Work, learning and technology development in manufacturing supply chains

Alan Brown
Institute for Employment Research, University of Warwick
alan.brown@warwick.ac.uk

ABSTRACT

This paper explores how the practices of learning, the modes of knowledge creation, work processes and technological development are all being transformed in an interactive and iterative way across organisational boundaries in manufacturing supply chains. Work, learning and technological processes are being reframed as companies search for continuous improvement in areas of design, manufacture and inter-organisational relationships as well as being concerned with improvements in quality, cost and delivery (DTI, 1999). As a consequence, the models of learning and innovation being adopted present a challenge to how we envisage the most effective ways to support work-based learning that has a significant inter-organisational dimension as well as cutting across a range of occupational and disciplinary perspectives. Such profound transformations in work and learning processes are also inextricably bound up with significant changes for the individuals centrally involved. Individual careers and identities are being transformed too.

Introduction

The paper is based upon two studies. **The first** was an evaluation of a major project designed to support inter-company learning networks in the automotive and aerospace industries. The project sought to support a number of companies in advanced supply systems with a strong focus on both immediate performance improvements and longer-term changes in how learning was conceptualised and supported across supply chains. The underlying approach to learning was that there is considerable value in attempting to link processes of knowledge creation with tackling the core problems of manufacturing practice as a means of engaging learners that have traditionally been difficult for educational institutions to reach. The model of learning used with its emphasis upon networking, knowledge creation, linking an initial focus upon performance with a

progressive broadening of ideas about learning and development was particularly well suited to its context: supporting learning and development in advanced supply systems. However, the scale of the effort and resources required to make the project successful means that considerable challenges would remain if the model were to be successfully implemented in a range of other contexts. **The second study** also focused upon the automotive and aerospace industries and was concerned with changing occupational identities. Employers attempt to shape employees' work identities through the organisation of work. However, they are partly constrained by employee expectations related to education and training, the occupational structure and the labour market. Employees, individually and collectively, also attempt to influence how their work is performed and play an active role in shaping their own work identities. Work identities are therefore influenced both by structural factors and the agency of employers and employees. Whereas the first study traced structural influences, the second concentrated upon how individuals sought to shape their own work identities, partly in response to the efforts of employers in France, Germany, Spain and the UK to shape those same work identities.

The strategic and operational contexts of companies have been influenced by the changing patterns of innovation within supply systems for complex products in the automotive and aerospace industries in the last decade. Current forms of product system integration now differ markedly from those of the past, which were based on single ownership of multiple stages of production and distribution. The newer forms have developed around the process of 'de-integration' in large companies, and are currently viewed in terms of the 'supply chain'. They are generally founded on large firm control over market access at strategic points in the total product system. This control is facilitated by intensive use of information and communications technologies and is used to achieve tight co-ordination over all stages of production. Advanced product systems are organised hierarchically, with the manufacturer at the top, controlling level. The characteristics of suppliers in the different tiers vary greatly, but some generalisations are useful. Those in tier one are mostly large or very large companies in terms of employee numbers and capitalisation. Many have a sophisticated technological base - for instance, those producing specialised electronic, electro-mechanical and mechatronic systems or subsystems. The capacities of the leading tier one suppliers include significant research and development, product design and other advanced innovative capabilities. These companies are pressed to develop these capabilities further by manufacturers that are increasingly outsourcing elements of product development and manufacturing (Abreu et al 2000). The tier one suppliers have an expanding role in aspects of product specification, but this is accompanied by closer scrutiny of their practices by the manufacturers through 'supplier assessment'. By contrast, the numerous companies in tiers two to four are mostly SMEs, including many micro enterprises. Some of these provide specialist functions, but many, particularly in the automotive sector, have traditionally had limited technological capabilities. However, in the face of continuing pressures to reduce costs significantly, manufacturers and tier one companies have had a central, motivating, role in stimulating smaller companies to participate in learning networks with a view to process improvement and cost reduction. This potent mix is stirred further by (global) changes in patterns of supply, coupled with significant

restructuring within manufacturing, as the larger companies have sought to reduce the number of suppliers with whom they deal. If learning is primarily about responding to a challenge these are potentially very powerful learning environments, and indeed transformative learning occurred in some, but not all, contexts. SME's capacities for response are also shaped by a fundamental divide in the emerging supplier hierarchies between the suppliers of more specialised components or services and suppliers of commodity parts and components. The former generally depend on high levels of skills that can be hard to replicate – as is reflected in product development capacities, relative product complexity, and manufacturing capabilities. These capabilities yield relatively high returns and vehicle manufacturer or large tier one customers are often keen to retain these companies as suppliers, because of their contribution to product distinctiveness and value added in the end product. However, commodity items are increasingly sourced by large companies by electronic means, using 'reverse auctions' in which potential suppliers bid on price alone for supply contracts. This extends supply opportunities for suppliers in low labour cost locations, and puts pressure on commodity suppliers elsewhere. However, some commodity suppliers in Europe have retained advantages through their proximity to major manufacturing sites and their established abilities to comply with the total quality and kanban delivery requirements embedded in supply contracts.

