TECHNOLOGY: THE CONTINGENT NATURE OF ITS IMPACT*

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The pervasiveness of microelectronic-based technologies and rising levels of unemployment have led to special attention being paid to the role of technology in the workplace. Prescriptive statements about this impact have failed to do justice to the contingent and contested nature of these changes. Recognition of the quasi-political nature of this process may disrupt the hygienic tone of these prescriptions, but should lead to a more realistic appreciation of this process. This argument is illustrated with reference to both employment numbers and the nature of work.

Keywords: Technology, productivity, social change, employment, technological change

INTRODUCTION

The objective of this paper is to illustrate, using a diverse literature, the complex nature of the impact of new technology in the workplace. The centrality of work as a source of the means of existence and of psychological self-definition makes this a perennial concern, although it has a special piquancy because of developments in microelectronics and current high levels of unemployment. There is a role for reasoned reflection on the subject; it is, after all, not an area renowned for accuracy of prediction. In the late 1950s technical forecasters predicted that by 1980 at least 75 per cent of machine tools in the United States would be numerically controlled (less than 2 per cent are), and that there would be fully automatic metalworking factories (there are none).[1] Similarly, technology is a visible symbol towards which concern with work and employment issues may be directed. No doubt this visibility, as compared with the relative invisibility of

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'the economy', lead to its being selected for unwarranted as well as warranted criticism; its symbolic function is likely to overshadow its direct impact.

The first section of the paper concentrates on the impact of technological change on employment numbers, in particular the prospects of equilibrium between job generation and job displacement, and the contingent nature of the employment effect. In the second section attention turns to the qualitative impact of technological change and the determinants of the forms of the technology behind this impact.

THE EFFECT ON EMPLOYMENT NUMBERS

Recent surveys of the relationship between technological change and employment confirm the complex and varied interpretations placed on this relationship.[2] At the most abstract level, an argument that asserts a type of neutrality for the technical factor can be characterised as follows: technological change leads to increased productivity which is in turn reflected in any or all of higher profits, lower prices and higher wages. This in turn leads to an increased demand for goods and services which results in increased demand for labour elsewhere in the economy, thus soaking up any employment displaced in the innovating industry. However, reservations can be expressed about the logic of this argument.

It has become clear that growth in industrial output need not be accompanied by growth in employment, as evidenced by the experience in OECD countries over the last twenty years.[3] That is, there appears to be a growing pattern of 'jobless growth' whereby increased demand is accommodated through existing levels of labour.[4] This emphasises the importance of distinguishing job displacement and job generation as distinct processes.[5] Even when new products occasion new investment, the changing labour intensity of the production process is a central factor in determining the job generation that follows. By implication it need not equate with the level of job displacement. The nature of the technology is also of significance in that the pervasiveness of the technology affects the prospects for compensatory job creation. The growth of employment in the service sector, which has for some time compensated for declining employment in manufacturing, has been based on both the increasing productivity of labour in manufacturing and the relatively low labour productivity in the service sector.[6] However, development of micro-processor based technologies, such as electronic data processing, has meant that the

service sector itself has increasingly become the site for application of such technologies.[7] This in turn is likely to provide the potential for increased labour productivity within the service sector, thus disrupting one of the key factors in the ability of that sector to provide compensatory employment.

The neutrality argument can accommodate the concept of jobless growth, but only by asserting the equilibrium-seeking behaviour of the system as represented by a change in factor prices, specifically a reduction in the price of labour such that labour is substituted for capital. Ignoring for the moment the question of the extent to which the price of labour does vary with the level of unemployment, the time lag is not an insignificant matter. Freeman, for example, notes that:

> Some of those who have examined the treatment of technical change and employment in terms of the main schools of economic thought have concluded that prolonged high levels of technological unemployment are quite consistent with the theoretical assumptions of all the main paradigms.[8]

Pavitt is more blunt: equilibrium may exist in the long term, but "the long term is receding to infinity".[9] It is thus doubtful whether it is valid, and certainly whether it is useful, to assert *a priori* the neutrality of technology with respect to absolute employment numbers.

