planers, borers, slotters, mechanical draughtsmen; brass finishers, machinists usually, for manufacturing non-corrosive metal products; copper smiths employed in the engineering trade; machine-joiners (erectors) employed in the construction of machinery for cotton, silk, and woollen production; and ships' smiths. [R.C. on Labour (1893) Q.22655]. The overall membership of the Society increased continuously from 43,150 in 1874 to 71,221 in 1891, with an increase in the number of branches from 377 to 509; by 1898 the total membership was 91,000 [Jefferys (1945) pp.93, 138].

The growth in the size of the ASE membership coincided with the high point of organised trade unionism in nineteenth century England. It occurred in the period 1896-1898 when there were between 1,326 and 1,358 trade unions, with a total membership in 1898 of 1,752,000 members, including 144,000 woman members [British Labour Statistics, Historical Abstract 1886-1968, Department of Employment and Productivity, London, H.M.S.O. 1971, table 196, p.395]

An important measure of the political and financial strength of a union was its ability to withstand protracted disputes. The longest strike in the mechanical engineering industry began in Sunderland in June 1883. It was also notable in that it provided the background for the political realignment of employers. The strike arose over a claim by the ASE local executive for an increase in wages, and a restriction in the number of apprentices. There was also a demand for the withdrawal of the Inquiry Note. ['Record' (1883/4) pp.71, 76]. This seems to have been a limited but bitterly contested dispute and lasted until 1885. The employers took out writs against the men to force them to return to work; and with assistance from the Iron Trades Employers' Association (I.T.E.A.), non-union labour was imported in an attempt to break the strike. ['Record' (1883/4)]

During the course of this dispute there began a loose federation of engineering employers in the Tees and Hartlepool and Tyne and Wear areas, and a joint committee was set up to co-ordinate policy action. Subsequently, the ASE were forced to withdraw on all points in December 1885; the employers conceded no issue and recorded

"... a decisive victory". [Record 1884/5]

This employer combination gave rise to what became known as the North-East Coast Association. [Wigram, E. (1973) p.22]. The following year came a link-up between the Clyde and Belfast employers. But a more comprehensive federating attempt came in 1895.

The first meeting of the incipient national federation was held on 20th November 1895 where it was proposed that the Clyde and Belfast, Barrow and N.E. Coast Engineering Employers should combine. I believe the immediate issues addressed by the combined employers were significant in so far as they related to the definition and deployment of craft skills. They concerned:

a) apprenticeship, b) overtime, c) minimum rates, d) limitation of hours, e) demarcation of work. [E.E.F. Minute Book, (1895-1899)].

The initial confrontation between the ASE and the newly formed federation came in the following year, 1896, and clearly displayed signs of employer recalcitrance over the questions of substitution. The Society had put forward a number of claims in different geographical areas concerning the employment of non-union men on work traditionally

reserved for artisans, and restructuring of overtime. The claim employers considered most contentious was

> '...only members (of the Society) should work machines at rates fixed by the Society, and that one man should work only one machine' ['Record' (1896/7) p.134]

The conflict gradually intensified and in relation to the strike of Society members at Dunsmuir and Jackson's at Govan, a special meeting of the executive of the Federation was convened at Carlisle in August 1896. The chairman, Dyer (Wm. Armstrong & Co.), reiterated the employers' position regarding machine manning, and advocated that the Board should give the widest possible publicity to the machine question and to their determination to 'exercise their rights'.

The employers argued that they

> "... have always exercised their right to appoint any man whom they might choose to man the machine in their shops ... whether the man is a skilled or unskilled workman or whether, he belongs to any Society or not ..." [EEF Minute Book (1896)]

This particular dispute concluded with a central figure in the Govan dispute, a non-union man, leaving the workshop (to take up a 'better appointment'), and another non-unionist being taken on in his place. ['Record' (1896/7) p.135].

The principle of substitution was reasserted during the next strike involving Messrs. Earle's at Hull. In contention was the insistence by the ASE that their fitters or turners only should be allowed to work milling machines. The employers' executive meeting resolved that

> '...the Federation should strenuously resist all demands, and the Associations should agree and resolve to support such action'. [EEF Minute Book (1896(a)]

This was an appeal for the local associations of engineering employers in other parts of the country to demonstrate their solidarity. The Belfast Employers Association, the North Western Association, the N.E. Association and Barrow all agreed to support the Federation. The combination had strengthened the resolve to resist ASE claims, particularly concerning machine manning. The EEF executive wrote to the Glasgow district committee of the Glasgow ASE, where a machine-manning dispute had also arisen. The letter made it clear that as far as engineering employers were concerned, ownership of property constituted the right to its disposition, and rejected the right of the Society over control of machine tools.

'...the Federation distinctly decline to admit the right of your Society to claim for your members exclusive rights to work any particular class of machines'. [EEF Minute Book (1896)(b)]

The message was unequivocal: the machines and their manning were under direct managerial control:

'The machines are the property of the employers and they are solely responsible for the work turned out by them; they therefore will continue to exercise the discretion they have hitherto possessed of appointing the men they consider suitable to work them'. [loc.cit.]

8.3.0

The Machine Question and the Great Strike

Agitation on the part of the ASE therefore continued, generally revolving around the substitution question, until a crisis was reached in February 1897. There were strikes at the works of the Sunderland Forge and Engineering Company, and at Barrow. An ASE claim regarding the former workshops was that two boring, milling, and horizontal drilling machines should be worked by Society men. At Barrow the issue concerned the employment of unskilled workers at reduced rates and fixing of rates governing payment to men on machines. ['Record' (1897/8) p.135]. These issues were discussed at a specially convened meeting of the Federated Association in London, where the significance of the ASE's actions was spelled out by the Federation Chairman: The ASE men at Pallion, Sunderland, attempted to restrain non-Society men from working some new boring machines introduced into the Sunderland Forge and Engineering Company. Three turners at the Naval Construction and Armaments Company, Barrow simultaneously lodged a claim to enforce a rate of wages, being the amounts the Society had rated the machines they were working. The third major issue was at the Armstrong Ordnance Works at Elswick, where there was a Society claim over the manning of a new automatic gauge-grinding machine. [EEF Minute Book (1897)].

A special meeting of the executive Board of the Employers Federation convened in London on 26th February, and resolved that a letter be sent to ASE secretary Barnes specifying instances of the aggressive action on the part of the ASE, causing

> '... considerable trouble to the employers who are members of the above Federation'. [loc.cit]

The letter clearly stated that the call for the displacement of unskilled machinists at Sunderland was unacceptable as the men

> '...have been and still are working (the machines) to the satisfaction of the employers'. [Ibid]

The meeting resolved to resist 'encroachments' upon the rights of the employers, and pledged to assist the three companies directly involved in the dispute. As a practical measure the executive also agreed to subsidise the Sunderland Forge and Engineering Co. to the rate of 15/- per man on strike. The ASE executive was informed of two principal conditions attaching to the employers' directive: unless 1) work was resumed at

Sunderland and Barrow on or before Friday 12th March, 2) the Society agreed to meet with the Federation to discuss the settling of all questions at issue, the Federation would issue notices to end the employment of ASE members in their employ. The Federation resolved, as a result of the negative reply on both counts from the Society,

> '...that on the 27th March and on each of the three succeeding Saturdays, the services of 25 per cent of the members of the ASE in their employment will be dispensed with'. [Ibid]

The scale of the lock-out threat was considerable. If the employers carried out their threat, notices of a lock-out would have been posted at Barrow, Belfast, the Clyde, Liverpool, N.E. Coast, and London, at all shops owned by members of the Employers' Federation. This would affect between 20,000 and 30,000 engineering workers, besides indirectly many thousands of unskilled workers. [The Times, 10th Mar. 1897]. It was agreed on 23rd March that a meeting between the parties be arranged: the disputed machines at the works of the Sunderland Forge and Engineering Company to remain idle during the negotiations.

On 2nd April, the Manchester District Engineering Employers Association was formed.

> 'Twenty important northern and Midland firms have announced their adhesion and they are desirous of federating with the Employers Federation of Engineering Association'. [The Times, April 1897]

This group of employers, many of whom were already members of the I.T.E.A., were admitted to the Federation.

8.3.i.

<u>The Machine Conference and the 48-Hour Issue.</u>

Conferences were held in London on 1st, 2nd, 13th, 14th and 15th April 1897. The machine question was most exhaustively discussed,

> '...indeed it being the most important matter under discussion it took up the greater portion of the time of the Conference'. ['Record' (1897/8) p.136]

Despite the protracted discussions both sides remained adamant and held to their position. The Conference has been since known as 'The Abortive Machine Conference'. The men at Sunderland and Barrow had remained at work; but the ASE was evidently anxious to test the popularity of its cause in pressing for a resolution of their claims. The ASE Secretary, Barnes, expressed the inevitable confrontation as a 'trial of strength',

outlining the Society's strategy in terms of its appropriateness in relation to trade and the popularity of its cause. In a letter to the Dundee Weekly News he wrote,

> '...a trial of strength with this Federation is inevitable, and the present is as favourable an opportunity as was likely to be presented to us. Trade is brisk, the weather good, and the issue a popular one'. [22 May, 1897]

Anxiety over the impending major confrontation stimulated a more rapid growth of companies seeking federation. They assumed that employers' combinations were crucial in opposing what was financially and numerically the strongest amalgamated union at the time. The evidence suggests that they were realistic in this. Indeed, Mann, a prominent ASE member, who stood for the General Secretaryship of the ASE in 1891, seemed to personify the militancy and politically-growing awareness in the ASE, when he wrote

> '...let them have it. Everything favours the men; the state of trade, the prospects for the next year, the unions' finances and the opinions of the members'. [Mann, T. (1897) p.144]

London provided the location for a tactical turn of events although it seems initially to have been in an ambiguous position vis à vis the other major centres of employer interests. There was no Engineering Employers' Association there. The A.S.E., making a rational assessment of the prevailing situation in this area, extracted important concessions from a number of the smaller firms. Prominent among these was the granting of an eight-hour day, the culmination of Society pressure; due principally to a circular sent on 30th April, to firms from a Joint Committee of Trades. This body seems to have been an ad hoc strategic Committee composed of members from the A.S.E., Boilermakers, Steam Engine Makers, United Society of Smiths and Hammermen, London and Provincial Society of Coppersmiths, London Society of Drillers, United Machine Workers Association ('Record' (1897/8) p.137].

Up to 5th August the A.S.E. claimed to have had concessions regarding the eight-hour day from 204 firms in London. This, however, was disputed by the Federation, who argued that their investigations revealed that only 66 of these could have been classed as engineering firms, the remainder being public bodies, brewers, contractors, and similar bodies ['Record' (1897/8) p.138]. The Federation maintained also to have persuaded many of the firms who conceded the eight-hours day to rescind and to join the Federation. The ostensible cause of the dispute

was the eight hours' question, but the more substantive issue seems to have been that of labour substitution.

The evidence indicates that the 48-hour issue originating in July 1897, for practical purposes, may be regarded as peripheral to the central issue, machine manning. A leader in the journal 'Engineering' argued:

> 'The length of the working day is only part of the question in dispute; a more important matter is the control of machines'. [1st Oct. 1897]

'Engineering' held that the question of labour control was the central issue. There was, it was suggested, no objection to trade unionism 'in the abstract', but the dispute was to be resolved by ousting

> '...sundry trade unions from privileges of which the...gained posession in the past...the 48-hour question is as nothing'. [Ibid]

According to The Times of 4th December, the 8-hour day issue was not discussed seriously at all at the Conference.

Iron Trades Employers Association (ITEA) reports suggest that employers were confronting the A.S.E. behind the eight-hour issue, but were clearly determined to press for the extension of unskilled machine manning,

> '...employers were determined not to agree to any settlement that did not include all the points that had previously been at issue, and which were discussed at the abortive Machine Conference in April 1897'. ['Record' (1897/8) p.139]

Those London firms who were members of the I.T.E.A. brought the matter before that body, who asked for the co-operation of the Federation. As a result the largest London Employers formed themselves into an Association which was admitted to the Federation [loc.cit].

An ultimatum was sent by the Joint Committee of Trades to a number of firms in the London region that had refused to concede the eight-hour day. Failure to concede was threatened with a strike on 3rd July at 1 p.m. The Employers' Federation wrote to the Joint Committee and received no reply. On 1st July an employers' meeting was held in Manchester with representatives from the three leading engineering Employer Associations, the Engineering Employers Federation, the Shipbuilders Federation, and the Iron Trades Employers' Association. It was clear from the nature of the resolution passed at that meeting that the confrontation was inevitable. A telegram was sent to the Joint Committee intimating that in the event of a strike as indicated, notices would be immediately given by the

members of the Associations affiliated to the Federation that a 25 per cent reduction of workers would take place of the members of each union in their employment. Each society represented on the Joint Committee received a copy of the lock-out threat.

On 7th July, it had been reported that in London, on the N.E. Coast, at Glasgow and Greenock and elsewhere employers had posted notices for the discharge of 25 per cent of their men, and it was further reported that

> '... it has become clear that notices will be necessary for the remaining 75 per cent'. [Times, July 1897]

Simultaneously the Leicester Iron Trades Employers Association passed a unanimous decision to lock out 25 per cent of union men employed in their shops. It was estimated that in all 80,000 would be affected. [Ibid.]

The Boilermakers Society and Pattern Makers withdrew from the negotiations at this stage, arguing that they would not take part in the stoppage of work in the London district. The remaining union members struck and the employers dischargod members of these unions. The notices to the 25 per cent of members of the unions connected with the Joint Committee terminated on 13th July, on which date the remaining 75 per cent withdrew their labour on instructions from their Societies; 16,944 members of the A.S.E. left work in this way. The total number of men of all trades on strike being over 25,000. [Engineering,Oct.1897 p.136].

At the beginning of the action about 180 firms were involved: by the middle of July 250 firms had aligned against the workers ['Record' p.139]. Throughout August, September and October further accessions were recorded. On 8th October the Board of Trade estimated that 579 firms were directly concerned in the dispute and that the total number of men on strike, or locked out, was 45,000. Employers at Sheffield, Oldham, Keighley, Ipswich, Heywood, Edinburgh, Leith, Aberdeen, Nottingham, Dundee, Bristol, Hanley, Preston, Blackburn, Burnley, Rochdale, Wigan, Ashton, Leicester, Huddersfield, Bradford, Carlisle, Otley, joined during this period. The cost to the A.S.E. from their contingency fund was put at £127,000 [Engineering, Oct. 1897]

The percentage of enforced unemployment among members of trade unions rose from 2.5 in July 1897 to 5.1 in December. Total membership of Unions at this time was 1,731,000. The number of skilled and unskilled workers, unemployed and unionised workers, i.e. constituting a reserve of

relatively experienced labour was 43275 in July and in December, 88281 - Figures from which persons locked out or on strike have been excluded. If the latter were included to take into account the engineers, the total would have doubled to approximately 168,200 in December 1897. The published figures for the engineers were: Men idle, Engineers 25,000; allied workers 10,500; non-unionists, 10,000; labourers, 33,000 - total 80,000 [British Labour Statistics (1971); Times 20 Dec. 1897]

From the outset of the dispute the employers claimed that a combination of factors instigated by unions rendered economic production impossible:

> 'Their opposition to piece-work, their insistence on uniform rates of wages, their restriction of the number of machines a man may look after, and their hampering regulations in regard to demarcation of work, are alone sufficient to put British producers at a disadvantage, which must bar them from the markets of the world'. [Engineering, Sept. 1897].

This claim was vigorously contested by the ASE secretary, Barnes; although at first confidently predicting a successful outcome to a dispute of not more than six weeks, was forced to concede that the

> '... fight is going to be one of the biggest things we have ever had in this country'. [Labour Leader, 21 Aug. 1897]

Kier Hardie, editor of the Labour Leader, argued that the employers were in fact using the dispute to seize the opportunity to smash the A.S.E., a result of which, he contended, would be more substitution of skilled by unskilled workers.

> '... They will in future recoup for themselves for any present losses by being free to run their machines with low-paid labour, run their shops with apprentices and youths at half a journeyman's pay, and even reduce wages all round'. [Labour Leader, 11 Sept. 1897]

Barnes was convinced that 'a war against Trade Unionism has been started' and that there was collusion between certain members of the aristocracy (e.g. Lord Wemyss, later Lord Elcho), Dyer and his associates, and members of the Free Labour Protection Association. [Report in Labour Leader, 18 Sept. 1897]. This latter body had some 182,000 members; having been formed in 1893, it seems to have been a source of 'blackleg' labour of the kind called up by the ITEA. Its main function was to supply strike-breaking labour. Ideologically it counterposed the assumed threat posed by 'Socialistic agitators' and provided the common ground that was purported to exist between the 'cause of Labour' and that of Capital:

'The free labourers and the employers are on the same side ...' [Engineering, 15 Oct. 1897]

According to Jefferys the Association was in fact composed entirely of

'riff raff (who) broke and damaged in a few weeks more tools and machines through inexperience than a skilled engineer damaged in a life-time'. [Jefferys, J. B. (1945) p.416]

8.3.ii

The Interaction of Political and Technological Aspects of the Conflict

The financial aspect of the dispute was proving serious for the A.S.E. It was reported by Barnes that £30,000 had been distributed in early September as part of the fifth distribution of strike pay since the onset of the dispute. Resources were being depleted at the rate of £10,000 per week. [Labour Leader, 16th Oct. 1897]. John Burns, ASE official, writing to the Times in September argued that the dispute was particularly destructive to working class aims despite an upturn in the economy. He cited, among other things, the economic background against which the strike and lock-out took place. For example, in the twenty years from 1876, engineering trade exports increased tenfold (to £70,000,000); up to 1895 there had been a diminishing of the number of strikes e.g. from 1211 strikes in 1889 to 876 strikes in 1895, while lock-outs by masters increased.

'This unfortunate dispute has for its object, on the masters' side, the crippling and annihilation of working class combinations ... that is the impelling motive and the real object of the Employers Federation'. [27th Sept. 1897]

[Burns, a member of the A.S.E. since 1859 was also well-known as a member of the Social Democratic Federation, and prominent in advancing the cause of the unskilled as well as his own Society Members. He was to figure largely in the 1897 dispute, together with A.S.E. Secretary Barnes in writing pamphlets and letters to the press such as The Times, where he attempted to counter the bias advocated in them, and muster support for the men. [Jefferys, J. B. (1948); Kynaston, D. (1976), King Labour, 1976].

Hardie, also conscious of the deleterious effects of a protracted dispute both on the morale and financial resources of the union, proposed a strategy to force the issue: 1) Pool all the unions' funds as a fighting fund for those locked out; 2) proclaim a general strike and

'... bring the trade of the nation to a standstill'. [Labour Leader, 16th Oct. 1897]

However, confidence in their ability to exploit the new technology seems to have pre-empted any possible concessions on the employers' side regarding machine-operating with unskilled labour. In response to an initiative by the President of the Board of Trade (Sir Courtenay Boyle) on 20th October, to bring the two sides together, the E.E.F. executive drafted what might be termed an Engineering Employers' manifesto. (See Appendix 2).

It was prefaced by two clauses drawn up by the President of the Board of Trade to the effect that both sides were to acknowledge the right of combination of each other. The Board of Trade proposed:

> 'The Federated Employers, while disavowing any intention of interfering with the legitimate action of trade unions, will admit no interference with the management of their business" (1st Clause). "The Trades Unions, for their part, while maintaining the right of combination, disavow any intention of interfering with the management of the employers'. (2nd Clause) [Quoted in 'Engineering' 2nd Nov. 1897]

Three basic principles of employer control were reasserted in this document and clearly reiterated the employers' views which had increasingly hardened during the course of the dispute: The inability of employers to reduce working hours, due, it was argued, to increasing foreign competition; that Britain had no monopoly of labour-saving machines; and new machines in use could be more profitably used with inexperienced hands.

8.3.11(a).

Press Reaction

As might be expected, Press reaction varied according to affiliation. One source, suggested that the E.E.F. proposals were characterised by the rhetoric of employers 'defending common rights' and 'staving off revolution':

> 'The employers have revolted against the encroachments by way of tyranny of certain trade unions, and that their proposals may be taken to represent the charter of freedom ...' [Times, 4th Dec. 1897]

The Times further suggested that the confrontation had evolved beyond the boundaries of a single trade dispute to embody more universal principles. The engineers' dispute was perceived as a cause celebre of wider employer-labour relations at a particularly crucial period. Thus the proposals, it was argued,

'... have the support of a strong body of employers unconnected with the federation and having nothing to do with the engineering trade'. [Ibid.]

This newspaper consistently encouraged the employers' side, and, countenanced their actions throughout the strike and lock-out:

'... the employers' ... proposals ... may be taken to <u>represent the charter of freedom'</u>. [4 Dec. 1897][My emphasis].

Other sections of the Press favoured the workers' side. The Birmingham Trades Journal had referred to the A.S.E. with evident pride, as

'.. the boast and pride of trade unionism in this country'. [July 1897]

Early in the dispute, critical of the employers' refusal to accede to a conference or to accept mediation, one view was that,

'There is the overmastering feeling that the refusal of mediation by the Masters implies a determination to smash the Engineers' union irrespective of the merits of the Controversy"' [Daily Record, 12 Oct. 1897]

The position of the Masters was argued to be untenable according to another source, because of their intransigence over the question of a full representative conference. [The Saturday Review, 20 oct. 1897]. Public opinion, it was asserted, '... is all on the side of the men'. [loc.cit]

There seems to be susbtance in the assertion that the Federation was attempting to break the unions, if the views of Siemens, as President of the London Employers' Association, corresponded to any consensus of employers' views.

'The fact is...we want to get rid of Trade Unions altogether, for their interference in the working of our business has been intolerable in the past'. [Reported in Labour Leader, 16 Oct. 1897]

Union opinion was sceptical of this kind of rhetoric, believing that profit margins had been maintained at reasonable levels. The Armstrong, Whitworth Company's results, for example, showed a profit of £446,871 16s. 11d for the year ending 30 June of that year. [Published in Labour Leader 2 Oct. 1897]. Col. Dyer, the Federated Employers' principal negotiator was a director of that particular company.

The Unions initially refused to accept the proposed 'Conditions of Management', and the decision of the employers not to reduce hours in any way. The management proposals were, however, seriously discussed by the union representatives despite the overt hostility displayed in statements of some of the management representatives. Sir Benjamin Dobson, for

example, head of the largest machine and engineering firm in Bolton, and employer representative contended that

> '... employers have made up their minds not to lend their establishments to the furtherance of a system of tyranny which insists that, willy nilly, every employer must bow down to the local union panjandrum'. [Quoted in Times, 14 Dec. 1897]

8.3.iii

The Engineering Employers' Manifesto: Preliminary Considerations

The evidence shows employers were determined to extend the reorganisation of work and widen control of labour by eliminating constraints imposed by skilled workers, particularly in the operating of machine tools:

> 'The machine is still the most important feature of the dispute. We have heard of no offer of compromise in this matter, and we do not see how the employers can entertain any'. [Engineering, 1st Oct. 1897] [my emphasis]

The emphasis on labour-substitution was evident in the employers' policy document. As an E.E.F. letter to the President of the Board of Trade said:

> '... during the past three months ... in many cases from 20 per cent to 50 per cent more work of equal quality has been produced from machines by comparatively inexperienced hands compared with that produced by the men who previously worked the machines'. [EEF Minute Book, No. 1, 26th Oct. 1897]

There were two significant factors in this declaration. The first was that EEF employers no longer regarded skilled artisan labour as indispensable labour; it could be replaced by unskilled labour using the new technology.

Second, it seems to bracket out the areas in which engineering employers had consolidated their widening control over skilled labour power, and thus over the means of production. For this reason I considered it important to draft these areas in some detail in order to explore some of the forces which strengthened employer power.

The dilemma facing the union representatives was evident in their statement to their members. Burns issued a statement to the effect that only two courses of action were open to the men. One, to summon a national convention of trade unions for the purpose of organising a fund of not less than £15,000 a week to enable the men to continue to strike. Two, to declare the strike at an end, accept the Masters' proposals, and resume work as soon as possible [Times, 9th Dec. 1897].

Neither Hardie's nor Burns's strategies was adopted, and in early December, management proposals were put to union officials who reluctantly reported to their members,

> '... only a consciousness of the serious position in which our members are placed, and the length of time over which the stoppage has extended, with all that such involves, induces us to put before you such proposals, which to our mind, are diametrically opposed to the first principles of trade unionism'. [Quoted in Engineering, 10th Dec. 1897]

The E.E.F. proposals in general were severely criticised on 13 December by an Oxford group**, who argued that

> '... it cannot be held that, prima facie at least, the ultimatum is anything but a deliberate attempt to overthrow the principle of collective bargaining - that is, in a word, an absolute denial of the legitimate action of trade unionism as such'. [Quoted in The Times, 14 Dec. 1897]

The use of the term 'ultimatum' in this context provides an illuminating commentary on what were purported to be areas of discussion and negotiation.

The inflexible nature of the EEF proposals was reiterated in the same issue of the Times, in which there was a threat of further lock-outs: 'An official of the Employers' Federation last night stated that, in the event of the conference breaking up today 30 additional firms will lock-out their men at the end of the present week. He expressed the opinion that the fight was only now commencing'. [The Times, 14 Dec. 1897]

On 17th December the clauses of the management proposals were considered by the ASE executive as a whole and, in general, approved. The 48-hour question was again raised as a separate issue and on the refusal of the employers to negotiate on this point, the official conference deliberations were adjourned, and the union memberships balloted on the whole of the matters in dispute [Times, 18th Dec. 1897].

** The Master of Balliol, the President of Trinity, the Principal of Jesus, Professor Esson, Dr. Fairbairn, Mr. Arthur Sidgwick, Mr. T. C. Snow, Professor Markby, the Rev. H. Rachdall, and other members of the University.

The twenty-fourth distribution of strike pay took place the day after the adjournment and £35,000 was paid out to the 80,000 engineering workers locked out and on strike. The skilled workers received strike pay at the rate of 15/- per week; the allied workers, 12/- to 15/-; non-unionists, 8/-; and labourers, 5/- [Times, 20th Dec. 1897].

The vote undertaken by the A.S.E. demonstrated a high degree of unanimity in rejecting the E.E.F. proposals, despite apparent hardship. Of 40,000 votes recorded, 39,850 rejected the proposals; 150 voted for acceptance. A ballot among non-unionists throughout the metropolitan area showed 370 against acceptance, and 0 for acceptance [Ibid].

Thus by December no form of settlement had been reached, and Barnes in a speech at Enfield was pessimistic about the outcome. He argued that re-submitted proposals by management, put forward as a result of the A.S.E. ballot, showed some gains in that the status of the union had been recognised; and the right of unions to take the initiative in case of grievances was conceded by employers [Times, 19th Dec. 1897]. On other more substantive issues he admitted that the crucial factor was the employers' strong position regarding the deployment of unskilled workers. Their production policies would radically change workshop organisation. The influx of partially - or untrained labour into the industry would, he argued, clearly accelerate the division of labour and increase narrow specialisation.

> '... on other points there was considerable risk, and they really amounted to the bringing into the workshop of a new body of workmen, which would answer the purpose of the employers, leading to the specialisation and subdivision of the trade. The unions would have to be extremely careful in adapting themselves to the new conditions...' [Ibid]

His analysis was perceptive, for on the 31st December a leading engineering employer, Sebastian de Ferranti, put the case regarding the employment of unskilled workers. In a speech to the Manchester District Engineering Trades Association he argued that employers were now part of a political struggle and were engaged in a conflict with Socialism:

> 'It is not the ASE simply, it is absolutely Socialism, and that Socialism would ruin the country...'(Quoted in Wigham(1973 p.282).

Employing fresh men irrespective of the level of skill in order to train them in narrow, company-specific skills was a tactic designed to break ASE control, and to reassert

> '...one of the strongest things we can do today is to show the ASE that they are not masters...'(Ibid.283).

What was the source of the employers' confidence as demonstrated by De Ferranti?

For him, it was the increasing use of standardized tools and instruments, such as gauges (deriving from Whitworth's research earlier in the century). Through this technology unskilled labour could be more effectively deployed:

> 'Most of them appreciate what it is to use a gauge within three weeks or a month. They turn out work much better and several times over more quickly than our experienced mechanics did before...'(Ibid.p.283).

Thus the existence of a large reserve of labour and simplified machining operations considerably strengthened the employers structural position, less dependent than it had been on skilled artisan labour. De Ferranti argued,

> '...I think it is very imortant that you should get your works going and push on without the ASE...'(loc.cit).

Employer control of technology was clearly vital to management's conduct of the strike. As a leader in 'Engineering' said: "If there had been no improvements in methods of production ready to hand it is quite possible that Mr. Barnes would have won the 8-hour day ... the employers would have trusted to quicker speeds, heavier feeds, and more energy on the part of the men to compensate for the loss of the hour in the dispute". [28th Jan. 1898]

The increasingly conciliatory nature of the A.S.E. secretary seemed to be a retraction of the union defiance in the early part of the dispute and a tacit acceptance of the reorganisation of engineering workshops. But ideological and political pressure by the employers intensified during the closing stages of the dispute. The denigration of the political stance of the union side was paralleled by a sustained and more general criticism of socialist principles. The focus of this strategy was the unfortunate Barnes, ASE secretary, who was also subject to increasing criticism from his own side. The pro-Federation journal, Engineering, remarked,

> "Socialism, as preached by Mr. George Barnes ... and others of the same school, means social disintegration and the destruction of industry". [Engineering, 31st Dec. 1897]

Simultaneously, it was argued that management was the cohering factor in engineering production

> '... without (whom) every factory would be a mass of useless machinery, and its workmen an undisciplined and dangerous mob'. [Ibid, p.803]

Hardie in his journal leader, refuted a claim that it was the socialists on the A.S.E. executive that were responsible for the union collapse. He contended that it was an 'open-secret' that the pressure exerted by the smaller societies had a good deal to do in weakening the engineers' case [Labour Leader, 5th Feb. 1897]. In this connection I have referred to the refusal of two of the most important craft unions in the industry the Boilermakers and the Patternmakers to join the stoppages in London.

Sellicks, the A.S.E. President, tried to compromise on the 48-hour question, a move which stimulated further criticism of the way he and Barnes conducted the union case against the employers. He argued his case to the employers:

> 'Give us fifty-one all round ... you have given wages equal to it when trade has been good; and if you give us that the men will return to work on Monday'. [Quoted in The Engineer, 14th Jan. 1898]

Hardie contended that this gambit was construed as dissension among the union representative, and gave the employers

> ' a necessary impetus ... (and) the rank and file learned with dismay of the withdrawal of the eight-hour day'. [Labour Leader, 22nd Jan. 1898]

Reynolds Newspaper was also highly critical of Sellicks and Barnes and attributed the engineers' 'gigantic collapse', to the A.S.E.leadership executive under these two officials.

> 'We expected the failure of the engineers ... we cannot say that we are surprised at what has been for some weeks a potent fact, and which is now an acknowledged fact'. [Reynolds Newspaper, 30th Jan. 1898]

8.3.iv.

Formal EEF Proposals of November 1897: An Analysis

Assumptions underlying the E.E.F. November proposals support the case I argued earlier that the reorganisation of work and increased labour control was linked to the dequalification of skilled labour and the deployment of new machines manned by unskilled labour. With increasing skill dequalification and decomposition, the implementation of auto-machine production, a reserve pool of labour expanded to include

displaced skilled labour as well as the mass of the unskilled labourers. Hence employers could argue:

> 'Every employer shall be free to employ any man, whether he belong or not to a trade union'. [Times, 4 Dec. 1897] (Proposal)

The proposals in the Settlement covered: I - Freedom of Employment; II - Piecework; III - Overtime; IV - Rating of workmen according to ability; V - Apprentices; VI - Selection, Training, and Employment of Operatives; VII - Proposals for avoiding Further Disputes. (The full text is reproduced in my Appendix 2).

It seems to me they embodied two fundamental principles. First, there was a direct challenge to the principle of collective bargaining and a stress on individual negotiation; second was a reassertion of employers' management prerogatives and extension of integrated production processes based on labour substitution.

The Federated employers conceded few points throughout the dispute; they particularly rejected any union proposal that challenged the authority structure of factory organisation. Under the first head, Freedom of Employment, the union delegates had requested as a quid pro quo a guarantee that the employers would distinguish unionists and non-unionists, and would show no preference for the latter. The employers' response was to guarantee only the 'harmonious working together of unionists and non-unionists'. [Times, 4 Dec. 1897]. It was not made clear how this equilibrium was to be maintained - any sanctions were not stated.

The piecework principle (Proposal II), which I have argued was a major source of contention in previous disputes, was to be extended under the employers' proposals. The framing of this proposal was an attempt to strengthen the existing authority structure of factory organisation, by stressing the principle of individual negotiation. This was evident in the clause which related piece price to the individual workman and not to collectively agreed rates.

> 'The prices to be paid for piecework shall be fixed by mutual agreement between the employer and the workman who is to perform the work'. [Times 4 Dec. 1897][See my appendix 2].

Notwithstanding the long-standing resistance of engineering workers to the practice, it was to be extended further. Burnett, former A.S.E. Secretary, had written in 1876 that piece-work tended

> '... materially to impoverish men employed by the day ... and increases the probable element of disagreement between employers and employed' [Times, 12 Jan. 1876]

Burns put the same view twenty years later, in a letter to the Times, condemning the practice as exploitation:

> '... in a word, piecework in the engineering industry is but a transient method of stimulating a workman to greater intensity of toil, often to inefficient work thereby'. [27 Sept. 1897]

Thus the first two proposals, embodying the notions of employers' rights to employ any form of labour, and to negotiate conditions and wages outside the area of collective bargaining, were substantially supported by the 'Rating of Workmen' proposal (IV). Together they proposed a framework of work organisation through which employers substantially strengthened their control of the labour process.

Under Proposal IV, the rating of workmen seems to have been formulated to facilitate a workshop organisation based on undifferentiated labour. The reserve of available labour could be drawn upon and paid according to terms and conditions determined by employers, independently of recognised skills.

> '... No employer shall be restricted in employing <u>any</u> workman at <u>any</u> rate of wages mutually satisfactory to them'. [Times 4 Dec. 1897] (my emphasis).

The inference here was twofold. First, the framing of conditions of employment, and settlement of wages were solely management prerogatives and were negotiable only on an individual basis. In addition, under this proposal existing arrangements of collective bargaining could be more easily abrogated as the traditional craft skills constituting artisan status became more fragmented.

The journal 'Engineer' rationalised the proposals first by arguing that there had been a revolution in the methods of engineering. Barnes, A.S.E. Secretary, for example, was criticised as,

> '... he attempted to establish a corner in skilled labour at the very time when skilled labour was becoming a drug on the market'.
> [The Engineer, 28 Jan. 1898]

The development of new forms of technology rendered skilled labour more or less redundant:

> 'The heads of the leading firms of mechanical engineers ... had begun to see that skilled labour was by no means so essential to the conduct of their business as it had been'. [loc.cit]

Second, the 'Engineer' argued, wages should be calculated according to the laws of supply and demand; the element of 'skill' being discounted:

This ideology seems to have been inspired by developments in the United States:

> 'Let the individual take care of himself; what is he that he should be considered? This spirit extends through society generally; and it resulted ... in getting all that was possible out of the workman; then it was found that the better the man was paid the more could be got out of him ... the United States have supplied an object lesson to the English Engineers'. [loc.cit]

Underlying the issues of collective bargaining and machine manning was the provision and deployment of labour.

Two proposals relate to these issues. On apprentices (Proposal V), there was an unequivocal statement:

> 'There shall be no limitation of the number of apprentices'. [Wigham, E. (1973) p.285-289a]

The A.S.E. had recommended that the ratio of apprentices to journeymen should be one to three, and that the average number of men employed in the previous five years should be taken as a basis of calculation. The employers were intransigent on this issue, and stuck by Proposal V on unlimited "apprentices".

Disposition of machine tools was also a critical factor in this proposal. Ownership of the machines, it was argued, entailed control over its disposition and responsibility for the work turned out. It was further contended that a feature of that responsibility was the employers' discretionary power to appoint

> '... the men they consider suitable to work them and determine the conditions under which such machine tools shall be worked'. [Wigham, E. (1973) (a)]

The evidence shows that the kind of labour envisaged was to be adaptable and co-operative rather than quasi-independent skilled workers.

> 'The employers consider it their duty ... to employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen'. [loc.cit]

Underwriting this principle was the availability and accessibility of alternative labour together with highly developed machine tools. It was argued, for example, 'men of superior quality' were less in demand, because

'... apprentices and labourers have been doing work ... which has been supposed to be only within the compass of men who have been trained for years in the trade'. [Engineering, 4 Feb. 1898]

Clearly, the employers' concept of new workshop organisation depended upon a mass of undifferentiated labour, with a small echelon of skilled supervisors:

'Some employers ... only wanted one or two special men in a department, and were perfectly content in other respects to go on with the labour they had'. [Ibid. p.116]

Employers thus asserted that the control of the relationship of the number of apprentices to skilled journeymen was part of the inexorable laws of political economy over which they had little control.

This represened a crucial change in manufacturing ideology from one based on labour to one based on system and tools.

8.4.0.

The Termination of the Strike and Lock-out

The Joint Committee of Trades formally withdrew their demand for an eight-hour day on the 15th January 1898; this action was endorsed by the ASE. The retraction was evidently sudden; even Hardie was writing optimistically on 8th January that

'...the year opens well, and the prospects of a settlement by the end of the month are more rosy than ever...'(Labour Leader, 8th Jan.1898).

An important political element was introduced with the setting up of negotiating machinery to deal with future disputes. Here, the advantage to employers of federation was manifest:

'The formation of the Employers Federation will render impossible the occurences of the troublesome little district and local strikes which have in the past done so much mischief...'(The Engineer,21st Jan.1898).

Extension of reliable supervisory control in the workshops through a less militant middle echelon was anticipated in a proposal to withdraw foremen from union influence as much as possible:

'...we are happy to see a determined effort in that direction being made...'(The Engineer,21st Jan.1898).

On the practical issues of the resumption of work, the concerted efforts of the EEF and the significant contribution of associated institutions

such as the ITEA were demonstrated by the uncompromising conditions laid upon returning engineering workers.

Barnes, in the withdrawal of the strike notice of 15th January, assumed that as a consequence the lock-out notices would similarly be withdrawn, and the resumption of work would proceed on conditions negotiated during the dispute. The reply from the joint secretaries of the Engineering Employers' Associations Executive Committee, Biggar and Robinson, to the Joint Committee of the Allied Unions made it clear that there could be no such guarantees(EEF Minute Book,No.1, 21st Jan.1898).

> 'In the first instance, the employers can only restart a portion the men...'(Quoted in the Engineer, 21st Jan.1898)

It had been agreed policy prior to this that federated employers were at liberty to re-engage workmen who had belonged to the unions, but subject to satisfying employers

> '...that they have definitely left their respective societies...(and) shops will remain closed to trade union members until the Terms of Settlement have been accepted by the representative trade union societies...'(Engineer,14th Jan.1898).

The radical shift in power relations to the employers' advantage was significant in the post-strike situation, particularly regarding craft workers' autonomy, the questions of machine manning and the use of unskilled labour.

I have referred to the use made by employers of the Free Labour Association. Clearly there were gains by non-unionized labour as the craft unions' exclusivity was challenged as result of the lock-out and later by the Terms of Settlement:

> 'During the thirty weeks the dispute has lasted, many of the smarter labourers have been able to seize the opprtunity of rising to the ranks of skilled workers...so far as these men are concerned...they will take the place of those who managed the machines before the trouble...'(Engineer,4th Feb.1898).

Biggar argued the the EEF would strictly control work resumption. Accordingly only 25 per cent of unionists were to be taken on. Employers were, he maintained, also morally obliged, and in practice, pledged to support the

> '..free labourers (who) have helped them in their need...'(Quoted in The Engineer, 4th Feb. 1898).

One outcome of this policy was that workers, instead of being allowed to resume work in a body, were forced to apply individually:

> 'These works will be opened on and after Monday 31st January to the members of the Allied Unions...it will not be possible to start all the machinery at once. It will therefore be convenient if workmen desirous of employment will send in a written application, giving name and address to the manager of the department where they previously worked. The managers will, from day to day, inform men whose services are desired when work can be resumed...' Quoted in the Labour Leader, 5th Feb.1898).

The strike and lock-out had lasted from 13th July to 31st January 1898, and 702 firms were involved. It was estimated that over 47,500 men had been implicated directly; and in the period up, to, December 1897, allied trades such as shipbuilding showed a marked increase in unemployment, from 4.4 per cent to 14.1. per cent.

Following the strike the traditional function of the craft unions of confirming skilled status through union membership was considerably weakened.

The presence of an experienced reserve pool of skilled labour, supplementing the reserves of unskilled workers, constituted a situation after the strike which had not previously existed. Employers were in an unassailable position. This may be illustrated in the case of an incident at a machine tool company where about 70 members of the Society had struck. When the dispute terminated, thirty of these men

> '...presented themselves at 6 o'clock on Monday morning last...in the hope of getting back their work. One solitary applicant was engaged...'(Engineer,4th Feb.1898).

PART B THE POST STRIKE SITUATION

8.5.0.

Ratification of Employer Control

Judgements about the immediate practical effects of the dispute are tempered by the fact that there was no census of production until 1907. Figures for overall engineering production at the time of the first census give an approximate evaluation of the 'state of the market' against which the dispute had taken place. The value of gross output of engineering factories in the United Kingdom in 1907 was £87,817,000 [Census of Production (1907)]. This gross figure applies to the group of enterprises concerned with 'General Engineering', which included such areas as machine tools, hydraulic machines, boilers, mining industry, textile machinery, agricultural machinery. This section of the industry generated gross returns of £34,955,000, of which machine tool production was valued at £2,715,000 [loc.cit]. For the engineering industry as a whole, (including electrical engineering), figures were not available until the final report of the census of production in 1913. These indicate that for the Iron and Steel, Engineering, and Shipbuilding Trades the gross value of work done was £375,196,000; total U.K. production was valued at £1,765,366,000; the generated value of engineering industries thus amounted to 21.2 per cent of the total output, and the average number of persons employed in those industries was 1,539,415. [Census of Production (1913) (a)].

These figures are arguably close enough to the actual period of the dispute to indicate a highly productive market during the period of the strike and lock-out. The specific area of concern of this analysis, covered in the census by 'machinery', generated gross values of £34,955,000 [Census of Production (1907)], the largest single contribution under General Engineering, constituting nearly forty per cent of total production in this area. The machine tool sector, a relatively small part of the industry as a whole, alone constituted 7.7 per cent of the gross value.

The data outlined here suggest that the prevailing market ensured economic returns were secure during the dispute. In addition to preserving profit rates, the employers widened even further the areas of control over the organization of work, the implementation of new technologies, and the redesignation of skilled work in the industry.

8.5.1

Trade Union Support for the Engineers: A Question of Solidarity.

Regarding some of the social aspects of the dispute itself, on the union side, moral and financial support came from a variety of sources. In early December 1897, MacDonald, the Secretary of the London Trades Council, issued invitations to a general conference of trade unionists of the country to consider the best means of affording support to the organisations engaged in the dispute. He received 112 replies, all to the effect that the unions were prepared to take part in the proposed conference. Solidarity was expressed by the following: the Amalgamated Society of Railway Servants, the Durham Miners' Association, the Gasworkers and General Labourers' Union, the Ironfounders' Society of Great Britain and Ireland, the London Society of Compositors, the Operative Bricklayers' Society, the Cigarmakers' Society, and the British Smelters' Association. [Times, 23rd Dec. 1897]. In one day, officials of the Engineers' Society received £3,500 toward the lock-out fund. Included in this amount were the following donations: £225 from the members of the Engineers' Society in Johannesburg; £100 from the Boiler Firemens' Society of Great Britain; £50 from the Penrhyn quarrymen; £50 from the Mill Sawyers' Association; £50 from the United Kingdom Coachmakers' Society; £50 from the Card Machine Tenders' Society. [Ibid].

At the termination of the dispute it had been estimated that a total of £140,000 had been subscribed from outside sources to the workers in contention . To this was added £65,000 from the capital account of the different societies included in allied trades; and £230,000 subscribed in levies by men working. [Labour Leader, 5th Feb. 1898]. The capital account of the A.S.E. had been subvented by £65,000; which taken with loss of wages estimated at £1,200,000 for engineers and £1,800,000 for allied workers made a specific loss of £3,000,000, and a general total of £3,700,000. [Ibid]

The financial position of the Engineers' Society was parlous after such an enormous outflow of funds. It seems to me that some practical measure of the extent of the loss may be gauged from the evidence relating to the social labour costs during, and preceding the dispute. In 1880 a fitter in London earned 36/- for a 54-hour week (32/- in Birmingham); at the end of the 1890's this had risen to 38/- (36/-) [British Labour Statistics, Table 1]. Taking the industry as a whole, in 1886 nearly 60 per cent (59.4) of all engineering workers earned between 20/- to 35/- per week; less than 9 per cent (8.3) earned between 35/- and 40/-; and 3.8 per cent earned above 40/- [Ibid, Table 35]. Some retail food price fluctuations in London provide an illustration of the cost of living obtaining during the same period. For example, potato prices showed a 4 per cent drop in the period 1886-1898; the cost of bread rose by 12 per cent; bacon rose 4 per cent; tea fell 30 per cent; while flour rose 21 per cent [Ibid.Table 87]. In the period 1892-1898 alone, rent increases were nearly 7 per cent [Ibid. table 88]. I use these figures to show some of the cost, in social and financial terms, for an amalgamated union, albeit of much-vaunted strength, incurring a loss of nearly £3½m. against a background of increases in staple food prices and rents; while skilled worker wage rates had increased, in the eighteen year period 1880-1898, five and one-half per cent.

The accumulation of substantial funds for contingencies such as benefit and death schemes had been carried out by the A.S.E. in the period since 1851 and seems to have represented a demonstrable stability and astuteness on the part of the A.S.E. executive. The weekly levy for A.S.E. members was 1/- per week, with an entrance fee ranging from 15/- for 25 year old men to £2.10.0 for workers at age 40, after which membership admittances was not posisble [R.C. on T.U. (1869)].

This business acumen, aligned with the confidence engendered by a belief in their ability to command higher than average wages promoted a rising tide of ambition which culminated in the challenge to the engineering employers. The employers reacted by establishing a closer network of co-operation and confronted the A.S.E. over key issues which had been sources of contention since the onset of machine tool automation:

'... the vital character of the issues brought daily accessions to the Federation ... 702 firms successfully resisted the attempt to enforce a reduction of the working hours ... and who vindicated the Employers' right to Freedom of Management'. [EEF'Federated List' (1898)]

The significance of the engineering employers' combination was not confined to regularizing the implementation of new technologies, accelerating the decomposition of artisan skills, and consolidating their hegemony. As the proposals in the Terms of Settlement show, it reinforced their predominantly negative attitudes to trade training and education, the future of the apprenticeship, and the status of skilled workers.

