REVIEW ARTICLES MANUFACTURING TECHNOLOGIES AND HUMAN RESOURCE MANAGEMENT*

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* Review article of **Human Factors: Man, Machine and New Technology** edited by Tom Lupton (IFS, Bedford; Springer-Verlag, Berlin, 1986) pp. 400, DM 138 Hardback ISBN s 0-948507-22-5, 3-540-16527-4, 0-387-16527-4.

There is a conventional distinction between manufacturing technologies, transport technologies, and information technologies. In a short preface to this book, Lupton notes that these distinctions can be misleading, as they are being blurred by 'the march of invention'. He also points to the duality of technological change; it may be seen as either beneficial or detrimental by such different groups as citizens, consumers, and producers/employees.

The book includes a varied collection of 28 papers. About half of them were conference papers (mostly presented at the International Conference on Human Factors in Manufacturing). Most of the other half are acknowledged as having been previously published in a journal or a book. Nevertheless, it is useful to have such a collection in one place.

The book is in the series International Trends in Manufacturing Technology. The target readership is 'manufacturing managers, production engineers and those working on research into advance *(sic)* manufacturing methods'. It is more likely to be read by students of human resource management, organisational behaviour and technical change than by the target readership, who, unfortunately, would probably find the book too long and insufficiently focused. However, Lupton has organised the papers into six sections, each of which has a short introduction.

Section 1, General/Philosophical, contains four 'think pieces'. The viewpoints of Cooley and Rosenbrock, in particular, are well known.

Both criticise the continuing scientific management tradition of Frederick W. Taylor, whereby new technologies are increasingly being used to degrade people at work and to stifle human creativity, but they contend that there are other possible uses which could enhance people's control over machines.

Bullinger reflects on ten issues arising from action research on the introduction of new technology. For companies to create better quality jobs, he advocates proactive 'opportunity management' rather than the stagnation of 'crisis management'. He characterises the former as: 'active market behaviour, product innovations, qualified staff, selective collection and evaluation of information', in contrast to crisis management, which he characterises as 'reactive market behaviour, cost reduction, increase of profitability by cutting down on staff, ad-hoc collection of information' (pp 16-17).

Gold's research on organisations considering the introduction of computer-aided manufacturing (CAM), leads him to conclude that most key decision-makers are still locked into narrow capital budgeting criteria. Instead, he proposes that CAM should be seen as an aspect of fully-integrated systems of production. This implies that decision-makers should use broader criteria, which should include the longer-term implications of not introducing CAM, in terms of job losses, and market competition.

Section 2, Man-Machine Interface, focuses on some ergonomic issues associated with robots, visual display units (VDUs) and other workstations. Malone and Heasly call this focus 'human factors engineering'. The only Antipodean paper in this book (by T.A. Williams) comments on an Australian epidemic: repetition strain injury (RSI). He includes two brief public-sector case studies where the work organisation has changed from bureaucratic, to forms of self-management. Subsequently, both cases experienced a declining incidence of RSI.

There are three broad theories of job design. Firstly, that motivation to work is enhanced when jobs are designed participatively, to give operators discretion, responsibility, variety and opportunity for satisfying interpersonal contacts at work. Secondly, that work organisation should be designed only in relation to engineering and cost criteria, because enough people will adapt and work productively in whatever jobs emerge from the design. Thirdly, that there can be a fruitful compromise between the other two theories.

All six papers in *Section 3, Job Restructuring,* suggest ways of finding such a compromise. From a Swiss perspective, Ulich and Frei identify four human criteria which should be included in the design of

robot systems. Hertel describes VW Audi's processes of job design, as it introduced 100 robots. 'The objective was to match and to coordinate the manufacturing structure and new technology with the personnel structure and work organisation' (p. 127).

Larsson, General Manager of Volvo's famous Kalmar plant, reviews its work organisation and analyses how satisfactory it has been from the market perspectives of cost, quality and flexibility, as well as from the perspectives of the people who work there. His review was written 10 years after the plant was commissioned (1974). The plant innovated by introducing team working and by using assembly wagons, rather than an assembly line. The Kalmar plant was divided into 'financial result groups'. These each comprised two or three foremen's areas, most of which had their own assignment, line and staff workers, union representative, safety officer and instructors. Management was candid in providing feedback on finances to each area, where first-line supervisors had budget responsibilities and would also pass on any fault details directly to the individuals concerned. After seven years, the plant introduced a result bonus system 'paid at the same rate per hour worked to everybody' (except the plant manager) (p. 134). This system was based on seven indicators.