It is one thing to argue the non-congruence of job generation and job displacement; it is another to make precise statements as to the magnitude of this incongruence. Although it is beyond the scope and intent of this paper to delve into this matter at any depth, some indication can be given of the contingent factors upon which the employment effect depends. First, as already mentioned, the potential for jobless growth will affect the outcome. Secondly, the competitive position of an industry can mean that in the absence of technological change, employment may decline. This can be due to inability to compete in terms of either product or process. The former refers to inability to compete with technically more sophisticated imports, the latter to declining competitiveness due to either process technology developments or low-wage competition.[10] It is important, however, that the relevance of such competition as the imperative behind technological change not be exaggerated. Only an estimated 5 to 10 per cent of the Australian labour force is employed in industries directly involved in international competition.[11] A third factor of significance is the politics of the innovation process. Innovation is not a process in which some engineering calculation can be used to deduce the labour displaced

by a machine when introduced into a firm. Such engineering logic as an approach to innovation misses the whole point of the essentially social nature of a process in which the ultimate outcome is intrinsically tied up with workers' ability to resist potential job displacement (or at least to modify its degree), the extent to which job displacement is part of management's rationale for introducing the new technology, its ability to enforce this, and, by implication, the productivity effect.[12]

It is important to note that this discussion has implicitly accepted the stated connection between technological change and productivity; that is, that the former results in an increase in the latter. This is an assumption which may be questioned, particularly in the situation where much of the output is in terms of information used internally by the organisation and, therefore, not existing as a commodity which is directly marketed. It is quite possible that what is produced is increased activity rather than increased productivity. There is no necessary positive correlation between production of information and efficient organisational performance, and there may well be an 'ideology of innovation' whereby technological change is undertaken on the basis of presumption rather than investigation; that is, the presumption that such change will, almost in and of itself, lead to improved performance. Indeed, as Noble notes, firms rarely conduct postaudits.

> Nobody wants to document his errors and if the machinery is fixed in its foundation, that is where it will stay, whatever a postaudit reveals; You learn to live with it . . . The invisible hand has to do quite a bit of sweeping up after the fact.[13]

Lamberton *et al.* go so far as to suggest that recently observed declines in productivity in the United States may be due in part to new information technologies actually reducing productivity.[14] Certainly it has been argued by both Nelson and Leibenstein that intra-firm factors are central determinants of the productivity effect of technological change.[15]

THE EFFECT ON THE NATURE OF WORK

To present discussion of the effect of technological change as if absolute employment numbers were the sole source of concern with the employment impact would be misleading. Many of the concerns raised relate to the way the nature of jobs is changed by technological change. Throughout history disputes over the

introduction of new technology have involved this mix of absolute employment effect and changes in the nature of the jobs.

Machine-breaking did not begin with the Luddites; it was a not uncommon practice, in the absence of unions and organised strikes, whereby pressure was brought to bear on employers in support of various demands.[16] There was little inherent hostility to machinery specifically; simply it was the major available means whereby the interests of the employer could immediately be threatened. Even then, attacks on machinery were selective; for example, riots against spinning jennies in 1779 involved destruction of only the bigger machines — those that had to be housed in factories.[17] The increase in machine destruction between 1811 and 1816, known as the Luddite movement, occurred at a time of rapidly-rising food costs, declining wages and high unemployment.[18]

> . . . the worker was concerned not with technical progress in the abstract, but with the practical twin problems of preventing unemployment and maintaining the customary standard of life which included non-monetary factors such as freedom and dignity as well as wages. It was thus not to the machine as such that he objected but to these — above all to the whole change in the social relations of production which threatened him.[19]

Technological change is thus more than just a question of jobs in the absolute. The concern that is expressed by workers involves a complex inter-connection of concerns over employment and skills. A recent dispute which has illustrated these concerns has been that involving Telecom technicians. Since 1912, when the first public automatic exchange was introduced in Australia, maintenance of the equipment has been a decentralised activity organised at the district exchange level. With the introduction of computer controlled switching technologies in the exchanges during the 1970s, this practice came increasingly under review, manifest in particular by Telecom's proposal — first mooted in 1975 — to introduce centralised exchange maintenance. The Australian Telecommunications Employees Association (ATEA) responded by producing its own proposal in which it argued for the siting of responsibility for, and control of, switching maintenance at the district exchange level with support available on request from an Exchange Support Centre. The ATEA argued that the Telecom proposal would result in reduction in employment of technicians and that it was the first stage in a development which would significantly de-skill technicians through the removal from them of the diagnostic function.