Clearly these elements interacted with emerging ideas on technical education which, as the evidence has shown, tended to be overshadowed by part-time, evening class principles.

8.6.0.

The Issue of Machine Manning after the Settlement of 1898

Although it is clear the engineering employers were determined to consolidate the advantages gained through the 1898 terms of Settlement and their ratification in 1907 [see Appendix 2(b)], the question of machine manning was repeatedly in contention from 1898. Between 3rd February and 25th October 1898 six major disputes were recorded concerning unskilled manning of machine tools. [EEF Case Register, 1892-1906]. The Armstrong Whitworth Company was challenged in February over the use of labourers on a grinding machine. The General Electric Company in Manchester insisted on the employment of labourers on 36" vertical Boring Mills in July; while in August a Scottish firm (Clyde Mitchell) was confronted by Society men over the use of labourers on lathes. A strike occurred again in August against unskilled labourers being used on two Rolling Mills in Manchester. In October, men at the J. Bertram Company in East Scotland refused to man more than one machine. [Ibid - extracts from months stated].

The following year saw a similar situation with employers using unskilled labour on machine tools as the Terms of Settlement prescribed. Skill substitution generated resistance from Society men, despite the conditions laid upon them by the 1898 settlement. On three occasions the manning of turret lathes was contested. At Hull, Blackburn, and Burnley the employment of labourers, or 'handyman', on automatic machines was

challenged by the union. The attitude of one company toward 'self-improvement' was demonstrated by the sacking of a worker and the confiscation of machine part drawings done by him in a firm in Sheffield. [Ibid. Extract for 29th Nov. 1899 - Crooke Bros., Sheffield]. Multiple-machine manning was again challenged at a firm in Blackburn where the working of two lathes by one man was pressed by the management, the 'employers right (being) admitted'. [Ibid. 13th June 1899]. Similarly two adjoining planing machines in a plant in East Scotland were assumed by management to be capable of operation by one man, a position that was also contested.

Evidence suggests therefore that throughout 1900s the process of challenge and counter-challenge over machine manning continued unabated. Automatic machines such as turrets and capstan lathes were particularly in contention. However in none of the recorded cases in the E.E.F. minutes was there evidence of any concession granted by employers. In March 1906 a circular letter was issued to Local Associations of the Federation on the specific management problems associated with turret lathes. A case was developed over the manning of a No.16 Combination Turret lathe at the Manchester firm of Wm. Muir. A handyman was put to work on the machine under a charge hand (an A.S.E. member). Two members of the A.S.E. refused to handle work, turned off the machine and consequently '... discharged themselves". The firm replaced the turners with non-society men and continued to work the turret lathe with handymen. The A.S.E. men and apprentices struck in protest. The Federation decided to make a test case and took up the strike with the London Council of the A.S.E. [EEF Circular Letters]

8.7.0

Some Implications of the Great Strike and Lockout for Employers and Workers.

Engineering employers in the latter part of the century exercised the considerable advantages gained from their domination of new machines and different labour forms. The effect on the apprentice-journeyman ratio, for example, was evident. I have produced evidence which has shown that the ratio tended to increase as the perceived need by employers for any systematic training receded (my analysis above ch.5).

Even before the strike there was an inclination to dismiss apprentices when they became expensive: in some cases,

> '... there (was) a tendency to do without apprentices altogether'. [R.C on Labour (1894) p.115]

As I have previously argued, there was considerable use of boys as a form of cheap labour in this period. An illustration from Belfast shows this apprentice decline in practice. A small engineering concern in Belfast employed five journeymen and thirty-three apprentices. The recommended ratio at the time was 1:3 [Ibid].

In a report of 1893 Whittaker of the A.S.E. produced evidence which showed that it was not uncommon to find a ratio of 12 apprentices to two journeymen [R.C. on Labour 1893) q.22762].

The I.T.E.A. had previously advocated a 'flexible' non-binding system of training for young workers, canvassing the view that such a system would allow freedom 'on both sides', and permit a change of occupation

> "... where a lad is found on trial to be unfitted for the one at first chosen". [Ibid. p.116]

The confrontation between engineering employers and workers in the late 1890s was not therefore simply about the economics of production. It was also concerned with the reproduction as well as the deployment of labour power. The ability of A.S.E. members to confront employers turned largely on their claim to superior skills in the various engineering functions within the trade. In the view of the A.S.E. especially, the chief guarantee of such skill lay in the apprenticeship system.

Clearly the conception of engineering skill held by employers was changing. It was perceived by some as characterised by an increasing separation between basic craft skills and the underlying technical and scientific basis of those skills:

> 'The part played by manual labour in the creation of wealth is exaggerated. The part played by administration, by the genius which invents and the brain which controls, is persistently minimised'. [Saturday Review, 2nd Sept. 1897]

In other words, control over the labour process in engineering was seen in terms of regulation of new technologies in which the contribution of skilled workers was marginalized. Control over machines had become central to the dispute, reinforcing a closer direction of artisans whose skills, shedding their transferable qualities, had become increasingly company specific.

'The masters are indisputably in the right in claiming full control of their machines, for if intellect is not left as free as industry in the entire labour region there is no hope for the country which consents to see its brain-power laid in fetters'. [Spectator, 22nd Jan. 1898]

The pro-employer press reflected the changing emphasis on labour-control through technology:

'It is, in short, a fight for supremacy between a Union which regards itself as 'the aristocracy of labour' and the employers who feel that the power of directing their own works is rapidly slipping out their hands ... they ... want to lessen the power or the disposition of the Union to impose exasperating terms upon the conduct of industry'. [Saturday Review, 4th Sept. 1897]

8.7.1

Conflict over Power Relations: Job Demarcation

The post-strike disputes, viewed as part of the ongoing struggle over power relations in the workshops, highlight the ideology of control which rested on the contentious issue of job demarcation.

Faced with a prospect of gradual and persistent downgrading of their skills by employers, a number of strategies were open to engineering artisans. Among these was the maintenance of clear skill boundaries,i.e. the demarcation of jobs. This attempted to counter employer tactics to diminish the social and technical currency of any particular engineering craft skill by increasing job differentiation.

Employers, such as Robinson, Beyer, and Noble, whom I discussed above, argued for

a) the 'democratisation' of all skills, i.e. the breaking down of skill boundaries.

b) a rejection of the claim by a skilled minority that their skills demanded systematic training:

'If ... our conception of the 'skill' which we might have worked for and desired is what might be called 'craftsmanship', we must conclude that the demand for skill is, on the whole, declining'. [R.C. on Poor Laws (1909) p.346]

The employers' belief in the new technologies encouraged increased specialization in the workshops, undermining the generalized skills of the traditional metal tradesmen:

'The all-round ability, which used honourably to mark out the mechanic, is no longer in demand, so much as the work of the highly specialised machine minder'. [Ibid]

The essence of the demarcation issue was the claim by craftsmen to control delineated areas of craft knowledge and expertise. As Barnes argued,

> '... the skilled men require even more skill than they did because of the finer work and more intricate machinery ... side by side with automatic machinery there has come about more intricate and highly complicated machinery'. [Ibid. Minutes of Evidence, Vol. VIIII, Q.82943]

But the employers had been consistent and saw it in terms of an ideology of production,as an issue of control of work and labour. As they claimed during the dispute:

> '... trade unionism ... (as) the inviolable restriction of certain work to the members of the union, and demarcation of work is the necessary result of such a policy ... a new unionism which must therefore disappear ...' [Engineering, 15th Oct. and 5th Nov. 1897]

Later evidence submitted to official inquiries such as the Poor Law Commission(1909) confirmed these hostile views on the part of employers regarding the demarcation policies of the unions:

> 'There is ... pretty general agreement that at present Trade Union ideas and regulations are very inimical, if not hostile, to trade mobility - the many bitter and prolonged disputes about 'demarcation' being cited in proof'. [R.C. on Poor Laws (1909) p.348]

The Commission, held that trade mobility could be facilitated through 'technical training'.

> 'If, at school, young people were taught, first of all to be intelligent - to 'think', in fact - and if technical training were general-non-specialised, and teaching principles rather than practice - mobility would have a better chance'. [R.C. on Poor Laws (1909) p.348]

According to this view, the relation between engineering production and 'technical training' was unproblematic - it promoted trade mobility, the breaking down of barriers between trades, and 'democratised' the labour process.

> 'There would be no difficulty in providing for trained machine labour at least'. [Ibid. para. 239]

The concept of trade mobility was clearly used to promote the idea of fluidity of labour across skill boundaries. Ramsay Macdonald in his submission to the same 1909 Commission put forward the view that, with respect to trade mobility, there was an integral link between the

organisation of labour and the organisation of capital. [Ibid. Minutes of Evidence, Ans.V]

8.7.ii

Trade Union Rivalries: Employers' Initiatives

Developments after the turn of the century show that employers continued to capitalize on their extended control over the labour process. Noble, E.E.F. spokesman at the 1906 Royal Commission on Trade Disputes, adopting a new tactic, argued that inter-union rivalries had created a new function for employers; they were now occupying objective roles as mediators; a conception of management as 'innocent bystander'. [R.C. on T.D. (1906) p.161]. Another commented earlier that they were compelled to stand 'helplessly by' as demarcation disputes took place.

> 'Employers need more power ... to say what men shall perform certain work ...' [Saturday Review, 25th Sept. 1897]

But between 1890 and 1903 there were twenty four serious strikes recorded by the Employers' Association. These were principally concerned with the issue of demarcation and the expressed right of certain trades to exercise some kind of authority over methods and pace of their work. Of these, ten were directly concerned with the question of machine manning and related issues, and the assertion by the Society that its members were the competent workers for employment on machine tools.

In a particular case in 1901, the A.S.E. claimed that turret lathes should be worked by turners or at least apprentice turners. This claim brought them into dispute with unskilled workers, 'Machinemen'. Management's response in this case was to reassert their own claim that these machines had always been worked by 'Machine Boys' and 'Machinemen' (on account of the Factory Act now allowing boys to work through the night). [Synopsis of Demarcation Cases, E.E.F. Mar. 1901]

The point at issue was recorded as a demarcation dispute between the members of the 'A.S.E. and Machinemen'. Noble's evidence to the 1904 Royal Commission shows that this, as in the other recorded cases, the employers' view was enforced by the Federation [R.C. on T.D. & T.C. (1904) Q.2411].

Noble implied that the terrain of dispute had shifted from the confrontational arena of capital and labour to internecine rivalry within and between unions.

'... In comparatively recent years a far larger number of strikes in the north eastern district were due, not to disputes between employers and the employed, but between different trades among themselves ...' [Ibid. p.163]

The employers' belief in the durability and consistency of their triumph over the unions in 1898 underpinned the continuing struggles with the A.S.E; the watershed in labour politics was clearly located in that year.

8.7.iii

Federating Employers: The Pattern set for the Future?

It is evident that from the inception of the E.E.F. as an entity there was an increasing inflexibility characterising negotiations concerning labour substitution.

'In the engineering industry the epoch of change dates from the agreement effected between the Federated Engineering Employers and certain Allied Trade Unions in January, 1898, and to this the attention of the Commisison is specially directed'. [R.C. on T.D. & T.C. (1906) Q.2410]

The Engineering Employers Federation by this time had expanded to a membership of 865 employing 500,000 workers with an annual wage bill of £25,000,000. [loc.cit]

The employers reaffirmed their control that had been gradually expanding since the 1890s. W. Glennies, the A.S.E. secretary, highlighted the long-term effects of an earlier dispute,

'During our last dispute, while we were out for thirteen weeks, the employers filled the machines, and other places, where the men had been working, with apprentices, to the extent that when the strike closed, 24 per cent of our members could not get started again ...' [R.C. on Labour (1893) Q.22795]

Other than the direct, profound consequences of unemployment this was an issue that had other serious implications for skilled adult workers. With a substantial reserve of unskilled and boy labour to call upon there was added pressure on them. One of the effects was the restriction of the majority of skilled adult workmen engaged in the engineering trade to a working life of about twenty years. [Ibid. 3rd Report, Whittaker (ASE) Q.22762]. .

'... the majority of shops will not set a man to work who is over 40 years of age. That is the limit at which they will engage them ... if he gets out of a shop where he has had continuous employment as a permanent hand, he finds great difficulty ever getting into this trade again'. [Ibid. Q.22704]

A restriction on the length of working life acted as a disincentive for employers regarding both technical education and their response for appeals for a more radical reactivation of the moribund apprenticeship system.

The process of labour substitution by 19th century employers took a number of forms; the most common was the 'upgrading' labourers to machine work. Particularly noticeable was the employment of unskilled operators on repetition work, using automatic-type machines. This was firmly argued by Noble, in his 1893 Royal Commission evidence:

> 'In the particular works where I am engaged we have a great deal of repetition work. We have, for instance, a machine that does one particular thing and nothing else, and we have found that labourers who have been gradually trained and advanced do their work better than skilled mechanics. They devote themselves to one thing and they do it very well ...' [Ibid. Q.25220]

Clearly there was a marked decrease in employer reliance on skilled machinists. Employers had access to a reserve of labour, providing alternatives to artisan labour on a scale which had not existed in previous disputes.

8.8.0

Summary and Discussion

The evidence shows that issues concerning the survival of the apprenticeship system, and the questions of machine manning interpenetrated and underlay many engineering employer-labour disputes of this period.

I have sought to show that the 1897-98 strike and lock-out was more than a conflict over economic issues, but had wider ideological and political implications. It plainly strengthened the engineering employers' resolve to replace skilled labour and in the process confirmed their declining interest in the historical form of trade training, the apprenticeship system. New technologies implemented by them were specifically designed to ensure as far as possible the accommodation and integration of low-level skills. Concerns over skill differentials therefore assumed a central position in the dispute, and in any explanation of the critical importance attached by both sides to the question of machine manning and skill substitution.

From the 1860s the employers had focused on what they perceived to be the main impediments to the extension of their power and control in the factory system, of which the ideology and solidarity of the amalgamated union were the most significant. The employers carried their suspicion and hostility regarding the trade unions, which they had demonstrated in the Inquiry of 1868, throughout the century.

Thus by the 1890s they were 'absolutely resolved' to defeat the unions on significant issues, and believed that the

> '... engineering trade of this country cannot be carried on unless they carry their point'. [Times, 4th Dec. 1897].

A number of employers at the 1897 conference expressed views that serve to highlight the significance of these basic issues:

> 'The question of management is paramount ... Accident, the mere fact that the men entered in the early summer upon a conflict which they had not the slightest chance of winning has brought the question of management to the fore ...'

The strength of this conviction drawn from the belief that

> '... the skilled man grows less and less and the machine grows more and more'. [Ibid]

The dispute demonstrated the power and effectiveness of the employers' combination, highlighting also their capacity to extend control over the total labour process, especially over the organization of work. They insisted on the capitulation of the combined unions, despite what would seem to have been a weakness in their case by spreading the dispute from London to the provinces. In effect, this move made the cause of the metropolitan employers the cause of the whole trade. The struggle of power relations in the industry entered a new phase. For the first time the amalgamated union, the ASE, was confronted by a 'national' combination of engineering employers.

What of the effects of the strike on the issue of trade training and education?

Although obscured by the intensity of the conflicts over machine-manning, more profound ideas about the apprenticeship system, and technical training, were incorporated indirectly into a national engineering employers' policy.

The successful outcome of the conflict confirmed for employers that the historical method of trade training for young workers under apprenticeship schemes was clearly inappropriate for management needs. By

consolidating their decisive control over workshop training, according to their own prescriptions, they rendered ineffectual government proposals for a national system of technical education.

EEF deliberations in the period from 1898 through 1907(the year the 1898 Settlement was ratified) and beyond, were consistent in so far as they perceived management control of the labour process as characterized by employer dominance of new technologies manned by mainly unskilled workers.

Operational imperatives clearly took priority over training and education for young workers:

> 'the continuous evolution of the engineering industry has made it incumbent on the employers continually to be adjusting their processes and methods to meet the demands of the industry...'[EEF (1927)p.20].

The insistence upon full disretionary and exclusive powers in the area of training labour to meet their own, limited specialized needs enabled employers to circumvent the traditional resistance of artisans and the craft unions to labour and work reorganization.

The unions' claim to be beneficiaries of traditional craft skills turned largely on what they perceived to be a rational(and legal) basis for their authority over engineering skills, the apprenticeship system. In contrast, the employers diluted the relationship between young workers, 'apprentices', and journeymen, thus weakening the exclusiveness of skilled workers. The 'bound' apprentice was replaced by an ad hoc 'trainee' system contingent upon the needs of individual companies and the iron law of the market system:

> '...the proportion of apprentices to journeymen is controlled by an economic law and has varied only in small degree...'[EEF(1927(,p.18].

Economic short-termism underpinned the employers argument that the apprenticeship issue was in any event made more complex by the machine manning issue:

> 'the latter is in a transition stage and how far the work of the skilled man will be ultimately modified or restricted by the introduction of machines is imposible accurately to appreciate...'[EEf(1927)p.19].

As I argued in my previous chapters, the basis of the highly modified 'training' to be afforded under the Terms of Settlement at the end of the strike was already being gradually implemented during the years preceding the 1897 Conference. Col. Dyer, of the Elswick Works, Newcastle, and

Chairman of the Employers' Federation, principal spokesman on the employers' side, wrote in September 1897 that learning a trade was contingent upon the needs of production:

> 'The majority of the men employed had to go to the works during the strike as unskilled men and had been trained to perform the duties required of them, with the result that the output had been increased two-thirds...'(Times,5th Sep.1897).

The position was reaffirmed in the subsequent agreement of 1907 under which management formalized the tentative proposal of 1898 concerning selection and training. Under this article control over two critical areas of craft training, the apprenticeship system and the general principles governing access to traditional engineering skills, for example, young apprentices working alongside tradesmen were forfeited by the unions:

> 'Employers in view of the necessity of obtaining the most economical production whether by skilled or unskilled workmen, have full discretion to appoint the men they consider suitable to work all their machine tools and to determine the conditions under which they shall be worked...'[EEF(1907)p.393].

The collapse of co-ordinated engineering union resistance marked a decisive turning point for both unions and employers; the unions were forced to reassess their position via à vis the employers and the unskilled workers in the engineering trades. One source suggests that one of the political outcomes of the strike was the conversion of the trade union movement to the Independent Labour Party:

> 'Thoroughly disillusioned the unionists sought to supplement their inadequate industrial power by recourse to more determined political action'. [Crowley, D. W. (1956) p.662]

The 1897/98 conflict in the engineering industry confirmed the interpenetration of work and technology, and the power of the employers over their organization and implementation. It also vindicated the analysis by Marx of the interaction between labour power, machinery and modern industry. He argued that with substitution of human skill and labour by machine, the exchange-value of the workman's labour power vanishes. This put the worker at considerable risk:

> 'The workman becomes unsaleable, like paper money thrown out of currency by legal enactment. The portion of the working class, thus by machinery rendered superfluous, either goes to the wall in the unequal contest of the old handicrafts and manufacturers with machinery ... or swamps the labour market, and sinks the price of labour power below its value'. [Marx, K.(1867) (1961) p.431]

In my next chapter I seek to draw upon my analysis of the nature of the conflict between the E.E.F. and the A.S.E. in 1897 in order to show how the dynamics of this confrontation 'rendered skilled workers superfluous'. I shall examine some of the educational developments which were taking place in the period leading up to and during the strike and attempt to demonstrate more precisely the ways this conflict influenced the course of technical education.

CHAPTER 9

THE FORMATION OF THE CITY AND GUILDS OF LONDON INSTITUTE and the REACTION OF GOVERNMENT AND EMPLOYERS: LEGISLATING FOR TECHNICAL EDUCATION FROM THE 1860s.

9.0.0 Introduction

My aim in this Chapter is to show that the issue of 19th century technical education was related to a central problem facing a significant part of the skilled working class of the period. This was its relatively disadvantaged social position, and the corresponding difficulties in obtaining benefit from the kind of general and technical education available, from any source. Further, the situation was not perceptibly helped either by the formation of the City and Guilds of London Institute(CGLI) in 1878, or by the enactment of various pieces of legislation from the late 1880s.

The evidence suggests that artisans were unsure which position to adopt regarding technical education. On the one hand they sought to improve their access to technical education such as existed, through state provision. On the other hand, they attempted alternative strategies through the Workmen's Technical Education Union and similar bodies. They also exercised a lobby through their association with the Society of Arts. In earlier chapters I have discussed what seems to me contradictions underlying these educational initiatives. But there were also practical benefits deriving from these contacts exemplified in the Society of Arts' organisation of the technological examination system in 1873.

I have analysed the nature of the concerns expressed by skilled workers over the concomitant decline of the apprenticeship system. Part of this argument has been that employers were content, in the main, to allow the system to fall into decay; and resorted to increasing use of boy labour as opposed to apprentice labour.

In 1909 R. H. Tawney concluded that progress of invention in mechanical engineering had had the effect of multiplying the number of posts held by boys working automatic machines. There was an increase in

the proportion of boys under fifteen employed in the trade among toolmakers, and erectors, fitters and turners

> '... in fact in that very engineering trade which was once supposed to be a stronghold of the apprenticeship system". [R. H. Tawney(1909,p.555).

And as far as machine tools were concerned, it was probably the most influential of British engineering manufactures, and heavily dependent upon skilled labour, but according to Hobsbawm(1974)

> '...nowhere did foreign countries leap ahead more decisively than in this field...'(p.180).

Earlier, in 1878, specific concern over the changing conditions of skill acquisition and the chaotic state of the apprenticeship system in general, stimulated certain Livery Companies in London to consider ways of applying some of their bequeathed funds to encourage some form of technical education. Their immediate interests were the trades with which they were individually associated. By 1883, the Clothworkers Livery Company especially, believed the lack of 'proper' craft training and technical instruction were impediments to trades and manufacturers in England. [R.C. on T.I. 7th May, 1883, Minutes of Evidence]. There was also anxiety over the threat of hostile legislation by the Gladstone government intent on deploying Livery funds as a support for technical education [Brennan,E(1959); C.A.& P.L.R. Horn (1984)p.76)].

But the structure and organisation of the institution which emerged from the Livery Companies' deliberations, seemed to strongly reflect the employers' views on training and education, and reinforced the separation of craft practices and the apprenticeship pattern of training from technical education. My case in this chapter is that the formation of the City and Guilds of London Institute (C.G.L.I.) which developed from the Livery Companies' recommendation, institutionalised a part-time model of technical education for workers, and also put in train the notion of 'evening classes as a means of secondary education for the masses'. These developments were clearly influenced both by the State's reluctance to accept responsibility for technical education, and by the power of employers to significantly affect the pattern of trade training and technical education.

What, in effect, was the State doing about technical education provision? What was the nature of the interaction between the Livery Companies and the Science Directory at South Kensington? In what ways were the various Bills concerned with technical education, during the 1880s and 1890s, influenced by employers' views on technical education? Did the employers exert a demonstrable influence over emerging technical education developments?

Analysis of the formation of the CGLI and a number of pieces of legislation enacted during this period provide some insight into these questions.My analysis begins with a brief resume of existing provision in the 1860s and 1870s. This will be followed by an analysis of the relevant legislation up to the next century.

9.1.0

The Directory and Science Provision in the 1860's and 1870's

From the 1860s and 1870s the official attitude towards 'technical education' was narrow and based exclusively on existing science provision. The policy meant that any extension of provision had to be met either from voluntary contributions, or from existing resources under the Directory's science scheme.

The main emphasis was on a theoretical approach to science, a bias which was reflected in the range of science subjects taught in schools, and which was to remain unchanged until 1898. This invites the question, what ideololgy sustained these provisions and whether they were adequate and relevant to the working classes of the period?

As I discussed in my previous chapters, such provision was certainly fragmentary, particularly in the late 1860s. There were elementary classes, in 'science' subjects, generally held in connection with mechanics' or literary institutes. They were confined chiefly to London, Lancashire, the West Riding of Yorkshire, Cornwall; Birmingham, Glasgow, and Edinburgh. Elsewhere, these classes scarcely existed, with no classes in the North-east, Eastern and West Midlands, or Southern Counties. [R.C. on S.I. (1865) pp.iii,iv].

The object of the Science and Art Department in this context was to aid instruction in science in the following 23 "subjects": 1) practical, plane and solid geometry; 2) machine construction and drawing; 3) building construction, or naval architecture and drawing; 4) elementary

mathematics; 5) higher mathematics; 6) theoretical mechanics; 7) applied mechanics; 8) acoustics, light and heat; 9) magnetism and electricity; 10) inorganic chemistry; 11) organic chemistry; 12) geology; 13) mineralogy; 14) animal physiology; 15) zoology; 16) vegetable physiology and economic botany; 17) systematic botany; 18) mining; 19) metallurgy; 20) navigation; 21) nautical astronomy; 22) steam; 23) physical geography. [Council on Education (1867-8) pp.1-3].

The administration was based on a payment-by-results system, under the control of the chief executive at the Directory at South Kensington, Donnelly. Direct payments were to be made to teachers only on behalf of adult artisans or the children of artisans [Privy Council Memo. (1867)].

The avowed aim of government was therefore the encouragement of the teaching of 'science' in elementary schools through grants, and elsewhere through a scholarship scheme. No differentiation, according to specific skills or direct applications to industrial practices was made:

> 'The object is to promote instruction in Science especially among the industrial classes'. [Privy Council Memo. (1867) Appendix D]

9.1.1
The Nature of Government Control over Science Teaching

Although limiting the scope of science teaching in institutions under its financial and ideological control, the government also monitored other educational developments. Of these, 'technical education' was a key issue from the 1880s. The pressure from government to make technical education provision self-financing, other than that available under the Science Scheme, may be seen as part of the State's rigid adherence to free-market policies and its reluctance to accept responsibility for this branch of education. Governmental oversight of developments through the payment-by-results system seemed to be an ideological as well as an economic strategy, for even within its own terms of equating scientific with technical education, actual state support was limited. Moreover the crucial supervision of the Science Directory's annual examinations was in the hands of part-time inspectors. These were officers recruited from the Corps of Royal Engineers, 'who could be fobbed off with a fee of £1 a day...as temporary appointees...'[C.A.& P.L.R.Horn(1981)p.33]. The evidence suggests, however, that despite its reluctance to engage fully in technical education, government maintained a supervisory role over both state and non-state developments in the area.

As Horn(1982) said,

> '...the treasury's parsimonious approach...did not prevent it from censuring any "unnecesary" expenditure which might occur within the stringent limits laid down...'(p.22).

In his study of the educational reformer, Robert Lowe, Sylvester(1974) also made the point that,

> 'During the 1860s, the Treasury made further attempts to keep down expenditure on science subjects by placing restrictions on the amounts which teachers and pupils could earn in science...'(p.35).

Another effective means of government supervisory control was through the use of 'cross-appointments'. This provided for a government official sitting on a number of Boards and Committees reviewing science and technical education provision. Donnelly, who was also on the Board of the Society of Arts, and later the City and Guilds of London Institute, was a case in point.

But the ad hoc administration generally, and the payment by results system compounded to make science teaching as a profession unattractive (S.C. on S.I. (1868) p.v].

Commenting on a relative decline in the percentage of children taking science subjects as compared to non-scientific subjects between 1882-3 and 1887-8, the Journal of the Society of Arts attributed a 13 per cent drop to the negative effects of payment by results:

> '... other non-scientific subjects were more remunerative on the day of the examination'. [Journal Society of Arts (1889-90)]

Throughout most of the century there was a manifest shortage of science teachers.

'Technical education', ill-defined and fragmentary in the 1860s and 1870s, thus generated cautious government interest, tempered by prevailing financial constraints. Legislation followed in the 1880s which reasserted the government's intention to leave technical education funding to market forces and to put the onus of financing it on to the 'consumer' as much as possible. This was evident as early as 1869. Playfair alluded to this laissez-faire doctrine, asserting that government plainly wished to foster a 'self-help' attitude in technical education. For example, referring to Manchester, he argued in the Commons:

> '... if Manchester desires technical education she ought to provide it solely at her own expense'. [Hansard (1869) Col.205]

Thus the typical Victorian 'self-help' attitude was reiterated throughout most of the period. It re-appeared, for example, in a paper delivered by a prominent scientist and lecturer of the next decade, S. P. Thompson who became the first principal of the Technical College at Finsbury under the City and Guilds of London Institute. Speaking on 'technical education' he said:

> 'When they began to specialise instruction, it ought to be paid for by the parents, or by an endowment; it was not the part of the State to provide that kind of education'. [Thompson, S. P. (1879) p.43]

Attempts to modify the Directory's scheme originated as early as 1867(after the Paris Exhibition) and came from different factions such as the artisans through the T.U.C., and Society of Arts proceedings. The Society of Arts evaluated provision according to external examination results of Institutes in union with the Society.

Scientists such as Scott-Russell and Huxley also sought to effect a change in government attitudes, but made little progress.

W. E. Forster, responsible for the first legislation in compulsory education in 1870, argued in the House that the government's duty towards technical education was merely advisory and not a practical commitment:

> '... government's duty was guiding and stimulating those who were engaged in that branch of instruction'. [Hansard (1869) Col. 213]

Support for the government's free-market policy was found in the establishment Press of the day. The Times reported:

> 'We agree in the conclusion that the interference of the Government in technical education would be an act entirely beyond its proper province. No necessity exists to justify it ... <u>if technical schools be not established we must conclude that the alleged necessity for them does not exist. We may safely leave such a matter to the ordinary laws of supply and demand</u>'. [Times, 6th Feb. 1968][My emphasis]

Throughout the century the ASE had focused on the decline of the apprenticeship and had made clear its position regarding its place in technical education, provoking many disputes, culminating in the Great Strike in 1897. The historic Craft Guilds were also clearly affected by the social and technical transformation affecting the traditional craft apprenticeship system.

9.2.0

The City Livery Companies and the Beginnings of the City and Guilds of London Insititute

Concern over the decline of the apprenticeship system prompted an investigation by a committee set up by the Livery Companies in 1877 which reported in 1878. (The following were members of the Committee: Thomas Huxley, Sir Douglas Galton (Scientist and soldier in Royal Engineers), Sir Henry Faverman Word (Assistant Secretary of the Society of Arts), Lord Armstrong (leading engineering employer and industrialist), and Major General Sir John Donnelly (Secretary of the Dept. of Science & Arts)). This report was the first unofficial, but comprehensive survey of the extent of technical education in England. It revealed that there were 40 establishments engaged in some form of technical education in England (a complete list is shown in Appendix 22). Of these 16 were in London, the remaining 24 covered the rest of the country. [Livery Companies Report (1878)]

The committee drafted an outline scheme for a national system of technical education. It proposed the foundation in London of a Central Institute for 'higher technical instruction' (a similar proposal had been made by the Workmen's Technical Education Committee in 1868, my analysis above ch 6]. It also recommended the establishment of trade schools; the organising and administering of technological examinations; subsidising other institutions in London or in the provinces having technical education objectives. The City and Guilds of London Institute (CGLI) developed from these proposals in 1879.

The CGLI established a 'trade school', Finsbury Technical College; and a Central College at South Kensington comparable, it was argued, to the great Polytechnic schools of Germany, Switzerland and Italy, and corresponding to the Ecole Centrale of Paris. [R.C. on T.I. (1884) sec.vii]

Magnus, the first Director and Secretary of the C.G.L.I., was to argue later that the CGLI fulfilled a State function and that the work undertaken by the Institute would have been undertaken by a Department of State in other countries [Magnus(1910)p.107].

9.2.1.

C.G.L.I. Structure and Organisation

The governors of the Institute emphasized that it was not concerned with changing existing social and technical relations. This was recognised early in the life of the Institute and noted by the 1884 Royal Commission:

> '...(the Council of the Institute)... have no intention of interferring with any existing social institution, such as apprenticeship, or any other relationship between employer and employee, but aim only at supplying the want of further instruction which is everywhere felt to exist, by supplementing, and preparing pupils more thoroughly to profit by workshop training". [R.C. on T.I. (1884) 2nd Report, p.401][My emphasis].

There were four branches to the Institute:

a) The Central Technical College, South Kensington: A college for higher instruction of a 'university character', in mechanics and mathematics; civil, mechanical, and electrical engineering; chemistry.

b) The Technical College, Finsbury: 'An intermediate College' with day courses in mechanical and electrical engineering; and chemistry; and evening classes in the same subjects; and in applied art.

c) The South London Technical Art School: courses in modelling, drawing and painting; and house decoration.

d) The Technological Examinations Department: for the registration and inspection of classes in technology and manual training, and the holding of annual examinations in the subjects taught in those classes. [C.G.L.I. Calendar (1887-9)]

The Central Institute had courses arranged to suit specific students:

i) Trainee technical teachers;

ii) Instruction for professional engineers and architects;

iii) persons intending to take the management of industrial works, 'whether sons of employers or managers or superintendents'. [Ibid. p.4]

Prospective students were required to matriculate, i.e. pass an entrance examination, and be prepared to take a complete course of instruction in one of the chosen branches of technology. The vice-president and treasurer, Sydney Waterlow, in his evidence to the 1884 Royal Commission

on Technical Instruction, held that the students to the 'Central' would be of high calibre. They were the type of students who previously would have gone for their technological training to Germany or Switzerland. Also included would be students from Finsbury Technical College who entered by free or partially free scholarships. It was envisaged that the Central Institute should therefore be a

> 'a college for the most advanced scientific and technical instruction". [R.C. on T.I. (1883) p.518, 519]

A complete course lasted three years and the instruction included work in all four departments with a common first year, followed by specialisation in the chosen technology.The matriculation examination for entrance included mathematics and mechanics; mechanical drawing; physics; chemistry; French or German.

Engineering students took a common first year of mathematics; physics and chemistry, plus workshop and drawing office work. The second year included: the kinematics of machines; the dynamics of machines; the strength of materials; hydraulics and hydraulic motors. The third year, in addition to 'discipline engineering' such as water supply, bridge construction, included the following: the strength and stability of structures; more advanced parts of the theory of the resistance of materials; theory of the steam-engine and gas engines. [C.G.L.I. Calendar (1888)].

Clearly this kind of course demanded students with a sound basic education capable of coping with three years of full-time instruction; and able to pay fees of £75 per annum.

The courses offered at the Finsbury College were mainly directed at a different type of student.

9.2.11.

Finsbury Technical College

From the outset the professed aim of the Finsbury branch of the City and Guilds Institute was to provide

> '... a training on broad, practical and scientific principles, in those subjects which experience has shown best to fit a student to enter some one of the many careers connected with Civil, Mechanical, Electrical or Chemical industries". [C.G.L.I. Finsbury Programme (1923-4) p.vii]

The operation of this college was divided into two distinct sections: day classes for those who were able to devote one, two or three years to systematic technical education; and evening classes for those engaged in industry during the day and willing to take supplementary instruction in the evening.

There were four departments: mechanical engineering and applied mechanics; electrical engineering and applied physics; industrial and technical chemistry; applied art; the building trades; French or German so far as it related to the reading of technical literature. [C.G.L.I. Calendar (1888) p.49].

For day students the college prepared courses suitable for intermediate posts in industry, and as preparatory to entry to the Central Institute.

Admission to the day courses involved an examination in Arithmetic, algebra, geometry. For illustration the test for 1886 included the following:

i) Simplify

$$\frac{1\ 4/17 \times 6\ 4/5}{3\ 3/5 - 1\ 2/25} + 2/11 \text{ of } (2\ 2/5 - 3/4) - \frac{1\ 3/5}{12}$$

ii) Show that

$$\frac{1 + a^2 + b^2 - c^2}{2ab} = \frac{(a + b + c)\ (a + b - c)}{2ab}$$

iii) Describe a parallelogram to a given rectilineal figure, and having an angle equal to a given rectilineal angle.

Fig. 2

Examples of Test for Candidates Seeking Admission to Finsbury Technical College.

In the light of the evidence concerning general levels of education put forward by critics such as Playfair, Huxley, Solly, and artisans in the Society of Arts Conferences, the nature and form of these types of questions suggest that few pupils from the elementary schools would qualify for day entrance to Finsbury. Plainly artisans would need further general education or make recourse to the evening classes at Finsbury. This would seem to have been the case.

9.2.iii.

Evening Classes at Finsbury College

The evening classes were conducted under the same discipline division as the day courses with 'practical' additions. These included the Art industries, including cabinet making, and decoration in colour and relief. Courses were designed for

> 'apprentices, workmen, and foremen, engaged in the various trades ..." [C.G.L.I. Calendar (1888) p.81]

There was flexibility in the organization of courses for no course was compulsory for evening students. Selection of classes was on an ad hoc basis to suit the individual requirements of the students.

The mathematics and mechanical engineering department provided practical mechanics; mathematics; mechanical drawing; practical geometry.

The day classes in 1886 attracted about 155 students, mostly from 15 to 19 years of age, in the main studying for the full course of three years leading to the Certificate of the College.

Evening classes in the same year had 900 students, the great majority were workers, 14 to 40 years of age, employed during the day in the workshop or factory. [Ibid.]

Data relating to both colleges show the number of evening students far exceeded day students. In the case of the Central there were two and one half times as many evening students, and at Finsbury four times as many [CGLI (1896),pp6/7]. The preponderance of part-time evening students reinforces the argument that evening classes represented a form of 'secondary school for the masses'. This pattern was consolidated by the 'distance-learning' characteristics of the C.G.L.I. examination structure.(See sub-section 9.3.0 below).

The predominance of the part-time evening class model in England may be contrasted with comparable institutions abroad at the turn of the century:

German Town			English Town		
	Day Students	Evening		Day Students	Evening
Berlin	20	250	Bolton	40	2500
Chemnitz	60	NONE	Leicester	18	1000
Crefeld	200	NONE	Derby	100	1000
Nulhausen	150	NONE	Salford	60	1500
Reutlingen	150	NONE	St.Helens	NONE	1000

Table 5

Table showing respective numbers of day and evening class students in selected German and English towns in 1900. [Source: Shadwell, A. (1906) p.423]

Why did the part-time evening class form of technical education come to be so firmly established in England? Little debate on alternative models took place; the evidence seems to show that, on the contrary, patterns based on Continental models available at the time were firmly rejected(Scott-Russell; The Samuelson Commission of 1884). No adequate justification was offered as to why they were inappropriate for England. Technical education abroad was not dominated by the part-time principle.

Clearly some provision was made for day-time study here and this was provided at the Central Institute at South Kensington and at Finsbury. The relevance of the Central Institute was itself the centre of debate. It was argued for example that its location was likely to

prove 'not readily accessible to workmen'. [Magnus, P. (1910) p.98]. Its structure and organisation was premised on the separation of work and education. In this it reflected aspects of prevailing educational ideas which similarly separated mental and practical activities. In this respect Johnson (1969) has argued, that English education from the mid-1860's was conceived as a source of work-discipline or rational economic behaviour. At the same time the industrial economy rested on a base of child, female and adolescent labour, placing school and work in competition.

It seems to me that the CGLI pattern of technical education portrayed it as separate from its historical form, the craft apprenticeship, and institutionalised the pattern. A recent analysis says,

> '...the decline(of the apprenticeship)...called for a system of technical education which did not demarcate between the 'principles' and the 'technicalities' of technology...'(Beecham (1982)p.64).

But clearly this is the very pattern that originated with the CGLI. Beecham seems to assume that the dichotomy only arises 'whenever the technical education ...came under the control of the State...'(Ibid p.62).

Sponsors of the new system of technical education and training, mainly City Livery Companies, assuming effective practical training was being carried out in industry, believed in the need for a separation of the exercise of craft skills, and the organisation, direction and control of those skills in industry. The structure of the CGLI reflected that belief.

9.3.0

The Technological Department at the C.G.L.I.

The technological department was responsible for the organisation and administration of the 'distance learning' students, i.e. those who studied in their own provincial and metropolitan institutes and were entered for the Institute examinations. These were set and marked in London.

Such was the prestige of the department that towards the end of the century the Institute directorate in technology came to regard the CGLI as,

> 'a powerful agency in encouraging the establishment of technical schools and classes throughout the country'. [C.G.L.I. (1896) p.8]

The figures of attendance and papers worked by students seem to support this claim. There was an increase in the number of candidates' papers from 202 in 1879 (the year the Institute took over responsibility from the Society of Arts) to 10,293 candidates in 1895 [CGLI (1901), Department of Technology Report 1900-01].

Given that there had been only very limited experience in distance-learning under the Society of Arts from the late 18th century, it was significant the way the director of the Department, Magnus, perceived its function in terms of a national context. He held that the technology examinations acted not merely as benchmarks against which various trades' knowledge could be compared but he also perceived them as

> '... fixing the standard of technological instruction for artisans throughout the country'. [CGLI(1896) p.10]

It is difficult to see how Magnus could have justified this assertion, in the light of criticisms concerning the quality and lack of technical teachers, the chaotic state of the apprenticeship system, and the overall lack of technical education provision. As Foden(1982) has argued,

> 'There is little direct evidence of any kind that the examinations had much demonstrable social and industrial impact at all. Industrialists, trade unions, and the main educational establishment...remained on the whole quite indifferent to what the Institute was doing...'(p.79).

But it also seems to me that Magnus's well-publicized view failed to take into account the political and ideological background to the rapidly declining apprenticeship system. A common assumption, evidently also held by Magnus, was that the work of the CGLI examinations department was being complemented by necessary practical training in the workshops. The evidence shows this was questionable.

What was the structure of the CGLI examination system which Magnus presumed was having such a marked effect on technical education developments? Did the C.G.L.I. organisation and structure reflect the power of the employers to influence important decisions in technical education? Was there any relation between government's reluctance to take a more positive role in the initiation and funding of technical education and employer pressure?

9.3.1

The C.G.L.I. Examination Structure

In 1879, the Institute assumed complete responsibility for all technical-related examinations originally organised and administered by the Society of Arts. Technological examinations had been introduced by the Society of Arts in 1873, the first of their kind. By 1877 the examination structure involved six separate examinable areas: a) commercial knowledge, b) domestic economy, c) fine arts applied to industry, d) music, e) technology of arts and manufacturers, f) elementary. [S of A (1878) p.85]. The inclusion of both music and technology in the programme of examinations indicates the wide-ranging subjects covered by the Society and the difficulties associated with definitions of 'technology'.The number of candidates at this early stage was never great: 6 entered in 1873, 68 in 1870, and 184 in 1878. There was a graded system of elementary, advanced, and honours in the examination. The specific subjects for examination were: cotton manufacture, paper, silk, steel making, carriage building, pottery and porcelain manufacturing: gas, cloth, silk-dyeing, calico-bleaching, dyeing and printing, alkali manufacturing, blow-pipe analysis. [Ibid.]

The CGLI thus inherited, in 1879, a system of technological examinations orginating with and sustained by the Society of Arts. These were based on local preparation of candidates for examinations set and examined in London. It also subsidised existing educational establishments, exercising a function the government had been unwilling to take up. The Samuelson Commission, the first public Inquiry into technical education provision, noted in 1884 that without this kind of assistance institutions providing technical instruction would have probably languished. [R.C. on T.I. (1884) p.814].

Donnelly, at the Directory, was responsible for the initiation and administration of the payment-by-results system organised from there. He was also a member of the executive committee of the the C.G.L.I. In this capacity he objected strongly to the C.G.L.I. assuming the examining role of the Society of Arts, with which he was also associated as an executive member. In a letter to the Times he complained the scientific basis of the Science and Art Department examination system was being eroded by the scheme proposed under the C.G.L.I. [Lang, J. (1978) p.23]. A Secretary of the Institute replied that the value of the examination scheme could

be measured by the number of candidates taking the Institute's papers. His evaluation was substantiated; in 1882 there were 1,961 candidates sitting for examination [loc.cit.].

The examination scheme of the Institute was perceived as an alternative to the Directory's science-based 'technical education' which was the basis of Donnelly's criticism.

9.4.0.

Differentiation of Knowledge in the CGLI.

A critical structural characteristic of the CGLI was the formation of two distinct foundations which I believe the evidence shows institutionalized the separation of one kind of system of knowledge ('Central') from another (Finsbury Technical College's evening classes).The vast majority of the Institute's students attended the latter. 'Central' students, exposed to certain forms of technical knowledge, were destined for supervisory roles in industry. Finsbury College evening students were prepared by the Institute to become more 'competent workers'.

The Central College concentrated mainly on the theoretical principles of industrial practices geared towards 'professional' people (not exclusively engineers); 'Centralians', were to organise and direct the activities of the workers. The Evening Class department at Finsbury held courses directed at subordinate workers, who were presented with a different conception of what was meant by 'technical knowledge'. As the 'Calendar' explained,

> 'The object of the Central Institute is to give ... advanced instruction ... in those kinds of knowledge which bear upon the different branches of industry, whether Manufacture or Arts'. [C.G.L.I. Calendar, (1887-8) p.4]

While the Finsbury College provided '... education of a thoroughly practical kind for apprentices ...' [Ibid. p.48]

Clearly the former was directed towards more theoretical aspects. Students taking other courses not directly organised by the Central, free to choose the form and duration of their courses, were advised that classes at this level could be restricted to trades that were relevant.

But students outside the Central Institute seem to have been handicapped. Lacking preparation, they were as one Institute teacher noted,

'totally unprepared by previous training for taking notes, and having little aptitude for dealing with formulae, were unable to assimilate the technical food placed before them ...' [Adams, H. (1883) Preface]

Despite such reservations, expectations of the evening class student were uncompromising. In 1901 students taking the ordinary grade examination, part I, in mechanical engineering would be expected to answer questions of this kind:

'The difference of tensions on the tight and slack side of a belt which drives a 30 in. pulley being 750 lbs., what H.P. is being transmitted to the shaft on which this pulley runs if it makes 120 revolutions a minute?' (30 marks) (C.G.L.I. (1901) Report, p.219] (one of nine questions to be answered).

Under the section dealing with fitter's work the following question is found in the part II examination:

'Sketch turning tools for the following purposes, showing clearly the cutting angles in each case:
a)Roughing out mild steel; b) roughing out gun-metal; c) finishing mild steel; d) parting mild steel; e) knifing mild steel; f) cutting a square thread of 1 in. pitch'. [Ibid. p.223] (20 marks) (one of four questions to be answered).

I quote these two examples because they clearly represented workshop knowledge an artisan or apprentice would be expected to draw upon in the C.G.L.I. examination in mechanical engineering. (In 1900 there were 955 candidates for this examination with 498 passes) [Ibid. p.7]

I believe the evidence also shows that the C.G.L.I. was differentiated along class and occupational lines, structured to accommodate prevailing work norms. An increasing differentiation of labour in the factories was paralleled by a differentation of knowledge in the Institute, reinforcing the notion that for the bulk of the workforce, manual labour was the dominant feature in their lives. The day and evening classes at the smaller Institute, Finsbury Technical College, illustrate my point. In 1892 the day school had 78 students from grammar and other endowed schools; 64 students from middle class schools; 57 from private schools, and 14 students from Board schools. This put the representation of students from manual-working backgrounds at six and one-half per cent. Attendance at evening classes at the same institute showed over fifty per cent artisan adults and young workers; mostly in the engineering trades. [C.G.L.I. Finsbury Programme (1893-4)]

9.5.0.