The first study: inter-company learning networks

The project involved in the first study aimed to stimulate economic innovation in SMEs through innovative learning. The approach centred on the development of two types of learning networks. Type 1 networks were process oriented, comprising workplace teams of operators and managers, that linked up to eight suppliers to a main, tier one, customer. They functioned through learning about the core tools and skills needed to improve performance. Teams undertook 'hands-on' learning by doing, which involved problem identification, and the development and testing of solutions. The type 2 networks were aimed at senior managers in SMEs in tiers two to four, which were linked as buyers or suppliers. The focus was on developing awareness of the scale of the threats that they face, and on establishing the measurement and improvement tools required to meet the increasingly demanding quality, cost and delivery standards of customers. Another aim of these networks was to foster the cultural adaptations needed in the current competitive environment.

The project built on earlier pioneering work by members of the partnership. A web-centred learning approach also supports the development of e-commerce capabilities and network group learning undertaken between multiple, linked workplaces. Learning support is provided, face to face and via project web-based facilities, by a team of experienced professional engineers, trainers, learning support specialists and mentors. In the type 1 networks, tier one companies persuaded their suppliers to identify key individuals with central responsibility for shopfloor innovation in supply management. These people, nominated as 'change agents', became project participants, and Open University students, following a course on Stimulating Competitiveness in Supply

Chains. They were invited to a series of one week, intensive workshops at the tier one company, led by an engineering tutor (employed by Industry Forum) together with a learning support tutor. In the four week intervals between workshops, the change agents applied what they learned in a practical context in their own companies. They kept in touch with other students via a computer conferencing system and undertook assignments designed to encourage them to reflect on their learning and the implications of applying it. The learning support tutor offered considerable educational support where necessary and marked the students' assignments. As the course progressed, the focus shifted from work in individual companies to collaborative learning across the network of participating companies. There are obvious advantages of such a programme for the tier one companies who see rapid benefits in terms of the cost, quality and delivery performance of suppliers. There are also competitive advantages for all the companies in the network. Students also gain as individual learners. Overall, the expectation is that the future competitiveness of the companies will be enhanced, whether they are working with this particular customer or not.

In the type 2 networks, groups of senior managers from SMEs are brought together at the site of one of the project partners for a diagnostic workshop which aims to help them identify the learning needs of their companies. They then participate in a series of half day workshops that match those needs and, again, use computer based conferencing and activities to keep in touch and to facilitate the application of what they learned within their own environments. The forerunner of the type 2 networks was funded from the DTI initiative 'Learning from Japan'. A Tier 2 supplier, realised that the key to supply chain performance rested with SMEs, so it reorganised itself and it's suppliers into a network that, together, concentrated upon enhancing performance through focusing upon quality, cost and delivery. They used Industry Forum engineers to work on production improvements, and set up a learning centre where employees, suppliers and customers could learn away from immediate pressures of work. Staff employed in the open learning centre offer training and development, but also get involved in adapting 'best practice' to different settings. The key driver of change has been the quality of sharing of information, knowledge and experience among suppliers across the supply chain.

Merseyside Automotive Group acts as the key intermediary group in another network. This time there is a very strong pull from the top of the supply chain, and the group has received DTI support in establishing an Automotive College. With impressive facilities and underpinning funding it has been possible for those in education and training to work hard at building relationships with companies. Even SMEs will work with trusted intermediaries once a relationship has been established, although it is important not to raise company expectations too quickly. The strategy is part of a sectoral approach to business improvement that includes the establishment of an e-business community and a programme of support for continuous improvement.

One key question is how generalisable are the findings from this project, given the high levels of external support. The first comment to make is that the level of provision of

organised learning support was high, with assessors and tutors offering considerable individual as well as group support. There is little doubt that a reduced level of learning support would result in far fewer employees being committed learners. There is also a paradox in that some of the initial enthusiasm for learning comes precisely because the learning does not seem like learning ('something hard that involves you in doing things you would not do if left to your own devices'). That is, there is a step change involved in building upon the learning attained from well-defined Industry Forum processes that focus upon improving organisational performance. That learning is initially limited in terms of its scope and more in-depth learning is by its very nature more challenging.