By its tenth anniversary, the plant had become Volvo's most efficient 'technically, socially and economically' with the lowest assembly cost and it used 15 per cent fewer person-hours per car than Volvo's average. However, in passing, Larsson mentions that 'Average gross absenteeism is 23-24 per cent', which seems high, though unfortunately he does not elaborate how this compares with other plants in Sweden. At the older and more conventional Nissan plant in Melbourne, Australia (which also assembles Volvo cars) absenteeism averages 8 per cent, while at Nissan's new plant in North-East England, absenteeism is less than 3 per cent. Both Nissan plants use assembly lines, though of course each has a different social and political context from Volvo's in Sweden.

It is also unfortunate that Larsson does not mention that the Kalmar plant is no longer at the leading edge, but is now rather dated. Volvo has built another nine plants since Kalmar. It would have been especially interesting if this paper had also reviewed how these subsequent plants had developed Kalmar's innovatory experiences.

Child identifies four prominent managerial goals for introducing new technology:

- reducing operating costs and improving efficiency
- increasing flexibility
- raising the quality and consistency of products
- improving control over operational processes (p. 40).

(On the basis of research at Durham, I would add the goal of keeping up with or ahead of competitors.) He also notes that new technologies facilitate fundamental changes in managerial work, leading to smaller, more cohesive management structures. Many supervisory and middle managerial positions may become obsolete, but some functions should become more important, for example, in-house training. Furthermore, Child foresees that 'the arguments in favour of semi-autonomous team working arrangements . . . are significantly strengthened once it becomes a practical proposition to make relevant information and feedback available to such teams' (p. 147).

Gerwin and Leung report on a case study of some organisational issues associated with the introduction of flexible manufacturing systems (FMS). They identify five key issues:

- the transfer of technical knowledge about FMS
- FMS workgroup structure
- quality control and maintenance problems
- impact of the FMS on other parts of the organisation
- the meaning of flexibility (which they try to conceptualise in six dimensions).

They see semi-autonomous workgroups and job rotation as appropriate forms of work organisation, with group incentive schemes as appropriate forms of pay system.

On the basis of four case studies of information technology and productivity, Boddy and Buchanan consider the implications of technical change on three 'levels of effect': operating, organisational and strategic. They criticise most managements as too pre-occupied with the operating criteria, but negligent of the consequences of organisational decisions and the strategic opportunities of new technologies. Too often, the potential strategic advantages of technical changes are not realised.[1] Moreover, there may be adverse, unanticipated consequences for managements who make decisions about technical change solely using operating considerations. In particular, managers often place undue emphasis on reducing labour costs, but overlook many of the other potential benefits of new technology.

Section 4, Management of Change, includes a paper by Lupton himself. He aims to explain reluctance to innovate in terms of organisation and 'middle management luddism' (p. 188). He elaborates a useful model which links the economic, technical, and social/psychological elements of the enterprise. The questions to ask when deciding about a new investment are:

1. Will it pay; i.e., will it have a satisfactory economic return?
2. Will it work; i.e., will machinery perform as specified?
3. Will they work; i.e., will the people involved accept the implications for them of the organisational and job changes needed fully to realise the promise of the technology, and have or can develop the necessary skills and aptitudes?

Lupton's model builds on the socio-technical approach, which is of course familiar to most social scientists, but, unfortunately, the message has not yet been absorbed by most practitioners who try to introduce technical change. Thus the model directs attention to question 3, which is all-too-often neglected by managers and engineers.

Rothwell and Davidson tentatively assess changes in labour utilisation, following the introduction of information technology in eight organisations. In some cases the new technology had been followed by centralisation, but in other cases by decentralisation. There was great variety. None the less, in general, they found a flattening of hierarchies, but a polarisation between the top and bottom, with a diminution of the supervisor's role. Also evident was insufficient planning by management, which led to more redundancy, with less retraining and redeployment than might have been possible with better planning. Older workers (especially women) were the most likely to be redundant.

Beaty of IBM (UK) describes the moves towards automation at its Scottish plant, which includes a totally robotised assembly line. IBM thoroughly reviews business, personnel and technical considerations before deciding on such major investments. In some respects, the stereotypical management style of major Japanese companies is similar to that of IBM. To promote employee acceptance of automation, IBM aims to have excellent communications with all levels and to 'Remove the threat to job security [so] people will be motivated to retrain or redeploy' (p. 211). Incidentally, among other things, Beaty asserts that the workforce in the West enjoy higher salaries than their counterparts in Japan (p. 211). But this is no longer true if the comparison is with Britain, where, by 1983, the total manufacturing labour costs were 10 per cent less than in Japan.[2] And the gap has been widening since then.