Ideology of Employers: Control and Influence in Emerging Technical Education

Histories of technical education, if examining the influence of employers at all, tend to portray employers as making 'demands' for skilled labour which were met by technical education. For example, Ashworth [1960] made the case for technical education by arguing that changes in skill levels and organisation of work created

> 'more fully mechanised factories, needing semi-skilled workers who could conform to a regular routine'. [p.198]

These, he held, could not be found from among a child population

'... left untouched in a state of dirt, ignorance and savagery'. [loc.cit.]

Argyles [1964] quotes with approval an assertion by Playfair that the 1851 Commission gave

> 'an enormous impetus to the movement in favour of the reform of our industrial methods ... (which) has revolutionized our system of technical instruction'. [p.14]

It would seem from the evidence that Playfair over-emphasized the idea of a technical education 'movement' and was confused over industrial 'reform' and the reorganisation of work. He ignored the influence of the growing militancy of employers, effectively challenging the skilled workers over work control, and particularly their attitude regarding skilled labour substitution.

The Institute's formalisation of two kinds of technical education, both abstracted from the traditional craft apprentice mode of training, confirmed the TUC's conceptualization of the apparatus of 'provided' technical education 1880s:

> 'The whole modern organisation of labour in its advanced form rests on a fundamental fact ... the definite separation between the functions of the capitalist and the workman ... each between the direction of industrial operations and the execution in detail'. [T.U.C. (1880) Dublin]

The particular structural characteristics of the C.G.L.I. therefore seem to me to reflect the ideology of engineering management - an examplar of an ideology of work giving rise to an ideology of education.

This management ideology may be illustrated with reference to one of the most prominent engineer-employers of his generation, Lord Armstrong. He was director of the largest engineering works in the

country, the Elswick Works, and whose views on technical education as an engineering employer were among the few publicly available at the time. He maintained, a) technical education was the preserve of minority:

> 'Those who would be benefited by scientific education of a technical education ... constitute a very small proportion of the population'. [Armstrong, W. G. (1888) p.50]

b) If warranted, the venue for a general technical education programme was the evening class:

'... at our factory we have night classes specially for the young...'(Ibid).

This view, given in evidence to a Select Committee in 1872. [R.C. on S.I. (1872) Q.9239], altered little with time, and embodied a notion of technical education as secondary to the market function of the company. His philosophy may be encapsulated in two comments in an 1888 article:

> 'Cheapness and superiority of quality will decide the victory in the race of competition ... (and) I am inclined to look upon colleges ... as luxuries rather than necessaries'. [Armstrong (1888) p.51][My emphasis].

This evoked a response from Playfair who argued,

> ' ... the capitalist with his large factories worked by machinery, has neither the time nor the inclination to bring up young men with a trained knowledge of his industry ...' [Playfair (1888) p.332]

Clearly, different production ideologies correspond to different production relations and authority structures. Thus I have contended that the 1897 Strike and Lock-out was such a crucial event: by acting as a catalyst between production ideologies ['technical' issues (length of the working day, machine manning, use of new technologies], and production relations ['educational' questions (technical training, apprenticeship; general, elementary and technical education)].

Recent writers, such as Roderick and Stephens(1978), have expressed this close interaction between tehnological developments and education in this way,

> '...the English education system was as great an influence as any other factor in explaining industrial performance in the period 1870-1914...it was the absence of an equivalent "revolution" in science and technical education which had the greatest bearing on ...performance' in the second half of the century...'(pp.170,171).

Notwithstanding Playfair's criticism of the 'capitalists' disinclination to train the young, his own perspective reflected the prevailing narrow vision and hinged on the issue of 'technical efficiency' and the quality

of skilled workers. In practice this meant 'efficiency' in terms of worker adaptability and conformity to factory discipline, sustaining company profits and control within the factory system, not so much 'competence' in the individual craftsman.

But he also highlighted the more specific issue regarding the employers' resistance to technical education and training in the period. His argument was a rebuttal of Armstrong who might be considered representative of the Victorian engineer-entrepreneur, viewing the company as a source of profit, and not a locus for systematic training. Armstrong's reputation as an engineer and the pre-eminence of his company, the Elswick Works at Newcastle, suggests a strong representation from this source in the newly-formed E.E.F. The evidence supports this. A main source of evidence on behalf of employers to the 1892 Royal Commission on Labour came from the Vice-Chairman of the same company, Captain Andrew Noble. During the 1897 conflict the leading representatve of the EEF was Col. Dyer, also a director of the Armstrong-Whitworth Company.

I am not proposing a conspiracy thesis or postulating a necessary consensus of opinion among engineering employers. I am suggesting that the evidence points to the existence of an often unrecognized relationship between increasing control over the labour process particularly by strong, federated employers such as Armstrong, Dyer, and Noble and the arguments put forward which related to the issue of technical education and training. These found an outlet in a number of ways: official inquiries, reports to Select Committees, responses to TUC demands, EEF Minutes, engineering institutes deliberations published in 'Proceedings', and in the crucial deliberations of the 1897 dispute. The principal concerns in these deliberations were pragmatic questions of length of working day, conditions of service, overtime issues, and wages. The evidence also suggests that embedded in these economic issues, were quite critical concerns regarding technical education.

I have thus asserted, in the context of the 1897 dispute, that the key questions regarding technical education were subsumed under the specifics 'machine manning', 'apprenticeship' and the principle of substitution. That is, 'technical education' per se was not a negotiable agenda item in the 1897 dipute, but it clearly formed a critical part of the unions' arguments concerning machine manning and the apprenticeship question. For the union side, the apprenticeship system was conceived as

central to any technical education system. The employers' case was represented by figures such as Dyer whose decisive views on these issues, reflecting employer dominance over technology, emerged during the dispute. As Burgess(1969) has argued,

> 'There exists a strong correlation between firms participating in the lock-out and advanced technology...'(p.18).

It therefore seems significant that the Terms of Settlement, concluding the 1897 Strike and lock-out contained the following in the ratified agreement of 1907:

> 'An apprentice shall be afforded facilities for acquiring a knowledge of the branch of the trade he adopts, and shall be encouraged to obtain a theoretical knowledge thereof as far as circumstances permit'. [E.E.F.-A.S.E. Agreement (1907) para. 6] (my emphasis)

This policy clearly corresponded with Armstrong's view that colleges were 'luxuries rather than necessities' (quoted above p.284). It also vindicated Donnelly's criticism of employers, when he argued in the 1881-4 Inquiry that,

> 'I do not think there is any strong general feeling on their (employers) part with regard to the value of such instruction'. [R.C. on T.I. (1884) Q.2572]

The clause in the ratification of the 1907 Terms of Settlement relating to the acquisition of technical knowledge by apprentices, was a qualified 'concession' to the unions and apprentices; but it plainly implied that 'technical education' was contingent upon the needs of the employer and the company. This concession to trade training did not appear in the two previous Agreements between the A.S.E. and E.E.F. Both the 1898 and 1901 Agreements studiously avoided reference to apprentices acquiring 'theoretical knowledge'. [E.E.F.-A.S.E. Agreements 1898, 90 - my appendices 2(a) 2(b)].

The foundation and development of the CGLI has long been regarded in existing accounts as the cornerstone of English technical education from the late 1870s. It seems to me simplistic to assume that such a development would take place uninfluenced by radical changes in industry, and by the political effects of numerous localized strikes and a national industrial strike. Similarly, perceived as a national system, technical education would clearly not operate in isolation from the political and legislative structure. It is therefore necessary to see the origin and development of the CGLI against the background of relevant legislation of the period. The singularly most important in the 1880s was the first

Royal Commission to inquire into technical education provision, which was published in 1884. But the origins of this Royal Commission itself reveal the prevailing ambivalence in government thinking towards technical education.

9.6.0

The Royal Commission on Technical Instruction 1881-1884

The Royal Commission on Technical Instruction (R.C. on T.I.) 1884, was the first 'official' attempt to determine the prevailing situation regarding technical education and training in England and Wales.

The first formal investigation had been undertaken by the City Livery Companies in 1878; the 1881-84 Royal Commission arose out of this Livery Company inquiry. Under Samuelson it was originally conceived as an unofficial inquiry i.e. not directly initiated or funded by the government. It was proposed by an M.P. Anderson, in a House of Commons debate in 1881 [Hansard, Apl. 1881, Col.251]. Mundella, the vice-president of the Council was unenthusiastic, and suggested that members might instigate their own research, 'at their own expense'. [Ibid]. In the event, four members of the Commons particularly concerned with the issue of technical education, formed an ad hoc committee in 1881. (My Appendix 21 shows the composition of this committee, with brief biographical notes).

It seems to me the Commission was especially significant in the way it highlighted for the first time and in a systematic way the employers' views on technical education during the course of its inquiries between 1881 and its publication in 1884. The Commission asked employers to comment on,

> '... the influence, on the industry in which you are engaged of the Science and Art classes, and other sources of technical and general instruction, which are available to the workmen, foremen and employers of your district ...' [R.C. on T.I. (1884) Appendix G]

It provides firm evidence of employer resistance to technical education. Donnelly, during his evidence, in reply to the question

'Can you suggest...the best means of promoting technical training...? prefaced his reply by suggesting first: The operative classes were much more convinced of the value of technical instruction than employers;

second, an essential condition for a technical education programme was the need to engage the support of employers:

> 'The Commission, or some other body, should get the employers of labour of this country to see and fully appreciate the value of such instruction'. [R.C. on T.I. Q.12871]

It is evident that industrial employers were reluctant to address such issues, and, as my analysis of the events leading up to conflict of 1897 demonstrated, engineering employers had not made an overt issue of technical education in that period. The Commission's research was first directed at the two sources of relevant education: The Directory's science scheme, and 'other sources', a reference to the C.G.L.I. and the Society of Arts. The 'more important' replies (published as Appendix C in the Report), showed that more than 50 per cent of employers responding, had a negative view of the effects of technical education. [Ibid. pp.642-53].

9.6.1

Government Concern over Employer Attitudes to Technical Education.

The attitude of the employers, revealed in the Inquiry, was clearly of concern to Donnelly, as the evidence has shown. But not fully grasped by the Commission or Donnelly were the problems in technical education compounded by the free-market policy of the government. The economic implication of this policy was the need to attract funding from the market which in turn strongly implied that employers assumed a critical importance in government thinking.

Donnelly, representing official views, attempted to persuade employers to accept more responsibility for technical education. He argued:

> '... (the employers) might ... at once do for science and art and industrial education what the recent Education Act did for Elementary education'. [R.C. on T.I. (1884) Q.2572]

A prominent engineer-employer, Siemens rationalised employers' attitudes to technical education by suggesting that there was a bias against technical matters and a 'prejudice against innovation' on the part of the English employers [R.C.on T.I.(1884) Q.1486].

Tradesmen were frustrated by employer reluctance, one said

> '... but yet I do not know what we should have to do to get (employers) to take an active interest in it (technical education)'. [Ibid. Q.3818]

And on the issue of apprenticeship another workers' representative raised the issue of systematic training,

> 'Employers should ... afford facilities for youths to be systematically taught for a given or fixed term, say of 5 years ...' [Ibid. 2854]

After it had begun its work the Commission was granted Royal Commission status (i.e. it was no longer an amateur, unofficial enquiry; self-funding and self-motivating). In brief,its main recommendations came down to this:

Following an injunction that the basis of a sound technical education system was a unified system of elementary and secondary education, it contended that existing arrangements for technical education were inadequate. Replicating Continental models of technical education was rejected; it was considered inappropriate to introduce the practice of foreign countries into England. It is evident that in philosophy and projection its main propositions reflected the prevailing model of technical education exempilified by the City and Guilds.

Regarding technical education for management of industrial enterprises, the Commission distinguished 'capitalists' who,

> '..will take the general, as distinguished from the technical direction of large establishments; and those at the head of small undertakings, or the persons more especially charged with the technical details of either...'[R.C. on T.I (1884) p.555],

and those with a 'technical' function educated in an institution where

> '...sound knowledge of scientific principles has to be combined with the practical training of the factory...(loc.cit).

There was a reiteration of the basic educational philosophy which assumed working class education to be secondary to work:

> 'For the great mass of our working population ... must necessarily begin to earn their livelihood at an early age ..." [Ibid. p.517] [My emphasis].

This philosophy seems to have been recognized and tolerated by workers. They perceived educational institutions as reflecting the ineluctable hierarchical structure of industrial work organisation, under which a minority, administered ('manage') the majority who labour (TUC Minutes 1880).

The Commission's specific recommendations for workers' technical education were undramatic and bland, emphasizing the inclusion of practical subjects in elementary schools with more science instruction:

a) Elementary schools should be encouraged to include drawing, metalwork and woodwork.

b) Science and art classes should be part of the school boards' curricula. Science should be 'more practical'.

c) Teacher training should include more provision for science.

d) Endowed schools should include technical and scientific instruction in the curriculum.

In the event the Commission's recommendations made little impact. The government was under no obligation to implement or subsidize any element of the Report's recommendations. Five years after the Report major deficiencies in provision were still evident. A subsequent Inquiry thus referred to 'disastrous gaps' (in provision). [National Asssociation for the Promotion of Technical and Secondary Education (1889) p.133]. By the turn of the century the effects of a lack of central directive and co-ordination was also manifestly clear[C.C.T.E. (1900)]

Plainly the political implication of the State's non-interference in technical education developments had been misconstrued by the Dean and professor of mechanical engineering of the Central Institute, W. C. Unwin, as confirming the prevailing 'self-help' policy. He argued later that from the 1880's science and engineering, had largely been developed by individual initiative and voluntary effort. This, he held, emerged as part of a 'marked jealousy of state interference'. [Unwin (1904)]. But the evidence is clear: The Inquiries of 1884 (and reaffirmed in 1889) highlighted the state's narrow vision and the employers' continuing resistance to technical education.

Neither the State nor the employers were prepared to make a full commitment to a national system of technical education. The evidence shows the State prevaricating, with no national policy for the training and supply of technical teachers; no overall strategy for higher education; and inadequate funding, ill-equipped to administer a national scheme.

To briefly illustrate with a single domestic example concerning employers, from later in the century: In a comprehensive report for a Special Committee on Technical Education for the London County Council in 1892, it was stated that in respect of part-time release for technical education, London in particular was singularly lacking:

> 'London is not only very far behind Germany and France in quantity and quality, but also far behind our chief provincial towns'. [L.C.C. Report (1892) p.4]

To be on a par with Manchester in the numbers of students in technical classes, London should have had, pro rata 148,000 entries: the report showed 24,000 registered. [Ibid.] By 1895 it was evident again that in London, many employers were unable to make concessions to boys for an allowance for part-time classes, although some encouraged attendance at evening classes. [London T.E. Gazette (1895)].

There is little doubt that there was considerable pressure from a variety of sources on the employers to assume at least partial responsiblity for technical education. In the main, the employers' views on the matter were not made explicit until revealed during the course of public inquiries into technical education provision in 1881-4, 1889, and more tacitly during the great strike; and later in 1906-1909.

But the evidence also shows the ambiguity of the employers' position. On the one hand they evidently approved the Establishment

policy of non-interference in technical education. This much was clear from their measured response to technical education schemes, favouring mainly a part-time pattern. On the other hand, the government was anxious to get them to adopt a more pragmatic approach to the whole issue of technical education and training. The combination of indecisiveness on the part of government and the ambiguous position of the employers ensured that the technical education of young workers was relegated to an inferior, part-time system which made few demands on either employers or the State.

9.7.0.

Continuing Reluctance of Employers: Legislation from the 1880's

However, the pressures brought by the National Association for the Promotion of Technical and Secondary Education(NAPTSE), the T.U.C., the Trades Councils, and other artisan sources, such as the Workingmen's Technical Education Union seem to have had an effect; for a number of legislative reforms relating to technical education followed. They were mainly attempts to co-ordinate the aims and objectives of both secondary and technical education. But I believe the evidence shows that the legislation still embodied an unjustified confidence in bodies like the newly-constituted C.G.L.I., and on the capacity for co-operation on the part of employers.

A series of attempts at technical education legislation were therefore made between the years 1884 and 1889 which, by and large, bore some relation to the recommendations of the 1884 commission. Roscoe was prominent in this, particularly in his work in the House of Commons (N.A.P.T.S.E. (1901) p.51. But these eforts were handicapped by the continuing problem of the locus of administration of technical education. A turning point seems to have come with the passing of the Local Government Act of 1888, which made possible the local organisation of post-elementary education on a systematic basis.

9.7.i.

The Local Government Act of 1888

This Act brought into being the County Councils which replaced the School Boards, a product of the 1870 Act. Under this new provision wide areas of local administration, of which education was to be part, were formed. As far as education was concerned, for the first time the whole country was placed under the jurisdiction of local authorities which were to be also responsible for raising a levy of a penny rate for technical or manual instruction. Any Council was able to appoint a technical Instruction Committee.

In addition, representatives of these Committees were to be incorporated into the governing bodies of all schools, colleges, and institutions giving technical instruction. [R.C. on S.E. (1895) pp.12-13].

The Act finally removed what hitherto had been considered a serious impediment to educational administration, viz. the absence of a representative and locally elected county authority. [Ibid.] This was a major criticism raised in the Schools Enquiry Commission of 1868. The 1888 Act was one of two specific Acts, the other being the Technical Instruction Act of 1889, which were innovatory by bringing non-elementary education under the aegis of rate-aid financing; and ensuring that a form of technical education henceforth could be locally administered. This clearly accorded with the frequently reiterated precepts of 'self-help' favoured by the government.

9.7.ii

The Technical Instruction Act of 1889

The government's central position regarding technical education remained unequivocal: existing science provision would constitute the basis of State technical education provision. During the course of a debate in the House, which preceded the 1889 Technical Instruction Act, government's policy of non-interference in technical education was reasserted. W. Hart-Dyke, Vice-President of the Council, argued the government case: The Bill,

> '... proposes to do no more and no less than extend the curriculum now existing in the Science and Art Department at South Kensington, throughout the country'. [Hansard (1889) Col. 509]

The responsibility for technical education innovation and expansion fell to local authorities not central government.

This later prompted Magnus(1910), principal of the Central Institute, to observe,

> '...the pedantic refusal on the part of the State to give trade teaching was one of the causes of our belated efforts to organize for this country a system of technical education...the direction of technical instruction remains very largely in the hands of a body receiving no direct help from the State...'(p.107-8).

It was also clear that the Technical Instruction Act would have little to do with elementary school, for it did not apply to scholars receiving instruction in the obligatory or standard subjects. Technical instruction according to the Act meant,

> '... instruction in the application of science and art applicable to industries ... it shall not include teaching the practice of any trade, or industry, or employment'. [T.I. Act (1889) Section 8]

The separation of work and education was reaffirmed.

The 1889 Technical Instruction Bill was introduced in the Commons in March by Henry Roscoe. With H. D. Acland he was one of the first secretaries of a new asociation, the National Association for the Promotion of Secondary and Technical Education (N.A.P.S.T.E.) Together they had served on the executive committee of the Association which they had initiated in July 1887, under the Presidency of the Duke of Devonshire. There were twenty-four members on the executive (N.A.P.T.S.E. (1907) p.2].

The executive had a generous representation from the earlier 1884 Samuelson Commission (Roscoe, Magnus, Swire Smith) (See Appendix 21)The Association was arguably a strong lobby for a model of technical education as conceived by the 1884 Commission. It has also been cited as evidence of the 19th century technical education 'movement':

> 'This was the first formalization of the existence of the <u>'technical education' movement</u> and its work continued until 1907...'(p.57).(Bailey(1983:57) (My emphasis).

Its principal aim was the promotion of legislation on technical education. The Association was critical of the 'general state of chaos' represented by the elementary education system, particularly the 'baneful' overlapping of the work of educational authorities. The uneven spread of educational provision and the fragmented nature of the administration compounded the associated problems of funding. The structure of the Education, the

Science and Arts Departments and the diversified work of the Charity Commission made administration unwieldly, confirming Playfair's criticism of 1871 (see my discussion above sub-section 6.1.0.). The payment by results system was denounced and there was criticism concerning the lack of technical teachers, manifesting

> 'disastrous gaps in the educational system ... chiefly in large centres of population ...' [N.A.P.T.S.E. Report (1889) p.22]

9.7.iii.

The Problem of the Supply of Technical Teachers

Apart from the difficulty of administering an expanding technical education system without a co-ordinated policy of administration there was also the problem of the grant system for elements in the Science and Art Scheme. There were weaknesses in making grants contingent upon examinations. The Association's criticism of the system for training technical teachers indirectly added substance to the workers' case for retention of the apprenticeship system as central to a technical education system. A technical education system institutionalised as separate from workshop activities represented a crucial abstraction of work from education.

This heightened the recurring problem of teachers who were generally ill-prepared for teaching technical subjects [Ibid. p.63]. Analysis of the type of qualifying test illustrates the point here.

For comparison I take questions from the Ordinary grade, Part I mechanical engineering paper,for tradesmen; and the First Year Final Examination for Teacher's Certificate in metalwork:

Ordinary grade, Part I, Mechanical Engineering:

> 1)Q. Given the effective pressure on the piston in a direct-acting steam engine at any instant (corrected for effect on inertia of reciprocating parts), show how it is possible by a simple graphical construction to determine the tangential turning force at that instant acting on the crank. Prove the correctness of any construction you give.
>
> (One of nine questions)

First Year examination for Teacher's Certificate:

> 2)Q. Name and briefly describe the kinds of metal you have used in workshop practice, stating their characteristic properties.
>
> (One of four questions) [C.G.L.I. (1901) pp.220, 301]

There seems to be a marked difference in expectation of fitters and turners, who sat the first kind of paper, and prospective teachers who would attempt the second. The knowledge content is also plainly different, with an assumed understanding of thermodynamics, and graphical drawing in the fitter's paper. The teacher's paper had an elementary, even superficial, knowledge content, compared with the knowledge expected of a general fitter or machinist in carrying out skilled workshop operations.

Another illustration from the teacher's Certificate paper serves to emphasise the point:

> Q. What is meant by 'Case hardening' and why is it adopted? Explain how to case-harden some small article.
> (One of four)

This kind of knowledge and application would be part of the fitter and turner's daily routine (See my Chapter 2, and Appendices 6 and 11).

The point here is to give some meaning and substance to the N.A.P.T.S.E. criticism regarding inadequate preparation of teachers of technical subjects. The knowledge content of the examination questions and expectations of fitters taking CGLI engineering papers presupposed a greater understanding of the relation between engineering craft practice and theory. Teachers, unless competent craftsmen, by virtue of their occupation would be unfamiliar with the structure or reproduction of workshop culture. However, opportunities for capable workers to attempt the technical teachers' paper were very restricted, as they rarely obtained release from work. Despite this, the report seemed to concur in the existing policy of government and the Commissioners on technical instruction that the 'true place for the teaching of trades was the workshop'. The N.A.P.T.S.E. report thus argued

> '... the object is not to interfere with the teaching of trades in workshops, or with the industrial and commercial training in the manufactory and in the warehouse'. [N.A.P.T.S.E. Report (1901) p.2]

This reflected the non-intervention policy in craft training advocated in the 1884 Royal Commission. A subsequent Board of Education report argued,

> 'It is a mistake to assume that training in school laboratories and workshops could in large part ... replace the workshop experience gained in works ...' [Board of Education (1908-9) p.90]

But, there remained the problem of what constituted technical education. The Bryce Commission was to note in 1895 that the government had been

> 'liberal rather than strict in interpretation of technical instruction". [R.C. on S.E. (1895) p.28]

By 1895 subjects under technical education included

> 'banking and financial science, principles of commerce: singing and musical notation, instrumental and orchestral music ... veterinary sciences ...' [Ibid.]

In sum, the situation from the 1880s seems to have been characterised by a number of contradictory elements:-

a) An ad hoc administration of the state education system, with organisation and financing fragmented and unco-ordinated.

b) A policy for the provision of 'science' in schools, and evening classes, inadequately serviced and weakened by a system of payment by results.

c) A prevailing assumption that the structure and level of trade training in industry was adequate; justifying a policy of non-interference on the part of the State.

The Bryce Commission of 1895 commented on

> '... a rich variety of (our) educational life ... (and) the usual results of dispersed and unconnected forces, needless competition ... and frequent overlapping of effort, with much consequent waste of money, of time, and of labour. [Ibid. pt.1, pp.17, 18]

But pervasive laissez faire doctrines and the philosophy of 'self-help', particularly in technical educational affairs, was maintained and came to be embodied in further legislation.

9.7.iv.

<u>The Local Taxation (Customs and Excise) Act, 1890</u>

The Local Taxation (Customs and Excise) Act of 1890 afforded further opportunity for 'self-help' on the part of local authorities. Through this, financial support for the new technical instruction legislation came from an unexpected source, unconnected with normal educational funding procedures. Technical instruction was mentioned in this 1890 Act as one of the purposes to which a residue of the money directed to be paid to local authorities from the Exchequer in respect of beer and spirit duties might be applied. This residue grant, known as the 'whisky money', was a fortuitous resource arising out of the

government's desire to placate the temperance movement. In a controversial piece of legislation designed to get rid of redundant public houses, considerable sums were generated which were not appropriated, in accordance with the intentions of the Act. Surplus funds were thus available. Acland, Vice-President of the Privy Council Committee on Education, proposed that in England the money should be re-allocated to technical education. This proposition was accepted and the Science and Art Department administered the allocation of the money, which in 1892-3 amounted to £472,000; and by 1901-2 had reached £859,000. [Brennan, E. (1959) p.88].

The provisions of these Acts were extended by an amending Act in 1891 (Technical Instruction Act, 1891), under which a local authority could aid educational institutions outside its own district. Scholarships also became available through this provision enabling students to pursue courses of study, as existed, outside their residential district. [T.I. Act (1891) Sec. 8]

The significance of these various Acts is more relevant to my analysis if they are examined together.The impetus provided by the 'whisky money' which arose out of the Customs and Excise Act, extended provision for local technical instruction. This inter-connection was possible because the funds under the 1888 Act could not have been diverted to technical education but for the existence of the 1889 Technical Instruction Act. But the appropriation of money and the rating powers granted under the 1888 local Government Act were not exercised on a national basis. A number of the newly-formed authorities were evidently not taking up the option of providing assistance to technical instruction in their areas.

The slow rate of uptake of available funds for technical education may be explained by local authorities diverting funds to other sectors. London, for example, applied its first allocation of 'whisky money' to relief of rates in the metropolis [Brennan (1959)]. In 1890-2 no money was spent on technical education, out of an allocation of £342,000. In 1892 the council spent £29,000 of its allocation in this way; this sum increased to £180,000 by 1902-3. [Argles, M. (1964), footnote p.31; Brennan (1959) p.89].

It was clear that the special funds were being re-allocated to secondary as well as technical education. A memorial delivered on behalf of Trades and Labour Councils, and Co-operative Societies, to the Bryce Commission in 1895 highlights this point. Arguing that the secondary education of the working classes must to a large extent be technical and manual, the memorial pleaded for a permanent allocation of funds for technical and manual instruction:

> 'We conceive that the very words of the Act which limits the application of this money, if used for educational purposes, to technical and manual instruction show that it should be chiefly applied ... to those who will be engaged through their life in manual work, and whose work requires, for its highest excellence, technical knowledge and skill'. [R.C. on S.E. (1895)]

9.7.v.

Acts of 1902 and 1903: School Boards Made Redundant

Further legislation around the early 1890s shows that the administration of wider forms of education was coming under government jurisdiction. Efforts were made to rationalize the generally ad hoc arrangements for the administration of secondary and scientific education, by the establishment of a Board of Education in 1899. This took the place of the Education Department (including the Department of Science and Art). The Board was charged with the 'superintendence of matters relating to education in England and Wales ...".

Two subsequent Acts of 1902 and 1903, the Education Act and the Education (London) Act, respectively, finally swept away the old School Boards. They removed restrictions placed upon the kind of higher education which county council, boroughs and urban district could aid. These Acts of 1902 and 1903 placed a positive obligation upon local authorities to

> 'consider the educational needs of their area ..." [Royal Colleges (1906) p.6]

For the first time funds were to be allocated for the purpose of technical education as a part of higher education provision. The Acts of 1902 and 1903 called for a) the definite appropriation to purposes of 'education other than elementary' of the grant available under the Customs and Excise Act. b) The extension of the rating limit for post-elementary education to two pence in the £ (it had previously been limited to a penny rate).

The development of an institution such as the CGLI from 1879, needs to be seen against the background of these legislative developments, for a number of issues arise. The various pieces of legislation attempted to resolve initial legal and administrative difficulties, which constrained the allocation of funds to education purposes other than elementary. The time scale was significant: It was not until 1899 that for the first time the government was committed to legislation for technical education. This legislation came thirty years after the tentative proposals of the Workmen's Technical Education Committee, and twenty years after the foundation of the CGLI. Government response was both circumscribed and slow.

The 1889 Act also made it plain that it did not cover the teaching of trades, but restricted 'technical instruction' to

> 'instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries and employments. It shall not include teaching the practice of any trade or industry or employment'. [T.I. Act (1889) Sec.8]

This was a crucial reaffirmation of a long-standing policy, and begged a number of questions particularly relating to the attitudes of employers to technical education and the status of the apprenticeship system. Neither the CGLI, nor the State, had jurisdiction over factory-based training, but employers clearly did. The CGLI structure did however meet with the approval of most employers because of the part-time, evening pattern of courses.

I wish to discuss this further and examine some of the views of employers after the legislation of the 1880s and 1890s.

9.8.0

19th Century Problems of Educational Provision and Access Carried over into the 20th Century.

Like the recommendations of the 1884 Royal Commission, the 1889 Technical Instruction Act appeared to have only a marginal effect on technical education development. The employers still remained to be convinced of the need of their support for technical education.

In 1889 one-tenth of the total number of students in science and art were being taught under school Boards [Hansard (1889) Aug. Co.509]. Some groups found the situation unexceptional; in the year of the Great Strike one leading newspaper noted:

> '... technical education is not needed for the masses of people. Indeed they are better without it ... and only teaches the workman to think that he is as good as his master or overseer ...' [Times, 20th Jan. 1897]

But by 1902 the effects of years of ad hoc, torpid administration and the lack of a definite policy for higher education surfaced. Representatives at a higher education conference concluded that after the 1902 Act, technical education was in serious danger of being neglected. Under this Act, the provision covering special funds (which I have referred to above) reserved for its use, was altered. [H.E. Conference (1903) [.18].

In 1903 it was again feared the level of technical and secondary education was in a comparatively low state vis à vis countries such as Germany and Denmark [Ibid.]. Figures showed cities such as Liverpool and Birmingham with populations of 685,000 and 600,000 had less than 7,000 and 5,000 pupils respectively in secondary schools. This compared unfavourably with places like Hamburg (700,000) and Copenhagen (400,000) which had 22,000 and 12,600 pupils respectively in secondary schools. [Ibid. p.26].

The influence of the employers was again highlighted in the early part of the century. A Board of Education memorandum in 1905 again expressed concern over the employers' response to renewed calls for technical education provision. An inspectors' inquiry found their response 'disappointing':

> '... unless this co-operation exists in some way or another neither employers nor employed will derive full advantage from the expenditure of national and local funds upon technical instruction". [Board of Education Memo (1905)]

Two further factors emerged in this inquiry: the attitude of foremen to technical education, and the issue of part-time release for study at institute classes. Both also figured in a parallel inquiry by the Association of Technical Institutes (ATI) which reported that the

> '... older race of works managers and foremen (who) have not been technically educated themselves ... do not appear to like the idea of the younger generation knowing more than they do ... evening trade students (say) that their foremen will not set them free from working overtime on their class nights ...' [A.T.I. (1905) p.30]

The 1905 ATI survey revealed that of 59 firms, 19 firms allowed some kind of day release for young workers to study, i.e. 32 per cent. Of these, 12 firms paids the necessary fees, and 4 paid for books. Twenty firms did not recognise the technical institute certificate; and 13 firms filled vacancies with students from technical institutes, while 27 did not.

Firms appeared more inclined to support the younger workers when attending evening classes. Forty-three out of the fifty-nine encouraged students to attend, suggesting support for my hypothesis regarding engineering employers that they were more favourably disposed to a technical education system that had minimal impact on workshop schedules. Employers were conscious of the disadvantages of 'day-release': factors such as a drop in production; release of 'good' workers from valuable workshop time; the difficulty of replacement particularly when apprentices were working jointly with tradesmen. Of the fifty-nine firms covered by the survey, 26 were engaged in engineering, of which 42% allowed some form of part-time release (ATI (1905)). The attitude of foremen was critical here also; for it was within their province to allow young workers to forego overtime in the works on evenings when classes were held. Frequently evening classes students found that foremen would not free them from overtime working on class nights, or even on the evenings of the annual examinations. [loc.cit.]

In one town foremen were reported as 'very obstructive' [ATI(1905) p.30].

The foremen's traditional supervisory functions seem to have been extended in a number of ways in the course of technological and labour management changes. First and foremost were their critical abilities as competent craftsmen in workshops increasingly manned by unskilled labour. Second, they were crucial intermediaries between management and workers on the workshop floor with respect to the operation of management

strategies such as the piecework system and the deployment of boy labour. Third, a relatively new function, they closely monitored young workers' access to technical education.

Their standing with management had been reaffirmed in the 1884 Inquiry. A large engineering employer (Anderson of Easton and Anderson Iron Works) stated of foremen:

> 'We promote those (skilled workers) who, we fancy, have got the knack of organisation'.

(On a comparative note, F. W. Taylor rationalised his foreman role at Bethlehem Steel in the 1880's in a distinctive way: His fellow workers addressed Taylor, on his promotion to foreman:

> 'Now Fred, you are not going to be a damn piece-work hog are you...?
>
> Taylor replied:
> "Yes, I do propose to get more work out now ... you must remember I have been square with you up to now and worked with you ... now that I have accepted a job under management of the company, I am on the other side of the fence ... and I am going to try to get a higher output from those lathes ..." [Taylor, F. W. (1912) p.79]).

In England the evening class system became the focus of further inquiries into the 'release' system of technical education. Other bodies, concerned principally with engineering, were critical of the emphasis on the part-time, evening structure. For the first time the professional enginering Institutes were among these.

9.9.0

The Professional Engineering Institutes' First Inquiry into Technical Education.

The first major inquiry undertaken by the professional engineering institutions reported in 1906. The instigation for this came from the president of the Institution of Mechanical Engineers, J. Hartly Vicksteed, who broached the subject with the president of the 'leading' institute of the time, the Institute of Civil Engineers in 1903 [I.C.E. (1906)]. This inquiry was significant being a co-operative investigation covering the whole range of educational provision relating to technical education. The following major engineering institutes were represented: Civils, Mechanicals, Naval Architects, Iron and Steel, Electrical, Gas, Engineering

and Shipbuilding in Scotland, Mining, N.E. Coast Institute of Engineers and Shipbuilders.

The inquiry covered preparatory education in schools; training in offices, workshops, factories, or in works; training in universities and higher technical institutes; and post-graduate work.

The largest survey of its kind, having no official sanction from the government or government representatives on the committee, it covered 676 engineering firms, of which 39.5% (267) replied on the questions of technical education.

The committee was strongly critical of the prevailing tendency in engineering firms to encourage study by the evening class system and argued:

> 'Nothing should be done in the form of evening study which would impose undue strain ... the Committee think it is most important that all boys should at least maintain their scholastic acquirements during the introductory workshop course ...' [Ibid. p.13]

Given that many employers were members, or sought membership of the various institutes, it was revealing that the committee censured the employers' negative attitudes to technical education, maintaining,

> '... The sympathetic assistance of employers is essential to improvement in engineering education and training'. [Ibid. p.17]

The survey also revealed that of the mechanical engineering employers approached (200), of whom 41% (82) replied, only 7 per cent stated they were willing to grant facilities for training [Ibid. p.26]. The other largest single engineering group approached was Naval Architects and Shipbuilders (119 firms, of which 26.8% (32) replied).

The evidence suggests that the engineering employers' 19th century attitudes to technical education had been carried over. Their attitude remained suspicious and cautious, if not hostile, particularly regarding day-time release of workers for study. The evening class system was most favoured, involving minimal financial and administrative commitment.

The findings of the Engineering Institutes' specific study confirmed a more general study carried out by Sadler in 1904. M. E. Sadler, later to become secretary of the Board of Education, maintained the evening class system was difficult for students to follow, due to work commitments. It was also inefficient as a means of technical education [Sadler, M. (1904) p.121 et seq.].He focused on the inadequacies of the elementary school system as an explanation for this, arguing much of the

work done in evening classes was remedial in an attempt to compensate for shortfalls in the school system. Poor attendance due to long working hours and incidence of illness on the part of workers reflected on examination performance. This aspect of workers 'education' was further constrained by the rigidity of the external examination syllabus; for example the CGLI.

My examination of the CGLI has shown that the bulk of workers and young people seeking education made recourse to the evening school, as the only source of secondary or technical education.

9.10.0

Sadler's Inquiries: The Employers' Position in 1907

A further investigation, under Sadler, into the extent of facilities granted to young workers was published in Manchester in 1907 [Sadler, M. (1907)]. This inquiry was addressed to 16 railway companies, and 195 firms representing some of the chief trades and industries; of these 67 firms replied. The questions referred to technical education facilities and the nature of assistance granted by firms.

The results showed that 52 per cent of engineering firms (18 out of 34) allowed some kind of release for attending technical classes. Ten of the thirty-four granted special facilities for attendance at evening classes. This tended to take the form of a) release from overtime on the night of the class, b) permission to leave work early on class nights, c) permission to come late one morning in the week if a certain, minimum number of classes were attended. On the matter of fees, 24 out of the 34 firms offered some kind of inducement. These covered fees for classes, fees refunded (generally on condition of satisfactory attendance and examination), increase of wages, prizes and so on.

In a number of case studies, Sadler's inquiry sugested that individual firms exercised social and educational control beyond the workshop, even where there was no company-run school. Company conditions usually took the form of inducements of the kind referred to above, regarding fees and attendance. A common condition of employment for young workers seems to have been compulsory attendance at evening classes [Daimler Motor Co., Coventry; Dobson and Barlow, Bolton; Mather and Platt, Oldham; Hans Renold Ltd].

Some employers insisted that apprentices be given no choice in this connection, as one prominent employer uncompromisingly expressed it:

> 'During his apprenticeship attendance at evening classes should be one of the conditions which the boy must comply with, for two or three nights a week, the neglect of which would render him liable to be discharged'. [Mather (1909) p.346]

Sadler's 1907 inquiry seemed to portray engineering employers in a more favourable light with regard to technical education. Some even granted part-time day release; and practical assistance with fees. But, for the engineering industry as a whole, it was a relatively small sample involving only thirty-four firms, and included some of the larger companies of the time: W. G. Armstrong and Co.; Cadbury Bros., Vickers, Sons and Maxims; the United Alkali Co. The largest companies were also in the position to exercise considerable local control through the use of their own company school. This seems to me to be a way in which the ideology of workshop control, although limited, could be projected into a localised form of technical education. Armstrong's at Elswick make the point:

> '... classes not only develop thought and intelligence, but they also foster studious and steady habits and to raise the tone of the students ... students who are most regular ... and most earnest in their endeavours ... turn out to be the most efficient workmen ...' [W. G. Armstrong & Co. Response to R.C. Circular, p.647]

Clearly, institutional arrangements in a company-run school enabled employers to oversee the occupational socialization of their young workers [See my discussion above, Sub-section 7.4.0].

In a recent analysis, Grignon (1971) expresed such a position in class terms,

> ' The task of moralisation ... has allowed the 'moral level' of the working people to be raised ... those who occupy the lowest social position have interiorised the ability to behave in conformity with the interests of the dominant classes ..." [Quoted in Dickinson and Erben (1982) p.148]

It would be difficult to conclude from Sadler's restricted sample that there had a discernible change in the attitudes of a generality of engineering employers.

This particular study therefore needs to be viewed against the E.E.F./A.S.E. Agreement signed in 1907, which I have analysed. Regarding technical training, I pointed up the circumscribed nature of clause 6, in which facilities for training were contingent upon the demands of the

factory (my discussion, ch 3). Clause 7 spelled out the ideology of the workplace and clearly affected employers' attitude to questions such as day-time release of workers:

> 'Employers in view of the necessity of obtaining the most economical production whether by skilled or unskilled workmen, have free discretion to appoint the men they consider suitable ..." [E.E.F. Minutes (1907)] (my emphasis).

This clause unequivocally stated the principles upon which engineering production was organised. This applied to Federated members, and would not necessarily include all mechanical engineering concerns. But the central point remained; the A.S.E. had conceded the principle of workshop autonomy, and reinforced their dependence upon employers with regard to access to any form of technical education. Clearly it had implications for the form and organisation of the apprenticeship system as the practical component of technical education, interacting with the training outside the factory, in the technical institute:

> 'There shall be no recognised proportion of apprentices to journeymen ..." [EEF/ASE Agreement Clause 6]

9.11.0

A London County Council Inquiry into Employers' Attitude to Technical Education in the Metropolis

Concern over the effectiveness of evening classes as a means of providing for the technical education of young workers, prompted a London County Council inquiry in 1906 [LCC(1906)p.7]. A memorandum was sent to principals of polytechnics and other technical institutes through whom employers in the skilled mechanical trades were contacted. The object was to determine, with reference to part-time classes, the extent and nature of the co-operation which might be established between the employers in London and the Council 'in the matter of technical education'. [Letter from Clerk of the Council, Mar. 1906].

The Report showed local employers to be ignorant of the facilities that existed at the time:

> '... it is very doubtful whether the majority of employer fully realise what is being done, or avail themselves ... of the advantages offered to their employees". [Ibid. p.6]

Later the L.C.C. offered £5 bursaries for use by apprentices in order that they may be able to attend classes in the day time. This was again

offered through technical institute principals who contacted locally-related firms [LCC(1909)p.419].

Of the twenty-seven replies received by the L.C.C., only two indicated a willingness to allow apprentices time off during the day under this scheme. [Ibid.]

The L.C.C. concluded that

> '... at present (the results of the inquiries) do not afford much prospect of the introduction of 'part-time' classes on any scale at all commensurate with the need'. [Ibid. p.422]

Another L.C.C. sub-committee, the Skilled Employment Committee, had instituted a similar inquiry. As a result, limited extension to existing provisions was introduced, an early evening class, starting at 5.15, at Shoreditch Technical Institute. This was the concept of the 'twilight class'. It also met with little success [LCC1909].

The general conclusion reached by the LCC inquiries over the period 1892-1909 was that employer response was of 'the most meagre dimensions'. The employers had again demonstrated negative attitudes to technical education and also confirmed their unwillingness to make concessions regarding a part-time day release pattern. The Council concluded,

> '... there appears no prospect of inducing employers on any large scale to co-operate with us in the establishment of a satisfactory system ...' [Ibid. p.422]

This suggested to the Council that a more authoritarian approach might be needed.

> 'It would seem desirable for Parliament to give the education authority power to compel employers to allow their apprentices and learners 'time off' during the day to attend classes ..." [Ibid. p.423]

This seems to have been the first inclination to consider compulsory powers in local administration of technical education. The possible influence of Sidney Webb, who was Chairman of the LCC Technical Education Committee, the first of its kind, may be detected in this political manoeuvre. He argued, in particular, for local government control over its financing and administration. It was Webb who had earlier suggested that the city Livery Companies should devote some of their accumulated bequests to the cause of technical education in the metropolis [Brennan, E. (1959)].

9.12.0

Summary and Discussion

Although significant for its time, the impetus given to higher education by legislation such as the Royal Commission of 1884 and the 1889 and 1902 Acts, was largely counteracted in practice by other social forces creating priorities which local authorities felt compelled to meet. The LCC had experienced this, as the allocation of funds granted under the new Acts of 1890 and 1901 had shown (my reference above p.298). This issue had caused concern to trades unionists in 1895, and was expressed in a memorial to the Bryce Commission of that year.

The results of early 20th century inquiries such as the A.T.I.'s 1905 survey, Sadler's 1904 and 1907 studies, and the LCC 1906 and 1909 research confirmed the state's grindingly slow response, and the historical prejudice of employers against certain forms of technical education. It is plain that it was not only a question of employer ideology; national and local government political and economic priorities were also evident.

A Board of Education Report for 1908-9 admitted that these kinds of political and economic considerations significantly affected the extension of technical education provision [Board of Education (1908-9) p.68].

The report went on to suggest that one of the duties of managers of technical schools was to establish and maintain the closest possible relations with those under whom their students were employed. Under existing conditions,

> '... great importance attaches to any action taken by employers'. [Ibid. p.85]

Its inquiries in 1907-8, had shown that the increase in the number of students who were attending technical classes particularly during the day, was 'lamentably small' [Ibid. p.89]. The Board recommended an extension of the opportunities for part-time day study. Such an increase would not, it was suggested, be costly. [Ibid. p.86].

It also implied that one of the reasons for the lack of growth of technical institutions was a bias amongst the generality of employers against the so-called 'college-trained' man, and the employers' belief that the technical institute would replace workshop experience gained in the works [Ibid. p.90]. It seems to me that this represented a reassertion of

the commonly-held but mistaken view that employers were conscious of a need, and engaged in systematic training of young workers. The evidence relating to technological developments from the 1850s and the major disputes such as the 1852 and the 1897-8 engineering strike, points to another rationalisation. It was not that employers expressed fear about the decline or transfer of the training function, as the Board was to later imply. On the contrary, the engineers' dispute showed, if anything, that employers were concerned to consolidate their control of the labour process and extend the application of the principles of substitution. That is, they were continually seeking ways to replace skilled workers by unskilled operatives. The origin and development of any scheme of technical education therefore would clearly need to be considered against the background of this overall employer strategy.

The Board of Education, mainly concerned with general educational issues, was anxious to involve employers in technical education, despite clear evidence of their disinclination, over twenty years, to make more than a minimal commitment. The Board did not recognize the nature of the employers' influence over technical education; having no reason to believe it would have been part of an overall strategy to extend the limits of control over the labour process beyond the workshops.

Under the 1889 Act the Board, however, was responsible for sanctioning instruction in technical subjects in addition to administering the Victoria and Albert Museum, the Royal College of Music, and administering the Whitworth Scholarship scheme. It is significant that 'technology' was not defined until 1900, by a committee appointed to examine the function of the Board. In other words, there had been no "modus vivendi" governing technical education in the twenty years following the foundation of the CGLI and the eleven years after the 1889 Technical Instruction Act.

In 1900 'technology' was defined as,

> '... the application of different and specialised kinds of knowledge to practical occupations, including a) arts and manufactures, b) agriculture, c) commerce ... <u>It may be considered as a division of technical education ... superimposed on primary and secondary education ...</u>" [Committee on the Coordination of Technological Education(CCTE) (1900)][My emphasis].