One major problem faced in trying to generate interest of SMEs in learning and development (and in generating small business growth) lies with the career motivations and personal expectations of individual owners and managers. Many small firms adopt practices that are antithetical to efficiency and growth (Gray 1993). Indeed the most common small business ambition is for independence and autonomy rather than profits and growth (Gray 1998). Hence it is important not to understate the extent of learning support (and in some cases a cultural shift) that would be required to make the project approach applicable to a range of other settings. On the other hand, this particular example was very successful in its context. Hence it is worthwhile drawing out four lessons for supporting learning in small companies. First, it is clear that the focus upon improving organisational performance contributed to improving commitment to learning at work of both companies and individuals that have been traditionally hard to reach. Examples of demonstrable improvements in quality, cost and delivery made the link between learning and performance transparent. The support of large companies as lead organisations in supply systems was significant too. SMEs were much readier to take part in an initiative that had the explicit approbation of a major customer than if they were approached directly by providers of education and training. The participation of major manufacturers and Tier 1 suppliers in networks proved to be powerful initial 'hooks' to engage SMEs in learning activities. Second, once committed and after overcoming initial suspicions of learning and working with staff from other companies, there were considerable benefits from collaborative learning. The type 1 networks involving change agents from different companies working together meant that, in addition to transfer of 'good practice', they could get a 'feel' for the capabilities of the other companies and this opened up possibilities for greater collaboration (for example, in joint bidding for contracts). The type 2 networks engaged senior staff from companies directly thinking collaboratively and strategically about supply chain issues. In both types of networks there was value in learning as a member of a group, including from others with a variety of backgrounds - with mutual learning across hierarchical levels as well as between horizontally between departments and companies.

Third, there was a formal learning framework in the initial stages and a continuing structure of learning support - it was not just a question of bringing people together. The use of a wide range of learning methods helped improve commitment towards learning. These methods included: participation in production process improvement reviews and

implementation; Master Engineer workshops; group discussions; assignments; portfolio-building; discussions with tutor; use of computer-mediated communications for discussions, document transfer and tutor feedback. It was important there was rapport and a good working relationships between engineer and tutor in order that technical and learning development are mutually supportive. There was a key role for the learning support tutor in helping learners build and then sustain commitment towards their learning goals. The tutor role involved providing advice, guidance and information and supporting all aspects of learning. Learners at all levels greatly appreciated the support and encouragement of tutors. Fourth, the final stage was an attempt to move towards still more expansive learning beyond the immediate context. Many of the change agents recognised the value (and potential transferability) of the skills they were developing and this contributed to their commitment towards learning. For example, the skills required in coping with the challenges of trying to implement change involved compromise and dialogue and helped hone their communication skills. The project gave people support to help them engage in patterns of thought conducive to learning. The project gave learners generally, but especially the change agents, the time and space to engage in critical thought, self-reflection and personal development. This included opportunities for both collaborative and self-directed learning.

Overall then, the model of learning used in the project with its emphasis upon networking, knowledge creation, linking an initial focus upon performance with a progressive broadening of ideas about learning and development was particularly well suited to its context: supporting learning and development in advanced supply systems. The model of learning, rather than the particular details of the approach, could be transferable. If the model was underpinned by corresponding commitment of effort and resources, then it could be successfully implemented in a range of other contexts.

The second study: engineering identities

There is a strong demand from employers across Europe for workers with technical skills allied to 'modern' skill sets, including abilities to work in teams and communicate effectively. Companies in the four countries studied have been introducing greater flexibility in work and expect staff to accept resulting changes in patterns of work organisation, often involving team working or attempts to improve manufacturing practice through a focus upon continuous improvement. These changes are intended to improve competitiveness, and major manufacturers have been pressurising their suppliers, sometimes through the use of very aggressive year on year cost-downs. Flexibility in work organisation has been a major goal of employers in the sector, although there are major differences in companies' attempts to achieve this. Companies vary greatly in whether regular work activities provide a rich or poor learning environment, depending upon how work is organised, the nature of production and the size of the company. Employers' commitment to learning is very variable, but general competitive pressures and actions across supply chains are driving at least some learning in the workplace. Employers have been changing roles and responsibilities and experimenting with different patterns of work organisation (including team working,

manufacturing cells and varying skill mixes). In some cases the emphasis is more upon work intensification rather than high performance. Other companies are shifting from direct manufacturing to provision of engineering services and this requires changing skill sets for employees.