Mills of Westland PLC shows how this company adopts a consultative style of managing change, though, unlike IBM, Westland is unionised. Westland has joint management/union company councils. The company's declared policy is that of fostering the active participation of managers, trade union representatives and all employees. Mills argues that this fits Ouchi's description of Theory Z 'Humanistic Management'.[3] To achieve this style, Westland has

experienced a 'cultural change'. Since this paper was written, there was a bitterly contested takeover battle for Westland. Eventually, the battle was won by an American corporation. It would be interesting to know to what extent this 'new culture' has survived or been further changed.

Burnes reports on two engineering companies' experiences of introducing computer numerically-controlled (CNC) machines. He finds that the major managerial motive was to reduce shop-floor influence over the production process, which led to simplified and less rewarding jobs. Nevertheless, he argues that, to achieve the full benefits of CNC, managers should seek to increase the degree of skill and discretion used by operators, which would also increase product quality.

The next three papers each have an American perspective. Miller and Ault present 10 guidelines which managers should follow when introducing robots. The guidelines echo the prescription of other papers. Miller and Ault include some dramatic comparative cost data. After buying a US$50,000 robot, paying for the loan, installation, maintenance and depreciating it over eight years, the total cost is about US$6 an hour. By comparison, 'an ordinary automobile worker' costs an employer about US$10 an hour. Further, the cost of robots is falling, while that of people is rising. (The next paper cites the total cost of an employee in the same industry as between US$23 and $24 an hour, including benefits.) The average robot has only 2 per cent downtime with less scrap and produces higher-quality products, more safely than people. 'A robot also uses less energy than conventional machining, and doesn't need warmth, clean air or even light' (p. 249). Robots can relieve humans of such dangerous jobs as 'work in nuclear reactors with high radioactivity' (p. 252).

This paper urges 'managers to review their company's history . . [and to] . . be willing to learn from the past' (p. 257). Yet these authors also include an odd comment: 'It may well be that there is a need for a new Frederick W. Taylor to rationalise the new automatic processes' (p. 255). Evidently, Miller and Ault have learnt rather different lessons from history than Cooley and Rosenbrock, whose earlier papers criticise Taylorism.

Foulkes and Hirsch suggest that there will be increasing worker resistance and even sabotage to robots, which will reflect fears about job losses. The coming generation of 'smart' robots with rudimentary vision or tactile sense could displace as many as 3.8 million workers in the US. To induce positive employee responses about robots, this paper recommends that companies should begin introducing robots with a new product, or when expanding capacity, so that employment is increased, rather than the arrival of robots being accompanied by dismissals. It also recommends that companies demonstrate concern

for workers by assigning the first robots to the three 'D's — dull, dirty, or dangerous tasks — or the three 'H's — hot, heavy, or hazardous jobs. After two years of following these maxims, one company has experienced a dramatic reduction in worker compensation claims. In any event, this paper exhorts managers to have a 'no-layoff policy' and to plan to maximise retraining. In common with several other papers, Foulkes and Hirsch find 'management a greater roadblock than hourly workers', but that the supervisor 'was often overlooked, received no training, and was not kept abreast of events' (p. 265). In spite of the decline of American unions and the American propensity to engage in union busting, we can infer from this paper that at least some unionised companies which have successfully introduced robots (e.g., Westinghouse) have striven to work with the unions.

In *Section 5, Employment Effects,* Hunt concludes that, although robots are displacing some jobs in the US, others are being created which may require even higher skills than those displaced. This conclusion is based on the Upjohn Institute's detailed estimates of job losses and gains to 1990. These data are less alarmist than much of the media hype. He urges policy-makers, however, 'to begin rational planning for the human resource implications' (p. 275). From a rather different, German perspecive, Lahner argues that the productive potential of present and future technologies is so great that, unless some means are found to stimulate economic demand, unemployment is bound to increase. He sees the cause as society's failure to create demand, rather than in technologies displacing jobs.

Gould offers a critique of the UK's social and employment policies. He advocates radical policies to change the existing hierarchical division of labour and to redistribute the benefits flowing from technical change more widely. He argues that legislation should aim to improve the quality of life, through, for instance, promoting early retirement, job enrichment, work-sharing, job-splitting and a more equitable access to leisure facilities. Among all the papers in the book, this is the one which particularly aims to put technical change into a broad social context.

In *Section 6, Industrial Relations,* one scenario envisaged by Corina 'is of a working population triply split: between those with and those without work, the latter experiencing estrangement, and the former comprising both a group flourishing as the aristocrats of the new technology, and also a group experiencing more intense work uncompensated by requisite increases in real earnings or falls in hours' (p. 355). His paper reviews unions' 'positive' new technology policies in Britain and some other European countries, though he also touches on Australia, USA and some international trade secretariats. Among

other things, he includes in his list of union objectives: reductions in the working week and earlier retirement. However, he does not note that this list differs between countries. In Sweden, the former objective is not generally applicable, while in the US, there have been moves towards later retirement.