A subsequent Board Report of 1908-9 provided another restatement of the need to relate technology to both the wider educational and industrial systems. This again implied that employers were a crucial mediating

group. But as in the case of the LCC, at a local or metropolitan level, the Board was unable to judge the extent to which employers could resist demands on both levels for more active co-operation. My analysis of the 1897 dispute has pointed to the central issues here; and I reiterate the argument. The combination of a strong belief in the application of new technologies and the knowledge that the principal artisan union had been forcibly defeated in the 1897/8 conflict demonstrated that there was little incentive for employers to accede to a lessening of control of the labour process. There was much to be gained by widening that control into areas concerned with the reproduction of labour power, i.e. schools and institutes concerned with aspects of technical education.

The part-time, evening class pattern became the dominant feature of English technical education from 1879. It goes unremarked in existing accounts of the origin and development of technical education, that throughout the whole of the period from 1879, well into the next century, neither government nor employers modified their basic cautious and calculating attitudes towards technical education. Thus the effect of the 1897/8 conflict was first, to cement in place a particular management and production ideology informed by the principles of the free market that had been maturing since the onset of modern engineering practices, based on substitution, in the 1850s.

Second, I believe the evidence also shows that subsequent legislation left untouched the effects of the strike of 1897-8 and the ratification of the Terms of Settlement in 1907. It confirmed that engineering employers particularly, were primarily concerned, <u>not with future skilled labour requirements, but with current production needs</u>. As Noble, the spokesman for the EEF expressed it in 1906,

> 'In the engineering industry the epoch of change dates from the agreement effected between the Federated Engineering Employers and certain allied trade unions in January 1898 ...' [R.C. on T.D. and T.C. (1906) p.161]

He had substantial evidence to support this claim, reporting that during the 1897 dispute, his company had 10,000 men at work at a time when nearly all the works in Newcastle (Noble was director of the Armstrong works in Newcastle) were closed. His company had introduced at that time hundreds of milling machines (these were the machines I discussed above concerning the need to overcome the problem of rotating work which

required skilled turners). Not one turner or high class machineman was employed on these machines,

> '... as it was not at all necessary" [Ibid. Q.2415. [p.163] (my emphasis) (my discussion above p.306).

Noble's reference here to the question of machine manning focuses upon a form of technical development relating to the skilled/unskilled issue. It was a development that reached back to 1854 when Nasmyth made a similar proposition about current labour requirements rather than projecting future skilled labour needs:

> '... if we took the right means we do not require to depend upon what are reputed to be regularly-bred mechanics in the particular line, or what we call tradesmen'. [Nasmyth, J. (1854) p.108]

By 'right means' he clearly implied right for the employer in terms of depressing costs by employing cheap labour and raising production; he did not imply rights for the worker:

> "The great result of employing proper machines is, that you do not depend on dexterity. All you want is intellect and the faculty of managing machinery. You do not require manual dexterity". [Ibid.]

It was Nasmyth who later referred to the apprenticeship system as the

> "fag-end of the old feudal system". [R.C. on T.U. (1867-8) Q.19201]

Two of the major strikes of the 19th century both involved engineers, in 1852 and 1897. Wider economic considerations, particularly in the latter dispute tended to overshadow what, in this analysis, was equally crucial: the employers' powerful mediating influence in the form and course taken by technical education development after mid-century. Engineer-entrepreneurs such as Nasmyth, Whitworth, Armstrong, Dyer, Noble, had no definitive notion of technical education; but the evidence shows they had a strong influence on the way technical education was perceived by other employers.(I am aware that Whitworth instituted valuable scholarships for artisans in 1868, but these were limited and their original function changed considerably over time).

As I have shown, control of the labour process entailed dominance over new technologies, and extended control of labour power, including its reproduction in the technical education system (Clause 6) Terms of Settlement. The consolidation of corporate employer power, especially in the mechanical engineering industry, was confirmed in 1898. Complete control over practical training and access to technical education outside

industry was vested in the engineering employers (Clauses 5, 6, 7 of the Terms of Settlement.

Technical education, from its beginning under the aegis of the C.G.L.I., always had a central component controlled by employers - the apprenticeship system. Despite allowing the apprenticeship to decline throughout the century, the employers never relinquished control over the practical elements of technical education. Neither the local authorities, the CGLI, nor the Board of Education from 1890, had any jurisdiction over the practical training element of technical education. Thus a crucial factor of technical education remained employer-dominated.

Employers in the engineering industry, in the main a fragmented industry, were, first and foremost concerned with short-term profit-seeking, organising and controlling 'technology in use' in order to satisfy current production needs. It is clear from the evidence that they were not engaged in long-term projections of skilled labour requirements or promoting technical education, to which, at best, they had always been ambivalent. From the 1880s, the individual employer's implementation of technology in use was subsumed under a corporate (EEF) need to render the skilled workers union, the A.S.E., impotent.The Royal Commission of 1884, the Technical Instruction Act of 1889, and the subsequent Acts failed to induce any radical alteration in employer attitudes. As members of a corporate body such as the EEF, many engineering employer realized after 1897/8 that they had increased their power to impose virtually any conditions of work and concomitantly controlled access to education for workers in the industry. The 1897 dispute clearly showed that the radical shifting of power relations in the workshops in favour of the employers, resulting directly from the conflict over machine manning and the issue of labour substitution, rendered it virtually impossible for workers to defend their position regarding technical education. Thus the only proposed alternative concept of technical education, based on a close integration of craft practice and theory, was made redundant.

CHAPTER 10

DISCUSSION AND CONCLUSION

10.0.0. Industrial Conflict and 19th Century Technical and Educational Change

My aim in this study has been to offer an explanation of the origin and development of 19th century technical education, by extending the analysis beyond changes in educational policies and reform. I have attempted to show that, contrary to existing scholarship in this field, the social and technological changes emanating from conflicts within the mechanical engineering industry were a particularly significant influence on technical and educational developments from 1850.

Existing accounts of technical education and technological innovations, set predominantly within a consensualist framework, focus too narrowly on the opinions and advice of concerned 19th century individuals such as Playfair, Huxley, Roscoe, Scott-Russell, and other public figures, usually outside the industry. My critique of such analyses is that within their own terms of reference, they provide adequate accounts, but misdirected by attributing a 19th century 'movement' to an ad hoc structure of technical education perceived as an evolutionary growth out of the general education system.

Central to my own argument has been the idea that analysis of struggles over the reorganization of industrial work and technological innovations offers new insights into the sequence of events which led up to the formation of a national system of technical education.

The model of educational and technical change I proposed encompassed the notion that powerful employers, employing many skilled(and unskilled) workers, exercised an unrecognized influence beyond the immediate concerns of the factory. The nature of that influence was conditioned by the employers' control over much of the lives of young workers for whom technical education was ostensibly being drafted.

I therefore focused attention on the issues of labour control and the conflicts which resulted from work reorganization, changing definitions of skill, and the implementation of new technologies. I sought

a) to relate the conflictual nature of the social and technical relations of production to ideololgies concerned with technical education. b) To demonstrate that the forces underlying the development and implementation of new technologies were also those at work in the demise of the apprenticeship system and the development of technical education.

My main hypothesis was that embedded in many of the employer-employee disputes, over a range of issues associated with changing definitions of skill and the apprenticeship system, were fundamental, but often obscured, ideas about technical education.

The Great Strike and Lock-out of 1897/8 provided a critical case study in which I explored this hypothesis. I believe it has been shown that it embodied crucial elements of technical change which had gathered pace after the earlier major engineering strike of 1852. The Great Strike highlighted in particular the interrelation between issues of machine manning and innovation and questions of transformed power relations, which had ramifications outside the industry, such as the course taken by technical education developments.

Analysis of the 1897/8 conflict also provided an unexplored framework in which to explore the significance for technical education development of the predominance of the prevailing laissez faire economic policy. The outcome of the strike, as an outright consolidation of engineering employer power, confirmed that underpinning the employers' inflexible attitudes to work reorganization and technical education developments was the desire to maximize profits, linked with an unqualified reliance upon 'short-termism'.

Encouraged by the State's singular adherence to the workings of free market forces with respect to economics and technical education, employers, federated employers especially, entered upon a series of strategies for labour control and technology management which inevitably fostered a narrow vision of technical education. I showed that the formation of the City and Guilds of London Institute and educational legislation from the 1880s did little to counteract the baneful effects on technical education of the employers' commitment to profit maximization, despite the apparent irrational demise of the artisan class. Rather than facilitating the development of technical education on a more sympathetic and rational basis than a part-time, evening class structure, it reinforced the employers' unfailing belief in 'short-termism', which

stemmed directly from laissez faire policies. Contradictions emerging from state policies both in economics and education went unrecognized and obscured one of the more direct consequences of the 1897 dispute: the cementing in place of an essentially short-term ideology of production and a corresponding set of attitudes towards technical education which were to last well into the next century.

10.1.0. Problems of Artisan Elitism

Technical education provision, particularly from the 1870s and 1880s, was plainly part of wider social developments including political and ideological issues in addition to those I considered strictly relevant and have examined. The ideology and practices of engineering artisans were especially significant here because of their primary location in the leading manufacturing industry of the 19th century. I drew upon data from their conference resolutions and union proceedings to reveal their attitudes and beliefs about technical education, which I believe were crucially linked to their reaction to the increasing power of the employers over the labour process. In this respect I made the assumption that their views were the only articulated response emanating from the working class to any prevailing notions of technical education

Declarations of artisan elitism, bound up with the skilled workers' concerns regarding technical education and their assumed exclusivity, therefore took on special significance, characterized by such groups as the 'Junta'. This status-seeking class consciousness was not without its problems. An elite group of union representatives of the leading crafts, the 'Junta' did not display hostility to the general notion of profit-seeking, nor did they, to paraphrase Briefs(1937), show expressions of class solidarity or prove a 'gathering point for anti-capitalist, proletarian feelings'(p.209). On the contrary, engineering tradesmen, throughout the period from 1852(the year of the first major engineering strike) through 1897, tried not to distance themselves too far from the employers. Despite many industrial disputes, they maintained an uneasy alignment, as the details of the events leading to the Great Strike and Lockout of 1897 revealed. But as long as it served the artisans' sectional interests it continued. In 1869, for example, they appeared to share common objectives with the employers:

'...if we are to keep pace with our foreign rivals, in the artistic and scientific departments of industry, we must be afforded greater facilities for acquiring a larger amount of artistic and scientific instruction...'(Journal of Society of Arts, 21st May, 1869). [My emphasis].

In pursuing sectional interests by seeking association with employers on some aspects of technical education, the artisans failed to perceive the contradictions in their position vis a vis employers and the unskilled workers in the industry. They underestimated the implications of such an alignment for the implementation of the broader principles of technical education: control of the technologies at the site of production was inseparable from control of both the technical and social relations of production. My main proposition here was that strategies such as the piece-work system and the deployment of new technologies of the 19th century embodied elements of social control: as management-dominated technology superseded artisan-control of production. For the first time in the history of metal-machining, the tool was effectively removed from the artisans' hands and located on a machine capable of producing work of greater accuracy and finish, with a minimum of skill input. By 1868 it was possible for an employer such as Nasmyth to argue:

'The day will come in which steam engines will be made by girls. There is as much skill required in superintending a power loom or a spinning jenny with its thousand spindles, as a steam engine...'(R.C. on T.U. 1867/8,Qs 19190,19194).

The contradictions on the artisans' side clearly took different forms, but were evident in attempts to strengthen their status relative to the labourers, primarily through retention of the apprenticeship; and relative to the employers through the pursuance of the claim that they were historically repositories of skill. Major employers gradually building a more comprehensive federation were determined to eliminate the basis upon which artisans were attempting to justify their negotiating status: access to generalized craft knowledge. Thus a series of conflicts was generated throughout the second half of the century.

The artisans' reluctance to concede advantages to unskilled engineering workers, while reaffirming their status as 'aristocrats' of labour, clearly did nothing to moderate the main employers' authority in and beyond the workplace. The implementation of new classes of machines and modified workshop reorganization presupposed untrained labour: the prospect of manning machines presented the labourers with an incentive

to collaborate more closely with employers rather than maintain their traditional, subordinate roles in artisan-dominated workshops. Cole's(1937) thesis that employers constantly sought to break down skilled-unskilled divisions in the factory is supported by the evidence I have examined.

10.2.0.

Control over Technology and Management of Labour: The Issue of Interchangeability of Parts and Labour.

In the chapters of section one I maintained that one of the crucial characteristics of the skilled 19th century engineering craftsman, in relation to other workers and in terms of the quality of work produced, was accuracy of dimension. Measurement(skilled use of relatively fine instruments) defined engineering craftsmanship as distinct from 'gauging'(simple comparison with pre-made 'templates'. But early in the century the limits on component sizes was quite arbitrary and left much to discretion of the individual workman. In the light of this I focused on the seminal work of Whitworth in metrology. On the question of accuracy in engineering practice he noted,

> 'What exact notion can any man have of such a size as a 'bare sixteenth' or a 'full thirty-second' and what inconvenient results may ensue from the different notions different workmen as to the value of these terms...'(1857:49).

Whitworth was here pointing up the basis of engineering skill: the ability to control measurements. He early recognized the difficulty of using unskilled labour without subtle gradations of fine measurement and standardization:

> 'there was...(without them)...endless trouble, hopeles confusion, and enormous expense...'[my discussion above based on Smiles(1876)]

The use of gauges and templates in place of measuring, based on Whitworth's gauges, and the increasing prevalence of automatic machines transformed the workshops:

> 'All the mechanic has to do now...is to sharpen his tool, place it on the machine in connection with the work, and set it on the self-acting motion..nine-tenths of his time is spent watching the delicate and beautiful functions of the machine...'(Nasmyth R.C. on T.U. 1867/8).

Whitworth's and Nasmyth's insight was to perceive the relation between control over technology and precision measurement as underlying labour control. Technology-management and man-management coalesced; overall dominance being more firmly vested in the employer: that is, control of and in the new technologies. Employer access to alternative methods of reproducing precision work gradually eroded a crucial distinction between the skilled and unskilled in engineering workshops. Factory structure and organization was thus modified by employers intent on the increased employment of 'boy labour' and 'girl labour', as opposed to indentured apprentices.

A significant element of enginering trade training, the acquisition of the vital skills of precision working, was thus effectively removed from the artisan and control passed to the employer. Interchangeability of parts (based on newly established 'standards') entailed interchangeability of labour. It was at this level of traditional controls over workshop procedures that the artisans generated their formal resistance to workshop reorganization. In addition, their case against work reorganization embodied a plea for a form of technical education based on the traditional craft apprenticeship.

10.3.0.

Metal-Machining Innovations: The Significance for Employer Power.

Technical innovations underpinned the employers' systematic sub-division of technical knowledge and craft skills, formerly conceived as part of the repertoire of engineering tradesmen. Technical knowledge became increasingly mystified and was to become available on a 'need-to-know' basis: for example, operators no longer required a knowledge of cutting speeds and feeds, tool characteristics, cutting times, tool angles. Machining data and work schedules became the product of the 'toolroom'.

I considered it inappropriate to examine in detail F.W.Taylor's significant work in the sphere of tool cutting but argued, with reference to these technological developments, that one of the contributions of this American engineer was to bring into contemporary engineering practice the more rigorous studies on metrology similar to Whitworth's. He combined the innovative principles of 'standards' and interchangeability with his own revolutionary metallurgical discoveries, particularly his development of High Speed Steel, from the 1880s. Both he and Whitworth focused on the

paramount employer 'need' to improve labour control, eliminate dependence upon skilled labour, and cut costs.

Existing accounts of technological development, and labour process theories of management control of labour, emphasize the ideological component of Taylor's work, 'scientific management', but underrate the metallurgical innovations, which transformed the machining of metals. The essence of the work of Whitworth and Taylor was to establish the inseparability of the ideology of control, machine tool design and the metallurgical processes of metal cutting.

Consolidation of control over technical knowledge and the labour process by employers was vigorously pursued throughout the century and, as my analysis in chapter eight on the Great Strike of 1897/8 showed, was unambiguously confirmed by the defeat of the Amalgamated Society of Engineers(ASE) in 1898. Ratification of the employers' power came through the ASE-EEF Agreements of 1901 and 1907.

10.3.1.

The Struggle over Power Relations: The Breaking of Union Autonomy

Despite the radicalizing of engineering skills, the conflict of interests and the struggle over power relations continued after the 1907 Agreement; in fact the issues of machine manning and the apprenticeship question were repeatedly in contention from 1898. The crucial redefinition of skill was accompanied by the employers' assertion of the 'right to manage'. They also reasserted pressure to integrate the General Workers' Union, a union of unskilled workers, into employer-union discussions. Continuing to reiterate the Terms of Settlement of 1907, they argued:

> 'In making...appointments the employers shall have regard to the nature of the work to be done on...machine tools, and the degree of ability required from the workman...'(EEF(1927)p.23).

The ASE was forced to expand its craft interests 'downwards' in order to retain control over the lower-grade processes that accompanied the new technologies: a process referred to as skilled workers 'following the machines'. The unskilled workers, encouraged by the employers, increased their demands for machine operating opportunities. They claimed they were

> 'entitled to progress according to their ability...and the opportunities that occur...'(EEF(1927)p.24).

In focusing upon the interaction between expanding forms of technology and the reorganization of work I pointed up a discernible pattern in the employers' labour control strategies and the ideology of production based on widespread use of unskilled labour. It is also clear that employers were not prepared to moderate their highly qualified attitude over access to trade training. At a local level some introduced company-specific training embodying limited skills, usually based on up-graded unskilled labour. This element of work reorganization continued to be a source of conflict between skilled workers and employers.

This provided the context for an examination of my hypothesis that the forces underlying the development and implementation of new technologies were also those at work in the demise of the apprenticeship system and the development of a particular form of technical education.

Central to my thesis therefore have been the conflicts between engineering employers and labour. In chapter 4 I focused on the importance and relevance of labour process theories which have investigated conflicts associated with the nature of changes in the definition and use of skilled labour, the increasing domination of managerial control, and the transformation of work. I referred to the highly significant contribution of Braverman(1974) in the sphere of 'de-skilling' and the general nature of skill decomposition. Data analyzed for this study have showed that it was possible for employers to effectively decompose craft skills through the implementation of new technologies; details which Braverman's work ignored or assumed. My criticism of labour process theories, typified by Braverman, was that they too are constrained by relatively narrow parameters, and, in the main, do not extend analysis beyond the productive process.

Employer-employee conflicts first revolved around practical issues such as machine manning and economic efficiency. They also promoted the growth of an Engineering Employers' Federation (EEF). EEF representation at Inquiries and on Royal Commissions, revealed the ideology of production and, if only tacitly, underlying attitudes to technical education not previously recorded. Prominent among employers were Armstrong-Whitworth, Mather Platt's of Oldham, Atlas Engineering, and Vickers Maxim, whose submissions pointed to the emergence of a philosophy of technical education other than that available in strictly educational sources. It became clear that they perceived the part-time, evening class as the proper venue for technical education.

10.4.0.

Employers, Technology and Early Influences in Technical Education.

The employers' influence in technical education and related issues may be traced back to mid-century, in Inquiries and Commissions from about the 1850s. Whitworth's deliberations on the advantages of standardization and the use of unskilled labour, for example, were revealed as early as 1854 in his submission to the Royal Commission on Small Arms of that year. These and further official sources such as the Royal Commission of 1884, the Technical Instruction Act of 1889, and subsequent research by the ATI(1905), Sadler(1906), the Engineering Institutes, and the CGLI suggested that an account of the struggle for control over the organization of work shed new light on the origin and devlopment of technical education.

From the 1880s especially there was an increasingly close connection between engineering employers' dominance over new technologies, control of the labour process, and the form of technical education that was being developed at the time.

The specific case of the 19th century engineering industry thus puts into sharp relief the ideological position of employers and workers regarding technical education. Engineering employers were consistent in the level of support they were prepared to provide young workers. It was highly qualified and remained marginal to the needs of workers.

It is difficult to extrapolate from evidence relating to a small number of large employers to a generality of employers. There is little evidence, for example, regarding the attitudes and beliefs about technical education of the majority of 19th century engineering employers in what was essentially a small-firm industry. There is also a critical problem in explaining an assumed relation between an abstraction, 'employers', and making judgements concerning local employers of labour engaged in the production process. However it seems reasonable to conclude that, in the main, engineering employers were at best, equivocal about technical education. Often openly hostile to technical education schemes other than those based on the evening class principle they were not concerned with projecting future skilled manpower commitments, but with satisfying current production needs.

I have shown that a pattern of technical education based on the separation of work and education and its location predominantly in evening classes was a critical development clearly subject to employer intervention.

The Association of Technical Institutes' research of 1905, showed that the evening class system suited most employers because it suited their ideology of work and it was cheap: evening classes under the City and Guilds of London Institute were free for young workers, and no production time was lost through workers being released for part-time day classes.

But a Board of Education Report of 1908, substantially supported by Sadler's survey of the same year, unequivocally argued that the prevailing pattern of technical education based on the evening class pattern,

> 'retarded...and disheartened the student before he has obtained even such knowledge as he requires if he is to be an intelligent hand-worker...'(Board of Education(1908/9,p.86).

Nevertheless the pattern of technical education, for all practical purposes, had been set by the collapse of union resistance to work reorganization and skill redefinition, after the strike of 1897/8.

I believe it has been shown that for much of the 19th century the craft apprenticeship mode of training was the only form of technical education; and was perceived as such by the unions. Under the broad heading, The Apprenticeship and Work Organization, I put the case that artisans viewed the apprenticeship as central to any technical education system. In an important sense the transfer of control from artisan-dominated production processes to a model of employer-dominated technology, as part of the reorganization of work, meant that control over technical education was also displaced. This development, and the nature of the power relations within which it transpired has not been explored by existing scholarship on the origin and development of technical education.

This is not to suggest that existing accounts are implausible. Evidence I have examined has indicated, for example, that from mid-century, the artisans' perception of technical education in some respects paralleled the prevailing views of scientists such as Huxley, Lyon Playfair, and Scott-Russell, who were among the leading public figures expressing concern about the development of technical education.

Tradesmen also concurred in the generalized view that technical education made the skilled worker more competent and 'technically efficient'. But the reality of the situation, misconstrued by skilled workers, was that technical education provision was subordinated to the working of the free market, which clearly undermined their case for a retention of the apprenticeship as a basis for technical education. In neglecting the industrial conflicts which constituted the socio-political background to these developments, existing scholarship tends to be one-dimensional.

10.5.0.

The State, Employers, and Labour

My critical case study of the Great Strike and Lockout of 1897/1898 highlighted the protracted conflicts of interest of skilled engineering workers and their employers and the ambiguity of the artisans' position vis a vis the employers and the unskilled workers. The strike proved decisive in the transformation of union power and set firmly in place a set of ideas concerning the apprenticeship system and the issue of technical education.

In the aftermath of the strike employer power was further consolidated. In particular, the link between their desire to control the labour process and the need to increase profit was reaffirmed. I believe my analysis has shown that the pursuit of profit was the overriding imperative for 19th century employers. This was clearly in accord with the prevailing laissez faire economic policies of Victorian Britain. More than its rising industrial competitors an unqualified belief in the workings of the free market characterized most of Britain's economic behaviour.

As with the economy as a whole, the State perceived technical education as subject to the dictates of the free market. The distinguishing characteristic of this policy was that it was essentially short-term. With regard to profit-seeking, at the level of the individual employer, this constituted rational economic behaviour. But the expectation of the state regarding a national policy for technical education was clearly directed at long term projections for skilled labour. Thus the downturn in the supply of skilled labour, responding to short-term profit-seeking, seemed to manifest irrational economic

behaviour. The Terms of Settlement concluding the dispute of 1897/8 regularized this position, for no concessions to long-term training were formulated. Plainly what was rational at the level of the individual employer was to prove irrational at the level of national policy.

10.5.i.

The Legacy of the Great Strike.

I believe my analysis of the Strike has demonstrated that the essentially economic 'short-termism' of employers, actively supported by the State, significantly influenced subsequent legislation on technical education, the effects of which I examined in chapters 9 and 10. My analysis of reports such as those of 1902,1903,1905,1910, and government reports on trade training and education after the First World War showed that the predominant laisez faire policies inherited from the 19th century fostered a neglect of technical education.

The contradictions inherent in British 'short-termism' were ill-understood, partly because the behaviour of employers was, on the one hand perceived as rational, but on the other as irrational because it was incongruent with assumed national policies on technical education. A lack of understanding of these contradictions permeated policies on technical education from this period; and also characterizes consensualist accounts of the development of technical education.

10.5.ii.

The Role of the State Fixed

This finding clearly implies that the developments in the late 19th century were more than a late Victorian phenomenon, and that the critical influence of employers was sustained beyond the period under review in my thesis. But do subsequent events beyond this period serve to validate my research? Did government persist in its free-market policies and continue to perceive technical education on a tripartite model, involving the state, local authorities, and employers?

A brief examination of some of the inquiries relevant to the State, local authorities, and the employers in the first decades of the 20th century serves to illuminate these issues.

The State, from the outset clearly ambivalent about its role in technical education, assumed that the principal beneficiaries of technical education would be employers and young workers. The latter group were, for all practical purposes, powerless with respect to work organization and labour control. The government's assumption was that employers could realistically be expected to assume at least partial responsibility for technical education development and support. Was there any justification for this view?

The Acts of 1902 and 1903 which empowered local authorities to administer technical education in their areas were evidently failing by the end of the First World War. A large number of authorities had no Technical Instruction Committees, and a still larger number had no Advisory Committees composing employers and workmen as laid down in the Acts (Board of Education (1919).

It was also acknowledged at this time that the system of indentured apprenticeships had 'almost died out'. A miniscule number of employers allowed some form of part-time day release for classes, but it was admitted

> 'It cannot be expected that the majority...will do so voluntarily...'(op.cit).

10.6.0.

<u>An Uneasy Alliance: The State, Employers, and Local Authorities.</u>

The reluctance of local authorities to provide for the administration of technical education was attributed by the President of the Board of Education, Fisher, to the influence of employers. He argued there was a

> '...small and feeble response...from the industries which the Education Authorities tried to serve...'(op.cit).

Employers in general, were still said to be ignorant of the provision made in schools and colleges.

> 'The industries know nothing of the technical schools; they know nothing of the use which they might make of these schools; they do not believe in them...'(Board of Education (1919)p.31).

Notwithstanding Fisher's strictures, government's long-held conviction remained: a key factor in the resolution of technical education issues was a positive contribution from the employers, who should formulate and make known their needs, and be prepared to provide partial funding:

> 'It is almost imperative that(industries) should make financial contributions towards the work which is carried on for their benefit by local Education Authorities...'(Ibid.p.2).

This reveals that government had yet to understand the political implications of the anomolies created by economic 'short-termism' and long-term expectations for skilled labour. There appeared to be no recognition of the significance for technical change of power relations in industry or of the ideological position held by employers regarding the organization of work and control of labour which had remained basically unaltered since before 1898.

Through the last decades of the 19th century the employers had consistently demonstrated their unwillingess to support technical education on terms other than their own, and which did not match the prevailing ideology of production. Central to this ideology was the decomposition of craft skills and the widespread use of relatively unskilled labour. The demise of the craft apprenticeship needs to be seen therefore as part of the employers' more generalized and highly circumspect attitude towards institutionalized technical education.

But I believe the evidence has also pointed to another critical dimension in the government's appraisal of leading employers' attitudes to technical education, as revealed in public documents. The well-publicized ineffectiveness of the employers' responses deflected attention from the State's own very cautious attitude to technical education on a national scale. Early in the century, for example, it had rejected the recommendations of a Committee on Technology and Technical Education which reported in 1901. It was proposed to the president of the Board of Education,Lord Devonshire,

> '...technology(a division of technical education) requires for the purposes of administration a somewhat special organization as a division of the Office (Coordination of Technology Committee, 1901).

Regarding the local authorities Fisher criticized the lack of plan or method and the ad hoc development of technical education. Local authorities, he argued were

> 'not well adjusted to the needs of technical education...'(Letter to Board of Trade(1919).

Thus government attributed the relatively poor state of technical education to insufficient support from employers, and the inability of local authorities to provide adequate administrative servicing.

This highlights one of the key elements in my analysis of the events in this period, that of providing a detailed explanation for the evidently disjointed structure of technical education which emerged from the 19th century.

10.6.1

Tripartism in Technical Education: Emmott and Dugald Clerk

The government continued to perceive technical education as structured on a tripartite model: State, Local Authorities, and employers. But up to 1927 there had been no systematic contact between industry, local authorities, and education. The Emmott Report of that year was the first in the history of education to bring together representatives of education authorities, learned societies, and institutions such as the Federation of British Industries(FBI), and the General Federation of Trade Unions. Its significance is further heightened by the fact that it was only the second full inquiry into technical education; the first being the Royal Commission over 40 years earlier in 1884.

As the 1884 Inquiry, Emmott had only semi-official status, having been instigated by the Association of Technical Institutes(ATI), and was not government sponsored. Its main finding was that technical education was 'patchy and disorganized' rather than an organic whole. Given evidence from the various official and unofficial inquiries, and the generally acknowledged effects on apprenticeship and technical education of the Great Strike in 1897/8, it would seem unrealistic that a coherent pattern of develpoment could have been envisaged. One journal noted that the report showed how 'ill-coordinated were the parts of the educational machinery...'(Journal of Education and School World(1928).

This report was quickly followed by an inquiry into engineering education(Clerk Advisory Committee(1928). Under Dugald Clerk, this demonstrated, that systematic organization of works training was comparatively rare in the United Kingdom. Its main conclusion, distorted by underestimating the influence of major employers, was that very large numbers of engineering firms 'have little or no acquaintance with, or influence on, the provision made in technical schools'(p.28) [My emhasis].

Both Emmott and Dugald Clerk therefore confirmed the underlying inadequacies of the prevailing technical education system, without penetrating either the philosophy of education or the ideology of

production which leigitimized them. But a minority report in Dugald Clerk(H.E.Berriman), did allude to the power of the employers:

> '...no material advance is likely to be made in the technical education of the ordinary apprentices in the engineering trades until this subject is a recognized and established part of the Association** sphere of interest, and therefore regarded as coming within the administration of labour...'(Clerk Advisory Committee (1928 p.30).

Responding to a deputation from the Emmott Committee, Lord Eustace Percy, President of the Board of Education, emphasized the need to convert the evening class system, which dominated the part-time pattern of technical education, into part-time day education. But the failure of government to recognize the power of the employers over this issue was again evident. Resolute in its adherence to laissez faire economic behaviour it was not prepared to challenge the employers' position regarding short-term profit-seeking or their intransigence over day-release of young workers. I have shown that the government's ideological position makes logistic sense if the state of the apprenticeship is considered: For example, by 1925, less than 8 per cent of apprentices to the machinist trade were under indentures or written agreements; and over 40 per cent of general engineering firms employed no apprentices at all [HMSO(1928)].

Percy repeated the theme which had run since the 1870s:

> '...it will probably be found that the degree to which part-time education can supplement workshop practice...will depend largely on the willingness of employers to cooperate...in increasing the number and range of part-time classes...'[Board of Education. General Information Memo,No.8 (1928)p.14]

The issue of a part-time day release structure reappeared in the Balfour Report of 1929, which similarly reiterated the case for enlisting the support of employers. It maintained ;

> 'The allowance for time off does not appear to be nearly so widely adopted as one thinks it deserves to be...'[Balfour Report(1929)p.208]

**(The reference to 'Association' here is the Engineering Employers' Association (EEA), a body which assumed the role of the old EEF, and which was later to revert to the Engineering Employers Federation (EEF) later in the century).

Within this context of day-release, Balfour referred to the concept of 'education as a factor in efficiency'. I have analyzed the implications of this conceptualization, with its emphasis on economics and the fear of foreign competition. It featured largely in the ideas of thinkers on technical education, such as Huxley, Lyon Playfair, Scott-Russell; and permeates justifications for present technical education structures in existing accounts on the rise of technical education.

I concluded that the decomposition of craft skills, the basis of technical training, was well advanced even as the first formal technical education structure was being debated by these scientists. In other words the decline of systematic craft training, as the practical component of theoretical studies, had reached the stage in the late 1920s when this aspect referred to by Balfour, was moribund; but still government expectations of the employers persisted.

By the 1930s the pattern eatablished in the 19th century had become stabilized, despite the contradictions relative to local and national interests engendered by a reliance upon the workings of the free market. Successive governments' inability or unwillingness to moderate the employers' dominance and control over access to technical education served to reinforce the structure and consolidate the underlying values of laissez faire doctrines. Subsequent developments, punctuated by the Second World War and the post-war education legislation, produced few innovations and the pattern continued well into the Robbins' era.

10.7.0.

<u>The Contemporary Situation: Dependence on Employers Reasserted</u>

Further evidence of employer intransigence may be found in research from the 1970s. A major study of the education of engineers for the manufacturing industry by the British Association for the Advancement of Science (BAAS)(1977) examined the place of employers in craft training. It concluded that

> 'Good training places are scarce and much of industry does not appear to recognize its role in the development...of the engineer...it has been evident for some time that the traditional providers(of training places)...can no longer be expected to meet...the demand'[BAAS(1977)p.32].

This parallels the evidence given to a Commons Select Committee on Science and Technology, in the previous year. The Select Committee highlighted a basic lack of collaboration between the medium and small companies and technical education institutions:

> 'Companies manufacturing machinery and batch production companies...in general the small to medium size companies...are least receptive to collaboration in any form...'(Select Committee Report(1976).

The report also recognized the recurring problem of funding inherited from 19th century. This was an issue taken up by the Conservative Political Centre(CPC). The CPC set up an inquiry under Professor Thornton in 1977, publishing its report in 1978. One of the main proposals was the creation of an 'integrated education-training programme'(paras 3.5-3.7). But it could not fail to see a critical dependence upon the employers for the success of this kind of structure:

> '...integrated courses will involve close collaboration between educational institutions and engineering organizations...'(para 3.39).

The reluctance of the employers to release staff to attend courses was noted(para 3.12). The recommended solution was novel in that it attempted to moderate the employers' attitudes through proposed tax subsidies as an incentive to support technical education:

> '...the cost...of up-dating courses...together with any associated costs of retraining should be directly allowable for tax purposes...'(Op.cit p.29)

10.7.1.

Education Versus Labour Control

Criticisms of the employers' response to appeals for technical education support continued up to the 1970s. The persistence of these criticisms has had important implications for the way the current EEF perceives its position on technical education and also highlights the regularity with which employers have maintained their guarded attitude to its provision.

The EEF has rationalized the problems of technical education, as articulated since the last century, in terms of its interrelation with the consolidation of employer control over the labour process. The recent Select Committees, the BAAS, and other institutions perceived the problem in terms of inadequacies of training within the industry; the EEF deflected criticism by arguing that the needs of 'industry' were different from those of the 'individual company':

'...the employer is best suited to identify the training needs of...young people...'[EEF (1976) p.23].

My earlier chapters dealing with the Terms of Settlement of the 1897 strike showed the employers then were similarly concerned with 'identifying needs of young workers':

'Employers have the right to select, train and employ whom they consider best adapted to the various operations carried on in their workshops...'[Terms of Settlement(1898), clause 6, my Appendix 2(a)].

A concept of education grounded on employers' 'rights to manage' as a basis for trade training was, in the main, illusory in the 1870s, as it appears to be in the 1970s and 1980s. The 1976 manpower study by the EEF is itself condemnatory in his respect:

'...the fact that many...young people receive little or no training is a matter of serious concern. It warrants attention by both employers and the Engineering Training Board...'(EEF(1976) Appendix D para 9).

But I believe engineering employers still perceive the training issue predominantly in terms of individual companies' 'need' for increasing control of labour, and the use of technology as a means of improving productivity rather than in terms of complementing a policy of technical education for the engineering industry. Hence the employers' rationalization of the problem as 'a conflict of interests':

'...there is an inherent conflict, as yet unresolved, between the interests of the industry as a whole and those of the individual...'(Ibid p.21).

Contemporary engineering employers thus still embody the 19th century notion of the need to control the total labour process. Since 1898 they have institutionalized their control over access to technical education and their hegemonic control over production processes. As in the previous century they emphasize current production needs rather than projecting future skilled manpower requirements.

Current management thinking rests on four assumptions, which maintain a singular familiarity:

'First, the need to give a greater attention to the management of manpower...secondly, the need to improve greatly our use of existing manpower, so as to improve productivity...'(EEF(1976)p.12).

With regard to new recruits a third assumption states, 'there is a particular need to keep the age of recruitment low...'. While the fourth states simply of the need 'to improve the image of the industry' (loc cit).

Many factors concerning the problem of training and the issues of technical education remain partly obscured in current employers' thinking as their counterparts in the previous century. But in the new situation, the tradesmen, no longer considered as threatening, have been substituted by another assumed potential block on total control of the labour process; professional engineering groups.

Two specific EEF papers, Manpower in Industry(1976) and the submission to the Finniston Inquiry of 1980, support my contention here.

10.8.0.

Employers and the Question of Professional Autonomy

The Federation clearly holds a highly circumscribed view of the professional engineering institutions; in effect relegating their function to the provision of a forum for their members.(EEF Submission to Finniston (1979).The academic function of the institutes, according to the employers, is overvalued:

> '...they should reduce or cut out their quasi-academic role and carefully consider offering membership independent of academic qualification... (loc cit).

This strongly resembles the employers' historical perspective on technical education: A system of technical education will be 'tolerated' if it is calculated not to intrude in the production process, i.e. not to interfere with the deployment of men and machines, but to support the demands of current production. I put this proposition, not to suggest an employer conspiracy, but to underline the point that some powerful engineering employers have harboured a long-standing suspicion of groups capable of some kind of autonomy legitimized outside the workplace. Such groups were perceived as inimical to total control in the 19th century in the case of the artisans. The Institution of Mechnical Engineers was founded in 1847, but it never represented a threat to employer control of the labour process for accreditation by the Institution came much later in the century, and the managerial-technical function bifurcation was to become a 20th century phenomenon.

The present situation in relation to 'professional' engineers appears analogous to the artisans' in the 19th century. Just as the ASE, in a sense, conferred skilled status on certain workers, 'artisans', the professional institutes, confer professional status.

Such a system of credentialism contradicts a conception of control held by certain employers:

> 'Membership of one of the professional institutions put little added value on a person...'[EEF Submission(1979)p.4].

The EEF added that there was no case for, 'licensing of engineers to practice their profession...it would not be a practical proposition'(loc cit).

Engineering employers evidently believed the existence of an accrediting, professional body outside the industry, diminished their overall control of the labour process. Institutions anxious to promote the interests of their particular engineering specialisms, were critical of the employers' poor response to appeals for technical training provision.

Professional engineering institutions, the Institute of Electrical Engineers especially, expressed dissatisfaction with the general level of trade training. In 1979 it argued that the failure of the engineering industry to attract recruits was due to:

> 'the poor, and in many cases a total lack of training (in the industry itself)...' (New Scientist,25th Oct.1979 p.283).

For ten years the IEE had advocated a restructuring of education for engineers, and was instrumental in the setting up of the most significant inquiry into education for engineering in recent times, the Finniston Inquiry of 1980.

10.9.0. The Finniston Inquiry

Finniston(1980) held a quite different view of professional engineering institutions, arguing,

> 'We believe that the Institutions are uniquely placed to promote awareness of development in engineering practice and new technology...(and)...the quality of assessment (of comptetence) by the best of them is extremely thorough and rigorous...'(paras 5.39,5.43).

The question of funding and the provision and level of training provided by industry was raised again and regarded as inadequate, contrasting unfavourably with the practice on the Continent, U.S and Japan:

> '...it is generally agreed that the provision of training was inadequate both in quantity and quality...(and)...there were few proposals as to (suggestions for training) were to be financed...'(p.187).

It concluded that industry should be 'responsible' for training(loc cit). Reference was also made to the ill-defined nature of local authority support, and implied that legislative provisions were still relatively unclear,

> 'apart from oblique references to inadequate training grants...' (para 5, p.187).

10.9.1

Continental Practice and British Industrial Culture

Finniston's comparative assessment points up the effect of the critical influence of engineering employers over the labour process in England; and highlights the singular development of industrial managerial practice vis a vis foreign countries. Of the Continental countries it was argued;

> '...working practices were systematized, formalized and written down...the companies concerned placed great importance on these systems...'(Ibid p.40)

It goes on to suggest that this approach to work organization,

> 'may not accord with the British industrial culture which has traditionally emphasized personal freedom'(loc cit)

This statement begs a number of crucial questions concerning the nature of freedom within the industry, and the processes whereby access to technical education and training has been systematically chanelled by employers concerned more with control than education.

The Finniston Report was again critical of the attitude of British employers, expressing particular concern over the nature and degree of links between the various branches of the education system and industry. The lack of interest shown by them in each stage of the education-industry process was noted:

> '...the employers of engineers have been insufficiently involved in each stage, although they are the ones who inherit the product others have produced...')Ibid para 6.5).

I have indicated in this study how I believe it is possible for such a statement to be made sixty years after Fisher, President of the Board of Education, said,

> 'Up to the present time technical instruction has been organized from outside the industries whose full interest and cooperation it has never succeeding in securing...'[Board of Education(1919)p. 1]

10.10.0.

A Pattern for the Future: Lessons Unlearned?

I believe my analysis has demonstrated that the ideology of employers in the engineering industry has had a significant effect on the development of both technology and technical education. Embedded in this ideology is a notion of technology generating a self-sustaining impetus, behind which society trails. The employers' significant influence in perpetuating such an ideology is obscured. Employers in general would view with satisfaction the implied technicism in the conclusion of the Finniston Report:

> 'The industrial society of the future has to adapt not just to the consequences of past changes but also to the enhanced rate of change which new technology and its adoption throughout the world are creating and will continue to create'(Finniston,para 6.29,p.158)(my emphasis).

The current situation appears to confirm Finniston's prediction in terms of the industrial society, implying workers, adapting to technology. In August 1989 the Secretary of State for Employment, Fowler, argued the new technologies, more advanced computers, and robots change the nature of jobs and the demand for skills. Less skilled workers are not needed and the new technology is '...increasing demand...for people with higher level skills...'(Employment Gazette, Aug 1989, p.408)

The reproduction of this skilled labour is to be the responsibility, not solely of government, but the familiar combination of government, education authorities, and employers. Of the latter Fowler, re-stating the established view, said, '(They) should invest in re-training their own employees...'(p.408). In this capacity they are expected to be part of the main agencies for change in technical education and training, the new Training and Enterprise Councils(TECs), 'potentially the biggest revolution in training in our history...'(Ibid)

Throughout the country 90 TECs are envisaged, of which 19 have been approved to date. Clearly the model proposes a highly decentralized structure; serving local areas. It is anticipated that they will coordinate local organizations, becoming 'a focal point for improving the integration of vocational education, training and economic development..'(Ibid p.399).

But it is not clear, even with this latest initiative, how employers are to be persuaded to embark on this development at this stage. It would seem old contradictions remain. On the one hand, the CBI argue in the same journal, 'Britain's workforce is undereducated, undertrained and

underqualified...'('Vocational Education and Training Task Force',Ibid p.402). On the other hand, the Seretary of State maintains, 'it is a far cry from the black days of the collapse of the apprenticeship system at the end of the 1970s to where we are at present. There are over 386 000 young people in training...'(p.408).

Most evidence points to the collapse of the apprenticeship system at the beginning of the century; the Secretary of State's reference appears a gloss on a long-term decline, the origins of which I have examined in this study. In terms of the proportion of workers under training, the figures from the Gazette show that in 1989, the percentage of employees who are apprenticed in mechanical engineering trades is 1.9; other trainees account for 0.7 percent(Ibid, table 1.14, 'Apprentices and Trainees by Industry: Manufacturing Industries')

I believe the most recent evidence reaffirms government's deep-seated ambivalence concerning technical education. Throughout the period under discussion, it has seemed plausible for the State to assume that employers would assist in its funding and organization. It seems to me that further research is needed to deepen understanding of the rationale underlying the State's apparent inability to perceive the implications of the employers' highly circumspect view of technical education. My study has attempted to show that part of such analysis is the need to unravel the complexities involved in basing long-term projections for a national system of technical education while maintaining strict adherence to short-term economic policies.

Government's failure to recognize the interrelationship between new technologies and social and technical developments beyond industry is not examined in existing scholarship on the origin and development of technical education. Much of this work embodies the belief that an explanation of the rise of technical education in 19th century England is principally a question of its contribution to economic efficiency, and its place as part of educational policy and reform. Minimum regard is taken of the ambiguities inherent in economic 'short-termism', so powerful in Victorian Britain.

Focusing primarily on engineering employers I have shown that their transformation of work and critical redefinitions of skill accompanying the implementation of new technologies in the 19th century has not been considered by successive governments as significant beyond the immediate, instrumental impact on industrial production. Since the late

19th century, there has been a failure in accounts of technical education developments to perceive the wider, social and technical implications of transformed technologies. The reorganization of work was not merely a change of hardware and production techniques, but involved a significant modification of the control of labour, and the introduction of a radical ideology of production. The essence of this ideology was the decomposition of skilled labour and the deployment of new technologies premised on widespread use of cheap, unskilled labour schooled in a narrow range of low-level, company-specific skills. The decline of the traditional apprenticeship makes logistic sense against this background. If the traditional apprenticeship represented a form of technical education for much of the 19th century, its decline symbolized for employers the irrelevance of a formal, institutionalized system of technical education.

Radical technological innovations developing from the 1850s had a profound effect on the way technical education was perceived by powerful employers; and the conflicts generated by work reorganization critically influenced the structure and form of technical education from the last decades of the 19th century.

APPENDIX 1

The Mechanical Engineering Industry in the Latter Half of the Nineteenth Century

It has been argued that the combination movement in industrial enterprises in the final quarter of the nineteenth century affected only a small part of the entire range of British industry [Payne C. L. 1967]. One of the largest general engineering employers and a leading EEF spokesman, Sir Benjamin Browne, distinguished the large and small firm, suggesting as a criterion a company's ability to pay compensation: 'If you define the large and small employers as men who can or who cannot pay heavy compensation claims without feeling them, I think you might say that more than two-thirds of the working class work for small employers.' [R.C. on Poor Laws, 1909].

Only two mechanical engineering two companies were represented in the top-fifty-two largest by 1905, Armstrong Whitworth and Vickers Maxim, which were ranked eleventh and sixth respectively [Payne, (1967), pp.527, 539] (18 of the top 52 companies were in brewing and distilling and 10 in textiles - revealing an emphasis on the manufacture of consumer goods and British strength in textile production. (A comparative note suggests a different bias in U.S. manufacturing where 37 companies of the top 52 were engaged in capital or producer goods as distinct from 13 engaged in consumer products).

Figures for the composition of the machine tool industry at this time are not available from any official sources. One study using unofficial sources shows a relatively slow growth in the machine tool industry in the period 1870-1913 in terms of the number of firms actually engaged in machine tool production. Using commercially produced

directories, Kelly's Directory of Merchants, Manufacturers and Trades, published annually from the 1890s, Floud catalogues this slow growth [Floud, R. (1976)]. Between 200 and 350 firms formed the industry in the 1870s and 1880s; between 350 and 450 in the early 1900s, before a decline to around 250 between 1910 and 1913. [Floud (1976) p.32].