Conflict between workers and employers will often emerge as

workers seek to maintain skills and the employers seek to introduce new technologies which affect these skills.[20] At the core of this is the fact that the technologies which involve the skills that workers seek to preserve may not be as economically efficient as new technologies. Indeed, the power that some workers have through the skills that they hold may be seen as a hindrance to efficient production. Andrew Ure, a consultant to manufacturers in the 19th century, argued for automation because,

> By the infirmity of human nature it happens that the more skilful the workman the more self-willed and intractable he is apt to become and of course the less fit a component of a mechanical system in which by occasional irregularities he may do great damage to the whole.[21]

This perspective towards the role of labour in the productive process has flowed through to the present day. Rada refers to the

> profound tendency of capital to become as independent as possible of the human factors that condition its reproduction. Automation, the star of the micro-electronic universe, can be seen as the tendency to withdraw as many human elements as possible from production (manufacturing and administration), owing to their unreliability . . . This "unreliability" includes the relative slowness of human beings in the performance of certain operations, the cost of their labour and their political propensities.[22]

The importance of this extract is that it points to the fact that 'efficiency' cannot be divorced from questions of reliability, predictability and control. To the extent that efficiency involves not just volume of production, but also consistency and predictability of production, controlling sources of inconsistency and unpredictability *is* an efficiency issue. This does not mean, however, that on occasions questions of efficiency and control cannot be separated. For example, the desire to maintain or strengthen control may, in specific instances, lead to management selecting technological options which are not necessarily more efficient. This has been a central theme in studies of the labour process, one of the major developments in the sociology of work and organisations of the last decade.[23] The central focus is on the development of organisational structures and technologies, and the conditions of their development. In discussion of the role of control in the development of the labour process, a study by Marglin of the development of the factory is almost ritually cited as the definitive example of the pre-eminence of control criteria over efficiency criteria in the development of capitalist work technologies.[24] Marglin argues that the evidence available from the time of the Industrial Revolution in England indicates that the centralised

organisation manifest in the factory system became established not because of inherent technical superiority, but because of the discipline and supervision that such a technology involved. This interpretation is supported by Dickson, who argues that the early factories were less technically efficient than the system they replaced.[25]

In a more recent context, both Noble and Wilkinson, in independent studies of the introduction of numerically controlled (NC) machine tools, conclude that the form of the technology chosen related more closely to the desire to centralise control in the hands of management than to any clear-cut efficiency criteria.[26] A new generation of machine tools based on computer numerical control (CNC) utilises a minicomputer control unit so that the programmed information for many operations can be stored in the machine itself. With this technology tapes can be created or edited on the shop floor, as is the case in a factory in Kongsberg, Norway, where the machine operators were trained to do this work. In this factory,

> when they (the operators) are satisfied with a program and have finished producing a batch of parts, they press a button to generate a corrected tape which, after being approved by a programmer, is put into the library for permanent storage.[27]

Certainly, from this point on, the machine now carries out automatically the task for which it has been programmed. In a sense, therefore, the operator has been de-skilled in that his skill is exercised infrequently, although he maintains a level of control over the job. De-skilling is thus not a simple matter of declining use of a skill, but is also fundamentally related to control in the work place. If the worker still feels 'in control' of some aspect of the job, then objective decline in skill usage need not be felt to be de-skilling. Given that work is a central life activity both in terms of provision of material needs through wage or salary and in terms of self-definition, de-skilling can be a threat to both bargaining power in the labour market and perception of worth. However, in practice, the evidence provided by Noble and Wilkinson indicates that the programming function has in most cases been preserved for supervisory staff, and where the machinists have intervened, often to correct faults and improve performance, the response has tended to be to seek further consolidation of control in the hands of the supervisory staff. This is by no means the only possible outcome, however, because the introduction of new technology is, in Edward's terms, "contested terrain" in which the final form of the technology in practice is "negotiated" through worker

resistance and the varying degree of management concern to increase control.[28] Thus Wilkinson also provides examples of factories in which the programming function has been retained by the skilled operators.