In spite of all the union policies, most technical change continues to be introduced by employers unilaterally. Where there are bilateral discussions, these usually occur within the existing industrial relations machinery, especially where manual workers are concerned. But some British unions have negotiated special technology agreements. Williams and Steward analyse 240 such agreements made between 1977 and 1983. Most of these were negotiated by a few general/white-collar unions. The majority (171) of agreements are *procedural* (which establish a framework for handling technological change in general), 39 are *specific* to a particular new machine or system and represent a typical craft union approach, while 30 combine both approaches in *combination* agreements. These latter agreements indicate a strategic conception of negotiating technical change. Evidently such a conception is still relatively rare among trades unionists, as well as among managers.

Despite much union and employer rhetoric about the quality of working life, more than 80 per cent of the technology agreements include no reference respectively to protecting skills, maintaining career structures, or maintaining job satisfaction (p. 377). By contrast, almost 84 per cent of the agreements include provisions for employment security, while nearly 70 per cent include health and safety provisions. However, some of these provisions highlight the lack of information and expertise among management and union negotiators. 'In one early agreement a "refresh rate" for VDU screens of 57 Hz was agreed as a compromise between management requests for 55 Hz and the union policy of 60 Hz. Although no equipment was available with this refresh rate, the standard was borrowed and inserted into agreements at a number of workplaces' (p. 375).

Interestingly, the two papers on union policies and technology agreements are juxtaposed with some analysis of union and management behaviour in practice, which often differs from their stated objectives, depending on the precise context.

Koziara identifies five functions of American unions: contract negotiation (collective bargaining), contract administration, service to members, union administration and external activity. She analyses the introduction of robots in manufacturing industry on each function. Her conclusion is that both procedural and substantive bargaining will become more complex for both parties, and that unions will have to have much better forms of communications with their members and to relate more to external organisations, in an attempt to influence

policy. Nevertheless, Koziara thinks that unions will continue to lose membership and bargaining power. According to this paper, only one aspect of industrial relations is likely to become less complex: grievance administration, because robotisation tends to reduce the number of disciplinary grievances about poor workmanship!

Two Ferranti PLC managers, Wallace and Whitehall, describe the introduction of successive generations of NC and CNC machines since 1952. They illustrate a demarcation dispute that precipitated a 12-week strike 'in which management found itself in the middle'. This occurred following a technological change, because 'an operation [was] moved from the province of one worker [the planner] to that of another [the craftsman] . . . it amounted to who pushed certain buttons on the control panel of the machine' (p. 333). Although Ferranti has had 'only one serious dispute in its 42-year history', about 'employee participation arrangements', and 'almost always' has taken care to engage in advance consultation about technological change, the writers admit 'there have been isolated occasions in the past where the practice has been omitted with resultant problems' (p. 333). These managers frankly conclude that 'Company negotiators will have to change their traditional approach to one which looks increasingly at future developments and makes provision for the consultation and involvement of the employees' (p. 335).

This paper also describes an interesting Teaching Company Scheme between Ferranti and Heriot-Watt University, Edinburgh. Such collaborative schemes are worthwhile ways of helping to foster innovation, and skill formation. They represent an excellent form of co-operation between industry and academia.

This book includes a wealth of insights into the process and some outcomes from technical change in advanced industrial societies. In short, there are genuine choices available for those making decisions about new technologies. The successful management of technical change is invariably facilitated by involving at an early stage specialists in human resource management, and the employees most likely to be concerned. This implies an increasingly important role for personnel managers in formulating strategies, not in merely devising remedial tactics.

The book does not have an index, which would have been especially helpful, because similar issues are discussed in several papers. Nevertheless, this substantial book is a valuable collection in that it is multi-disciplinary; its authors include: engineers, ergonomists, psychologists, sociologists, and practitioners who have themselves introduced new technologies. Still on the horizon, however, lies the challenging task of trying to integrate such approaches into an interdisciplinary synthesis. Such a synthesis would be of even greater value, both for practitioners and students.

NOTES AND REFERENCES

1. cf. G.J. Bamber and R.D. Lansbury, 'The human factor in logistics', in: P. Gilmour (ed.), *Logistics Management in Australia,* Longman Cheshire, Melbourne, 1987.
2. G.J. Bamber and R.D. Lansbury (eds), *International and Comparative Industrial Relations: A Study of Developed Market Economies,* Allen & Unwin, London, Sydney and Boston, 1987, p. 252.
3. W.G. Ouchi, *Theory Z: How American Business can meet the Japanese Challenge,* Addison-Wesley, Reading, Ma., 1981.