In terms of size of the firms, statistics are also fragmentary; different assumptions concerning the constitution of the 'firm' generate different figures. Generally, 19th century machine tool building was highly specialised and labour-intensive. Workforce size in individual companies in the leading machine tool companies appear from one authority's analysis, to be atypical for the mechanical engineering industry as a whole. [Saul, S.B. (1967) p.156].It was not uncommon for larger engineering companies to make their own machine tools. Sometimes these were also made to order for other engineering concerns.

Between 1842 and 1910 the average company workforce engaged in machine tool construction in the U.K. was in the region of 650 persons. There were nineteen principal companies engaged in this line of work (see appendix 1(a) attached), of which eleven had 500 or less workers; and two with more than 1500 employees (Greenwood and Batley, and Herbert of Coventry [Saul (1967) p.14]. Another comparative figure might be informative here. The American situation in the early 1900s points to a different structure, toward economies of scale. The Allis Chambers Company of Chicago employed 12,000 men in engineering in 1903. This figure was quoted by Barnes, the A.S.E. secretary who visited this plant as a member of an Industrial Commission in October-December 1902. (He referred in this context to the Armour School of Technology in Chicago which at the time had 1000 students in the School engaged in engineering). [Mosely Commission (1903) p.58] The Westinghouse Company in

Pittsburgh had a permanent workforce of 6000 men; and the American Locomotive Company at Schenectady covered 62 acres and produced 35 locomotives a week, with a workforce of 10,000. [Mosely Commission (1903) p.14]

A modern survey shows the predominance of the small engineering company in the sphere of general mechanical engineering in England, which would include machine tool building. Of over 4000 companies, 3526 employed fewer than 25 persons; 44 employed between 400 and 999 persons; and 12 firms employed between 1000 and 1999 persons. There were 13 companies employing more than 2000 persons by the 1960s. [Digest of Statistical Information (1971) p.47].

The most recent survey in this particular field shows that the 19th century trend of the small engineering firm has been maintained. The Engineering Training Board (EITB), the coordinating body of technical training schemes in the engineering industry since 1964, covered 24,600 establishments. In 1981 it was reported that of these, 48.7 per cent employed less than 25 workers; only 2 per cent of firms had more than 1000 employees; but over 40 per cent of the labour force worked in this 2 per cent of companies (Coombe Lodge Report, (1981), 13, 14.

APPENDIX 1(a)

Principal Specialist Machine Tool Makers in Britain 1840-1914

Date	Name	Location except when shown	Employment 1913
1842	Buckton	Leeds	400
1842	Muir	Manchester	400 in 1894
1852	Hulme	Manchester	300 in 1888
1853	Craven	Manchester	1000
1856	Greenwood & Batley		Leeds 2000 in 1903
1857	Kendall & Gent		Manchester 400
1859	Smith & Coventry		Manchester 500 in 1894
1864	Cunliffe & Groom		Manchester 200 in 1892
1865	Asquith	Halifax	200
1865	Dean, Smith & Grace		Keighley 400
1866	Stirk	Halifax than 500, 1930s level	N/K, but certainly less
1868	Butler	Halifax	350
1868	Archdale		Birmingham 600
1874	Lang	Johnstone	700
1880	Richards		Manchester 500
1884	Parkinson		Bradford 550
1887	Holroyd	Rochdale	250
1889	Herbert	Coventry	1600
1890	Ward	Birmingham	650

Source: S. B. Saul (1967) p.156.

APPENDIX 2

Terms of Settlement 1898

GENERAL PRINCIPLE OF FREEDOM TO EMPLOYERS IN THE MANAGEMENT OF THEIR WORKS

The Federated Employers, while disavowing any intention of interfering with the proper functions of Trade Unions, will admit no interference with the management of their business, and reserve to themselves the right to introduce into any federated workshop, at the option of the employer concerned, any condition of labour under which any members of the Trade Unions here represented were working at the commencement of the dispute in any of the workshops of the Federated Employers; but, in the event of any Trade Union desiring to raise any question arising therefrom, a meeting can be arranged by application to the Secretary of the Employers' Local Association to discuss the matter.

Nothing in the foregoing shall be construed as applying to the normal hours of work, or to general rises and falls of wages, or to rates of remuneration.

NOTE. - No new condition of labour is introduced or covered by this clause. It simply provides for equality of treatment between the Unions and the Federation by reserving for all the members of all the Trade Unions, as well as for all the Federated Employers, the same liberty which many Trade Unionists and many employers have always had.

Special provision is made in the clause and in the subsequent 'Provisions for avoiding future Disputes,' to secure to workmen, or their representatives, the right of bringing forward for discussion any grievances or supposed grievance.

1. Freedom of Employment. - Every workman shall be free to belong to a Trade Union or not as he may think fit.

Every employer shall be free to employ any man, whether he belong or not to a Trade Union.

Every workman who elects to work in a Federated workshop shall work peaceably and harmoniously with all fellow employees, whether he or they belong to a Trade Union or not. He shall also be free to leave such employment, but no collective action shall be taken until the matter has been dealt with under the provisions for avoiding disputes.

The Federation do not advise their members to object to Union workmen or give preference to non-union workmen.

NOTE. - The right of a man to join a Trade Union if he pleases involves the right of a man to abstain from joining a Trade Union if he pleases. This clause merely protects both rights. The Federation sincerely hope that a better understanding will prevent any question of preference arising in the future, and advise the members not to object to Union workmen.

2. Piecework. - The right to work piecework at present exercised by many of the Federated Employers shall be extended to all members of the Federation and to all their Union workmen.

The prices to be paid for piecework shall be fixed by mutual arrangement between the employer and the workman or workmen who perform the work.

The Federation will not countenance any piecework conditions which will not allow a workman of average efficiency to earn at least the wage at which he is rated.[1]

The Federation recommend that all wages and balances shall be paid through the office.

NOTE. - These are just the conditions that have been for long in force in various shops. Individual workmen are much benefited by piecework.

A mutual arrangement as to piecework rates between employer and workman in no way interferes with the functions of the Unions in arranging with their own members the rates and conditions under which they shall work.

3. Overtime. - When overtime is necessary the Federated employers recommend the following as a basis and guide:-

That no man shall be required to work more than 40 hours overtime in any four weeks after full shop hours have been worked, allowance being made for time lost through sickness or absence with leave.

In the following cases overtime is not to be restricted, viz:-

Breakdowns in plant.

General repairs, including ships.

Repairs or replace work, whether for the employer or his customers.

Trial trips.

[1] In reply to an inquiry as to the interpretation of this paragraph the employers' secretaries on 21st January, 1898, wrote to the general secretary of the ASE stating that the general note (appended to the explanations) which disclaims any intention of reducing the wages of skilled men 'applies both to time wages, and to piece-work earnings - in the latter case there is no intention of interfering with the usual practice of making extra payment for extra effort.'

It is mutually agreed that in cases of urgency and emergency restrictions shall not apply.

This basis is to apply only to members of the Trade Unions who are represented at this Conference.

All other existing restrictions as regards overtime are to be removed.

It is understood that if mutually satisfactory to the Local Association of Employers and the workmen concerned, existing practices regarding overtime may be continued.

NOTE. - These overtime conditions are precisely the conditions now in operation in various places, though in many Federated workshops no limitation whatever exists at the present time. In many cases this will be the first attempt to regulate or prevent excess of overtime.

4. Rating of Workmen. - Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the Unions or any other body of workmen in their collective capacity arranging amongst themselves rates of wages at which they will accept work, but while admitting this position they decline to enforce a rule of any Society or an agreement between any Society and its members.

The Unions will not interfere in any way with the wages of workmen outside their own Unions.

General alterations in the rate of wages in any district or districts will be negotiated between the Employers' Local Association and the local representatives of the Trade Unions or other bodies of workmen concerned.

NOTE. - Collective bargaining between the Unions and the Employers' Associations is here made the subject of distinct agreement.

The other classes simply mean that as regards the wages to be paid there shall be (1) Freedom to the employer; (2) Freedom to the Union workmen both individually and in their collective capacity - that is to say, collective bargaining in its true sense is fully preserved; and (3) Freedom to non-unionists.

These conditions are precisely those in operation at present on the North-East Coast, the Clyde, and elsewhere, where for years past alterations of wages have been amicably arranged at joint meetings of employers and representatives of the Trade Unions.

5. Apprentices. - There shall be no limitation of the number of apprentices.

NOTE. - This merely puts on record the existing practice and is to prevent a repetition of misunderstandings which have arisen in some cases.

6. Selection, Training, and Employment of Operatives. - Employers are responsible for the work turned out by their machine tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen

NOTE. - There is no desire on the part of the Federation to create a specially favoured class of workmen.

PROVISIONS FOR AVOIDING DISPUTES

With a view to avoid disputes in future, deputations of workmen will be received by their employers, by appointment, for mutual discussion of questions, in the settlement of which both parties are directly concerned. In case of disagreement, the local Associations of Employers will negotiate with the local officials of the Trade Unions.

In the event of any Trade Union desiring to raise any question with an Employers' Association, a meeting can be arranged by applicaiton to the Secretary of the Employers' Local Association to discuss the question.

Failing settlement by the Local Association and the Trade Union of any question brought before them, the matter shall be forthwith referred to the Executive Board of the Federation and the central authority of the Trade Union; and pending the question being dealt with, there shall be no stoppage of work, either of a partial or a general character, but work shall proceed under the current conditions.

NOTE. - A grievance may be brought forward for discussion either by the workman individually concerned, or by him and his fellow workmen, or by the representatives of the Union.

In no instance do the Federated Employers propose conditions which are not at present being worked under by large numbers of the members of the Allied Trade Unions.

The Federated Employers do not want to introduce any new or untried conditions of work, and they have no intention of reducing the rates of wages of skilled men.

These conditions, with relative notes, are to be read and construed together.

It is agreed that there shall be a resumption of work simultaneously in all the workshops of the Federated Employers on Monday morning, 31st January, 1898.

Parties mutually agree that the foregoing shall be the terms of settlement.

Source: WIGHAM, E. (1973) The Power to Manage, London, Appendix D, pp. 285-289.

APPENDIX 2(a)

AGREEMENT

Made this 29th day of November, 1901

between

THE ENGINEERING EMPLOYERS' FEDERATION

(hereinafter called the "Federation") of the one part

AND THE

AMALGAMATED SOCIETY OF ENGINEERS, the STEAM ENGINE MAKERS' SOCIETY,

and the UNITED MACHINE WORKERS' ASSOCIATION

(hereinafter called the "Trade Unions") of the other part.

General Principles of the Freedom of Management

It is agreed as follows:-

Employers shall not interfere with the proper functions of the Trade Unions, and the Trade Unions shall not interfere with the Management Employers in the management of their business.

Employers shall have the right to introduce into any Federated Workshop, at the opinion of the Employer concerned, any condition of labour under which members of the Trade Unions were working prior to the date of this Agreement in any of the workshops of the Federated Employers, and the Trade Unions shall have the right to bring forward for discussion any question arising therefrom, as hereinafter provided for.

Nothing in the foregoing shall be construed as applying to the normal hours of work, or to general rises and falls of wages, or to rates of remuneration.

Freedom of Employment

Every workman may belong to a Trade Union or not as he may think fit. Every employer may employ any man, whether he belong or not to a Trade Union.

With the desire to secure peaceable and harmonious working in Federated Workshops, the Trade Unions will not permit on the part of their members any interference with non-union workmen , nor countenance any objection to working with them. The Federation will not permit of difference of treatment between union and non-union workmen in the ocurse of their work, and will not countenance their members objecting to employ union workmen.

Piecework

Employers and their workmen have the right to work piecework.The prices to be paid for piecework shall be fixed by mutual arrangement between the employer and the workman or workmen who perform the work, and the employers guarantee that they shall be such as will allow a workman of average efficiency to earn at least his time rate of wages, with increased earnings for increased production due to additional exertion on his part.

The Federation will discountenance any arrangement or re-arrangement of prices which will not allow a workman to obtain increased earnings in respect of increased production due to such additional exertion, and the Trade Unions will discountenance any restriction of output.

The Federation agree to recommend that all wages and balances should be paid through the office.

The mutual arrangement as to piecework rates between Employer and workman in no way interferes with the Trade Unions arranging with their own members the rates and conditions under which they shall work.

Overtime

The Federation agree to recommend that, when overtime is necessary, no union workman should be called upon to work more than 40 hours overtime in any four weeks after full shop hours have been worked, allowance being made for time lost through sickness or absence with leave.

In the following cases overtime is not to be restricted, viz:-

Breakdowns in plant.

General repairs, including ships.

Repairs, or replace work, whether for the Employer or his customers.

Trial trips.

In cases of urgency and emergency, restrictions shall not apply, but the Federation will recommend its members to avoid excessive overtime.

Rating Workmen

Employers shall have the right to employ workmen at rates of wages mutually satisfactory to the Employer, and the workman or workmen concerned.

The Trade Unions shall have the right to arrange with their members the rates at which they will accept work, but shall not interfere with the wages of other workmen.

General alterations in the rates of wages shall be negotiated between the respective Employers' Associations and the local representatives of the Trade Unions.

ApprenticesThere shall be no limitation of the number of apprentices.

Manning of Machine Tools

Employers shall have full discretion to appoint the men they consider suitable to work all their machine tools, and determine the conditions under which they shall be worked.

Selection, Training and Employment of Operatives

Employers shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen.

Displacement of Labour

The Federation recommend their members that when they are carrying out changes in their workshops which will result in displacement of labour, consideration should be given to the case of the workmen who may be displaced, with a view, if possible, of retaining their services on the work affected or finding other employment for them.

Provisions for Avoiding Disputes

With a view to avoid disputes, deputations of workmen shall be received by their employers, by appointment, for mutual discussion of questions in the settlement of which both parties are directly concerned.

In case of disagreement it shall be competent for either party to refer the question to a conference to be held between the Local Association of Employers and the Local Representatives of the Trade Unions.

In the event of either party desiring to raise any question, a Local conference for this purpose may be arranged by application to the Secretary of the Employers' Association, or of the Trade Union concerned, as the case may be. Local Conference shall be held within twelve working

days from the receipt of the application by the Secretary of the Employers' Association or of the Trade Union or Trade Unions concerned.

At Local Conference, Members of the Executive Board of the Federation and Members of the Central Authority of the Trade Union or Trade Unions may be present, in addition to the local representatives.

Failing settlement at a Local Conference of any question brought before it, it shall be competent for either party to refer the matter to the Executive Board of the Federation and the Central Authority of the Trade Union or Trade Unions concerned.

Central Conference - which shall be composed of Members of the Executive Board of the Federation and Members of the Central Authority of the Trade Union or Trade Unions concerned - shall be held within twelve working days from the receipt of the application by Secretary of the Employers' Association or of the Trade Union or Trade Unions concerned.

Until the question has been discussed in Local and Central Conference, there shall be no stoppage of work, either of a partial or of a general character, but work shall proceed under the current conditions.

Provisionally accepted.

R. SINCLAIR SCOTT, E.E.F.

Chairman.

A. W. GOLIGHTLY,
(A.S.E.)
Vice-Chairman

GEO. N. BARNES
JAMES SWIFT S.E.M.
MATTHEW ARRANDALE

SOURCE: Engineering Employers Federation, Minute Book, No. 2, 1899-1904.

APPENDIX 2(b)

AGREEMENT

made this Twenty-second day of March, 1907.

between

THE ENGINEERING EMPLOYERS' FEDERATION (hereinafter called "The Federation") of the one part,

and

THE AMALGAMATED SOCIETY OF ENGINEERS, THE STEAM ENGINE MAKERS' SOCIETY, AND THE UNITED MACHINE WORKERS' ASSOCIATION (hereinafter called "The Trade Unions") on the other part

---

The Representatives of the Engineering Employers' Federation on the one hand and of the Engineering Trade Unions on the other being met in joint Conference, and being convinced that the interests of each will be best served and the rights of each best maintained by a mutual agreement, hereby decide to adopt Measures to avoid friction and stoppage of work.

IT IS THEREFORE AGREED as follows:-

General Principles of Employment

1. The Federated Employers shall not interfere with the proper functions of the Trade Unions and the Trade Unions shall not interfere interfere with the Employers in the management of their business.

2. Employment of Workmen

Every Employer may belong to the Federation and every workman may belong to a Trade Union or not as either of them may think fit.

Every Employer may employ any man, and every workman may take employment with any employer the workman or the Employer belong or not to a Trade Union or to the Federation respectively.

The Trade Unions recommend all their Members not to object to work with Non-Union workmen, and the Federation recommend all their Members not to object to employ Union workmen on the ground that they are Members of a Trade Union.

No workman shall be required as a condition of employment to make a declaration as to whether he belongs to a Trade Union or not.

3 Piecework

Employers and their workmen are entitled to work piecework, provided:-

(a) The prices to be paid shall be fixed by mutual arrangement, between the employer and the workman or workmen who perform the work.

(b) Each workman's day rate to be guaranteed irrespectively of his Piecework earnings.

(c) Overtime and Nighshift allowances to be paid in addition to piecework prices on the same conditions as already prevail in each workshop for time work. All balances and wages to be paid through the office.

4 Overtime

The Federation and the Trade Unions are agreed that systematic overtime is to be deprecated as a method of production and that when overtime is necessary the following is mutually recommended as a basis, viz:-

That no Unions workmen shall be required to work more than 32 hours overtime in any four weeks after full shop hours have been worked: allowance being made for time lost through sickness, absence with leave, or enforced idleness.

In the following cases overtime is not to be restricted:-

Breakdown work, repairs, replacements or alterations for the Employers or their customers.

Trial trips and repairs to ships.

Urgency and emergency.

5 Rating of Skilled Workmen

Employers have the right to employ workmen at rates of wages mutually satisfactory to the employer and the workman or workmen concerned.

In fixing the rates of skilled workmen, the employer shall have regard to the rates prevailing in the District for fully trained and skilled men.

Unions, while disclaiming any right to interfere with the wages of workmen other than their own Members have the right in their collective capacity to arrange the rate of wages at which their Members may accept work.

General alterations in the rates of wages in any district shall be negotiated between the Employers' Local Association and the local representatives of the Trade Union or Unions concerned.

6 Apprentices

There shall be no recognised proportion of apprentices to journeymen, but it shall be open to the Unions to bring forward for discussion the proportion of apprentices generally employed in the whole Federated area.

An apprentice shall be afforded facilities for acquiring a practical knowledge of the branch of trade he adopts, and shall be encouraged to obtain a theoretical knowledge thereof as far as circumstances permit.

7. Selection,Training and Employment of Operatives and Manning of Machine Tools

Employers have the right to select, train and employ those whom they consider best adapted to the various operations carried on in their workshops and to pay them according to their ability as workmen.

Employers in view of the necessity of obtaining the most economical production whether by skilled or unskilled workmen, have full discretion to appoint the men they consider suitable to work all their machine tools and to determine the conditions under which they shall be worked.

The Federation recommend their Members that, when they are carrying out changes in their workshops which will result in displacement of labour, consideration should be given to the case of the workmen who may be displaced, with a view, if possible, of retaining their services on the work affected or finding other employment for them.

8. Provisions for Avoiding Disputes

With a view to avoid disputes, deputations of workmen shall be received by their employers, by appointment, for mutual discussion, of any question in the settlement of which both parties are direclty concerned: or it shall be competent for an official of the Trade Union to approach the Local Secretary of the Employers' Association with regard to any such question: or it shall be competent for either party to bring the question before a Local Conference to be held between the Local Association of Employers and the Local Representatives of the Trade Unions.

In the event of either party desiring to raise any question a Local Conference for this purpose may be arranged by application to the Secretary of the Employers' Assocation or of the Trade Union concernod as the case may be.

Local Conference shall be held within twelve working days from the receipt of the application by the Secretary of the Employers' Association or of the Trade Union or Trade Unions concerned.

Failing settlement at a Local Conference of any question brought before it, it shall be competent for either party to refer the latter to the Executive Board of the Federation and the Central Authority of the Trade Union or Trade Unions concerned.

Central Conferences shall be held at the earliest date which can be conveniently arranged by the Secretaries of the Federation and of the Trade Union or Trade Unions concerned.

There shall be no stoppage of work, either of a partial or of a general character, but work shall proceed under the current conditions until the procedure provided for above has been carried through.

9. Constitution of Conferences

An Organising Delegate of the Amalgamated Society of Engineers shall be recognised as a Local Official entitled to take part in any Local Conference, but only in his own division. In case of sickness, his place shall be taken by a Substitute appointed by the Executive Council.

Any Member of the Executive Council or the General Secretary of the Amalgamated Society of Engineers may attend Local Conference, provided that the Member of the Executive Council shall attend only such Conferences as are held within the division represented by him.

A Member of the Executive Council or the General Secretary of the Steam Engine Makers' Society and of the United Machine Workers' Association respectively may attend any Local Conference in which the Societies or either of them are directly concerned.

Central Conferences shall be composed of Members of the Executive Board of the Federation and Members of the Central Authority of the Trade Union or Trade Unions concerned.

An Employer who refuses to employ Trade Unionists will not be eligible to sit in Conference.

Signed on behalf of:-

The Engineering Employers'Federation:-

"A. P. HENDERSON", Chairman

"ALLAN M. SMITH, for Secretary.

The Amalgamated Society of Engineers

"DAVID GARDNER", Chairman.

"GEORGE N. BARNES", Secretary.

The Steam Engine Makers' Society:-

"HENRY DAVIES", Chairman

"WM. F. DAWTRY", Secretary.

The United Machine Workers' Association:-

"WILLIAM KEMBLE", Chairman.

"MATTHEW ARRANDALE", Secretary.

SOURCE: Engineering Employers' Federation, Minute Book, No. 3, 1907.

APPENDIX 3

Machine Tool Classification

Machine Tools may be classified according to the nature of the cutting action imparted to the work by the cutting tool of the machine. One 19th century authority simplified the classification and reduced the various cutting actions to shearing; paring; scraping. [Rankine, W. J. McQ., (1878); Spon's Dictionary of Engineering (1874)] The first designation implied a basic guillotine action, the second was based on the principle of a wedge, and the third, literally the removal of excess material by a process of scraping by hand. A more elaborated classification from America introduced a five-fold typology in which machines for shaping and fitting metal were said to act by: (a) compressing (b) shearing (c) paring (d) milling (e) abrading or grinding. [Hutton, F. R. (1883)]

Those tools which act by paring (c), were the most common in the workshops and more relevant to this study, and may be divided into two classes. The first includes those in which the relative motion of the tool and work is circular or spiral. These can produce surfaces of revolution such as cylinders, and include lathes, drills, and boring machines. Lathes have a wide number of variations but a broad distinction may be drawn between the plain centre-lathe, a machine tool designed for the 'one-off' job capable of use with a wide range of fixtures and attachments; and semi- or fully automatic special lathes. The principal variants in semi-automatic lathes were Capstan and Turret lathes, which may be regarded as modified centre lathes embodying permanent fixtures suitable for batch and mass production work. (A modern standard classification of machine tool type categorizes 120 lathe types including 10 kinds of turret lathe; 55 kinds of centre lathe; 10 toolroom lathes; 26 multi-tool and production lathes; 16 camshaft lathes; 13 specialist

machines (relieving, wheel turning, profiling, gun boring); 25 screwing machines; plus 18 types of automatics ranging from 'Swiss types up to 5mm. capacity; and 8 different capstan or ram type machines. [Ministry of Supply (1950)]

The second group of machines which cut by paring includes those in which the relative motion of the tool and work is rectilinear. These will produce plain surfaces through the use of planers, shapers, and slotters; and also 'curved surfaces '. [Hutton (1883) p.75]

Milling machines (d), may be described as a class of machine tools in which metal was removed by causing the work to be moved against a revolving cutting tool, called a milling cutter which could be mounted horizontally or vertically, and which had several cutting edges. 'The typical feature of the milling operation is the fact that the rotating tool (the milling cutter) has a number of cutting edges each of which works over only part of its rotary path and travels over the remainder without cutting.' [Koenisberger, F. (1962) p.116] The first English application of the milling machine as a production tool, which tended to rival the longer-established shaping machine which worked in the horizontal plane, was at the re-modelled Enfield Armoury in the late 1850s. One hundred of these early machines were ordered from an American Company, Robbins and Lawrence of Vernon, to increase the production of gun locks at Enfield. [Hollingum (1976) p.190] The first 'universal' (or modern-type) milling machine was produced by the American Company, Brown and Sharpe, in 1862. It did not figure as a standard production, or specialist tool, in England until some time later, and was not listed in the tool catalogues in the 1860s. The leading engineering journal, The Engineer, did not publish a detailed description of the milling machine until 1884. [Hollingum (1976) p.192].

The grinding machine (e), comprises a wheel head or 'abrasive' wheel, and revolving wheel spindle on which the grinding wheel is mounted and either a work head and revolving work spindle, or a reciprocating or revolving work table. The wheel and its spindle revolve independently of the work, and the wheel head may be controlled by a traverse feed, an infeed, or both. These machines could be used for grinding internally and externally; round section material or flat. Until the appearance of Brown and Sharpe's first commercial grinding machine in 1864, the technique was used entirely for correcting or 'truing up' steel parts which had been distorted by the hardening process, although an article appeared in The Engineer of 25th April 1856 showing a machine for grinding or polishing circular saw plates. [Hollingum (1976) p.193] These parts used for example on the sewing machine, the bicycle (both new mass-produced high consumption articles) and other devices requiring hardened steel parts of high precision were machined 'slightly over-size, hardened, and then ground to final size and finish with very light cuts taken on the simple grinding machine used in the period.' [Woodbury, R. S. (1967) p.631].

However, Brown and Sharp developed the grinding machine into a more general purpose tool more compatible with an expanding technology form, i.e. one designed to increase production and depress costs. The changed conception involved a departure from the grinding machine used for correcting operations on hardened components to an integrated production process based on the 'roughing' lathe (A technique developed and advanced by F. W. Taylor in his cutting tool research during the same and subsequent period). The logic of rationalised integrated production techniques characterised by Brown & Sharpes' tool developments also demonstrated the interrrelation between machine tool developments and

significant findings in cutting tool research, such as those at the Bethlehem Steel Works and elsewhere under F. W. Taylor.

> '... the demand for an increased accuracy in machine construction in general ... call(s) for machines which are better adapted to produce uniform surfaces and accurate work than the lathe and the planer of the past ... The only successful field which seems open to us .. is to use the lathe as a roughing tool, or machine to bring the work approximately to the desired size, then to finish by grinding with every wheels on a suitably designed machine ... (and) in duplicating parts of small machinery on the interchangeable system, such as sewing machine shafts, needle bars etc. they are unexcelled.' [Brown & Sharpe (1891), p.9]

APPENDIX 4
Screw Thread Production

The William Sellers Company of Philadelphia conducted research on the technical difficulties associated with screw thread production and by the late 1850s had developed a screwing machine in which 'The screw thread (was) cut in a single operation and the finished bolt was released by the withdrawal of the dies, the machine being driven continuously in one direction without reversing or stopping'. [Stewart, C. P. (1861), p.231] An original factor in this development was that it embodied a semi-automatic principle in a complex machine tool operation, and, significantly for management enabled machine screw cutting to be accomplished at speed, without the necessity of employing highly skilled labour.

> 'This ... machine has the advantage of rapidity of action, producing a perfect thread in one running up ... in the ordinary screwing machines the screw had to be run up three times to make a good thread, which with three times of with-drawing made six times altogether for a screw to pass through the machine; in addition the time of stopping and reversing the ordinary machines was entirely saved in the new one, the machine running constantly in the same direction.' [Stewart (1861), p.235]

The Sellers Company also advocated the adoption of a standardised screw thread system for the United States, and eventually the American ('Sellers') threads incorporating a form angle of 60°),became standard practice. [Anderson, J. (1867), p.372] [the English system developed by Whitworth was 55°].

Machines approximating to American Specifications were in use in the U.K. at least by 1858. One machine was producing nearly 1,000 bolts per day, ¾" diameter with 1¾ inches of thread as against, 500 per day of 10½ hours, ¾" dia., with 1¼ inches of thread when cut by 'hand' machine i.e. by the conventional method. [Stewart (1861), p.235] This level of production had nearly trebled by 1884 through the development of solid, collapsible dies (i.e. the thread-cutting element - the dies - collapsed

or sprung open releasing the work at the end of the cut); and further refinements, such as chip clearance (removing surplus metal from the component after being machined) and stock releasing through automatic 'jaws'. [Sellers (1884), p.6]

The standard machine tool in use before the Sellers' research was a bolt screwing machine capable of, more or less, continuous production 'arranged so that the machine need not be stopped to fix and loosen nuts ...' [Buchanan, G. (1864)] A more sophisticated English machine was a self-acting stud (a 'headless bolt' threaded both ends) and screwing machine incorporating a semi-automatic principle, a capstan rest to carry six tools instead of the normal slide rest. [Whitworth Catalogue (1882) p.2][The Capstan was a hexagonal 'head' mounted on a short slide on the lathe capable of carrying a variety of cutting and grinding tools on each of the six faces which could be automatically brought in to cutting position by the rotation of a wheel mounted on the front of the machine].

American developments in screw cutting generated machines capable of producing bolts of the above dimensions at the rate of nearly 3,000 per 10 hour day, with 2 inches of thread, using unskilled labour [Sellers (1884) p.6]; a process that was further developed. For example, tests carried out by the Niles Tool Works indicated that work requiring 30 hours on conventional lathe screw cutting could be accomplished in 6½ hours on a specialised screw machine. 'It is enough to say that <u>one screw machine will do work which would require three or four small lathes</u>, and that the work is <u>uniform in excellence</u> ... these machines are <u>run by unskilled men</u>, the care and setting of the tools, of course, being confined to a skilled man.' [Niles Tools (1891) pp.41, 55].[My emphasis].

APPENDIX 5

Basic Machine Tool Designs in Use in the Nineteenth Century

One of the primary and most versatile machines of the period was the boring mill or vertical lathe; these machines were normally distinguished by the rotation of the work and the tool. They represented one of the range of tools developed for what might be described as an increasingly complex configuration of engineering tasks.

> 'A lathe would be a tool when the work revolved while the tool has only linear motions, while a boring machine would be one in which the work was stationary and a cutting tool described the surface of revolution.' [Hutton, F. R. (1883) p.73]

The vertical lathe or boring mill was, in fact, a lathe, and an outstanding high production machine as far as management was concerned; it was capable of taking large diameter work located in the horizontal plane; and relatively high cutting speed were attainable. By the 1900s locomotive tyres, 42 inches diameter could be turned on such a machine at the rate of 25 pairs in less than 8 hours. A detailed breakdown of this specific production process illustrates the revolutionary nature of machine tool technology in the period spanning the centuries. A leading American machine tool company, the Niles-Bement-Pond Co. recorded that 25 pairs of 3'6" diameter wheels were machined in 7 hrs. 54 mins. with one operator and one helper; the average time for turning was 19 mins. The operations were divided as follows)

Average time putting wheels on lathe		2 mins. 53 secs.
" "	roughing (i.e. taking rough, heavy cuts where finish is not critical)	9 mins. 26 secs.
" "	finishing (light, smoothing cuts to size)	5 mins. 24 secs.
" "	taking wheel out of lathe	1 min. 17 secs.
	Total Time	19 mins.

Cutting conditions: Depth of cut 5/16in.; feed 13/32 in.; speed 16ft. per min. [Calder, J. (1910) p.959]

The vertical lathe figured largely in cutting trials conducted by the American engineer, F. W. Taylor, in the period from 1880 to 1903. (Taylor, F. W. (1906)] The developments in machine tool production arising out of Taylor's work seem to me to stand beside Maudslay's seminal work on the Slide Rest in aiding managements' attempts in the decomposition of skills.

Another versatile machine was the horizontal boring machine, a machine tool having a movable work-table and a rotating boring head, the component carrying the cutting tool. The work-table is mounted on cross-slide* supports, 'ways', which are fixed to a 'saddle'. The saddle slides on the base or 'bed' of the machine heavy-sectioned work and required high degrees of skill in 'setting up', the process of accurately locating and gripping the workpiece preparatory to machining, and also in tool maintenance and control. In the 'steam engine' period it was the machine used for boring out the large cylinders for these and similar kinds of engines. 'Boring is .. most difficult to do for the action of the tool cannot be watched as in turning ...' [Spon's Dictionary (1873) p.2322] By the early 1900s a systematised management-constructed work sequence on this type of machine could look like this:

Machine Handling Time for Betts Horizontal Boring Mill:

Total Handling Time for Turning Table End for End ..... 2.41 mins.

	Mins.	
Take of two bolts 5/8 x 4		0.38
Walk six feet	0.05	
Take off other two bolts ⅝ x 4		0.38
Take out key	0.04	
Turn table end for end		0.38
Put in key	0.04	
Put on two ⅝ x 4 bolts and tighten		0.52
Walk six feet	0.05	
Put on other two bolts ⅝ x 4 and tighten		0.52
Walk six feet	0.05	

TABLE A [Hathaway, H. K. (1914)]

Total Handling Time for .....

Moving Spindle forward (2in)	0.08
Moving spindle back (2in) This time includes going after helper	0.08
Move end support back 2 ft. Helper not at machime	2.35
Move end support forward and tighten (2ft.) Helper at machine	0.80
Move auxiliary table forward (2in.)	0.26
Move auxiliary table back (2in.)	0.29
Raise table, includes loosen four 4⅜ x 4 bolts, start machine, raise and tighten	1.60
Lower table, includes loosen four 4⅜ x 4 bolts, start machine, lower and tighten	1.60
Total time	6.34 mins

TABLE B [Hathaway, H. K. (1914) p.538]

Evidence suggests that management favouring this kind of work sequence perceived the traditional type workshop organization, under which the workman was responsible for the method and pace of work, as inefficient both in terms of production rates and unit costs. The object of fast-working machines and accurate tools of the 'new' type was to save hand labour. It follows that some employers of engineering labour would systematically equip workshops with at least some of the most accurate machine tools specifically designed to promote more 'productive' use of labour power. Engineering management made more extensive use of capital-intensive technology such as fixtures, and jigs for developing the range of machines such as the universal mill, engine lathes (i.e. Power driven), shapers, boring machines, drills and grinding machines. [Orcutt, (1902) p.36] These machines, if of the best calibre, in terms of consistent performance and accuracy, formed the basis of what was termed the 'tool-room', where '... none but machines of the highest accuracy should be allowed.' [Orcutt (1902) p.31] The 'tool-room' concept was a relatively late development and may be said to derive from studies concerned with management skills generated by Taylor, Gilbreth and their associates in the 1880s. For the purposes of outline the following range of machines may be considered more or less standard in a mechanical engineering workshop in the period 1860-1910.

Using a typology from Acherkan, N.(1967)[pp.14, 15] in addition to those already referred to the common machines may be categorised as follows. All machine tools are divided into nine main groups depending upon the type of processing operations they perform or the tools they employ. Additionally, each main group is further divided in nine subgroups (types) 'characterizing the specific purpose of the machine tool, its construction arrangement, degree of automaticity or the type of

cutting tool employed.' [Acherkan, p.14] The nine-fold typology and its variants are based on modern machine tool developments and do not necessarily reflect the level of Victorian machine-based engineering practice; it does however, provide a guide to the principal machine tool forms developing in the period.

The groups are as follows:

Group 1 Lathes, including semi-automatics; vertical turning and boring mills; turret lathes*.

Group 2 Drilling and boring machines, including upright drill presses (drilling machines); jig borers; radial drills (in which the drill can be moved over the work on a 'radial arm' to any desired position, so that a large number of holes may be drilled in the workpiece without moving it)*; boring machines; horizontal drilling machines.

Group 3 Grinding machines, including cylindrical grinders; internal grinders; tool and cutter grinders; surface grinders (all available from the 1860s)

Group 4 Combination machines, including general purpose machines; semi-automatic machines; automatic machines.**

Group 5 Gear- and thread-cutting machines, including shapers and planers for spur gears (the conventional gear tooth shape); gear and thread grinders.**

Group 6 Milling Machines, including vertical knee type milling machine (in which the spindle axis, the component carrying the cutter, is vertical and the table is movable longitudinally on a saddle and vertically together); horizontal knee

*Available as standard production machines at least by 1864 (Descriptive List of General Machinery, G. Buchanan & Co.)

**A development characteristic of the 1880s.

type milling machines; fixed-bed and planer milling machines (for work requiring heavy cuts).

Group 7 Planers, shapers, slotters, including open-side planers (machining through 'free-access' on side of the machine); shapers; slotters, 'The term planing is or may be applied to all tools with rectilinear movement, for producing planes or other work performed in straight lines. Shaping and slotting machines belong to the same class.' [Spon's Dictionary (1873)] (The last named machine operates in a vertical plane vis à vis the other two which are always horizontal in operation).

Group 8 Cutting-off machines, including saw-cutting machines; power hacksawing machines; cutting-off lathes (specially-tooled lathes for cutting bars to length).

Group 9 Miscellaneous. Acherkan's classification includes modern developments such as tool-testing machines; dividing machines, balancing machines. As these were relatively late in the period covered (Taylor's work on tool testing in the 1880s excepted), it would seem more appropriate to include under this head some of the catalogued machines characterising the Victorian period.

The London-based company G. Buchanan, for example, manufactured a range of the conventional tools, apart from a specialised range, which included: Nut-shaping machines, capable of machining nuts, shaft ends up to 6 in. diameter, operating on two sides of the nut simultaneously. Plate bending machines taking work up to 10ft. wide; plate planing machines, '... a very powerful machine for planing edges of iron plates for shipbuilding.' [Buchanan, G. (1864)] Hydraulic presses; bar sawing machines, fitted with two circular saws 3'6" dia. to cut bars 7ft. to 24ft. long; crank axle lathes, to turn two wheels at once up to 4ft. dia.; slotting machines for

locomotive frame plates, with bed (base) 24ft. long, stroke (length of cut, in this case, vertical 'stroke'), to admit articles 4ft. wide; with two cross-slides and refinements, for example, a self-acting longitudinal rack motion (implying the cutting head (or ram) was driven by gears, and self-feeding after each stroke). Other special tools were in use, their nature reflecting the dominant influence of railway engineering and shipbuilding in the development and marketing of machine tools. Spon's, the authoritative engineering reference of the period, also catalogues: Multiple drilling machines (for drilling a number of holes simultaneously); compound planing machines for connecting rods. This latter machine incorporated four tools acting at once, quadrupling the work of an ordinary machine. Axle lathes for turning the bearings and wheel fits on railway axles; hydrostatic wheel presses, for forcing on or off the wheels of railway cars.

By 1887 some employers focused on both conventional machine tool and fitting operations in order to extend control over the work process,and especially basically craftsman-dominated skills as exemplified in shipbuilding. At this time electro-magnetic tools for riveting, drilling, tapping (generating internal threads), caulking (making joints water-tight), were introduced. The application of these tools and the rationalisation of their introduction seemed to be based less on technical or mechanical efficiency than on the facility they afforded management in furthering control over costs and production rates.

> '... Until now the shipbuilding industry has been to a great extent controlled by the trades union of riveters, so that employers of labour have been unable always to regulate the cost of work as affected by the rate of wages or by the speed at which the work was completed ... it is of great importance that they should possess such a means of controlling both the cost of the work and the rate of construction ... as is furnished by these electro-magnetic machines. [Rowan, F. J. (1881) pp.330, 331]

The critical mechanical function of these tools was their operating mobility; they could be clamped to the side of iron and steel work in any position, offering a more flexible operation function than the more traditional, static procedures. The generalisation of the principles underlying this type of development was also linked to bonus or premium systems of wage payments that were introduced from the 1880s, including the shops where the above electro-magnetic machines were developed. [Rowan, F. J. (1901), p.884 et seq.] The ideology of workshop production embodying these new technologies was expressed in clear terms '... the system (premium system) provides an admirable check upon any excessive rise in wages cost, as each contributory cause becomes apparent, and can be investigated the moment it arises and suitable means taken to prevent a recurrence in future. [Rowan (1901) p.885].

APPENDIX 6

Preparation and Cutting Sequence of Metal-Cutting Tools

A brief outline of the geometry of metal-cutting tools and the cutting sequence of a machine tool operation will illustrate the significance of this process for an analysis of methods of increasing intensity of labour in a machine shop.

In order to remove surplus metal from the material being cut, the 'stock', the cutting tool is first forged by the machnist and then ground (shaped to size using a standard grinding or emery wheel) to produce the necessary cutting angles. These [Spon's Dictionary (1873) p.2921] These angles vary according to the material being cut and the tool composition; in the period up to the late 1880s this tool material was known as plain carbon steel (The composition and metallurgical properties of this metal had a critical bearing on the rate at which various metals could be cut (see appendceis 6-8) - the standard tool-preparation rule of the period was that the harder the material being machined, the greater the wedge angle and the smaller the clearance angle). The machinist was responsible for forming and maintaining the correct angles on the cutting tool; the primary objective was to keep the tool edges sharp enough to slice through the metal, with a wedge angle sufficient to provide strength, and a minimum of clearance to prevent undue overheating from friction due to the cutting forces.

In general, it may be noted, that the toughness, tenacity, and hardness of steel increase with the quantity of carbon it contains, '... but good steel never contains graphite ... iron with less than 0.65 per cent of carbon is wrought iron; from that to 2.3 per cent of carbon forms steel; and when the quantity of carbon is larger, the metal is considered cast iron.' (See appendix 6b, 6c) Further analysis of these features of the

cutting tool process is undertaken below; two basic variables will be considered at this point.

Apart from the cutting tool angles,two other critical metal-cutting variables were initially determined by the machinist, the depth of cut (the amount of penetration into the workpiece by the cutting tool), and the feed rate (the amount the tool travels per revolution or 'pass'). Once these variables had been determined, the depth of cut (which depends upon material being cut and the cutting tool material) was applied, often by use of a micrometer wheel, and an appropriate feed rate through the self-acting mechanism activated. This latter function employed the use of a lever to engage a nut housed in the saddle, carrying the slide rest, supporting the cutting tool, with the leadscrew driven by a gear train ('cogs' in mesh, i.e. driving and being driven). See fig 1 where the geometry of gear 'meshing' is outlined; together with the kind of arithmetical computation that would be expected of the skilled machinist in order to accurately determine the correct ratio of turns of the work to linear movement of the tool. Referring to a lathe, the gear train was arranged so that the headstock, carrying the workpiece, moved the work in a constant ratio movement relative to the travel of the cutting tool. This means that, in the case of a centre lathe, the work revolves at a predetermined rate (revolutions per minute, R.P.M.) whilst the cutting tool advances a contant amount parallel or at right angles to the axis of the work (in inches per revolution). Lathes were available with longitudinal and cross-feed motions driven by gears and the rack (a long 'screw', flat on one side and fixed to the bed of the machine) giving 16 changes of feed to each. The operator had only to secure a sliding arm to the proper figure on an index stud and the machine would cut the pitch indicated by the figure. [Bement, Mills & Co. (1893) p.29]

By 1863 machines such as heavy duty centre lathes were available with a capacity for taking work up to 20ft. diameter on a faceplate* 14ft. dia. with a bed 36ft long.' [Collins, (1863)[p.29]

* 'Faceplate': A plate-shaped iron device for holding large or irregular-shaped work.

6(i) <u>The Principle of 'Idling Time'</u>

A basic simplified example will illustrate the significance for production technology of the principles of 'idling' and cutting time on a centre lathe.

Given: A mild steel bar 10in. diameter, 18ft. long to be reduced to a diameter of average 8in.

Speed of lathe = 150 revolutions per minute (R.P.M.)(workpiece speed)

Feed rate of tool = 0.062in (i.e. in. per revolution of the workpiece)

Depth of cut = 0.058in (i.e. 0.116in reduction of diameter)

In one minute tool advances 150 x 0.062 = 9.3 in.

∴ Time taken to travel 18' $= \frac{18 \times 12}{9.3}$ = 23 min.

Each complete traverse reduces diameter by 0.116 in.

∴ in order to reduce diameter by 2 in, $\frac{2}{0.116}$ = 17 traverses need to be made,

∴ Total time taken in actual cutting = 23 x 17 = 391 min. or 6½ hrs.

Another illustration based on the heavy centre lathe serves to make the point further: With a bed 36ft. long, it would be possible to take work 28ft. long, with a range of diameters say 18" as typical; if the material to be cut was mild steel it would have been cut with a plain carbon steel tool at a maximum of 20ft./min. (ref. Spon's Dictionary of Engineering, 1873, p.2322). In order to reduce the diameter by 3in, the following conditions would apply: (depth of cut = 0.058 in, traverse 0.062in)

Given 18in. dia. @ 20ft./min, r.p.m. = $\frac{20 \times 12}{\pi \times 18} \times 4.24$ r.p.m.

In one minute tool advances 4.24 x 0.062 = 0.262 in.

∴ Time taken to full cut full length, $28' \frac{28 \times 12}{0.262}$

$= \frac{336}{0.262} = 1282.4$ min. = 21 hrs.

i.e. for a reduction in dia. of (2 x 0.058in = 0.116in)
∴ For a diameter reduction of an average 3in.
$\frac{3}{0.116} = 25.8$ traverses would be necessary.
∴ Total cutting time required = 25.8 x 21 = 541.8 hrs.
(or 9½ weeks @ 57 hrs. per week)

The second example indicates that when cutting mild steel of relatively large cross section using plain carbon steel tools of the period, it could take over two working days of 10 hrs each to complete a single traverse or 'pass' on a component. This time, it will have been noted, refers to actual cutting time when the machine is travelling (traversing) under self-acting principles. The implication for employers was that cutting time, particularly on large components, was in fact 'idling' time in that the machinist was engaged in observing and checking the cutting action; not actually performing a specific technical task. Employer reasoned it was possible to utilise the machinist's 'non-productive' time. In practice this usually meant increasing the number of machines supervised, i.e. working more than one machine (in appendix 16 the principle of 'multiple-manning' is explained with examples from Germany and America)

APPENDIX 7

Common Nineteenth Century Materials Used in Engineering Production

Maximum cutting speeds depend mainly upon the material being cut and the metallurgical composition of the cutting tool. The principal material for cutting metals throughout the nineteenth century was plain carbon steel. The essential difference between cast iron, a common fabricating material of the period, and steel was the amount of carbon contained in the constituency of the metal. Pure iron, called ferrite, is a soft metal having a structure composed of crystals or grains. Cast iron contained approximately 92%-94% iron and about 3½% of carbon, plus some small quantities of constituents such as silicon (2%), manganese (1%), sulphur (0.1%), and phosphorous (0.3-1.2%). [Chapman, W. A. J. (1943) p.12]

Steel is fundamentally an alloy of iron and carbon with the content of carbon varying up to a maximum of 1½-2½ per cent. If the carbon content is increased beyond this level, excess carbon is distributed throughout the material in the form of free graphite. Further increases would merge the metal into the group of metals termed the cast irons. Thus the crucial constituent in plain carbon steels was the presence of carbon up to about 1-2 per cent only. For a material to be classed as a steel there must be no free graphite (as in cast iron) in its composition. [Spon's Dictionary (1873) p.2921] As a general guide the plain steels (as distinct from complex alloys which were developed late in the nineteenth century) were classified according to their carbon content:

Steel	Carbon %	Uses
Dead Mild	0.1-0.125	Wire rod, sheets, tubes
Mild	0.15-0.3	Boiler plates, brdige work, drop forgings, general workshop use
Medium	0.3-0.5	Axles, drop forgings, agricultural tools
Carbon	0.5-0.7	Springs, locomotive tyres, hammers
High	0.7-0.9	Springs, shear blades, chisels
Carbon	0.9-1.1	Press dies, punches, screwing dies, axes, picks
	1.1-1.4	Razors, files, drills, gauges, metal-cutting tools

[Source: Chapman (1943) p.16]

APPENDIX 8

Nineteenth Century Experiemnts with Special Metal-Cutting Steels

At one period in the cutting trials, up to 1889, Taylor compared the performance of two steels, the English Mushet air-hardening steel and an alloy he had developed whilst at Midvale Steel Works. The compositions of these metals were as follows:

	Tungsten	Chromium	Carbon	Manganese	Silicon	Phosphorous	Sulphur
Mushet	5.441	0.398	2.150	1.528	1.044	-	-
Midvale	7.723	1.830	1.143	0.180	0.246	0.023	0.008

Percentage Composition of Mushet Self-Hardening Steel
and Midvale Self-Hardening Steel
(Source: Taylor, F.W. (1906)]

The following metallurgical analysis is based largely on an Abstract of Selected Papers collated by the Cutting Tools Research Committee of the Institute of Mechanical Engineers. [Proc.I.Mech.E. (1923)] (Between 1841-1921 these abstracts cited 369 articles on cutting tools research. After Taylor's published work in 1906 there were 145 articles up to 1921. In roughly the same period the American Society of Mechanical Engineers - A.S.M.E. - cited 296 works, indicating the intensive activity into this aspect of technological research.)