The studies of the labour process have gone well beyond the use-abuse metaphor and have contributed to the growing evidence that assumptions about how technologies will be used form part of the development process such that technologies can function as "bearers of social relations". Noble, for example, notes how

> N/C was always more than a technology for cutting metals, especially in the eyes of its MIT designers . . . it was a symbol of the computer age, of mathematical elegance, of power, order and predictably of continuous flow of remote control of the automatic factory.[29]

Indeed, conceptualising the impact of technology in use-abuse terms is now seen as indicative of a naive and superficial understanding of the nature of technology and of the processes underlying its development. However, in a significant sense, a related concept was implicitly reintroduced with the development of understanding of the contested nature of the innovation process. As outcomes are seen as the result of such contestation, so attention is directed away from both a determinism based on engineering potential and one based on the inevitably and thoroughly capitalist nature of technology. The clinical cleanness of the use-abuse metaphor is not re-admitted, but a certain contingency resulting from contestation has certain 'use'-related parallels. In fact, this use aspect is further illustrated by the studies undertaken by Wilkinson which clearly showed the range of control possibilities associated with a particular technology.[30] That is, the process of innovation, the meshing of a new technology into an organisational system, may result in a technology in one context being developed to enhance management control while in another that 'same' technology may be used to maintain or increase operator control over the work process.

This control aspect has been noticeable by its absence in management texts, probably because it introduces a level of organisational politics not in keeping with the theory of fundamental consensus implicit in this literature. An exception is Minzberg.[31] Normally, according to Minzberg, control is co-ordination that is determined by the neutral demands of efficient operation. Sometimes, however, a 'control mentality' asserts itself. That is, control is categorised as either neutral (required for co-ordination) or as a psychological condition of individual managers. It would not be accurate to accuse Minzberg of psychological

reductionism, however, as he clearly locates the development of this control mentality in the structure of the organisation, specifically the inherent incompatibility of the social and technical systems in mass production organisations. For Minzberg, control is equated with concern with control, a concern which results from the operation of certain styles of organisation. Thus, automation is interpreted as displacing the major sources of conflict and "with them goes the control mentality".[32] Control as an issue in the social relations of production simply does not inhabit this universe.

For similar reasons many of the job re-design theorists appear to underestimate the significance of these pressures. Davis and Taylor, for example, argued that:

> Advanced technology presents us with a number of opportunities to develop new, more humane organisational forms and jobs providing a high quality of working life . . . the new technology both increases the dependence of the organisation on the individual and on groups and requires more individual commitment and autonomous responsibility in the work place. These requirements for mutual dependence and independence provide opportunities to redress past deep-seated errors in social organisation and members' roles. Such opportunity may now be at hand to overcome alienation and provide humanly meaningful work in sociotechnical institutions.[33]

The doubtful assumption underlying this argument is that the organisation of production is orientated towards such ends; indeed, as previously argued, individual autonomy may be seen as evidence of a problem and not as a solution. Noble expresses this as follows:

> In the case of automation, steps are taken less out of careful calculation than on the faith that it is always good to replace capital with labor, a faith kindled deep in the soul of manufacturing engineers and managers . . . Thus automation is driven forward not simply by the profit motive, but by the ideology of automation itself, which reflects the social relations of production.[34]

In a recent analysis of the United States economy, it has been argued that attachment to traditional forms of centralised and hierarchical management control has prevented the United States from moving into flexible-system production on which re-establishment of a competitive advantage could be based.[35] As robotics becomes more sophisticated, new generations of robots will become suited to an increasing range of industrial application. In particular, because of their re-programmable and multi-functional character (in particular as their visual and tactile senses improve), they are likely to become of significance in flexible

manufacturing systems, the re-programmability leading to the potential for automation of batch production, a form that has traditionally provided limited opportunities for rationalisation.[36] A further associated development is that of computer integrated manufacturing, the fundamental integration being between computer-aided design and the actual engineering operations. Like Minzberg, Reich sees the development of automation as having a fundamental effect on relations of authority in the workplace, specifically that:

> the radical distinction heretofore drawn between those who plan work and those who execute it is inappropriate to flexible-system production.[37]

Such a conclusion is only possible in the absence of an understanding of the politics of the workplace and within an unrealistically determinist view of the form and impact of technology.