I briefly outline the significance for machine cutting of the addition in a basic carbon steel structure of the various alloying elements in the above steels.

Tungsten: With from 9 per cent to 18 per cent addition of this constituent the brittleness of the steel is increased but the cutting capacity is greatly improved. Tungsten steels also possess a power of resistance to abrasion.

Chromium: The function of chromium is the formation of a double carbide with tungsten, which imparts a very high degree of hardness and excellent resistance to abrasion.

Carbon: As noted, too high a carbon content is undesirable causing brittleness. This constituent is reduced in content when alloyed with chromium, a characteristic to be noted in the Mushet steel.

Manganese: This is present in all steels. Steels containing 1.5 per cent manganese and 0.3 per cent carbon are appreciably stronger and tougher than plain mild steel and were not considered expensive.

Silicon: Up to a maximum of 3 per cent, this element improves the hardness and cutting qualities for machining hard material. To a limited

extent it counteracts the effects of tungsten, the durability of the tool increasing as the silicon content decreases.

Sulphur: Present as an impurity, tends to form dangerous films of iron sulphide; the manganese present forms in conjunction, manganese sulphide which counteracts this tendency.

Experiments were conducted both in America and England to improve still further the cutting efficiencies of the air-hardening steels. These consisted essentially in a series of tests made with tools of various chemical compositions, and heated to different temperatures. It was during the course of this type of investigation that Taylor seems to have established a crucial empirical point that, although both carbon and air-hardening steel deteriorate rapidly when the temperature rises above a cherry red (colour of the oxide film on the surface of the metal), some chemical compositions of the air-hardening class of steels rapidly pass through this condition. The efficiency rises slowly at first, and then rapidly as the temperature rises, reaching a maximum at the point when the tool begins to crumble ('burnt' steel). He noted that the Nushet steels were breaking down or were injured by over-heating at between 1550°F and 1700°F.

> '... but to our surprise, tools heated up to or above the high heat of 1725°F proved better than any of those heated to the previous best temperatures, namely cherry red; and from 1725°F up to the incipient point of fusion of the tools, the higher they were heated, the higher the cutting speeds at which they could run.' [Taylor, F.W. (1906); Thompson (Ed) (1914) p.260]

The exploration of this phenomenon led Taylor and his colleague, J. Maunsel White, a metallurgist, to the inclusion of another constituent to the chromium-tungsten steels. This was molybdenum, used either in combination with or as a substitute for tungsten. The proportions of the Taylor-White metal varied but generally depended upon the work the steel was intended to do:

0.75 per cent chromium, with 4 per cent tungsten or molybdenum, or a mixture of the two latter with chromium.

This would be suitable for machining mild steel at the highest speed. For working hard steel or chilled iron (iron usually with a very hard 'skin'):-

3.0 per cent chromium, 5.0 per cent tungsten, 4.0 per cent molybdenum. (See Appendix 6(a)

The heat treatments for the hardening of these steels was itself a radical departure from conventional hardening procedures: they heated the steel to about 1000°C, then rapidly cooled it in a lead bath to about 800°C, keeping it at that temperature for about ten minutes, followed by natural slow cooling in lime or some other inert non-conducting powder. When quite cold it was re-heated to warm red, and allowed to cool in the open air. [Iron & Coal Trades Review (1902) p.1516] The high degree of heating evolved for this process was clearly an inversion of all theory and practice of thermal treatment existing previously. [Gledhill, J. M. (1904) p.12]

8.1 The Development of High Speed Steels

The results obtained in cutting trials with the new steels, referred to as High Speed Steel (HSS), indicated a machining potential capable of transforming tool cutting processes. One of a number of manufacturers of the steel in Sheffield was reported as saying '... the results are so extraordinary that they would not be believed if published.' [Iron & Coal Trades Review (1902) p.1576] The greatest manufacturing economy effected by these innovatory steels was the greatly increased capacity for rapid metal removal. It was also shown that the extra power required to remove metal at a higher speed than at low cutting speed, was not proportional to the large extra amount of work done by the high speed cutting; for the

frictional and other losses did not increase in the same ratio that a high cutting speed bears to a low cutting speed. Tests carried out by one researcher, Gledhill, produced the following power consumption results:

Material being cut	Depth of cut (in.)	Feed (in.)	Speed (ft/min)	Power
Hard steel	3/16	1 1/16	17	5.16
Hard steel	3/16	1/16	42	4.18

These figures show a 19 per cent power saving with an increase of cutting speed of 2½ times

[Source: The Iron Age (1904) p.14]

Further experiments on power consumption demonstrated that by doubling the depth of cut to 3/8 in. the saving in power was as much as 28 per cent. [The Iron Age (1904) p.14] The conclusion drawn from these tests was that in laying down new plant and machines the '... introduction and use of high speed steel would have considerable influence in reducing expenditure on capital account.' [loc.cit.]

Tests carried out in 1910 at the Alfred Herbert Company in England showed the rate of metal removal was increased 12 times using HSS compared with ordinary carbon steel tools (See appendix 13).

Appendix 9

Whitworth's Plug and Ring Gauges

The ring gauge consisted of a heavy disc of metal with a hole very accurately bored and ground to close tolerances of size. A shaft could be machined until it just fitted into the ring gauge hole; slightly oversize the shaft would enter, slightly under size it would be slack. Corresponding to the ring gauge of a given size was a ground shaft which fitted the ring exactly, this was the plug gauge for that specific size with a 'pairing' function to determine hole sizes within prescribed limits of tolerance. It was possible with gauges such as these to produce work in the workshop to within 0.001 in. and with grinding, close tolerances of + or - 0.0001 in. Whitworth pressed for the official adoption of his standards which he maintained enabled '... the workmen (to) measure to the 1-20,000th of an inch, and these measures are as familiar and appreciable as those of any larger dimensions ...' [Whitworth, J. (1857) p.48] The comprehensive nature of the gauges may be illustrated by an extract from the Denominations of Standard Gauges:

'(1) Whitworth's External Cylindrical Gauges

External Diameters in terms of the inch.

Fifteen gauges from 1/16th to 1 inch, increasing by sixteenths of an inch.

Twenty-four gauges from 1 1/16th to 4 inches, increasing by eighths of an inch.

Eight gauges from 4 1/4 inches to 6 inches, increasing by quarters of an inch.

Nineteen gauges from 0.1 to 1 inch, increasing by five one-hundredths of an inch.

Thirty gauges from 1.1 to 4 inches increasing by tenths of an inch.

Ten gauges from 4.2 inches to 6 inches, increasing by fifth of an inch.

(2) Whitworth's Internal Cylindrical Gauges: Internal Diameters in terms of an inch (see 1). etc. [Whitworth, J. (1876) p.71]

A range of two hundred and twelve gauges was developed to cover a variety of sizes from 1/10 inch up to 6 inches for both internal and external measures. The importance for mass production processes of having stabilised standards for a given range of components was first realised, as suggested above, in firearm production.

APPENDIX 10

Institution of Mechanical Engineers' Criteria of Turret Lathes

An article in the proceedings of the Institute of Mechanical Engineers, 'Light Lathes and Screw Machines,'(Proceedings 1901), set down some criteria for turret lathes. These were prefaced by the observation that

> '... at present automatic machines are being introduced for producing in quantities machines parts which had hitherto to be made by skilled men at higher cost.' [Proc.I.Mech.E. (1901), p.260]

According to the Institution, turret machines would embody at least the following features, in addition to the conventional requirements of a standard lathe.

(a) Self-centring chuck for gripping wide variety of work diameters, capable of positive holding when under its heaviest cut.

(b) There should be a suitable means of feeding forward the stock when required, without undue loss of time.

(c) The revolving tool-holder should be designed to allow the greatest range of action, support the tool without spring; bring the tools into action, accurately adjusted; and revolve and adjust itself automatically.

(d) Independent stops should be provided for each tool, with automatic, power cut-out.

(e) The means of traversing the turret should allow quick movements while

changing the tool position, and of steady motions while cutting.

(f) A cross slide is usually desirable to carry forming, cutting-off, and chasing tools (for certain kinds of thread); and its position should be easily and accurately adjustable. [Proc.I.Mech. (1901) p.262]

The reiteration of speed, accuracy, and automaticity in this definition of the turret machine, clearly locates this machine as crucial to a mass-production manufacturing form, using unskilled labour.

Initially the turret lathe was a slightly modified version of the ordinary centre lathe, but was later refined to become a sophisticated automatic machine tool. Its significance for interchangeable manufacture was that by substituting the tailstock* with a turret, a range of machining operations involving different tools could be brought into action without any particular skill on the part of the operator. The turret was a robust, six sided ('hexagon turret') device mounted on the lathe bed, capable of being rotated, and with linear movement, holding six or more different forming and cutting tools, each of which could be pre-set (by labour other than the operator if necessary) in order to machine to pre-determined dimensions. As each tool was required in a machining sequence, it was brought into cutting position by a relatively short movement of a capstan or pilot wheel located on the front of the machine near the operator's right hand. This was a process of 'indexing', i.e. automatically rotating the turret and bringing a new face of the hexagon and hence a fresh tool into position after each cutting operation. This constituted a great saving in labour time, for tool-changing operations were eliminated at each

intermediary stage. For long production runs this was one of the critical operating features, the other being the semi-automatic principles involved which required skilled labour only for tool-setting and grinding.

The advantages for management were elaborated in a contemporary journal. The Engineer(1899) noted that

> '...machines of this type (the turret lathe B.C.) require a number of special tools to suit the various classes of work they have to perform, and therefore the services of a good tool fitter even for a single machine are essential. When there are three or four in use, the changing of tools on each is not ... so frequent as in the case of a machine working alone, and thus one tool fitter is sufficient to keep them going ... with a number of tools a mechanic can be employed to supervise the setting of the cutter and the adjusting of the machines, while the actual operating of them can be entrusted to less expensive hands working under his instructions ... for the turning and screwing of studs, etc., in large numbers, the automatic machines, five or six of which can be operated by a single man, of course effect an immense saving.' [The Engineer (1899)]

Further potential of this machine was later realised with the addition of a four-position front tool post, and a single-tool rear tool post, both mounted on a cross-slide, and capable of movement at 90° to the lathe centre line. This combination rendered possible a machine tool with eleven tooling positions; six on the hexagonal turret, four on the front tool post, and one on the rear tool post. Provided the movements of the cutting tools were controlled with positive adjustable stops or dials, the operator's time could be more or less solely directed at metal removal. Work-setting time also had been radically reduced.

The first turret machines in production use were American, dating from the 1860s, made by Pratt and Whitney, and Brown and Sharpe, the latter firm becoming pre-eminent in this field. (Steeds, W. (1969) p.93).

*This was a device located on the lathe bed of conventional design primarily used to support the end of long pieces of work, and to carry small tools such as drills.

Roe(1916) ranked the turret lathe as the '... first radical improvement on Maudslay's slide-rest', and put the first turret lathe as a product of Robbins & Lawrence in 1854. [Roe, J. W. (1916) p.143] The 1867 Paris Exhibition revealed a fairly sophisticated application of turret principles to screw manufacture; there was also a clear reference to their use in England as early as the 1850s. Anderson, one of the jurors at the Exhibition, said

> 'Brown and Sharpe exhibit a machine for making descriptions of screws out of rough bar ... every instrument necessary for its production is placed in suitable holders ... the wire or bar passes through the centre of the revolving spindle, when tool after tool is successively broughT into action, and screws of perfect identity are thereby produced with facility.' '... The system was introduced into England by Mr. Hobbs, after 1851, for his lockmaking, and afterwards it was brought into some of the operations of the War Department, but in no previous example has the system so well developed as in this machine.' [Anderson, J. (1867) p.373].

	NAME OF TOOL	YEAR OF TRIAL	VANADIUM Va	MOLYBDENUM Mo	TUNGSTEN W	CHROMIUM Cr	CARBON C	MANGANESE Mn	SILICON Si	PHOSPHORUS P	SULPHUR S	MATERIAL BEING CUT: MEDIUM STEEL FORGING	HARD STEEL FORGING	HARD CAST IRON
*ENGLISH TOOL	JESSOP CARBON*	1894					1.047	0.189	0.216	0.017	0.017	16 FT	6 FT.	15½ FT
	BETHLEHEM MESH	1896			8.40	1.86	1.43	0.23	0.126			61 FT	19 FT.	39 FT.
⊕ ORIGINAL TAYLOR-WHITE STEEL	BETHLEHEM⊕ HSH	1898			8.00	3.80	1.85	0.30	0.15	0.075	0.030	58 FT.	30½ FT.	43 FT.
	TOOLS USED AT LINK-BELT Co.	1903			14.71	2.90	0.70	0.12	0.196	0.017	0.010	64 FT	34 FT.	44 FT.
	THE 'BEST' HSS. USED BY TAYLOR	1906	0.32 0.29		17.79 18.13	5.95 5.47	0.68 0.67	0.07 0.11	0.149 0.04			99 FT	41½ FT.	52 FT.

DERIVED FROM TABLE 138
PROCEEDINGS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
VOL 28. 1906

CHEMICAL COMPOSITIONS AND CUTTING SPEEDS OF VARIOUS TOOL STEELS USED BY F.W. TAYLOR BETWEEN 1894 – 1906

THE EFFECT OF HIGH-SPEED STEEL ON METAL-REMOVING PERFORMANCE

MATERIAL CUT: STEEL FORGING		OCT. 1898	MAY 1899	JAN 1900	% GAIN IN CUT OF 3RD OVER 2ND	% GAIN IN CUT OF 3RD OVER 1ST
CUTTING SPEED	FT/MIN	8.92	21.75	25.25	16	183
DEPTH OF CUT	IN	0.23	0.278	0.30	8	30
FEED	IN	0.07	0.065	0.87	32	24
WEIGHT OF METAL REMOVED	lb/HR	31.18	87.52	137.3	68	340

TABLE SHOWING INCREASE IN METAL REMOVED BEFORE AND AFTER INTRODUCTION OF H.S.S AT THE BETHLEHEM STEEL WORKS.

SOURCE: AMERICAN MACHINIST 11 AUG 1901 1784

TOOL STEELS AND CUTTING RATES PRACTICAL EXS.

APPENDIX 12

Some Findings Illustrating Increased Cutting Capacities with High Speed Steels

In terms of cutting performance measured by the rate of removal of surplus metal, a practical illustration comes from a variant of HSS, called Novo steel made in Sheffield. This new material was used in a multiple-tool roughing, operation (large stock removal where finish quality was not crucial) as follows: A rope transmission sheave, 23 ft 6in. diameter, 6 ft long was roughed off simultaneously by five tools of 1in. by 2 in. Novo steel. The speed was 27 ft per minute and in the roughing operation the five tools working all at one time removed stock at the rate of 500 lb per hour. These five tools ran continuously for a period of 36 hours without grinding. [Iron & Coal Trades Review (1902) p.1516]

A measure of the metallurgical and mechanical advances made by the tools was further demonstrated in America, effected by the Link-Belt Engineering Company in America, one of the first firms to introduce the new process into their machine shops. Tests were conducted on cast-iron rings 6' 6" diameter bolted to the table of a 7-foot boring mill. A Mushet tool, under the test cut removed 5¼ lb of metal and broke down after one minute. (See Appendix 6(a) for details). An HSS tool, under the same conditions of cut, feed and cutting speed, removed 106 lb of metal in 10 minutes and when removed was in perfect condition. [Iron & Coal Trades Review (1902) p.1517] The durable properties of these metals may be gauged by the level of cutting forces sustained during the trials. The actual pressure against the tool in each case exceeded 3¼ tons while

the pressure per square inch with one of the test tools (of larger cross-sectional area) was 143,000 lb; the HSS tool had sustained a corresponding pressure of 130,000 lb per sq.in. [loc.cit.] Tabulated results of this particular research are to be found in appendices6(a),6(b),8,11(a),13. These findings clearly demonstrate the effect of new metallurgical discoveries on production. The extension of these technological principles to control of the labour process was graphically shown by the Link Belt Company, used by Taylor in a number of his experiments. It was argued by this Pennsylvania company that time studies were essential to the full exploitation of the new cutting tool technologies. A series of time studies were made, as a result of which it was finally determined '... that a man should run 3½ machines simultaneously ... or to obtain his maximum wage scale he is required to turn in 3½ times as many machine hours as the number of hours he works. [American Machinists (1911) p.18]

My interpretation of Taylor's work in these processes leads me to conclude these new mechanical properties were critical to new machine operations particularly those significantly concerned with roughing.* Some of the machining stresses, whilst severe were adequately accommodated by many grades of HSS, producing greatly increased rates of metal removal. This facility was clearly demonstrated in trials on a 30 ton steel on a lathe, (30-ton steel - steel with a tensile strength of 30 tons per sq. inch). Cutting conditions were: depth of cut of ⅝ in., i.e. 1¼ in. reduction in diameter in one cut, with a ¼ in. feed per revolution, at a cutting speed of 90 ft. per minute. The Results were as follows:

Material being cut	Cutting speed (ft/min)	Depth of cut (in.)	Feed rate (per rev)	Area of cut sq. in	Weight of metal removal per min.	per hr
30-ton forged steel	90	⅝	¼	0.21875	68.75	4010

[Source: Gledhill (1904) p.15]

The stress on the tool in this roughing operation was 78.5 tons per sq. in. In a similar test cut with 35-ton tensile strength steel, a resistance to cutting of 115 tons per sq. in. was recorded, suggesting to the researcher the significant finding that '... if proper care be taken, tools of high speed steel are quite capable of withstanding any pressure likely to be met in ordinary workshop practice. (loc.cit.

Appendix 13

Tests Using HSS Carried Out by the Alfred Herbert Company in England

TOOL	R.P.M.	CUTTING SPEED FT/MIN/	FEED PER REV.	FEED PER MIN.	WEIGHT OF METAL REMOVED/MIN.
Carbon Steel	149	58.5	0.0134	2.01	0.753 lb
Special H.S.S.	470	185.00	0.05	23.50	8.8125 lb

Source: Brackenbury H.L. 'High Speed Tools' in Proceedings Institute of Mechanical Engineers Vol. 79 Jul. 1910

APPENDIX 14

Brief Historical Note on the Origin of the Apprenticeship System

The system that Nasmyth(1867) had referred to as the 'fag end of the old feudal system' dated from the Elizabeth Statute of 1563. As Originally conceived the apprenticeship system was carefully regulated, defining the social classes from which apprentices might be taken, and enacted that seven years was the qualifying period to practice any trade. In this way the skilled were bracketed out from the unskilled and there was a clear demarcation between the various skilled trades and with the unskilled. [R.C. on Labour (1894)] The concept of the 'company' or 'fraternity' was to have been important in the earlier period for the apprentice was committed to a period of 'servitude' to a specific company from whom 'freedom' had to be acquired after fulfilling the obligations of the statutory period. Those responsible for apprentices were 'masters' and conditions imposed on both parties were strict and obligatory. Such conditions emanating from the "Statute of Apprentices" of 1557 remained in force for two and one-half centuries. [Evans, A. (1890) p.7]
This represented a system characterised by a more or less strictly delineated teaching and learning situation for clearly defined and discrete skills.
The watershed in the dissolution of the master-apprentice relation may be put at 1814, in which year the provisions relating to apprenticeships in the Elizabethan Statutes were finally repealed. From that period there ceased to be any legal guarantee for the restriction of the number of workmen in any trade. [Evans (1890)]

The legal requirements and obligations under the old system constituted a formal contract between the relevant parties. With the repeal, it seemed only a matter of time before the methodical exploitation of young workers, unprotected by any form of legislative enactment, would be concretised. This is not to argue that there was carte blanche exploitation of the young worker completely unprotected by legal statute. There were, in fact, various legal instruments extant e.g. the Emplolyers and Workmen Act of 1875 which laid down conditions of employment and procedures governing disputes between master and apprentices. [39 and 39 Vic. Cap.90 1875, p.1020]. I have maintained in my analysis that, in the mechanical engineering industry, the process of disintegration of the formal apprenticeship sharpened from about the middle of the century with significant changes in standardisation and machine tool developments. Statutory obligations notwithstanding, what was clearly present in the old system and conspicuously absent by the end of the nineteenth and the beginning of the 20th century was the expectation and reciprocal basis of the relationship between the apprentice-learner and the master. The evidence shows that, in the main, the concept of 'master' in the old meaning of the term had been rejected by the employers.

APPENDIX 14(a)

Forms of Apprenticeship

During most of the period under discussion three forms of apprenticeship may be distinguished. Apprenticeship under indenture, apprenticeship under written agreement, and apprenticeship under oral agreement.

In the first case the agreement is expressed in a form which sets out in detail and with solemnity the various conditions to which the employer and the apprentice agreed to be bound (the concept of the 'bound apprentice'). It demonstrates that there was a clear set of expectations generated not only by a formally designated transmission of specific skills but it was also accompanied by a cluster of norms and values associated with those particular skills. As originally conceived, the agreements were a recognition of the autonomous character of skilled artisans' work and the inculcation of accompanying norms and values, '... the apprentice shall and will diligently, faithfully, soberly, and honestly, according to the best of his knowledge, skill and ability, serve the masters ... during the said term, and obey, observe, and fulfil all and every the instructions, orders, and lawful commands of the masters and those put in authority under them.'

The employers' obligations were also clear: 'The masters will accept the apprentice as an apprentice during the said term, and by the best means that they can, will instruct him, or cause him to be isntructed in (specified areas B.C.) the branches of the business of a manufacturing engineer ...' [Indenture (1904) (a)].

Clearly the term 'apprentice' presupposes that it had a defined specificity in relation to a branch of the engineering industry and implied an obligation to engage in the practice of teaching a trade. The 'mysteries of the trade' were part of a cultural as well as a

technological transmission in the engineering workshops. Formal adherence to this particular form operated under highly structured agreements, embodying legal sanctions. '... the apprentice ... signing this indenture (doth) bind himself for the whole term of his apprenticeship to serve his masters ... and do all he can to further his masters' interest their secrets to keep and their lawful commands to obey'.

Written agreements were usually simpler in form than indentures and were required where an apprenticeship was entered into for a period of more than one year but less than the traditional period of 4 to 6 years. This was necessary in order to make the contract enforceable. There was a commitment laid upon the employer to teach the apprentice, commonly through the use of skilled journeymen; and the apprentice to serve for the stipulated time. Both the indenture and written agreement patterns carried simple but necessary features. There may be summarised as the employer undertaking to teach the apprentice under the various conditions laid out; and the apprentice to serve the employer. In addition it was usual to provide for the terms of apprenticeship, the wages to be paid in each year of the apprenticeship, the trade(s) or branches of trade which the apprentice is to be taught and the binding of the boy's parent or guardian as a third party to the agreement. (Board of Trade Report (1915) p.15].

Apprenticeship under oral agreement was used when an employer orally agreed to take a boy as apprentice for the purpose of being taught a skilled trade. The terms of such a contract seldom went beyond fixing the length of the apprenticeship, the hours of work and the wages to be paid. The terms and conditions may be explicitly advertised conditions of apprenticeship obtaining at a particular establishment. An oralagreement

was valid, but unless it was to be performed within the space of one year it was unenforceable. [Ibid p.18]

APPENDIX 15

The Differential Piece-Rate System

Under this system of payment F.W.Taylor proposed a mechanism of paying 'men' not 'positions' and tended to isolate the worker in terms of his personal skill, energy, punctuality, attendance, rapidity etc, with which he performed his work. Two different rates were offered for the same job; a high price per piece, in case the work was finished in the shortest possible time and in perfect condition; and a low price, if it takes a longer time to do the job, or if there were any imperfections in the work. The avowed intention was to allow workers an enhanced daily wage rate; a numerical example provides an illustration:

Ordinary system of piece-work		Differential rate system	
Man's wages	$2.50	Man's wages	$3.50
Machine cost	$3.37	Machine cost	$3.37
Total cost/ day	$5.87	Totalcost per day	$6.87
5 pieces produced		10 pieces produced	
Taylor cited specific work example)		(actual production rate)	
Cost per piece	$1.17	Cost per piece	$0.69

(Source: Taylor,F.W.(1916).

The incentive under this particular example of the differential system was the offer of a permanent $3.50 per day, with increased output. The arithmetic will show that wages increased in this instance 40 per cent while production was doubled, and per unit cost reduced by 41 per cent. In global terms it was estimated that as a result of the implementation of 'efficiency' measures at Bethlehem Steel, output increased from 300-500 per cent, costs reduced by 60 per cent, and saved, strictly on the level of labour costs, $126,000 over a two-year period [Palmer, B.(1975) p.39]

MATERIAL CUT :	SOFT STEEL			MEDIUM CAST IRON			SOFT C.I.		
CUTTING TOOL USED:	PLAIN C	MUSHET	HSS	PLAIN C	MUSHET	HSS	PLAIN C	MUSHET	HSS
SPEED FT/MIN	31.2	63	132.5	24.6	23.6	60.0	22.5	31.6	52.25
CUT IN	0.058	0.058	0.058	0.062	0.062	0.053	0.141	0.186	0.364
TRAVERSE IN	0.062	0.062	0.062	0.062	0.062	0.062	0.125	0.125	0.125
AREA SEC. CUT IN^2	0.0036	0.0036	0.0036			0.0033			0.045
DURATION MIN	20	17	20	17	20.5	30	8.53	32.75	30
AREA M/C'D FT^2	3.26	5.5	14.25	2.19	2.51	9.26	1.0	5.36	16.4
AREA M/C'D FT^2/MIN	0.163	0.326	0.712	0.128	0.122	0.308	0.117	0.163	0.547
TOTAL WEIGHT REMOVED } lb.	$7\frac{1}{4}$	$13\frac{1}{2}$	29	$3\frac{1}{4}$	$5\frac{1}{4}$	20.75	$13\frac{1}{4}$	$73\frac{1}{2}$	219.75
WEIGHT REMOVED } lb/MIN	0.362	0.794	1.45	0.191*	0.256*	0.69	1.55*	2.25*	7.325

*TOOL FAILED

EXTRACTED FROM REPORT ON EXPERIMENTS WITH RAPID CUTTING TOOLS MADE AT MANCHESTER MUNICIPAL SCHOOL OF TECHNOLOGY UNDER AUSPICES OF A JOINT COMMITTEE OF MEMBERS OF THE MANCHESTER ASSOCIATION OF ENGINEERS AND OF MEMBERS OF THE SCHOOL OF TECHNOLOGY SUB-COMMITTEE – OCTOBER 1903

TABLES I IV V. VIA. SOURCE : ENGINEERING 30 OCTOBER 1903 PP590-3

MATERIAL BEING CUT	C CARBON	MN MANGANESE	SI SILICON	P PHOSPHOROUS	S SULPHUR	TENSILE STRENGTH
MEDIUM STEEL FORGING	0.34	0.54	1.76	0.037	0.026	lbs. 70280
HARD STEEL FORGING	1.00	1.11	0.305	0.036	0.049	101860
HARD CAST IRON	TOTAL C 3.32 COMBINED C* 1.12	0.68	0.86	0.78	0.073	

* THE HARD CONSTITUENT IN THE IRON

DERIVED FROM TABLE 138 FOLDER 20
PROC. ASME VOL 28 1906

CHEMICAL COMPOSITION AND TENSILE STRENGTH OF MATERIALS USED IN CUTTING TRIALS BY F.W. TAYLOR BETWEEN 1894 - 1906

APPENDIX 16

Multiple-Manning of Machine Tools - Examples from U.S. & Germany

On the question of multiple-machine manning in engineering workshops I argue that this had been a management-oriented production strategy in England for at least forty years prior to the 1890s. In the 1850s for example, Nasmyth was arguing that one partially-trained man could effectively supervise six machines. On a comparative note, evidence shows that this practice of one man operating more than one machine characterised the operator new technologies in machine production in other countries. For example, cases were reported in Germany of two large lathes being operated by one man; two men attending three punching machines (for 'stamping' out metal components under heavy pressure, with high shearing forces over pre-set forms or 'dies'). In some operations one man supervised the running of five machines. [Engineering, Oct. 1897]

Distinct from America and Britain, the systems that developed in Germany to control work were almost exclusively systems for the control of working time. Bonus systems of the American and British pattern had not asserted themselves generally to the extent that they had in the English-speaking societies. [Groh, D. (1978) p.361] One account by Groh puts the view that cost-accountancy offices were essential to strict work-time control; replacing the more or less ad hoc work books and wage books which had operated hitherto. 'Thus long before the introduction of time and motion studies with the stop-watch, the cost-accountancy offices were in a position to make time studies that enabled them to estimate even the new jobs with a fair degree of accuracy.' [loc.cit] Regardless of whether pay was by the piece or by day rates, the real control of working time was transferred to the cost-accountancy office; this, Groh

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asserts, developed into an 'archive of work and prices.' [Groh (1978) p.362]

In contrast, in the U.S. higher wages were the main incentive and thus attempts were made to rationalise 'work' and the debate centred on the organisation of work and workshops. Thus it might be argued that American machine shop practice as far as craftsman status and shop function were concerned provides an examplar of the variations possible within a free market economy. In general, U.S. machine shops had formerly reflected the A.S.E. workshop ordinances. The A.S.E. had branches in America from 1861, when the first branch was opened in Buffalo; by 1871 this number had risen to 20. This 'colonial' extension of the Society ended in 1920 when the International Association of Machinists (U.S.) superseded the A.S.E. as the leading craft engineering union, after what was described as a 'David and Goliath' struggle for indigenous control. [Jefferys, J. B. (1945) pp.61, 73]

Regarding the issue of labour power exploitation through the operation of automatic machines in America there seems to be some ambivalence. It was argued, in the first instance, that the one-man-one-machine rule expressed the protest of the trade against the breaking down of a custom which ossified during a period when machines were comparatively new and comparatively crude. [Commission on Labor (1904) p.105] The development and exploitation in the shops of automatic machines compelled a modification of that expression of protest. Evidence suggests that no restriction whatever was put on one man running more than one machine when such machines came under the classification known either as 'auto' machines or 'double' machines. [loc.cit.] In the late 1890s there were twenty-four American Pratt and Whitney 'auto' machines operating at the Enfield Small Arms Factory (E.S.A.F.), currently known as the Royal Small

Arms Factory (R.S.A.F.), attended by three men. 'There is no new screw machine of English design which would want so little for attendance. Screws turned out on these machines were made more or less perfect against standard gauge measurement and made for about 3d. per 100.' ['Engineering', 3rd December 1897]

The extent of the range of exploitation and intensification of labour through this application of 'auto' machines of American design may be judged by the reference to their automaticity in 'Engineering': 'American tool-makers can offer a choice of several types of absolutely automatic machines, requiring not only no skilled attendance, but a single attendant can look after eight, ten, or even more, in some cases.' [Ibid.] Clearly, the question of definition was important for any differentiation of applied skilled relevant to the various machines. In the case of the American workshop the functions of various grades of workers was made fairly explicit. In contrast, I have previously argued that much of the struggle in the mechanical engineering industry in England was often localised and related to the 'casual' nature of skill definitions. Disputes centred on the indiscriminate use by employers of unskilled adult and boy labour as machine-labour susbtitute. [E.E.F. minuted letter to Board of Trade; statement issued by the D. Smith Co.,[See sub-section 8.1.0 in main text; Robinson, and Nasmyth evidence quoted in their evidence to the R.C. on T.U. (1868); evidence of A. Noble to the R.C. on Labour (1893).

The American workshop embodied a number of relatively well-defined distinctions regarding both labour power and machines. 'Machinist', for example, was defined (officially from 1901) in terms of a generalised set of machine tool and fitting competences: '... a machinist is a competent general workman, competent floor hand, competent lathe hand, competent

vice hand, competent planer hand, shaper, milling machine, slotting machine, die sinker, boring-mill hand, tool maker.' [U.S.Commission on Labor (1904) p.104[] The concept 'handy' man was guardedly acknowledged by the craft union, e.g. the National Metal Trades Association which drew up the 'machinist' definition, in so far as all machine shops were recognised as employing 'so-called "handy" men'. But it was further held that the machinists '... have never admitted this term and do not recognise the "handy" men at all, they say there are machinists and helpers.' [loc.cit.] The skilled worker was characterised by his ability to '... take any piece of work pertaining to his class, with drawing or blueprints, and prosecute the work to successful completion within a reasonable time. He shall also have served a regular apprenticeship, or worked at the trade for four years.' [loc.cit.]

Automatic machines seem to have been a principal focus for the 'skilled-unskilled' demarcation. They were distinguished from conventional manual control machines in union references as machines that required no special skill to supervise them, the only skill necessary being to adjust the tool or cutter. The machine having been set in motion performed the work without further supervision. [U.S.Commission on Labor (1904) p.106]

The union view as put by the President of the International Association of Machinists regarding jurisdiction over manning control of this kind of machine was that, '... in some instnaces one man has charge of five or six of these machines, and this with the approval of the union.' [loc.cit.] With respect to conventional or non-automatic machine tools, however, union resistance to indiscriminate manning was strong. This covered the operation of machines such as the centre lathe, planer, shaper, slotter, radial drill press, boring mill (horizontal or vertical),

milling machine, railway wheel ('tyres') turning and boring machines, requiring traditional machinist skills to operate.

Such distinctions tended to be blurred in England. At Blackburn in the late 1890s a firm had a large slot-drilling machine and a small planing machine side by side. It was contended by management that they were easily worked by one man who had been 'brought up' by them from a labourer by graded advances until he was receiving 24/- per week. [The Times, Nov. 1897]

The mechanical functions of these machines were in practice quite different, the latter machine having a horizontal reciprocating motion, and the former usually operated in a vertical plane. This difference notwithstanding, the proximity of the machines to each other in this specific case seems to have been an important criterion in management ideas on determining the nature of machine supervision.

But, how was controlled accuracy of machining possible, given the different operating characteristics of the two machines? In my view, this provides an illustration of the practical effectiveness and efficiency of the slide rest principles and Whitworth's development of engineering standards. In both cases the slide rests and leadscrews, carrying the tool cutting element, would have been sufficiently accurate by this time, to allow the operator to apply precise, graduated rotary movements by a hand-wheel to activate accurate linear movements at the cutting surface. Once set, by this means, the machines could cut according to self-acting principles. The associated problem of dimensional control was largely overcome, as argued earlier, by the inclusion of accurately-finished machine tool features which acted as constraints on the machining functions, such as stops, automatic trips, ratchet systems, and adjustable dimension control systems. In this way

two sets characteristics, integrated into the machine tools, enabled a relatively unskilled operator control over compound machining operations.

A critical aspect of skill had been transferred from the skilled tool maker, through the machine to the operator, who did not necessarily embody the initial skills; and through him by use of standardisation features, to supervisors, representing employers. This seems to me to be what Marx characterised as a process representing the historical reshaping of the traditional, inherited means of labour, into a form adequate to capital. 'The accumulation of knowledge and of skill, of the general productive forces of the social brain, is thus absorbed into capital, as opposed to labour, and hence appears as an attribute of capital, and more specifically of fixed capital, in so far as it enters into the production process as a means of production proper.' [Marx. K. (1977) p.694]

The Blackburn case revealed another aspect of management-dominated technology. Being unable to replace the unskilled machinist at 24/- per week, against the A.S.E. claim for 30/-, management locked out the A.S.E. men when they refused to accept depressed rates. [Times, Nov. 1897]

The expedient of locking-out skilled workers rather than employ them in an area of specified technical need, would seem to demonstrate the authoritarian nature of control associated with newmachines. There is in this illustration a recognition by management of the integral nature of the link between labour control and changing forms of technology. This clearly served to consolidate the structure and form of this authority concept of reproduction of labour power and appropriation of labour power.

APPENDIX 17

Results of Final Examination in Technical Subjects under Society of Arts, 1867

	No. of Papers Worked	No. of 1st Class Certificates	No. of 2nd Class Certs.	No. of 3rd Class Certs.	No. of Papers No Certs. Awarded	% Failure
Arithemetic	520	141	110	149	120	23
Algebra	87	15	29	20	23	27
Geometry	41	2	7	22	10	24
Mensuration	55	3	11	15	26	47
Trigonometry	9	1	2	4	2	23
Conic Section	8	4	4	-	-	-
Principles of Mechanics	27	6	4	7	10	37
Practical Mechanics	38	2	13	8	15	39
Magnetism, Electricity etc.	32	1	4	8	19	59
Light and Heat	35	1	4	7	26	74
Chemistry	76	5	13	30	28	37
Animal Physiology	45	3	9	19	14	31
Botany	16	1	2	4	9	56
Mining and Metallurgy	1	-	1	-	-	-
Geometrical Drawing	240	16	59	72	93	39

Source: Journal of the Society of Arts, 21st June 1867, Table II, p.508

APPENDIX 18

Location and Number of Candidates in Society of Arts Examination, 1867

Name of Local Board	No. of Candidates at Final Examination 1867)	
Birmingham & Midland Institute	29	
Bolton (Mechanics Institute)	13	
(Science School)	18	
Burrage-Road (Plumstead) Evening Classes	45	
Carlisle (Mechanics Institute)	4	
Glasgow (Anderson Univ. Pop. Evening Classes)	45)	
(Athenaeum)	37)	
(Institution)	11)	130
(Mechanics Institution)	37)	
Leeds (Mechanics Institute)	25	
London (City of London College)	57)	
(Lambeth Evening Classes)	9)	
(Mechanics Institute)	43)	
(Royal Polytechnic Institute)	46)	189
(St. Stephens Westminster)	8)	
(St. Thomas Charterhouse)	1)	
Manchester (Mechanics Institute)	59	
Salford	41	
Woolwich (Royal Arsenal)	26	
(St. Thomas's Schools)	25	
York	16	

Source: Journal of Society of Arts, 21st June, 1867, from table I, pp.506/7

APPENDIX 19

LIST OF SUBJECTS IN SCIENCE EXAMINATIONS IN SCIENCE SCHOOLS, 1867

Subjects	Number of Students in 1867
Practical, Plane, and Solid Geometry	1,749
Mechanical and Machine Drawing	1,409
Building, Construction, and Naval Architecture	862
Elementary Mathematics	1,436
Higher Mathematics	41
Theoretical Mechanics	433
Applied Mechanics	165
Acoustics, Light, and Heat	1,443
Magnetism and Electricity	1,434
Inorganic Chemistry	2,380
Organic Chemistry	638
Geology	303
Mineralogy	82
Animal Physiology	1,196
Zoology	591
Vegetable Physiology and Economic Botany	257
Systematic Botany	195
Mining	24
Metallurgy	117
Navigation	672
Nautical Astronomy	610
Steam	166
Physical Geography	1,349

Source: Privy Council Committee on Education, Memorandum Relating to Business of the Privy Council Office, Prepared by Direction of the Lord President, PRO Document, ED24/55.

APPENDIX 20

Executive Committee of the City and Guilds of London Institute, 1887

President - H.R.H. THE PRINCE OF WALES, K.G.

Chairman - Mr. H. C. SAUNDERS, Q.C.

The Rt. Hon. The Lord Mayor	)
The President of the Royal Society	)
The President of the Chemical Society	)
The President of the Institution of Civil Engineers	)
The Chairman of the Council of the Society of Arts	)
Rt. Hon. Earl of Selborne, F.R.S., Chairman of Council	) Ex-officio
(Mercer) Vice-President	)
Sir Frederick Bramwell, F.R.S. (Goldsmith)	)
Vice-President	)
Sir S. H. Waterlow, Bart., Treasurer (Clothworker)	)
Sir R. N. Fowler, Bart., Ald., M.P.(Salter)	)
Vice-President	
Ald. Sir Thomas Dakin (Spectacle Maker)	) Corporation of London
Mr. Joseph Beck, F.R.A.S. (Goldsmith)	)
Rev. H. Clementi Smith, M.A.	)
Mr. Daniel Watney (Coombe)	) Mercers' Company
Rev. C. G. Lane	)
Mr. John Watney (Mercers' Hall)	)
Sir J. R. Jennings	) Grocers' Company
Mr. J. H. Daniell	)
Mr. G. Gripper	) Drapers Company
Mr. W. P. Sawyer	)
Mr. R. P. Barrow	)
Mr. E. Lonsdale Beckwith	)
Lt. Gen. L. Nicholson, C.B., R.E.	)
Mr. John Warren	) Fishmongers' Company
Mr. W. Norris Nicholson	)
Mr. A. W. Gadesden	)
Mr. George Matthey, F.R.S., F.C.S., F.I.C.	)
Sir Frederick J. Bramwell, F.R.S., M.Inst.CE	) Goldsmiths' Company
Sir Frederick Abel, F.R.S.	)
Mr. H. C. Saunders, Q.C.	)
Mr. Charles Barry, F.S.A.	) Skinners' Company
Mr. L. B. Sebastian	)
Mr. R. B. Woodd	) Salters' Company
Mr. H. Rokeby Price	Ironmongers' Company
Mr. Richard Berry	Vintners' Company
The Rt. Hon. Viscount Cross, G.C.B.	)
Lt. Col. John Britten, F.R.Hist.S.	)
Rev. Prof. Thomas Wiltshire, M.A., Treas. G.S.	) Clothworkers' Company
Mr.Owen Roberts M.A.	)
Mr. Wm. Bousfield, M.A.	)
Mr. E.C. Robins, F.S.A., F.R.I.B.A.	Dyers' Company
Mr. Ebenezer Viney	Leathersellers' Compar
Mr. Philip Crellin	Pewterers' Company
Mr. E. Pocock	Cutlers' Company
Mr. John Brunt Mackey	Tallow Chandlers' Com

Mr. Charles J. Shoppee, F.R.I.B.A.	) Armourers' and Brasiers' Company
Mr. C. O. Humphreys	Saddlers' Company
Ald. Sir William Lawrence	Carpenters' Company
Sir Henry Doulton	Cordwainers' Company
Mr. George Shaw	Plumbers' Company
Mr. Aldred Chantler	Coopers' Company
Mr. Frederick Blasson Carritt	Plaisterers' Company
	Stationers' Company
John Watney	) Joint Honorary
W. P. Sawyer	) Secretaries

Source: C.G.L.I. Calendar 1887-8

APPENDIX 21

Membership of the Royal Commission on Technical Instruction, 1881-4

Bernhard Samuelson (Chairman); H. E. Roscoe, Philip Magnus, John Slagg, Swire Smith, William Woodall.

Biographical note:

Samuelson was Liberal M.P. for Banbury and North Oxfordshire for over thirty years.

Roscoe was Liberal M.P. for South Manchester after 1885.

Slagg was Liberal and Free Trade M.P. for Manchester from 1880.

Smith became a Liberal M.P. in 1915.

Magnus was the only member to live well into modern times, dying in 1933 at the age of 91. He was appointed Director and Secretary of the new City and Guilds of London Institute in1880. After 1888 he was Superintendent of the Institute's Department of Technology.

Woodall was Liberal M.P. for two pottery towns from 1880-1900. He studied developments in technical education in Germany, in 1897.

Source: Argles, Michael.

The Royal Commission on Technical Instruction 1881-4: Its Inception and Composition. Vocational Aspect, XI, 23, 1959.

APPENDIX 22

Extent and Distribution of Institutes of Technical Education in Britain, 1878

The Artisan Institute, St. Martin's Lane, W.C.
South London Workmen's College
Workmen's College, Great Ormond Street
College for Working Women, Fitzroy Square
Middle Class Schools, Cowper Street
Birbeck Institute, Chancery Lane
St. Margaret's Technical Schools, Westminster (just opened)
The Royal Polytechnic Institute, Regent Street
Islington School of Science and Art, Essex Road, N.
Telegraphist School, General Post Office, E.C.
King's College, London
London Institute, Finsbury Circus
Gresham College
University College, London
Crystal Palace School of Practical Engineering
The Royal School of Mines
The Huddersfield Mechanical Institute and Trades School
Yorkshire College of Science, Leeds
Owens College, Manchester
Keighley Trade School
Oldham Science and Art School
Leeds Mechanical Institute
Strand Mechanical Institute
The Royal Indian Engineering College, Coopers Hill
Trade and Mining School, Bristol
Building Trades Institute, Manchester
Dockyard Schools
Royal Marine Schools
Chemists and Druggists Schools, Bradford
Colliery Schools
Railway Schools
Co-operative Societies Schools, Rochdale
Cookery Schools
Glasgow Technical College
Anderson Institute, Glasgow
The Agricultural College, Cirencester
North of Scotland School of Chemistry and Agriculture, Aberdeen
Royal Naval College, Greenwich
Hull Navigation School
Plymouth Navigation School

Also Whitworth Schoclarships formed 1868 with endowment of £3000

Source: Livery Companies Committee,
Report on Technical Education, London, 1878

APPENDIX 23

Actual Expenditure on Education and Science in Britain 1871-1880

YEAR	For Education	For Science and Art	
	£	£	
1871-72	1107430	211083	(19)
1872-73	1313078	230420	
1873-74	1424877	257788	
1874-75	1566275	262637	
1875-76	1881630	285234	(15)
1876-77	2127522	301620	
1877-78	2463287	299494	
1878-79	2732534	305324	(11)
1879-80	2854067	317086	

Figures in Brackets Represent Percentage of Total Expenditire Spent on Science and Art.

Source: Actual Expenditure As Per Appropriation Accounts.
Board Memorandum,App.A. (PRO Document ED 23/71).

APPENDIX 24

The Organic Composition of Capital: Examples of Profit Decline in Mechanical Engineering from 1850 - Calculations based on Marx's Theory

I believe it has been shown that improvements in machine tools incorporating self-acting principles for semi-auto working, precipitated important changes in the organisation of work and in the technical culture of the machine workshop. It seems plausible to extrapolate from this and look for evidence which suggests that, given a set of social relations congruent with expansionary technological forms, more machines would be put to use by employers in order to further exploit the potential for increasing rates of production and extending control over labour. In this appendix I examine the 'problem' for employers associated with operating with a 'refractory' labour force offering resistance to exploitation through expanding machine processes. One way of expressing this was in terms of the organisation of work itself and control of the workers needed to operate within it. This has been referred to as the organic composition of capital. [Marx, K. Capital, Vol. I. op.cit.] In the sense employed by Marx it was economic factors that brought about a change in the ratio of fixed capital in the form of machines and variable capital as expressed through wages.

> "... economic factors bring about ... that change in the technical composition of capital by which the variable constituent becomes alway smaller as compared with the constant". [Marx. K., Capital, Vol. I,(1887) p.612]

The ratio referred to in this context is that represented by the ratio of the means of production employed to the mass of labour necessary for their employment, designated by the fraction c/v. According to Marx:

> "the rate of profit (was) inversely related to the growth of surplus value or of relative surplus labour, to the development of the powers of production, and to the magnitude of the capital employed as

(constant) capital within production". [Marx, K., Grundrisse,(1877) p.763]

The importance of this mathematical relationship here is that it enables an expression to be derived incorporating surplus value, vairable capital and constant capital.

Surplus value, or the rate of surplus value, was defined by Marx as operative within certain parameters; in which workers, creating the means by which they may be paid wages in addition, contributed to the creation of other parts of total capital. Marx noted,

> "Since the worker must reproduce the part of the capital which is exchanged for his labour capacity just as much as he must reproduce the other parts of capital, the relation in which the capitalist gains from the exchange with labour capacity appears as determined by the relation of surplus labour to necessary labour". [Ibid. p.764]

This therefore is the ratio between surplus labour and necessary labour; using symbols s and v the expression becomes s/v. This ratio is referred to as the rate of exploitation. The profit rate may be expressed in terms of these variables, constant capital (c), variable capital (v), and surplus value (s). These are related in the following expression:

$$\text{Rate of profit} = \frac{s}{c + v}$$

> "In its immediate form, profit is nothing but the sum of the surplus value expressed as a proportion of the total value of the capital". [Ibid. pp.763, 767]

I have suggested above that given certain conditions, it would be reasonable to assume that employers might increase machine tool development. It might now be further assumed that given increased opportunities to increase production and extend managerial control as I have argued, this development would continue uninterrupted. Also, given that surplus value is directly related to labour power (s/v), it would remain more or less constant, then an increase in fixed capital over variable capital would lead to a fall in the profit rate. That is, an

increase in the organic composition of capital (c/v) leads to profit rate decline. Assuming the ratio of surplus value to labour power to be more or less constant, i.e.s/v changes little over a given period of time, the assumption is that the ratio within, say, an eight-hour day, would be something like 5:3 or three hours regarded as time necessary to reproduce labour power (necessary time for sustenance of the worker), and five hours representing surplus labour (over and above that necessary to maintain labour power). The assumption is that this ratio would remain fairly static while the amount of constant capital (c), in the form of machines would rise, because of the changes in technologies I have analysed above.

I will quantify these assumptions using the following components for the purposes of illustration.

In the periods 1849-1854, and 1861-1865, the average export of steam engines and other machinery increased in value from £665,329 to £1,862,786 (a percentage increase of one hundred and eighty). [Reports from Commissioners, 10th Report, R.C. on T.U. 1867-68, written submission of J. Robinson (Director Atlas Engineering Works), table III, p.60] The number of firms in the machine tool industry rose from 128 in 1870 to 312 in 1898 with an increase in industrial production of 65 per cent.

> "Between 1871 and 1881 the numbers of machine makers increased 28 per cent up to 160,797. The total number working and dealing in machines and implements in England and Wales (1881) was 267,976 ..." [U.S. Nicholson, The Effects of Machinery on Wages, Swan Sonhenson, London, 1892 (1878) p.88]

The output of the engineering industries as a whole rose by 2.8 per cent between 1870 and 1913, while output of the leading firms in the machine tool industry was 7.2 per cent. The total output during the same period rose from £32,238 to £1,219,878. [Floud, R. The British Machine Tool Industry, 1850-1914, C.U.P. 1976, pp.33, 35] The value of labour power

indicated by Robinson's figures presented to the Royal Commission on Trade Unions, shows an average rate for skilled workers in engineering as 31 shillings per week in 1863. [Robinson, J. op.cit. Table IV p. 60] Another source indicates that between 1840 and 1856 skilled engineering artisans' earnings rose from 29s to 38s in London; Manchester figures for the period 1846-1886 show an increase from 30s to 34s. [Burnett, J. (ASE Secretary) Trade Unions as a Means of Improving the Conditions of Labour. Edinburgh, 1886, pp.21, 21] If the number of skilled artisans in employment (or assumed to be in employment for purposes of illustration) is gauged by paid-up members of the A.S.E. (a body that by definition was restricted to skilled engineering workers only), the following may be deduced.

Members of A.S.E. (1865) [Burnett, J. 30th Annual Report ASE 1881] - 33 007; (1879) [Ibid.] - 44 087; (1891) - 71 221 [Jefferys, J. B. The Story of Engineers, op. cit, p.93] Total value of machinery produced in the corresponding years was £3,264,000; £5,080,935; £15,000,000. [Burnett, J.; Jefferys, J. B. Ibid. - Trade Unions as a Means ... op. cit.]

These figures may be illustrated by the following configuration (for the period 1865-1891)

ASE Membership		Average value Labour power (shillings/week)	Value of machines produced (£)
(1) 1865	33 007	33	3,264,000 (Burnett)
(2) 1879	44 087	37	5,090,935 (Burnett)
(3) 1891	71 221	38	15,000,000 (Jefferys)

These variables may be expressed as part of a formula to determine the rate of profit for the years indicated; the formula is:

$$\text{Rate of profit} = \frac{\text{Surplus value (s)}}{\text{Contant capital (c) + variable capital (v)}}$$

For simplicity the ratio for rate of exploitation of labour power representing surplus value and variable capital in the form of wages

$$\frac{(s)}{v}$$

will be assumed to be 3:2 [After Jalee(1977).

1) Rate of profit (1865) = $\frac{\text{surplus value (1½ times labour value(s)}}{\text{value of machinery (c) + annual value labour power (wages) (v)}}$

$$= \frac{4{,}248{,}000}{3{,}264{,}000 + 2{,}832{,}000} = 69.6\%$$

$$\frac{(33 \times 52 \times 33007)}{20}$$

2) Rate of profit (1879) = $\frac{s}{c + v} = \frac{6{,}361{,}754}{5{,}080{,}935 + 4{,}241{,}169} = 68.2\%$

3) Rate of profit (1891) = $\frac{s}{c + v} = \frac{10{,}554{,}951}{15{,}000.000 + 7{,}036{,}634} = 47.8\%$

The steep drop in profit rate indicated by the 1891 figures is probably unrealistic; figures for this year come from a different source (Jefferys) than those for the years 1865 and 1879 (Burnett). The latter's figures could be assumed to be reasonably accurate for the period as they were tabulated in the official annual report of the ASE which quoted official returns for the relevant period. The trend, however, is discernible in relative if not absolute terms. The wage rates would seem to be uncontentious and are supported by other sources [The medium adult wage rates between 1860 and 1880 were calculated at 18/- and 24.3/. The highest decile, which could reasonably be expected to include engineering artisans, was between 27/-

and 36/- for the same period (Crowley, D.W. 1956,p.101), including those submitted to the Royal Commisison in 1868; the evidence contained in this report includes that from Robinson. Using figures from this source a similar exercise to determine profit rates may be attempted.

The Atlas Engineering works of which Robinson was a director had a fairly constant workforce of 1600 in the period 1851 to 1865 [Robinson, J. 10th Report, op.cit.] The prevailing weekly wage rates for three years, 1851, 1861, 1865 were 30.18/-, 30.44/-, 30.47/-, respectively. [Ibid. Table II, p.59]

Assuming i) a static workforce at skilled rates; ii) the ratio s/v remaining constant at 3:2, the following conditions apply:

	Workforce (No)	Average Value Labour Power (Shillings/Weelk)	Value of Machinery Produced £
1851	1600	30.18	133,065
1861	1600	30.44	268,339
1865	1600	30.47	310,456 [Ibid]

Rates of profits for the Atlas Engineering Works, for the period 1851-1861-1966.

1) Rate of profit (1851) $= \frac{s}{c + v} = \frac{188,323}{133,065 + 124,548} =$ (1)*

$= 72.8\%$

2) Rate of profit (1861) $= \frac{s}{c + v} = \frac{189,945}{268,339 + 126,630} =$ (2)*

$= 48\%$

3) Rate of profit (1865) $= \frac{s}{c + v} = \frac{190,132}{310,456 + 126,755} =$ (3)*

$= 43.4\%$

*(1) $\frac{30.18 \text{ shillings} \times 1600 \times 52}{20}$

*(2) $\frac{30.44 \times 1600 \times 52}{20}$

*(3) $\frac{30.47 \times 1600 \times 52}{20}$

The decline in rate of profit is evident over a fifteen year period; assuming for illustration that the workforce would not have all received rates at the skilled level, figures for a grade of labourer, 'helpers', indicate the following, 19.50/-, 18.15/-, 18.12/- [Ibid. Table II, p.59] for the corresponding years. Taking an average figure between the skilled rates and the helpers' rates, wages of the order of 24.84/-, 24.29/-, 24.29/-, arise. It can be shown that, given these wage levels the corresponding profit rate for the same period would be 65.6%, 41.0%, and 35.8% respectively.

Certain features concerning these figures warrant further elaboration. First, it has been assumed that increases in machinery production, generalized in the form expressed by the illustrations, imply that machine manufacturers or machine tool makers would, to a larger or smaller degree, reflect the trend. That trend being recognized in the increasing mechanisation of engineering production. As an example, one major mass-producing company, the Singer Sewing Machine Co., might be cited. During the period 1870-1910 this company installed machine tools of the following order: 1776 milling machines, 903 grinding machines, 969 drilling machines, and 892 automatics;

> "... the existence of relatively cheap labour did not inhibit the use of the most modern machinery". [Saul,S.B. The market and the Development of the Mechanical Engineering Industries, 1870-1914; in Saul, S. B. (Ed), Technological Change: The United States and Britain in the Nineteenth Century, Methuen, London, 1970, pp.160, 161]

Second, the ratio of the increase in constant capital in the form of machinery, relative to variable capital, wages (the increasing organic composition of capital) produced an effect approximating to the postulate of declining profit rates; an effect that would seem difficult to check through employer pressure on wages. Third, if the rate of exploitation of labour power s/v, remained fairly constant then, given increasing use of macinery as suggested by the illustrations above, profit rates demonstrably declined, and other strategies by employers might be expected. The range of options open to employers would be limited. The depression of wages, a powerful expedient in the short-term, showed inconclusive results as a sanction when applied as a function of a constant rate of exploitation. There was clearly an incentive to explore other means to counter the decline in profit rate. The imperative to maintain wage levels at the socially-determined level, with little variation over time, but accompanied by a stepping-up of the productivity of labour, i.e. through the use of machines and intensifying labour power, could be considered. In effect, to increase the level of exploitation, i.e. changing the rates of surplus labour relative to necessary labour. This can be demonstrated by assuming a change in the level of exploitation from 3:2 to 5:3 as suggested above. Assuming average wage rates as in the last example and other similar conditions obtaining, the profit rate profiles could become:

1) Rate of profit (1851) $= \frac{s}{c + v} = \frac{172,223}{133,065 + 103,334} = 72.8\%$

2) Rate of profit (1861) $= \frac{s}{c + v} = \frac{168,410}{268,339 + 101,046} = 45.5\%$

3) Rate of profit (1865) $= \frac{s}{c + v} = \frac{168,410}{310,456 + 101,046} = 40.92\%$

These figures demonstrate that with an increase in the rate of exploitation of labour as expressed in the ratio s/v, from 3:2 to 5:3,

profit rates could be increased 7.3%, 4.5%, 4.12% respectively for the years 1851, 1861, 1865 at the Atlas Works.

How was it possible to raise the level of exploitation and minimise workers' resistance, from a hypothetical rate of 3:2 to higher configurations in the expectation of slowing the decline in the profit rate? I have shown that two important employer strategies were developed: the piece-work system and the exploitation of child labour; and the application of new technologies in the form of rapid cutting tool and machine accuracy and control, involved in the reorganisation of workshops.

References and Bibliography.

Acherkan, N. (Ed) (1967) Metal Cutting Machine Tools. MIR Publishers, Moscow.

Ackrill,M. (1987) Manufacturing Industry Since 1870, Philip Allan, Oxford.

Adams,E.W.(1911). 'Time and Motion Study in the Link-Belt Company', American Machinist,Vol XXXIV.

Adams, Henry (1883) Notes on Mechanical Engineering, London (Adams was a 'Registered' CGLI Institute Teacher).

Adamson,J(1964) English Education 1789-1902, Cambridge University Press.

Addison, F. (1979) The Social Imagery of the Skilled Engineer, Ph.D. Thesis, University of London.

Aldcroft,D.H.(Ed)(1968), The Development of British Industry and Foreign Competition, 1875-1914: Studies in Industrial Enterprise, Allen and Unwin, London.

Allen, W. (1867)(ASE Secretary) Parliamentary Reports; Reports from Commissioners, Royal Commission on Trades Unions, 1st Report.

Amalgamated Society of Engineers (A.S.E.), Annual Reports (Amalgamated Union of Engineering Workers).

Amalgamated Society of Engineers (A.S.E.) (1872) Resolution (extract) passed at Manchester Conference of the A.S.E. 24th July, in Reports from Commissioners (1875).

A.S.E.-E.E.F. Agreement (1907) Agreement between E.E.F. and combined representatives of the A.S.E., the Steam Engine Makers' Society, and the United Machine Makers' Society, Mar. 1907, (My Appendix 3 gives details of the full document).

A.S.E.-E.E.F. Agreements (1898, 1901) [My Appendices 2(a), 2(b)].

A.S.E.-E.E.F. Agreement (1907) [My Appendix 2(c)].

ASE(1898), Notes on the Engineering Trades Dispute, London, ASE [LSE Library,HD 5/39 P2669].

ASE(1897) ASE Reply to Col Dyer,LSE Lib.R(Coll EB XLIX.9.MIII.

American Machinist (1899), Nov. 9.

American Machinist (1900) 16th August; also 1911.

American Society of Mechanical Engineers (A.S.M.E), Transactions, Vol.15 (1893); Vol XXIV(1903).

A.S.M.E. (1912) Majority Report of Sub-Committee on Administration of A.S.M.E., in Thompson, C. B. (Ed.) (1914).

Amos, Ewart C. (1898/99) The Engineering Times, Vol. 1, Dec. 1898 to June 1899 (Member I.Mech.E.).

Anderson, J. (1854) (Chief Engineer of Royal Arsenal, Woolwich). Evidence to Select Committee on Small Arms (1854), Parliamentary Papers, Vol XVIII,Qs. 371, 794.

Anderson, J. (1867) Parliamentary Papers, Vol. XXX. Reports on the Paris Universal Exhibition,Pt 2, 1867-68. Report on Machine Tools.

Anderson, J. (1877) Reports from Commissioners, Vol. XXXIV. Philadelphia International Exhibition. Report on Machine Tools for Working Metal, Wood and Stone.

Anderson, J. (1880) Reports from Commissioners, Vol. XXXIII. Paris Universal Exhibition, 1878, Vol. I and Vol. II. (Introduction to General Machines).

Applegarth, R. (1869) Report on the International Working Men's Congress at Basle, Sep. 1869, in the Times, 15th Sept. 1869.

Argles,M.(1959) 'The Royal Commision on Technical Instruction,1881-4, Its Inception and Composition', Vocational Aspect,XI,23.

Argles, M. (1964) South Kensington to Robbins: An account of English Technical and Scientific Education since 1851. Longmans, London.

Armstrong, P. (1986) 'Management Control Strategies and Inter-Professional Competition', in Knights, D. and Wilmott, H. (Eds)(1985).

Armstrong, W. G. (1888) 'The Vague Cry for Technical Education', Nineteenth Century, Vol. XXIV, July., London.

Armytage, W.H.G. (1964) Four Hundred Years of English Education, Cambridge University Press.

Armytage, W. (1970) A Social History of Engineering, Faber and Faber, London.

Artizan Club: 'The Artizan' (A Monthly Journal), Jul/Aug 1869.

Ashby, Sir Eric (1965) 'Education for an Age of Technology', in Singer, Charles et al (1965) pp.776-799.

Ashworth, William (1963) An Economic History of England, 1870-1939, Methuen, London.

A.T.I. (1905). Association of Technical Institutes, Report of an Inquiry as to the Co-operation of Employers over Technnical Education, London.

Baernreither,J.M(1889) English Associations of Working Men, Swan Sonnenschein, London.

Bailey,Bill (1983), 'Policies of Government: Influence of Pressure Groups 1850-1900, The Technical Education Movement', Journal of Further and Higher Education,7,3(Autumn),55-68.

Barnard,H.C.(1963) A History of English Education, University of London Press.

Barth, C. G.(1914) 'Slide Rules for the Machine Shop as a Part of the Taylor System of Management', in Thompson, C. B. (Ed).

Baxendale, et al (1976) Technology, the Labor Process and the Working Class, Monthly Review Press, New York.

Becker, D. M. and Brown, W. (1905) 'High Speed Steel in the Factory', The Engineering Magazine, Vol. 29, Sep.

Bee-Hive [Working Class Journal edited by George Potter].

Beecham,B.J.(1982), 'The Universities and Technical Education in England and Wales', Journal of Further and Higher Education,6,1,(Spring).

Bell, D. (1973) The Coming of Post Industrial Society, Basic Books, N.Y.

Bement, Mills & Co.(1893),Illustrated Catalogue of Metal-working Tools, Philadelphia.

Benjamin, C. H. (1906) Modern American Machine Tools, Constable, London. (Professor of Mechanical Engineering at the Case School of Applied Science, Cleveland, Ohio).

Berg,Maxine(Ed)(1979),Technology and Toil in 19th Century Britain, CSE Books,London.

Berg,Maxine(1982),The Machinery Question and the Making of Political Economy,Cambridge U.P.

Berg,Maxine(1985), The Age of Manufactures, Fontana Press, London.

Bingham, J. H. (1949), The Period of the Sheffield School Board, 1870-1903, Northand, Sheffield.

Birmingham and Midland Institute Journal (1902-03).

Birmingham Municipal Technical School Magazine(1892),(1905).

Blanchet,J.(1953), Public Opinion and Technical Education in England 1867-1906: A Study of the Awakening of Public Opinion to the Importance of Scientific Research and Technical Education as Factors of Economic and Military Power, D.Phil Thesis, University of Oxford.

Blauner, R. C. (1973) Alienation and Freedom, University of Chicago Press, Chicago.

Board of Education, Statistics (1894-1901), Memorandum on the New Scheme of Regulations for Evening Schools and Classes under the Board of Education, Statistics and Returns, P.R.O. Document ED24/83.

Board of Education, Memorandum of Board of Education, 1905, HMSO, London.

Board of Education (1908-9). Report from Commissioners, (1910) Vol. XXII, Col. 5130.

Board of Education (1926) Survey of Technical Education, H.M.S.O.

Bowles,S and Gintis, H. (1977) Schooling in Capitalist America, R. & K. P. London.

Brackenbury, H. L. (1910) 'High Speed Tools', Proceedings of I.Mech.E., Vol. 79.

Bramhall, W.(1867) in Reports of Artisans, Journal Society of Arts(1867).

Braverman, H. (1974) Labor and Monopoly Capital, Monthly Review Press, N.Y. & London.

Brecher,J. et al(1978), 'Uncovering the Hidden History of the American Workshop',The Review of Radical Political Economics. Vol. 10, 4, Winter

Brennan, Edward (1959) 'Sidney Webb and the Technical Education Board', Vocational Aspect, 23, Autumn, also Sprll 1960.

Brennan,E.(1975), Education for National Efficiency: The Contribution of S and B Webb, Athlone Press, London.

Briefs, Goetz A. (1937) The Proletariat: A Challenge to Vestern Civilisation, McGraw Hill, New York.

British Association for the Advancement of Science (1897), 49th Annual Report, London.

Briggs,Asa and Saville,J(1967) Essays in Labour History, Macmillan, London.

Briggs,Asa(1970) The Nineteenth Century: Contradictions of Progress, Thames and Hudson, London.

British Labour Statistics (1971) Historical Abstracts (1886-1968), Department of Employment and Productivity, London, table 102.

British Labour Statistics (1971), Historical Abstracts 1886-1968, Tables 159, 196.

Brown,A.B.(Ed)(1868) Engineering Facts and Figures for 1868, Spon,London.

Brown and Sharpe Manufacturing Company(1891), Treatise on the Construction and Use of Universal and Plain Grinding Machines, Providence.

Buchanan, G. & Co.(1864),(1884) Descriptive List of General Machinery. London.

Buchanan, R. (1841) Practical Essays on Mill Work and Other Machinery (3rd Edition revised by G. Rennie). London.

Buchanan,R.A. (1985), 'Institutional Proliferation in the British Engineering Profession, 1847-1914', Economic History Review,38,1.

Buckingham, Earle (1920) Principles of Interchangeable Manufacture. Industrial Press, New York (1941). (Member American Society of Mechanical Engineer, ASME).

Burawoy,M (1978) 'Towards a Marxist Theory of the Labor Process: Braverman and Beyond' Politics and Society, 8, No. 3-4.

Burawoy, Michael (1979) Manufacturing Consent: Changes in the Labor Process under Monopoly Capitalism, University of Chicago Press.

Burawoy, Michael (1985) The Politics of Production, Verso, London.

Burgess,K.(1969) 'Technological Change and the 1852 Lockout in the British Engineering Industry,' International Journal of Social History,14,Pt.2.

Burgess,K.(1972)'Trade Union policy and the 1852 Lockout in the British Engineering Industry', International Review of Social History,17,Pt3.

Burgess,K.(1975) The Origins of British Industrial Relations, Croom Helm.

Burgess,K.(1986) 'Authority Relations in the Division of Labour in British Industry with Specific Reference to Clydeside,c1860-1930', Social History, Vol VII,May.

Burn,D.L.(1931),'The Genesis of American Engineering Competition,1850-1870', Economic History,ii, Jan. 292-311.

Burnett, J. (1881) 30th Annual Report A.S.E.

Burnett, J. (1886) Trade Unions as a Means of Improving the Conditions of Labour, in Oliphant, James (Ed) (1886).

Burns, T.(1962) 'The Sociology of Industry', in A. T. Welford (Ed)(1962).

Burris, B. (1985) 'Technocratic Management: Social & Political Implications', in Knights, D. & Willmott H. (Eds) (1985)

Burris, Val (1980) 'Capital Accumulation and the Rise of the New Middle Class', The Review of Radical Political Economics, 12, (Spring).

Burton,F.G.(1905), Commercial Management of Engineering Works, Scientific Publishing Company Co. Manchester.

Butler, J. & Co. Victoria Iron Works, Halifax, General Catalogue.

Calder, J. (1910) Rapid Production in Machine Work, Proc.I.Mech. E., Vol 79 (Calder was a member of A.S.M.E.).

Calvert, M. A. (1967) The Mechanical Engineer in America, 1830-1910, Johns Hopkins Press, Baltimore.

Cantrell, J.A. (1984) James Nasmyth and the Bridegewater Foundry: A Study of Entrepreneurship in the Early Engineering Industry; printed for the Chetham Society.

Cardwell,D.S.L(1972) The Origin of Science in England, Heinemann, London.

Cardwell, D. S. L(1972) Technology, Science and History, Heinemann, London, p.46.

Carpenters' Company's Technical School(1964) The Story of the Carpenters' Company's Technical School, 1891-1905, London.

Carroll,C(1979) 'Craft Education and Training for the Engineering Industry,' Coombe Lodge Report, Vol 12.3.

Census of Production (1907) Accounts and Papers, Vol. CIX (1910) London 1913, Statistical Tables, Sec.7, table 1, p.29.

Census of Production (1907) (a) Part 1, General Report, Final Report(1913), table 21.

Chadwick, R. (1965) 'The Working of Metals', in Singer et al, (1965) p.605 et seq.

Chapman,W.A.J.(1943), Workshop Technology,Pt.I, Arnold, London.

Checkland, S. G. (1972) The Rise of Industrial Society in England, 1815-1885, Longmans Green, London.

Children's Employment Commission (1864)(C.E.C) 3rd Report, Appendix and Evidence, Parliamentary Papers, Vol. XXII, 1864.

C.E.C. (1864) 1. Evidence of F. N. Cotterill of Cotterill's Screw Bolt Works.

C.E.C. (1864) 2. Evidence of J. Hetherington.

C.E.C. (1864) 3. Evidence of G. Norton, Manager Horton's Screw Bolt Manufactory, Darlaston.

C.E.C. (1864) 4. Evidence of W. Elkington, Manager, The Crown Nail Co. Wolverhampton.

C.E.C. (1864) 5. Evidence of foreman at Messrs. Walker and Hackney, Bury.

C.E.C. (1864) 6. Evidence of Nathaniel Shaw of John Hetherington & Sons, Machine Makers, Manchester.

C.E.C. (1864) 7. Evidence of Mr. Walker of Walker & Hackney, Bury.

C.E.C. (1864) 8. Evidence of W. Madeley, partner in Messrs. Parr, Curtis and Madeley.

C.E.C. (1864) 9. Evidence of Mr. Palmer, partner in Messrs. Platt Brothers & Co., Oldham.

C.E.C. (1864) 10. Evidence submitted by Messrs. Iver and Hall, Bury.

C.E.C. (1864) 11. Evidence of Johnson of the Ashbury Railway Carriage and Iron Company Openshaw, Lancs.

C.E.C. (1864) 12. Evidence of John McEwen, submitted to Government investigator H. W. Lord.

City and Guilds of London Institute(CGLI)(1880), Technological Examinations for 1879, London.

CGLI(1882,1883), Report to Governors.

CGLI, Calendar for the Session 1887-8.

CGLI (1896) A Short History of the City and Guilds of London Institute for the Advancement of Technical Education, CGLI, London.

CGLI(1901) Department of Technology, Report 1900-1901, London.

CGLI Finsbury Technical College Programme (1893-4); also Programme for 1923-24 (1924).

CGLI, 'The Central' [Journal of the Central Institute of the CGLI, edited by E. Frankland Armstrong].

Clapham, J. H. (1938) An Economic History of Modern Britain Vol. 3, Cambridge University Press.

Clark,J.,McLoughlin,I.,Rose,H.,King,R.,(1988) The Process of Technological Change, Cambrige University Press, Cambridge.

Clarke,R.O.(1957)'The Dispute in the British Engineering Industry,1897-1898: an Evaluation', Economica,94,May,128-137.

Clegg, H. A., Fox, A. and Thompson, A. F. (1964) A History of British Trade Unions Since 1889, Clarendon Press.

Clegg,S. and Dunkerley, D. (1980) Organisation, Class and Control,Routledge and Keegan Paul, London.

Clements, R. V. (1961) 'Trade Unions and Popular Political Economy 1850-1875', The Economic History Review, 2nd series, XIV, 1.

Cole, G. D. H. (1937) 'Some Notes on British Trade Unionism in the Third Quarter of the Nineteenth Century', International Review of Social History II.

Collier, Wm. & Co. (1863). Price List of Machines and Tools. Manchester.

Collins, H., and Abramsky, C. (1965) Karl Marx and the British Labour Movement, Macmillan, London.

Colt, R. (1854)(Leading Arms Manufacturer and Employer) Evidence to Select Committee on Small Arms (1854).

Coltham, S. (1965) 'George Potter, the Junta, and the Bee-Hive', International Review of Social History.x.1965.

Committee on the Co-ordination of Technological Education(C.C.T.E)(1900), Minutes 1900-01, Report to President of Board of Education, the Duke of Devonshire, P.R.O. Ed.24/36.

Committee on Labor (1911), evidence to Hearings before the Committee on Labor of the House of Representatives, 62nd Congress, 1st Session on House Resolution 90. Investigation of the Taylor System of Shop Management, April Congressional Hearings 41st-73rd Congresses, 1869-1934, Vol. 41, 1908-1911, p.254. (Evidence of Gompers, President of the American Federation of Labor, A.F.L.).

Conference Report (1868). Conference on Technical Education, Journal of Society of Arts, 31st Jan. 1868.

Contemporary Review(1877).XXX, [G.Howell, 'Trade Unions and Apprentices']; also Idem, 55,(1889).

Coombe Lodge Report(1981),13,14 (Report by the Principal Training Officer of the Engineering Training Board(EITB).

Coombs, Rod (1978) 'Labour and Monopoly Capital', New Left Review. 107.

Cotgrove, S. (1958) Technical Education and Social Change, Unwin, London.

Cotgrove, S. (1968) The Sociology of Science and Technology, Bath University Press.

Cotgrove, S. and Box, S. (1970) Science, Industry and Society, Allen and Unwin, London.

Couch,V.J.(1955), A Sociological Interpretation of the Development of Technological Education in England, France and Germany During the 20th Century, Ph.D Thesis, University of London.

Cowan, I. R. (1969) 'Sir William Mather and Education', The Vocational Aspect of Education. XXI. 48. Spring.

Crocker,F.B.(1901) 'The Electric Distribution of Power in Workshops', Quoted in Du Boff(1967).

Cronin,James(1979) Industrial Conflict in Modern Britain, Croom Helm, London.

Cronin,James(1987) 'Strikes and Power in Britain, 1870-1920', International Review of Social History,XXXII,2.

Crowley, D. W. (1956) The Origin of the Revolt of the British Labour Movement from Liberalism, 1875-1906, Ph.D. Thesis, London.

(The) Daily Chronicle, 20th Jan. 1897.

Curtis,S.J.(1963) The History of Education in Great Britain, University Tutorial Press, London.

Cutler, Tony (1978) 'The Romance of Labour', Review Article, Economy and Society, 7, 1, p.80.

(The) Daily Record, 12th Oct. 1897.

Davies, M. and Broadhead, F. (1975) 'Labor and Monopoly Capital: A Review', Radical America, 9.

Derry,T.K. and Williams,T.I.(1960) A Short History of Technology, Oxford.

Dickinson, H. and Erben, M. (1982) 'Technical Culture and Technical Education in France', British Journal of Sociology of Education, Vol. 3, No. 2.

Dictionary of Scientific Biography (1976) Gillespie, C. C. (Ed.), Vol. XIII, New York.

Digest of Statistical Information(1971), The Mechanical Engineering Industry,National Economic Development Office(NEDO),Sep. table 4.1.

Directory of Science (1895) A Directory of Science, Art and Technical Colleges in the U.K. (1895), Institute of Civil Engineers, London.

Dobbs, A. E. (1919) Education and Social Movements 1700-1850, Longman, Green & Co., London.

Donajgradski, A. P. (1977). Social Control in Nineteenth Century Britain, Croom Helm, London.

Donnelly,C. Evidence to Royal Commission on Trade Unions(1868); also evidence to R.C. on Trade Instruction (1884).

Du Boff,R (1967), 'The Introduction of Electric Power in American Manufacture', Economic History Review,xx,3.

Dubin, R. (1959) Working Union-Management Relations: The Sociology of Industrial Relations, Prentice Hall, New York.

Dundee Weekly News 22nd May 1897.

Dunlop,O.J(1912) English Apprenticeship and Child Labour, T.Fisher Unwin, London.

Dunlop,J.T. and Galman,W.(Eds)(1978) Labor in the Twentieth Century, Academic Press, N.Y.

Edwards, R. (1979) Contested Terrain, Basic Books, London.

Elbaum,B.(1979),'The Labour Process, Marxist Structures, and Marxist Theory, Cambridge Journal of Economics,iii'

Elcho, Lord, Letters,Elcho to Walpole (1856), 2nd Nov. 1856 and Dec. 1866, Wemyss MSS, (RH4-40/8). [Elcho was the eldest son of the 8th Earl of Wemyss(Register of Archives,Edinburgh, Rh4/40/9)].

Elcho (1865) Letter to Solly, May 1865, Wemyss MSS. (RH4-40/8).

Elcho (1867). Address by the Executive Committee representing the operative classes of the United Kingdom, to Lord Elcho, Glasgow(RH40/8)

Elcho (1885) Speech in House of Lords, in Socialism at St. Stephens, 1864-1885, Liberty and Property Defence League, London, 1885.
(Elcho was President of the L. & P.D.L.).

Eldridge, J. E. T. (1971) Sociology and Industrial Life. Nelson, London.

Elger, A. (1979) 'Valorization and Deskilling: A Critique of Braverman', Capital and Class No. 7.

Elger, A. (1982) 'Braverman, Capital and Accumulation and Deskilling', in Woods, S. (1982).

Employment Gazette(1989), Department of Trade and Industry, London, Jul/Aug.

Engels, F. (1882) Letter Engels to Kautsky; letter (1883) to Bebel, in Torr,Dona(Ed)(1934).

Engels, F. (1889) Letter to Sorge, Dec. 1889, in Torr,Dona(Ed)(1934), p.461.

The Engineer 12th Dec. 1890. Report of a Visit to American Workshops by the Iron and Steel Institute (England).

The Engineer. 28th Jan. 1898. 2nd Dec. 1898. 15th Dec. 1899.

The Engineer(1978). 'Highlights of 120 Years'.

Engineering. (1867) 19th July

Engineering(1897) 24th/29th Sept. 1st Oct.22nd Oct.29th Oct.3rdDec.

Engineering. (1903) 30th Oct: Vol xxx 1905.

Engineering Employers Federation Minute Book, No. 1, 1895-1899, London.

EEF(1896) Conditions of Federation,LSE Lib. R(Coll),E.B.xlvi,4.

E.E.F. Minute Book (1896) Minutes of Executive Board of the Engineering Employers' Federation, 13th Aug. 1896; 19th Dec. 1896.

E.E.F. Minute Book (1897) Minutes of a Meeting of the Whole of the Members of the Federated Association, London, Feb. 1897.

E.E.F 'Federated List' (1898) List of Federated Engineers and Shipbuilding Employers who resisted the Demand for a 48-hour working week, E.E.F. Glasgow, Preface.

E.E.F. Case Register (1901) Minutes 1895-1906, Minutes of 15th Jan.

Engineering Employers' Federation (b) Index Nos. 1-2, Minute dated 10th Nov. 1903.

E.E.F. Case Register (1903/4) Minutes 28th Dec, Jan 1904, 5th Feb 1904.

E.E.F. Case Register (b) Minute 9th, 10th and 12th August 1904.

E.E.F. (1904) Article 7 of Agreement between Engineering Employers Federation and Amalgamated Society of Engineers, made on 22nd Mar. 1897, Minuted as complete document in E.E.F. Minute Book, No. 3 1904.

E.E.F. Circular Letters to Local Associations, Jan. 1901-Dec. 1906, Index Nos. 1-294, 13th March, 1906.

E.E.F. Minute Book No. 3 1904-1907.

E.E.F. Minutes (1907). Agreement between E.E.F. and A.S.E. 22nd March, 1907 [My Appendix 2(c)].

EEF (1926)Decisions of Central Conference,1898-1925, LSE Lib.Rx20.972.

Engineering and Allied Employers Federation(1927) Thirty Years of Industrial Conciliation, London.

Evans,Austin(1890), The Law Relating to Aprentices, London.

Evans,Francis (1986) 'Masters of the Machine', The Times Higher Educational Supplement, 19.9.

Eyre,J.V,(1958), Henry Edward Armstrong, Butterworth.

Faibairn, W. (1864) Treatise on Mills and Millwork, 2nd Edition, 2 Vols. London.

Faunce,W.A. and Form,W.H.(Eds)(1969),Comparative Perspectives on Industrial Society, Little Brown, Boston.

Feldman, A. S. and Moore, W. E. (1969) 'Industrialisation and Industrialism' in Faunce, W. A. and Form, W. H. (Eds)(1969).

Ferguson,E.S.(1968) Bibliography of the History of Technology,M.I.T.

Fisher.H.A.L.(1919) Proposals for Developing the National System of Technical and Commercial Instruction; Reply to Prime Minister's Inquiry regarding Technical Education, Public Record Office (PRO)Document,3rd Dec.

Flanders,A.(1964) The Fawley Productivity Agreements: A Case Study of Management and Collective Bargaining, Faber, London.

Flanders, Allan (1970) Management and Unions, Faber & Faber, London.

Idem(1970) 'Trade Unions and the Force of Tradition', in Management and Unions (Idem)

Fleck, Sir A. (1965) 'Technology and its Social Consequences', in Singer et al (1965).

Fleming ,A.P.M. & Brocklehurst(1925), A History of Engineering, A & C Black, London.

Fleming A.P.M. and Pearce,J.G.(1916) Principles of Apprentice Training, Longmans , London.

Floud, Roderick (1976) The British Machine Tool Industry, 1850-1914, C.U.P.

Floud,R.(1985) 'Technical Education, 1850-1914: Speculations on Human Capital Formation', in Joberg,L. and Rosenberg,N.(1985).

Foden,F.(1982) 'The Technological Examinations of the City and Guilds of London Institute', in McLeod,R.(Ed)(1982).

Ford, H. (1921) My Life, New York.

Form of Indenture (1904) Tyneside Engineering Company.

Foster, John (1977) Class Struggle and the Industrial Revolution, Methuen, London.

Fraser's Magazine: Volumes for 1870 and 1871.

Friedman,A.(1977) Industry and Labour: Class Struggle at Work and Monopoly Capitalism, Macmillan.

Galloway, D. F. (1958) 'Machine Tools', in Singer, Charles et al (1958) pt. vii ch.26. (Director of Research Association, G.B.).

Garner,A.D.(1985) 'The Society of Arts and the Mechanics' Institutes(1851-1854)', History of Education,14,4,Dec.

Garnsey, Elizabeth (1981) 'Rediscovery of the Division of Labor', Theory and Society, Vol. 10, 3rd May.

Gibbons, M. & Johnston, C. (1970) 'Relationship between Science and Technology', Nature, 227.

Gledhill,J.M.(1904),'The Development and Use of High Speed Tool Steel', in Iron Age,10th Nov.

Goldthorpe, J. H. (1964) 'Social Stratification in Industrial Society', Sociological Review Monograph No. 8.

Gordon, D. M. (1976) 'Capitalist Efficiency and Socialist Efficiency', in Baxendale et al (1976).

Gorz, André (1976) The Division of Labour, Harvester Press, Brighton.

Gospel,H.F.and Littler,C.(Eds)(1983) Managerial Strategies and Industrial Relations, Heinemann,London.

Goss,D.(1988) 'Diversity, Complexity and Technological Change: An Empirical Study of General Printing', Sociology, Vol 22,3,(Aug)417-443.

Gowing, Margaret (1978) 'Science, Technology and Education: England in 1870', Oxford Review of Education, Vol. 4, pp.3-17.

Gramsci, A. (1971) Selections from the Prison Notebooks, Hoare, Q. and Newell Smith, G (Eds)(1971), Lawrence and Wishart, London,.

Granovetter,M. and Tilly,C.(1988) 'Inequality and Labor Process', in Smelser,N.J.(Ed)(1988).

Gray, R. Q. 'Styles of Life. The Labour Aristocracy and Class Relations in Later Nineteenth Century Edinburgh'. International Review of Social History 18, 1973, pp.428-452.

Gray,R.Q.(1976) The Aristocracy of Labour in 19th Century Britain, c 1850-1914, Macmillan, London.

Groh, Dieter(1978),'The Intensification of Work and Industrial Conflict in Germany,1896-1914', Politics and Society, Vol.8,3-4.

Grossick,G(1976) 'The Labour Aristocracy'. Victorian Studies XIV 3, Mar.

Gulowsen,Jon(1988) 'Skills, Options and Unions: United and Strong or Divided and Weak', in Hyman,R. and Streeck,W(Eds)(1988).

Habakkuk, H. J. (1962) American and British Technology in the Nineteenth Century, Cambridge U.P.

Hackwood, F. (1889) Wednesbury Workshops; or Some Account of the Industries of a Black Country Town, Horton Brothers, Wednesbury.

Haines (1958) 'German Influence upon Scientific Instruction in England 1867-1858', Journal of Victorian Studies, Vol. 1, Mar. 1958, pp.215-244.

Hall,B.T.(1912) Our Fifty Years: The Story of the Working Men's Club and Institute, London.

Hansard (1869) Col. 160. Report to House by B. Samuelson (Chairman of Samuelson Report on Technical Education 1868).

Hansard (1869). 3rd Series, Vol. CXCVIII, July. 1869-Aug. 1869, Col. 198, Col.199

Hansard (1881), 3rd Series, Vol. CCLX, Mar. 1881-May 1881, col. 546, (Speech by Broadhurst, M.P. for Stoke).

Hansard (1881), cols. 527, 537, 538(on the decline of the apprenticeship).

Hansard (1889), 3rd Series, Vol. CCCXXXIX, Aug. 1889 Col. 1252. [Mather, M.P.].

Hansard (1889). 3rd Series, Vol. CCCXL.

Harrison,J.F.C(Ed) (1974) George Howell, Eminently Victorian, B.B.C., London, pp.98, 113.

Harrison,Royden(Ed) The English Defence of the Commune 1971, Merlin Press, London.

Harrison,R. and Zeitlin,J.(Eds)(1985) Divisions of Labour: Skilled Workers and Technological Change in 19th Century England, Harvester Press.

Hartwell,R.M.(1971) The Industrial Revolution and Economic Growth, Methuen.

Hathaway,H.K.(1914), 'Elementary Time Study as a Part of the Taylor System of Management', in Thompson,C.B.(Ed)(1914).

Hearn, Francis (1978) Domination, Legitimation and Resistance: The Incorporation of the Nineteenth Century English Working Class, Greenwood Press, Westport, 1978.

Heward,Christine(1980) 'Industry,Cleanliness and Godliness: Sources in the History of Science and Technical Education and the Working Classes, 1850-1910', Studies in Science Education,7, (1980).

H.M.S.O. (1915). Inquiry by Board of Trade into the Conditions of Apprenticeship and Industrial Training in Various Trades and Occupations in the U.K., London, [Engineering, Shipbuilding and Allied Trades, p.57].

H.M.S.O. (1928) Ministry of Labour. Report of an Inquiry into Apprenticeship and Training. History of Apprenticeship, Pre-War Apprenticeship, 1814-1914, London.

H.M.S.O. (1928a) Legal Status of Apprentices at Common Law, p.18.

H.E. Conference (1903). Report of Proceedings of the Conference on Higher Education between NAPTSE (National Association for the Promotion of Technical and Secondary Education) and Representatives of the County and County Borough Councils and other Educational Bodies, held at the I.Mech.E., 17th March 1903 [Chairman Lord Avelney], Tracts on Education, 1850-1903, London, 1904

Hill,C.P.(1973) British Economic and Social History 1700-1964, Arnold, London.

Hirszowicz, M. (1981) Industrial Sociology: An Introduction. Robertson, Oxford.

Hobsbawm, E. J. (1951) 'The Tramping Artisan', Economic History Review, Series 2, III, (1950-1951).

Hobsbawm, E. J. (1954) 'Labour Aristocracy in Nineteenth Century Britain', in Saville, J. (Ed.) (1954).

Hobsbawm, E. (1968) Labouring Men, Weidenfeld and Nicholson, London.

Hobsbawm,E.J.(1974) Industry and Empire, Penguin.

Hobsbawm E.J.(1984) 'Labour Aristocracy', Economic History Review, XXXVII, 3,(Aug).

Hoffman,Ross,J(1933) Great Britain and the German Trade Rivalry 1875-1914, University of Pennsylvania, Pennsylvania.

Hollingum,Jack(1976),'America's Contribution to "rough-and-ready" labour Saving Tools', in the Engineer(1976).

Horn,C.A.and Horn,P.L.R.(1981) 'Payment by Results and Technical Education', Journal of Further and Higher Education,5,1,Spring,30-39.

Horn,Pamela(1982) 'The Corps of Royal Engineers and the Growth of British Technical Education', Journal of Educational Administration and History,14,1,Jan.

Horn.C.A.and P.L.R.(1983), 'The ATTI and its Policies, 1904-1914',J.E.H.E.,7,1,Spring,8-22.

Idem.(1984) 'The CGLI and Technical Education in Victorian England',J.E.H.E.,8,1,Spring,75-898.

Horner, J. G. (1900) English and American Lathes, Whittaker & Co., London (Member I.Mech.Eng.).

Hoxie,R.F.(1914), Objections to Scientific Management,Appleton, New York.

Hoxie, R. F. (1918). Scientific Management and Labor, Appleton, New York (This publication, based on the 1915 investigation into 'scientific management' on behalf of the U.S. Commission on Industrial Relations includes, in addition to an analysis of Taylorism, an examination of the principal variants of the system which were the Gant and Emerson models, insofar as these differed significantly from the main tenets of F. W. Taylor's model).

Howell,Geo.(1878) Conflicts of Capital and Labour Historically and Economically Considered, Being a History of the Trade Unions of Great Britain, Macmillan , London.

Hughes,T.P.(1985) 'Edison and Electric Light', in MacKenzie,D. and Wajcman,J.(Eds)(1985).

Hutton,F.R.(1883), Miscellaneous Documents of the House of Representatives, 42nd Congress,2nd Session, Report on Machine Tools and Woodworking Machinery, in Report on Power and Machinery employed in Manufactures, Washington.

Huxley, T. H. (1868) Paper on Technical Education at Conference on Technical Education. Journal Society of Arts, Vol. XV, 31st Jan. 1868.

Huxley, T. H., (1887) Address of Behalf of the National Association for the Promotion of Technical Education, in Huxley,T.H. Collected Essays Vol. III (1893) London.

Hyman,R.and Streeck,W.(Eds)(1988) New Technology and Industrial Relations, Basil Blackwell,Oxford.

Imperial College of Science and Technology(1967) List of Papers and Correspondence of Lyon Playfair.

Inglis, John (1894) The Apprentice Question: Paper read before the Economics Section, Philosophical Society of Glasgow, Glasgow.

Institute of Civil Engineers(1891), Engineering Education in the British Dominions, London.

Institute of Civil Engineers(1906) Report of the Committee, appointed 24th Nov. 1903, and Report to the Council upon the subject of the Best Methods of Education and Training for all Classes of Engineers, London.

Institution of Mechanical Engineers(1901) Proceedings, London.

I.Mech.E. Proceedings(1903), Vol. 64, Discussion Paper on Technical Education, Vol 67 (1904), London.

I.Mech.E.(1923)Abstract of Selected Papers, 1841-1921, London.

Iron Age(1904), 'Profit in the Use of High Speed Tools',Dec.1st.

(The) Iron and Coal Trades Review(1902), 'New Tool Steels and their Advantages', 20th and 22nd June.