CONCLUSION

New production technologies rarely function in terms of productivity or cost as predicted, because there is a major difference between development of a new technology and successful innovation. It is not simply that a 'shakedown' period exists, but also that innovation is a social as much as a technical process. New technologies mesh into existing sociotechnical networks and the process of meshing is subject to a wide range of factors before the ultimate outcome is determined. Technological change is a contested social terrain in which presumptions which fail to distinguish potential from actual impacts confuse rather than clarify the issue. With respect to technological change, there is a tendency to adhere to a technological determinism which sees technology remorselessly moving forward with inevitable consequences. This does justice to neither the complexity of determining the employment consequences of the introduction of new technology, nor the options that exist in terms of the form and impact of that technology. The options referred to here are not reducible to the concept of choice as used by Jones and which is located in an implicit conception of society as the amalgamation of all the individual choices of the members of that society.[38] Choice, for Jones, involves asserting the right to choose, choosing, and by so doing escaping technological determinism and bringing about a desirable result. In fact, this implicitly is a form of technological

determinism — not its alternative — in that it attributes to technology all-pervasive powers in terms of social effects. Technological determinism involves more than simply presuming a remorseless unitary development of technology which we must accept; it involves a fundamental epistemological position on the independent causal status of technology. Choice as a concept applied to technology must be grounded in an analysis which asserts the technical feasibility of alternatives, but which clearly locates both the conceptualisation of alternatives and the decisions on the development of options firmly in an analysis of power relations in a society.

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12. That displacement has not occurred in the innovating firm does not mean that displacement has not occurred, as there is evidence that the effect may be felt not so much in the innovating as in the non-innovating firms. Macdonald *et al., op. cit.*, pp. 16-17.
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16. Hobsbawm describes this as "collective bargaining by riot". E.J. Hobsbawm, *Labouring Men*, Weidenfeld and Nicolson, London, 1964, pp. 5-22.
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18. *ibid.*, pp. 43-48.
19. Hobsbawm, *op. cit.*, p. 11.
20. As well as disputation between management and workers, technological change can lead to disputes between worker groups as the existing balance of responsibilities is disrupted. For example, within Telecom the Customer Service and Sales areas have traditionally employed clerks as the initial interface with customers and the resultant information has been passed to technical staff. With the increasing range and sophistication of telecommunication facilities, it will become necessary for those at the interface to have knowledge of the more sophisticated facilities and also skills appropriate to entering information into the system through a terminal. Thus there is considerable potential for a 'technician takeover' of clerical positions. See, for example, Australian Clerical Officers' Association, *Submission to the Committee of Inquiry into Technological Change in Australia* (CITCA), 1979, pp. 13-21.
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35. ". . . because flexible system production is premised on ever-changing

markets and conditions, it is less vulnerable than high volume production to shifts in demand. Its machines and workers are not locked into producing long runs of any single standardised good. For this reason, flexible-system enterprises have less need to diversify into several lines of business as insurance against declining demand in any one. Flexible-system producers thrive on instability. Too much stability and they would gradually lose their market to high-volume, standardised products in low-wage countries". R.B. Reich in *The National Times*, 1-7 April, 1983, p. 27.

36. "In the past, the flexibility demanded in the batch production system was provided by the skilled workers. The worker was central to all work performed in the production system and he responded very flexibly to any changes occurring in the manufacture of any given product. However, this manufacturing system has the disadvantage that great difficulties are encountered in rationalisation of production systems and saving of labour. In addition, partial automation or renovation of production facilities would not lead to any notable improvement in the productivity of the system as a whole". Ministry of International Trade and Industry, *National R and D Project: Flexible Manufacturing System Provided with Laser*, MITI, Japan, undated, p. 1.
37. Reich, *op. cit.*, p. 27.
38. Jones, *op. cit.*, p. 235.