Iron Trades Employers' Association(ITEA) (1876)(a). The Piece Work Question and its Results in Engineering and Other Shops in the Iron Trades of the Country, Manchester.[The ITEA was the forerunner of the EEF].

I.T.E.A. (1876)(b). Speech made in London 20th March 1876.

Iron Trades Employers Association Record(I.T.E.A)(1901), 1872-1900, London (the 'Record').

Isherwood,N.S.and Senker,P.S(1978) Technical and Organizational Change in the Machine Shop, EITB Mimeograph.

Jacoby, R. (1976) 'Harry Braverman, Labour and Capital',Telos, 29, Fall.

Jalee, Pierre (1977) How Capitalism Works, Monthly Review Press, New York.

Jefferys, J. B. (1945) The Story of the Engineers, 1800-1945, Lawrence & Wishart, London.

Jefferys,M(1947) 'The Skilled Engineer in 1861', Economic History Review,xviii.

Jefferys, M. and J. B. (1947) 'The Wages, Hours and Trade Customs of the Skills Engineer in 1861'. Economic History Review, XVII.

Jefferys,J.B (1948) Labour's Formative Years 1849-1879, Lawrence and Wishart, London.

Jevons,W.S(1910) The State in Relation to Capital, Macmillan, London.

Joberg,L. and Rosenberg(Eds)(1985) Technological Change, Employment and Investment, 8th International History Congress, Budapest, 1982. Published by the Department of Economic History, Lund University, Sweden, 1985.

Johnson, R. (1969). The Blue Books and Education, 1816-1896, Centre for Contemporary Cultural Studies, Birmingham.

Johnson, R. (1977) 'Educating the Educators: Experts and the State, 1833-9', in Donajgradski (1977).

Johnston,R.D.(1972) 'The Internal Structure of Technology', Sociological Review Monograph,18.

Jones, Gareth Steadman(1974),'Working Class Culture and Working Class Politics in London,1870-1950', Social History,7, Summer:450-508.

Jones and Wood(1985) Tacit Skills, Division of Labour and New Technology, mimeo.

Journal S.O.A. (1868) Journal of Society of Arts, London.

Journal Society of Arts (JSoA) (1889-90) Vol. 30.

Joyce, P. (1980) Work, Society and Politics: The Culture of the Factory in Later Victorian England, Methuen, London.

Joyce,P.(1984) 'Labour, Capital and Compromise: A Response to Richard Price', Social History,IX.

Keane,P.(1970),The Evolution of Technical Education in 19th Century England, Ph.D. Thesis, University of Bath.

Kerr, C., Dunlop, J. T. et al (1973) Industrialism and Industrial Man. Penguin, London.

Knights,D. Willmott,H. Collinson,D.(Eds)(1985) Job Redesign:Critical Perspectives in the Labour Process, Gower Press, Aldershot.

Knowles,L.C.A.(1966), The Industrial and Commercial Revolutions in Great Britain during the 19th Century, Routledge and Kegan Paul, London.

Knox,W.(1986), 'Apprenticeship and De-skilling in Britain 1850-1914', International Review of Social History xxxi,Pt2,166-184.

Koenisberger, F. (1962) 'Metal Cutting Tools', in H. Wright Baker, (Ed) (1962).

Koss, S. E. (1970) Sir John Brunner Radical Plutocrat, 1842-1919. Cambridge University Press , p.35.

Kransberger,M. (1962), 'Milling', in Wright Baker(Ed)(1962).

Kranzberg,M and Pursell,C.W.(1967) Technology and Western Civilization, Oxford University Press,Vol 1.

Kynaston,D.(1976) King Labour: the British Working Class 1850-1914, Allen and Unwin, London.

(The) Labour Leader, 6th Oct., 16th Oct., 24th Oct. 1891, Jul 1897 (a leading labour journal of the period edited by Kier Hardie).

Lacqueur, T. W. (1977) 'Religion and Respectability: Sunday Schools and Working Class Culture, 1780-1850', in Reeder(Ed)(1977).

Landes, D. (1969) The Unbound Prometheus, Cambridge University Press.

Lang, J. (1978) City and Guilds of London Institute, Centenary 1878-1978, C.G.L.I. London.

Larson, Margali Sarfatti (1980) 'Proletarianisation and Educated Labour', Theory and Society, Vol. 9.

Law,J.(1987) Review of MacKenzie,D. and Wajcman,J.(Eds)(1985), The Sociological Review,35,2, May 1987.

Lazonick, William (1977) 'Appropriation and Reproduction of Labor', Socialist Review, 38.

Layton,E.T.(Ed) 'Technology as Knowledge' in Technololgy and Culture 15,Jan(1974).

Lee, D. J.(1979) 'Craft Unions and the Force of Tradition the Case of Apprenticeship', British Journal of Industrial Relations, Vol. XVII, No. 1.

Lee, D. J. (1981) 'Skill, Craft and Class: a Theoretical Critique and a Critical Case', Sociology, 15, 1, pp.56-78.

Le Guillou, M. (1981) 'Technical Education 1850-1914', in Roderick, G., and Stephens, M. (Eds) (1981).

Levine,A.L.(1954), Industrial Change and its Effects upon Labour,1900-1914, Ph.D Thesis, University of London.

Levine,A.L.(1967), Industrial Retardation in Britain, 1880-1914, Garden Press Ltd.

Liepmann, Kate (1960) Apprenticeship. An Enquiry into its Adequacy under Modern Conditions, R. & K. P. London.

Lineham,R.S.(1895) A Directory of Science, Art, and Technical Colleges, Schools and Teachers in the U.K., Chapman and Hall, London.

Littler, Craig R. (1978) 'Understanding Taylorism', British Journal of Sociology, Vol. 29, 2 June 1978.

Littler, C. (1980) The Bureaucratisation of the Shop Floor. The Development of Modern Work System, Ph.D. London (L.S.E.).

Littler,C.(1982) The Development of the Labour Process in Capitalist Societies, Heinemann, London.

Littler, Craig and Graeme Salaman (1982) 'Braverman and Beyond: Recent Theories of the Labour Process'. Sociology Vol. 16, 2, May.

Livery Companies Report (1878). Report on Technical Education, London.

Llewellyn Smith, H. (1892) London County Council, Report to the Special Committee on Technical Education.

L.C.C. (1893) Resolution of London County Council, Appendix A35, Feb.

L.C.C. (1906) London County Council, Education Committee. Report of the Section appointed to consider the Question of Apprenticeships, London, January, 1906.

L.C.C. (1909) (a) Higher Education Report, on return of occupations to which children who left school during the educational year 1906-7 were sent, Feb. 1909.

L.C.C. (1909) London County Council Higher Education sub-committee Report, Minutes of Proceedings, Feb. 1909, p.415.

London Technical Education Gazette (1895) Oct. L.C.C., London.

London Trades Council(1869), Minute Books,19th May, 1868; 8th April, 1873; February 1878.

Ludlow, J. M. and Lld.Jones, (1867) Progress of the Working Class, 1832-1867, London.

MacKenzie,D. and Wajcman,J.(Eds)(1985) The Social Shaping of Technology, O.U.Press, Milton Keynes.

Magnus, P. (1910), Educational Aims and Efforts, 1880-1910, Longmans, London.

Maier,C.S.(1970), 'Between Taylorism and Technocracy: European Ideologies and the Vision of Industrial Productivity in the 1920s', Journal of Contemporary History,5,2,27-61.

Manchester Association of Engineers(1922) Report of the Lathe Tools Committee.

Manchester College of Science and Technology (1896-97) Syllabus for Session, Manchester Technical School.

Manchester Guardian,20th Jan 1897.

Mann, Tom (1897) Monthly Journal, June 1897.

Manwaring,T. and Wood,S.(1984), 'The Ghost in the Machine: Tacit Skills in the Labour Process', Socialist Review, Mar/Apl,74,55-85.

Manwaring,T. and Wood,S.(1985), 'The Ghost in the Labour Process', in Knights,D. et al(1985)

Marglin, (1974) 'What Do Bosses Do?', Review of Radical Political Economy, VI, Summer.

Marx, K.(1869) Letter to Engels, 5th April, in The Correspondence of Marx and Engels, in Torr,Dona(Ed) (1934).

Marx, K. (1878) Letter to W. Liebkneckt, Feb., 1878, in Correspondence of Marx and Engels (1846-1895),Ibid. p.355.

Marx, K.(1867),(1961) Capital, Vol. I. Foreign Language Publishing House, Moscow.

Marx, K. (1971) quoted in McLelland, D.(1971).

Marx, K. (1976) Wage, Labour and Capital, Progress Publishers, Moscow.

Marx, K. (1977) Capital, Vol. 1, Lawrence and Wishart, London.

Marx, K. (1977) Grundrisse, Penguin Books, Harmondsworth.

Mather (1909) Evidence of Sir William Mather (of Mather and Platt, Engineers of Oldham), the Commission on Poor Laws and Relief of Distress, P.P. Vol. XXXVI, Part VI.

McCann (1970) 'Trade Unionists, Artisans, and the 1870 Act'. British Journal of Eductional Studies XVIII.

McConnell, J. (1867) Engineering, 19th July (Juror in Machine Section, Paris Exhibition).

McCormick,Kevin(1988), 'Engineering Education in Britain and Japan: Some Reflections on the Use the 'Best Practice' models in International Comparison', Sociology,22,4,Nov:583-605.

McCullock,Gary(1987), 'School Science and Technology in 19th and 20th Century England: A Guide to Published Sources', Studies in Science Education,14,1-32.

McGrath, T. (1869) Letter to Engels, 5th April, in Torr,D.(Ed)(1934) The Correspondence of Marx and Engels, 1869-1898.

McGuffie,C.(1986) Working in Metal: Management and Labour in the Metal Industries of Europe, 1850-1914, Merlin Press, London.

McIvor,A.J.(1984) 'Employers, Organizations, and Strike Breaking in Britain, 1880-1914', International Review of Social History, xxix, Pt.1,1-33.

McKinlay,A.(1986) 'From Industrial Serf to Wage-labourer: the 1937 Apprentices Revolt in Britain', International Review of Social History,xxi,1,1986.

McLelland,D(1971) Marx's Grundrisse, Paladin Books.

Mcleod,R.(Ed)(1982) Days of Judgement: Science, Examinations and the Organization of Knowledge in Late Victorian England,Driffield, Nafferton.

McLoughlin,Ian and Clark,Jon(1988) Technological Change at Work, O.U. Press, Milton Keynes.

McLure,J.S.(1973)(Ed) Educational Documents, 1816 to the Present Day, Methuen, London.

Melling,J.(1980) 'Non-Commissioned Officers: British Employers and their Supervisory Workers, 1880-1920', Social History,5,183-221.

Melling,J.(1983) 'Employers, Industrial Welfare and the Struggle for Work-Place Control in British Industry, 1880-1920', in Gospel,H. and Littler,C.(Eds)(1983).

Ministry of Supply(1950), Enginering Industries Division, Standard Classification of Machine Tool Types,Pt,1,Metalworking Machines, HMSO.

Montgomery,D.(1976) 'Workers Control of Machine Production in the 19th Century', Labor History,17, Fall:485-509.

Moore,R.(1987), 'Education and the Ideology of Production', British Journal of Sociology of Education,8,2,227-242.

Moorhouse,H.F.(1973) 'The Political Incorporation of the British Working Class: an Interpretation', Sociology,7.

Moorhouse, H. F. (1978) 'The Marxist Theory of the Labour Aristocracy', Social History, III, 1, p.70.

More,Charles(1980) Skill and the English Working Class, Croom Helm, London.

More, Charles (1982) 'Skill and the Survival of Apprenticeship', in Wood (S),(Ed) (1982).

Morris,R.J.(1981) Review of More,C.(1980), British Book News,(1981).

Mosely Industrial Commission to the U.S. of America(1902), Reports of the Delegates, Report by ASE secretary Barnes, Manchester.

Murphy, G. (1870) Letter 14th July to Lord Elcho regarding a meeting to be held on 22nd July, at Lambeth Baths, Wemyss MSS, op. cit [RH4 40/8].

Murphy,P.J.(1978) 'The Origins of the 1852 Lockout in the British Engineering Industry Reconsidered', International Review of Social History, Vol XXIII, Pt2.

Musgrave,P.W.(1964), 'The Definition of Technical Education', Vocational Aspect, Summer.

Musgrave, P. W. (1966) 'Constant Factors in the Demand for Technical Education, 1860-1969', British Journal of Education Studies, XIV, Nov. 1965-May 1966.

Musgrave, P. W.(1967) Technical Change, the Labour Force, and Education, a Study of the British and German Iron and Steel Industries, Pergamon Press, Oxford.

Musson, A. E. (1957) 'James Nasmyth and the Early Growth of Mechanical Engineers', Economic History Review, 2nd Series, X, (1957).

Musson, A. E. (1966), Joseph Whitworth (1803-1887), Exhibition, I.Mech.E.

Musson, A. E. (1976) 'Class Struggle and the Labour Aristocracy, 1830-1860'. Social History III 1976.

Musson A.E. and Robinson,E.(1969) Science and Technology in the Indusrial Revolution, Manchester.

Nadworny,Milton(1957) 'Frederick Taylor and Frank Gilbreth: Competition in Scientific Management', Business History Review,XXXI, Spring.

Nasmyth, J. (1841) 'Remarks on the Introduction of the Slide Principle', in Buchanan R. (1841). Appendix B.

Nasmyth, J. (1854) Evidence to the Select Committee on Small Arms, Reports from Committees, Vol. XVIII.

Nasmyth, J. (1868) Reports from Commissioners, R.C. on Trades Unions, 10th Report. Parliamentary Papers Vol. XXXIV, Minutes of Evidence.

Nasmyth, J. (1868) Evidence to R.C. on T.U. July 1868.

Nasmyth, J. (1883) James Nasmyth, Engineer - An Autobiography (Ed. S. Smiles), John Murray, London.

National Association for the Promotion of Secondary and Technical Education(NAPTSE)(1899), Technical Education in England and Wales, 1st and 2nd Anual Reports, London.

Idem(1890) Guide to Evening Classes, London.

(The Dictionary) of National Biography(1965) Leder,S and Lee,S(Eds), London.

Nature, Volumes XX(1879), XXXIII(1885)

Neale,R.S.(1969) 'Class and Class Consciousness in Early Nineteeth Century England, Three Classes or Five?' Victorian Studies, XII.

Newcastle Weekly Chronicle, 3rd July, 1875.

Nichols,T(1977) 'Labour and Monopoly Capital', Sociological Review.

Nicholson,J.S.(1878) The Effects of Machinery on Wages, Swann Sohnenschein, London, Revised 1892.

Niles Tool Works(1891) Catalogue, Hamilton, Ohio.

Nineteenth Century(1888), Vol XXIV, September, London.

Noble,D.F.(1977) America by Design: Technology and the Rise of Corporate Capitalism, Knopf, New York.

Odger's Monthly Pamphlets, Nos 1 and 2 (1872).

(The) Observer, 12th August 1989.

Oliphant,J.(Ed)(1886) The Claims of Labour, Cooperative Printing Co., Edinburgh.

Orcutt,H.F.L(1902) 'Modern Machine Methods', Proc.I.Mech.E. Vol.62.

Oxhey,D.(1981) The Development of Craftsmen and Limited Workers, Coombe Lodge Report, 13,14.

Palmer,Bryan(1975) 'Class, Conception and Conflict: The Thrust for Efficiency, Managerial Views of Labor and the Working Class Rebellion, 1903-1922', Review of Radical Political Economy,7,2.

Pansieri,Raniero(1980) 'The Capitalist Use of Machinery: Marx Versus the Objectivists', in Slater,Phil(1980).

Parker,S.R(1975) 'Industry and Education', in Parker,S.R.and Brown,R.K (et al)(1975)

Parker,S.R, Brown,R.K, Child,J, Smith,M.A.(1975) The Sociology of Industry, George Allen and Unwin, London.

Parliamentary Papers(P.P)(1867-8) Vol XXX, Report of the Royal Commissioners on the Paris Exhibition of 1867. Report on Machine Tools.

P.P(1873) Vol LXXIV Technical Reports on the Vienna Exhibition of 1873.

P.P(1875) Employers and Workmen Act(1875), 38 & 39, Vic. Cap. 90, para 10

P.P(1877) Vol XXXIV Report on the Philaelphia Exhibition of 1876.

P.P(1880) Vol XXXIII Accounts and Papers, Reports on the Industrial Congress of Commerce and Industry at Brussels, 1880.

P.P.(1880), Vol XXXII Report of the British Commissioners on the Paris Exhibition of 1878.

P.P.(1882), Vol XVIII Report of the Commissioners on the Melbourne Exhibition of 1880.

P.P (1889) Technical Instruction Act(T.I Act).

P.P.(1901), Vol XXXI Report of the Royal Commission to the Paris Exhibition of 1900, Report on Machine Tools.

P.P.(1906), Vol LIV Report of the British Commission to the Exhibition of St. Louis,1904.

Payne,C.L.(1967), 'The Emergence of the Large Scale Company in Great Britain,1876-1914',Economic History Review,XX,3rd Dec.

Penn, Roger (1982) 'Skilled Manual Workers in the Labour Process', 1856-1964', in Wood, S. (Ed) (1982).

Penn,R.(1983),'Trade Union Organization and Skill in the Cotton and Enhgineering Industries in Britain, 1850-1960', Social History,Vol 8,1,Jan.

Penn,R.(1984) Skilled Workers in the Class Structure,Cambridge University Press, Cambridge.

Penn,R. and Scattergood,J.(1985) 'De-skilling or En-skilling', B.J.S.36,4.

Penn,R.(1986) 'Where Have All the Craftsmen Gone?', B.J.S.XXXVII, 1986.

Penn,R. and Scattergood,J.(1988) 'Continuities and Change in Skilled Work', B.J.S.XXXIX,1.

Perrucci,Robert and Gerstl,J.E(1969) The Engineers and the Social System, John Wiley, New York.

Piore,M.J.and Sabel,C.(1984) The Second Industrial Divide, Basic Books, New York.

Playfair, Lyon (1888). Reply to Armstrong (1888) Nineteenth Century,Vol XXIV, London.

Playfair to Taunton (1867). Letter from Lyon Playfair to Rt. Hon. Lord Taunton, cited in Journal of Society of Arts, Vol. XV (1867) p.477-8.

Playfair, Lyon (1871). Address at the Transactions of the National Association for the Promotion of Social Science, London.

Pollard,S.(1981) Labour in Great Britain, Cambridge Economic History of Europe, Vol.VIII, Pt1., Cambridge.

Polyani,M.(1964) Personal Knowledge, Harper Textbooks, N.Y.

Porter, C. T. (1908) Engineering Reminiscences, John Wiley, New York.

Poulantzas, N (1975) Classes in Contemporary Capitalism, New Left Books, London.

Practical Mechanics Magazine, Leader in Vol. IV, Third Series 1869.

Price, R. N. (1971) 'The Working Men's Club Movement and Victorian Social Reform Ideology'. Victorian Studies, 15, 2.

Price,R(1983) 'The Labour Process and Labour History', Social History,VIII,57-77.

Privy Council Committee on Education (1867);(1868) Memorandum Relating to the Business of the Privy Council, London. Public Records Office (P.R.O.).

Privy Council Committee (1867)(a). Minute of the Lords of the Committee of Council of Education relating to Scientific Instruction, London, Dec. (P.R.O.).

Public Record Office (PRO) Document ED23/71 (1889). Actual Expenditure as per Appropriation Accounts, for Education in Great Britain, Appendix A, London.[See also my appendix 23].

PRO Files(1897) The System of Apprenticeships with Special Reference to Apprentice Charities, Assistant Commissioners' Report, Dec. Also Files for 1919.

Rainbird,H.(1988) New technology, Training and Union Strategies, in Hyman,R. and Streeck,W.(Eds) 1988.

Randall, J. (1868) 'Journal', Paper on Technical Education, Conference at Society of Arts, 31st Jan. 1868. [Randall was one of the authors of 'Artisan' Reports, 1868].

Rankine,W.J.McQ.(1878), A Manual of Machinery and Millwork, Charles Griffen, London.

'Record' [Journal of the Iron Trades Employers' Association(ITEA)] 1872-1900, London.

Reeder,D.A.(Ed)(1977) Urban education in the Nineteeth Century, Taylor and Francis, London.

Reinfelder, Monika (1980) 'Breaking the Spell of Technicism', in Slater, Phil (Ed) (1980).

Report of the Committee on the Machinery of the United States of America (1855). Presented to the House of Commons in Pursuance of this Address, 10th July 1855, Harrison & Son, London.

Reports of Artisans (1867). Papers of Artisans Selected to Visit the Paris Universal Exhibition of 1867, in 'Journal'(Official Organ of the Society of Arts).

Report of the Proceedings of the Workmen's Technical Education Committee, (W.T.E.C) (1868) from the date of Appointment, 14th March.

Reports from Commissioners (1867/8), Vol. XXXI, 10th Report of Royal Commission Appointed to Inquire into the Organisation and Rules of Trades Unions and Other Organisations.

Reports from Commissioners (1875) Vol. XXX. Second and Final Report of the Commission Appointed to Inquire into the Working of the Master and Servant Act, 1867, and the Criminal Law Amendment Act, 34 & 35 Vic. Cap.32, p.115.

Reports from Commissioners (1893), Report of Royal Commission on Labour, Minutes of Evidence, Vol. III.

Rezneck,S(1932), 'The Rise of Industrial Consciousness in the U.S. 1760-1830', Journal of Economic and Business History,iv,4,Aug 1932.

Roberts, B. C. (1958) The Trades Union Congress, 1868-1921, Allen and Unwin,London.

Robertson,P.L(1974) 'Technical Education in the British Shipbuilding and Marine Engineering Industry 1863-1914'. Economic History Review, 2nd Series, Vol. 27, pp.222-225.

Robinson, J.(1868) evidence to the Royal Commission on Trade Unions [R.C. on T.U. 1867-68] [Director of Atlas Engineering Co. Manchester].

Roderick, G. W. and Stephens, M. D. (1970) 'Approaches to Technical Education in Nineteenth Century England'. The Vocational Aspects of Education Vol. XXII, 52, June 1970.

Idem(1978) Education and Industry in the Nineteeth Century, Longmans, London.

Idem (1981) 'Where Did We Go Wrong?' Industry, Education and the Economy in Victorian Britain, Falmer Press, Lewes.

Idem(1982) The British Malaise, Falmer Press, Lewes.

Roe, J. W. (1916) English and American Tool Builders, McGraw Hill, New York.

Roe, J. W. (1916) Interchangeable Manufacture, Transactions of the Newcomen Society, XVIII.

Rose,J(1895) Complete Practical Machinist, Baird & Co., Philadelphia

Rosenberg,N.(1963), 'Technological Change in the Machine Tool Industry, 1840-1910',Journal of Economic History,xxiii,Dec.

Rosenbloom,R.S. (1964) 'Some 19th Century Analyses of Mechanization', Technology and Culture, Vol 5, Fall

Rowan, F.J.(1887), 'On Electro-Magnetic Tools', Proc.I.Mech.E., Vol 38.

Rowan, F. J. (1901) 'Economical Manufacture of Marine Engines', Proc.I.Mech.E., Vol 61.

Rowan, F. J. (1903) 'Premium System', Proc.I.Mech.E., Vol. 66.

Rowe,J.W.F.(1928), Wages in Theory and Practice, Routledge and Kegan Paul, London.

Royal Colleges (1906). Final Report of Departmental Committee on the Royal College of Sciences (Historical Survey), HMSO.

Royal Commission on Scientific Instruction (R.C. on S.I.) (1865) Vol.XV. Council on Education (1867-8), Copy of Minute of the Lords of the Committee of Council on Education Relating to Scientific Instruction; and Explanatory Memorandum thereon. Accounts and Papers, Vol. LIV. Memorandum relating to the Business of the Privy Council Office (1867), PRO Document 24/55.

Royal Commission on Trade Unions 1867-1868 (a) Parliamentary Papers. Report from Commissioners (1968) Vol. XXXI. Report of Royal Commission appointed to Inquiry into the Organisation and Rules of Trades Unions and Other Associations, 1867-69.

R.C. on T.U. (1867-8). Royal Commission of Trades Unions, Reports from Commissioners, Vol. XXXIX.

Royal Commission on Trade Unions (1867)(a) 1st Report, Minutes of Evidence,Q 644.

R.C. on T.U. (1867) 1st Report, Q.998. Evidence of W. Allen.

R.C. on T.U. (1868) 10th Report, Minutes of Evidence.

R.C. on T.U. (1868 (b)), Q.985, Evidence of A.S.E. Secretary W. Allen.

R.C. on T.U. (1868) (c) Report, Evidence of engineering employer Bayer, Q.18878.

R.C. on T.U. (1868) (a), Q.18887.

R.C. on T.U. (1868) (c), Q.19137.

R.C. on T.U. (1868) (a), Q.19138.

R.C. on T.U. (1868) (a), Q.19058.

R.C. on T.U. (1868) (a), Q.19059.

R.C. on T.U. (1868) (c), Q.19201.

R.C. on T.U. (1869) (b) Minority Report. Dissent III pt. VIII (Signed 6th Mar. 1869).

Royal Commission on T.U. (1868) (a), XIth Report, Minutes of Evidence. (J. Paterson Smith, Secretary, Clyde Shipbuilders' and Engineers' A

R.C. on T.U. (1869) (a) XIc and Final Report.

R.C. on T.U. (1868 (b)) Appendix to XI and Final Report, pp. Vol. XXI, 1868-69, p.246.

Royal Commisison on T.U. (1869), Rules 13, 15 of A.S.E. revised, Eleventh and Final Report, Appendix in Parliamentary Papers, Vol. XXI, pp.252,3.

Royal Commission on Scientific Instruction (1872) (R.C. on S.I.) Vol. II, Parliamentary Papers, London.

Royal Commission on Technical Instruction (1884). [R.C. on T.I.]. R.C. on T.I. (1884), 2nd Report, Vol. III.

Royal Commission on Technical Instruction (1884) Parliamentary Papers XXXI, Vol. III, Minutes of Evidence (Shipton, Sec. Amalgamated Society of House Decorators and Painters: Member of London Trades Council.

R.C. on Depression of Trade (1885-6), Parliamentary Papers. Reports from Commissioners (1885-86) Royal Commission appointed to inquire into the Depression of Trade and Industry. Evidence submitted by practising tradesmen 1885. Q.1218.

Royal Commission on Depression of Trade and Industry (1886), (R.C. on D.T. and I) para. 84, p.xxxi.

Royal Commission on the Depression of Trade and Industry (1886). Recommendations and Final Report.

R.C. on Labour (1893-94) Parliamentary Papers. Reports from Commissioners Vol. XXXV, 20. Royal Commission on Labour , Summary p.115

R.C. on Labour (1893)(a) 3rd Report, Evidence of A. F. Hills, Managing Director, Thames Iron Works Shipbuilding Co. Ltd., Blackwall, London.

R.C. on Labour (1893)(b) 3rd Report, Evidence of Wigram, member of the firm of John Fowler & Col. Ltd., Engineers, Leeds.

R.C. on Labour (b) (1893). Minutes of Evidence, Vol. III (Evidence of J. Inglis, Partners in Mesrs. A. & J. Inglis, Engineer, Glasgow), Q.26149.

R.C. on Labour (c) (1893) Minutes of Evidence Vol. III, Qs. 25212, 25217, 25218, 25323, 25248. (Evidence of Captain Noble).

R.C. on Labour (e) (1893), Qs. 23235, 325212 (A.S.E. evidence from W. Glennies, ASE).

Royal Commission on Labour (1893), Third Report, Minutes of Evidence, Vol. III (Whittaker of the ASE).

Royal Commission on Labour (1894), Summary, Gp.A: Pt.II Iron, Engineering, Hardware, Shipbuilding and Cognate Trades.

Royal Commission on Secondary Education (1895), Vol. 1, Historical Sketch, Pt. 1 [The Bryce Commission].

Royal Commission on Trade Disputes and Trades Combinations (1904) Minutes of Evidence, 30th Nov. 1904. (Evidence Sir Andrew Noble)).

Royal Commission on Trade Disputes and Trade Combinations,(1906),R.C. on T.D. and T.C, Reports from Commissioners, Vol. 56, Q.2415.

R.C. on Poor Laws, Parliamentary Papers, Reports from Commissioners (1909), Royal Commission on Poor Laws and Relief of Distress.

Royal Commission on the Poor Laws and the Relief of Distress (1909). Reports form Commissioners, Vol. XXXVI, Part VI, Ch. 1.

R.C. on Poor Laws (1909), Evidence to Minority Report, The Misuse of Boy Labour.

R.C. on Poor Laws (1909) Qs. 93031 and 93035, Evidence of Sydney Webb.

Rubery,J.(1978) 'Structural Labour Markets, Worker Organization and Low Pay', Cambridge Journal of Economics, 2, 17-36.

Ryrie, A. C. (1976) 'Employers and Apprenticeship, Research Note'. British Journal of Industrial Relations, Vol. XIV, 1, March, pp.89-91.

Sable,C. and Zeitlin,J.(1985) 'Historical Alternatives to Mass Production: Politics, Markets and Technology in 19th Century Industrialization', Past and Present,108:133-176.

Sadler, M. E. (1904) Report on Secondary Education in Liverpool, Liverpool Education Committee.

Sadler, M. E. (Ed.) (1907) Continuation Schools in England and Elsewhere, Victoria University Press, Manchester.

Sanderson,M.(1983),Education, Economic Change and Society in England, 1780-1870, Faber and Faber, London.

Samuel,Raphael(1977) 'The Workshop of the World: Steam Power and Hand Technology in Mid-Victorian Britain', History Workshop,No.3 Spring.

(The) Saturday Review, 4th Sept; 25th Sept; 20th Oct, 1897, 'The Engineering Dispute from an Employers' Standpoint.'

Saul, S. B. (1967) 'The Market and Development of the Mechanical Engineering Industries, 1860-1914', Economic History Review, XX, 3rd Series, London.

Idem.(1968),'The Machine Tool Industry in Britain to 1914', Business History,x.

Idem(1968), 'Engineering', in Aldcroft,D.H (1968).

Saul, S. B. (Ed.) (1970) Technological Change. The United States and Britain in the Nineteenth Century, Methuen, London.

Saville, J. (1954) 'The Christian Socialists of 1848', in Saville, J. (Ed). Democracy and the Labour Movement. Lawrence and Wishart, London.

Schuler ,T. and Megarry,J.(Eds)(1979) Recurrent Education and Lifelong Education, Kogan Page, London.

Schultz, Theodore (1961) 'Investment in Human Capital', American Economic Review, 51, March.

Schwarz,B(1977) 'On the Monopoly Capitalist Degradation of Work', Dialectical Anthropology,2,2.

Scott-Russell (1869) Systematic Technical Education, Bradbury Evan, London.

Select Committee on Small Arms (1854). Reports from Commissioners, Parliamentary Papers Vol.XVIII.

Select Committee on Scientific Instruction (1868), Parliamentary Papers, Vol.XV.

Sellers, Wm. (1884) A Treatise on Machine Tools as made by Wm. Sellers & Co. Philadelphia (This 'treatise' is in fact a sales catalogue).

Shadwell,A.(1906),Industrial Efficiency: A Comparative Study of Industrial Life in England, Germany, and America, Longmans, London.

Sharp, P. R. (1971), 'Whisky Money and the Development of Technical and Scientific Education in the 1890's'. Journal of Education Administration and History, Vol. 4, Dec. 1971.

Sheffield and Rotherham Independent,27th Sep.1869 (Complimentary leader on Trade Union attitudes to Technical Education).

Shepherd, Michael (1978) 'The Origin and Incidence of the term "Labour Aristocracy"', in Society for a Study of Labour History, 37, Autumn.

Silver,H.(1983) 'Ideology and the Factory Child: Attitudes to Half-Time Education', in Idem(1983), Education as History, Interpreting Nineteenth and Twentieth Century Education, Methuen, London.

Simon, B. (1965) Education and the Labour Movement, 1870-1920, Lawrence & Wishart, London.

Simon, B. (1969) Studies in the History of Education. 1780-1870, Lawrence & Wishart, London.

Sims, G. (1981) 'Engineering', in Roderick, G. and Stephens, M. D. (Eds) (1981).

Singer, Charles et al(Eds) (1965) A History of Technology Vol. V. Clarendon Press, Oxford.

Singh,B.R.(1974) The Development of Technical and Vocational Education in Britain and America,1870-1940: a Comparative Study. Ph.D Thesis, University of London.

Slater, Phil (Ed.) (1980) Outlines of a Critique of Technology, Ink Links, London.

Smelser,Neil(Ed)(1988) Handbook of Sociology, Sage Publications, London.

Smiles, Samuel (1876) Industrial Biography, Iron Worker and Tool Makers. John Murray, London.

Smiles,Samuel(1879) Self Help, John Murray, London.

Idem(1904) the Lives of Engineers, John Murray, London.

Smith, C. S. (1967) 'Metallurgy: Science and Practice before 1900', in Kranzberg, M. and Pursell, C. W. (1967).

Smith, Merrit Roe (1977) Harpers Ferry Armory and the New Technology, Cornell U.P., Cornell.

Society of Arts(1868), Report on Conference on Technical Education, held on 23rd Jan.1868, Journal of Society of Arts, vol xvi,793,183-209, London.

Society of Arts(1869) A Petition from the Society of Arts to House of Commons for a Systematic Education Provision and a Competent Technical Education Service, 21st May (Journal).

Society of Arts (SOA) (1878). Programme of Examinations, 1859-1877, London.

Sohn-Rethel, A. (1972) 'Mental and Manual Labour in Marx', in Walton, P. and Hall, S. (Eds) (1972).

Sohn-Rethel, A. (1976), 'The Dual Economics of Transition', in Conference of Socialist Economists.

Sohn-Rethel(1978), Intellectual and Manual Labour: a Critique of Epistemology, Critical Social Studies, Basingstoke and London.

Solly, H. (1866) Letter to Lord Lyttleton, in Occasional Papers of the W.M. C & I.U. Tracts 1863-1883, London.

Solly,H (1868) Facts and Fallacies Connected with the Working Men's Club and Institute (Paper read before the Social Science Association at Sheffield, Oct 1865).

Solly, H. (1873) 'Trades Guild of Learning', in Workman's Magazine, Nos. I and V, published under Literacy and Critical Tracts, London.

Solly H.,(1878) Technical Education: A few thoughts and facts about it, Address to the Trustees of the Artisans Institute, London.

Solly.H.(1833-1893), Miscellaneous Papers, [LSE Collection,154].

Sorge,A. and Streeck,W.(1988) 'Industrial Relations and Technical Change: the Case for an Extended Perspective', in Hyman and Streeck(Eds)(1988).

Spectator,Jun26, Jul 10 1886; 22 Jan 1898.

Spon's Dictionary of Engineering (1873), Division VII. London.

Spon's Dictionary of Engineering (1874) Vol. III. Byrne and Spon (Eds) London.

Spon, E. and F. N. (1882) Papers on Mechanical Subjects, Part 1. London.

Spon,E(1885) Mechanics' Own Book,E & F.N. Spon, London.

Stanley-Stone,A.C(1925) The Worshipful Company of Turners, Lindley Jones, London.

Stark, D. (1980) 'Class Struggle and the Transformation of the Labor Process', Theory and Society, 9,1,89-130.

Steeds, W. (1970) A History of Machine Tools, 1700-1910, Clarendon Press at Oxford.

Stein, Margaret (1979) 'The Meaning of Skill: The Case of the French Engine Drivers, 1837-1917', Politics and Society, Vol.

Stephens,M.D. and Roderick,G.W.(1973) 'Changing Attitudes to Education in England and Wales,1833-1902', Annals of Science,3,June.

Idem(1883) 'The Role of Scientific and Technical Education in Early Industrialization in America and England', Vocational Aspects of Education, 35,90,Apl.

Stewart,C.P.(1861), 'Description of Seller's Screwing Machine', Proc.I.Mech.E.,Vol.12.

Stewart, (1974) 'National Attitudes towards Scientific Education in Early 19th Century England', Vocational Aspects of Education,xxvi,65.

Stonier,T.(1979) 'Changes in Western Society: Educational Implications', in Schuler,T.and Negarry,J.(Eds)(1979).

Sweezy,P.((1942) 'The Theory of Capitalist Development', Monthly Review,New York.

Sylvester,D.W.(1974) Robert Lowe and Education, Cambridge University Press.

Tawney, R. H. (1909) 'The Economics of Boy Labour', The Economic Journal, Vol. 19, 517-537.

Taylor, F. W. (1895)(a) 'A Piece Rate System, Being a Step Toward a Partial Solution of the Labor Problem', Transactions of the A.S.M.E. Vol.XVI, 1894-5.

Taylor, F. W. (1906) 'On the Art of Cutting Metals', ASME(1906) and in Thompson, C. B., (Ed.) (1914).

Taylor, F.W. (1910) Contribution to a Meeting of the Institution of Mechanical Engineers (England), 10th July 1910, in Proc.I.Mech.E. Vol. 79, 1910.

Taylor, F. W. (1911)(a) Shop Management, New York. (First read as paper at a meeting of the American Society of Mechanical Engineers (A.S.M.E.), Saratoga, 1903, Transactions A.S.M.E. Vol. XXIV.

Taylor, F. W. (1911) Testimony before the Special House Committee.

Taylor, F. W. (1911)(b) The Principles of Scientific Management, New York. Special Edition for confidential circulation among A.S.M.E. members.

Taylor, F. W. (1912) Testimony before Select House Committee, June 1912, in Taylor, Scientific Management (1964).

Taylor, F. W. (1964) Scientific Management, Harper and Row, London.

Taylor, P.W.(1975) 'The Development of Higher Technological Education in Britain', Journal of Educational Administration and History,8,2.

Tholfsen, Trygvie (1961) 'Transition and Democracy in England', International Review of Social History, 6, 2, p.247.

Tholfsen, Trygvie (1971) 'The Intellectual Origins of Mid-Victorian Stability', Political Science Quarterly, LXXX March.

Tholfsen,Trygvie(1976), Working Class Radicalism in Mid-Victorian England, Croom Helm, London.

Thomas,D.H.(1940), The Development of Technical Education in England, 1851-1889, with Special Reference to Economic Factors; Ph.D Thesis, University of London.

Thompson, C. B. (Ed.) (1914). Scientific Management: A Collection of the More Significant Articles Describing the Taylor System of Management, Harvard U.P.

Thompson, E. P. (1977) The Making of the English Working Class, Penguin, Hammondsworth.

Thompson, P. (1983) The Nature of Work: An Introduction to Debates on the Labour Process, Macmillan, London.

Thompson,P. & Bannon,F.(1985), Working the System: The Shop Floor and New Technology, Pluto Press, London.

Thompson, S. P. (1879) Apprenticeship, Scientific and Unscientific (Lecture given before Society of Arts, 3rd. 1879), Hamilton Adams, London.

Thomson, and Hunter (1978) in Dunlop J. T. and Galeman, W. (Eds)(1978).

Times, (The) 20 Jan,10th Mar,3rd Apl,7th Jul,14th Dec 1897.

Tomlinson, Jim (1982), The Unequal Struggle, British Socialism and the Capitalist Enterprise, Methuen, London.

Torr,Dona(Ed)(1934) The Correspondence of Marx and Engels, 1846-1895, Martin Lawrence, London.

T.U.C. Congress Minutes (1868), T.U.C. Microfilm. Also Minutes for 1871, 1874, 1880,1882,1885,1889.[TUC Library].

Turner, H. A. (1962) Trade Union Growth, Structure and Policy, Allen & Unwin, London.

Unwin, C. W. (1904) Article in the 'Central', Vol. 2, London [Official Journal of the Central Institute of the C.G.L.I.].

Urwick, L. and Brech, E. F. L. (1946) The Making of Scientific Management, Management Publication Trust, London.

U.S. Commission on Labor,Eleventh Special Report, (1904) Regulations and Restriction of Output, U.S. Congressional Hearings 41st-73rd Congresses, 1869-1934, Washington.

U.S.Congressional Hearings(1913-15), The Stop Watch and Bonus Sytsem in Government Work, Evidence of Congressmen Taverner, Vol 103.

Usher, J. T. (1895) The Modern Machinist, E. & F. N. Spon, London.

Veblin,T(1921) The Engineer and the Price System, Harbinger Edition.

Venables, Ethel (1967) The Young Worker at College: A Study of a Local Tech., Faber and Faber, London.

Walker,Jill(1981), 'Markets, Industrial Processes and Class Struggle: The Evolution of the Labour Process in the U.K. Enginering Industry', The Review of Radical Political Economics,12,4,Winter.

Walker,Pat(Ed)(1978), Between Labour and Capital, Black Rose Books, Montreal.

Walton, P. and Hall, S. (Eds) (1972) Situating Marx, Human Context Books, London.

Ward,James(1865) Workmen and Wages at Home and Abroad, W.S.Orr,London.

Ward, L. O. (1973) 'Technical Education and the Politicians (1870-1918)', British Journal of Educational Studies, Vol. 21, 1.

Waterhouse,Rachel(1957), A Hundred Years of Engineering Craftsmanship(Tangyes Ltd).

Watson,Hamish Brocket(1976), Organizational Bases of Professional Status: a Comparative Study of the Engineering Profession, Ph.D Thesis, University of London[LSE].

Wearmouth,R.F.(1937) Methodism and Working Class Movements, Epworth Press, London.

Webb,H.L(1898) 'English and American Methods in the Engineering and Iron Trades', Engineer,21st Jan.

Webb,S.(1904), London Education, Longmans, London.

Webb, Sidney and Beatrice (1911) Industrial Democracy, Longmans, London.

Webbs, S. and B. (1919) The History of Trade Unionism, Longmans, London.

Idem(1920) Industrial Democracy, Longmans, London.

Weekes,B.M.(1970), The Amalgamated Society of Engineers, 1880-1914, Ph.D. Thesis, University of Warwick.

Weiler, A. (1875) Letter to Sir Thomas Brassey, quoted in Price, R.N. (1971).

Weissenborn,G.(1861), American Engineering, New York.

Welford,A.T.(1962) Society, Problems and Method of Study, Routledge, London.

Wemyss Manuscripts (Lord Elcho, whose references appear above, was the eldest son of the 8th Earl of Wemyss (1841-1908). National Register of Archives, Edinburgh (RH4/40/9).

Westminster Gazette,Nov 12th,1898.

Whalley, Peter (1986) The Social Production of Technical Work, Macmillan, London.

Whitworth, J. (1840) On Plane Metallic Surfaces, Address to British Association Glasgow, 1840, in E. & F. N. Spon (1882), p.8.

Whitworth, J. (1841) On a Uniform System of Screw Threads. Paper read to Institute of Civil Engineers, in Spon, E.& F. N. (1882). p.19.

Whitworth, J. (1854) Special Report on the New York Industrial Exhibition presented to House of Commons, 6th Feb.; Harrison, London.

Whitworth, J. (1855) Report of the Committee on the Machinery of the United States of America, London.

Whitworth, J. (1856) Presidential Address, Institute of Mechanical Engineers, Glasgow, Proceedings of I.Mech.E. Vol. 8, 1856.

Whitworth, J. (1857) On a Standard Decimal Measure of Length, Proceedings Institution of Mechanical Engineers.

Whitworth, J. (1870) On Machinery. Observations at a dinner of the Foremen Engineers, London, Feb. 1870, in Spon. E. and F. N. (1882), p.60.

Whitworth, J. (1876) On Measurement, Paper Read at Conference of the Exhibition of Scientific Instruments, May 1876, in E and F. N. Spon (1882).

Whitworth, J. (1882) Illustrated Catalogue of Engineers' Tools Manufactured by Sir Joseph Whitworth and Company, Manchester, July 1882.

Wigham, E. (1973) The Power to Manage: A History of the Engineering Employers Federation, Macmillan, London.

Wigham, E. (1973)(a) The Terms of Settlement (1898). General Principle of Freedom to Employers in the Management of their Works, quoted in Wigham (1973), Appendix D.

Williams, T. I. (Ed.) (1969) A Biographical Directory of Science, London.

Winstanley, T. (1867) 'Journal'.Society of Arts. XVI (Metalworker).

Wood,S.(Ed) (1982) The Degradation of Work?, Hutchinson, London.

Wood,S.(1988) 'Betwen Fordism and Flexibility? The U.S. Car Industry', in Hyman,R. and Streeck,W.(Eds)(1988).

Wood, S. and Kelly, J. (1982), 'Taylorism, Responsible Autonomy and Management Strategy', in Wood, S. (Ed) 1982.

Woodbury, R. S. (1967) 'Machines and Tools', in Kranzberg, M. and Pursell, C. (Eds) (1967).

Woodbury, R. S. (1969) 'Machine Tools', in Williams, T.I.(ED)(1969)

Woodbury, R. S. (1972), Studies in the History of Machine Tools. M. T. Press, Preface.

Woodward, J. (1965) Industrial Organisation: Theory and Practice, Oxford University Press, London.

Wordworth, J. W. (1905) American Tool Making and Interchangeable Manufacture, New York.

Working Men's Club and Institute Union(WCIU), Tracts 1863-1883, London (1886).

Working Men's College, XIIth Annual Report(1880).

Working Men's Educational Union (1853), First Annual Report, London.

Workman's Technical Education Committee (1869). Report of Proceedings from 14th March 1868, to date, 1869, London.

Wright, F. (1871) The Journeyman Engineer, in Harrison, R. (Ed) (1972).

Wright, Thomas (1871) The Journeyman Engineer, Fraser's Magazine, July, 1871.

Wright,Thomas(1873) Our New Masters, Strahan, London.

Wright Baker,H.(Ed)(1962) Modern Workshop Technology, Macmillan, London.

Young,Nigel(1967) '"Prometheus or Troglodyte?" The English Working Class and the Dialectics of Incorporation', Berkley Journal of Sociology,Vol 12.

Young,Tom(1974) 'Technical Education: a Local or National Responsibility?' Education and Training, Vol 16,7, Jul/Aug.

Zeitlin, J. (1979) 'Craft Control and the Division of Labour: Engineers and Compositiors', Cambridge Journal of Economics, 3, 263-274.

Zeitlin,J.(1981), The Labour Strategies of British Engineering Employers,1890-1914, Conference on the New Unionism in Europe,1880-1920,Tutzing 1981.

Zeitlin,J(1983) 'The Labour Strategies of British Engineering Employers,1890-1922', in Gospel,H. and Littler,C.(Eds)(1983).

Zeitlin,J, and Harrison,Royden (Eds)(1985) Divisions of Labour, Harvester Press, Sussex.

Zeitlin,J and Tolliday,S(Eds)(1985) Shop Floor Bargaining and the State: Historical and Comparative Perspectives, Cambridge University Press.

Zeitlin,J.(1987) 'From Labour History to the History of Industrial Relations', Economic History Review,2nd Series,XL,2,159-184.

Zimbalist,Andrew(Ed)(1979),Case Studies on the Labour Process, Monthly Review Press.