In the UK in particular, organisational commitment rather than occupational identities drives much of the organisation of work, often with an explicit emphasis on flexibility and multi-skilling. These trends are noticeable to some extent everywhere, and some German companies viewed the attachment of workers to a single occupational perspective as problematic in attempts to introduce greater team-working. However, in all countries there are enormous variations in the degree of skill required of workers in different workplaces. Spain and the UK have in the past made more use of low skilled labour than France or Germany, particularly in small or medium size companies. However, even in sub-sectors utilising considerable knowledge intensive high value-added work, as in aerospace, high skill, high performance is not the only paradigm to use in the organisation of work. Indeed one specialist aerospace company found that its most profitable component had a very low technical specification and could have been produced by any general engineering company. In contrast, the costs on its specialist knowledge intensive work, that perhaps only two other companies in the world could undertake, were so tightly controlled by the customer that it made very little contribution to company profitability. Similarly, one automobile manufacturer in the UK with a new factory and an ultra-modern approach to the organisation of work was by far the least efficient company in the sector simply because it could not sell enough of its cars.

Some employers in all four countries studied seemed to have 'got the message across' to employees of the need to make changes in the organisation of work in order to make the company more competitive. There is a discourse based around an assumed global vision of effective working processes and practices, with employees in Germany, Spain and the UK all expressing satisfaction with their work despite significant work intensification. In some cases this was because a smoother production process had ironed out difficulties that had caused problems for workers in their jobs. However, some employees in all four countries also mentioned that they took a pride in the improved effectiveness of their companies even if this sometimes meant sacrifices upon their part. Overall changes in the structural context have meant that occupational identities in engineering are undergoing significant change, particularly in response to increased competition and changing patterns of work organisation. Occupational identities were particularly likely to be in flux for employees working in multi-functional teams, or as change agents, team leaders, or supervisory staff whose influence had been reduced, or in companies that have shifted from direct manufacturing to providing engineering services. In all these cases the type of work undertaken and the mix of skills required were changing, in some cases dramatically.

Individuals, however, are not passive in the face of change and the major aim of this project was to answer the question of how employees respond towards changes in their

working environment and working lives. What are individuals' strategies for coping with these changes and how do they affect their work identities? This section of the paper will look at individuals' personal responses, reactions and interpretation regarding changes at work. The focus is upon the strategic actions of those working in engineering based upon the 'strategic biographies' of individuals. This biographical perspective is useful, as for many individuals the nature of their commitment and work-related identity changes over time. Our interviews highlighted that the relationship between individuals and the occupational roles they were required to perform could be represented in terms of their patterns of strategic action across a range of structural, cultural and social contexts. Their careers could be mapped in terms of their patterns of relationships, orientation and adaptive response to work and it is possible to trace the dynamic development of individuals' characteristic repertoires of strategic action - their 'strategic biographies'.

An individual's pattern of strategic action regarding work could and did change over time. An individual may become disillusioned leading to a change from identification to adjustment, or an individual may follow a strategic career path for part but not all of their working life. Reactions to work could also change in response to particular events, such as promotion or redundancy, or changes in other areas of life (birth of children, death of a spouse and so on). The identification of different forms of strategic action did help us give meaning and shape to our interviewees' career histories by outlining what we found to be typical and relatively coherent repertoires of strategic response to the challenges of constructing work-related identities. Occupational identity formation processes and patterns of strategic action relate to a number of issues at the level of the individual, the organisation and society as a whole. There is a degree of interdependence between the structures of the labour market, the work environment and working conditions and occupational identity of employees. The product market is important here: where a sub-sector is undergoing very rapid change, especially in its product markets, then companies may wish for employees to have flexible occupational identities. In these circumstances great attention is then given to learning while working. Considerable resources and support for skill development and socialisation go into the formation of initial occupational identities, but all parties (employee, employer and state) should recognise that the reshaping of these identities to fit changing contexts also constitutes a major task.

While continuing education and training can play a role, it is perhaps more important to support processes of learning while working. This could be achieved in formal ways through support for systems of mentoring. However, it could also be achieved through paying close attention to the composition of development teams, such that employees taking on new, and especially hybrid, roles can be given some support in moving towards full engagement with the new roles. This could be accomplished through association and working with those further on in the process. The interesting point here is that development is a process and focusing upon outcomes such as qualifications may draw attention away from the process. For example, in the UK it is clear that employees, especially graduates early in their career, learn by moving from company to company, and this process leads to a transfer of 'tacit knowledge' that can benefit both the employee and the companies (Mason and Wagner, 2000). 'Teaching company schemes' are another

example of where there is support for a process - in this case (mainly engineering) graduates are attached to small companies to give the firms access to skills and expertise they do not normally possess. The graduate should act as a 'change agent' facilitating processes of business improvement (Senker and Senker, 1997). The key point for identity formation is that from the outset the (new) graduate learns that her or his role is about producing change - forging an identity, creating a role, helping others change - rather than fitting into a pre-ordained 'slot'.

Changing patterns of work organisation have frequently led to increased delegation of responsibilities, greater team working and the need for learning processes, which are related to more complex thinking and to assuming a broader responsibility for the whole production process. This means that technical skills need to be developed in combination with the development of communication skills, the ability to learn independently and in teams, IT skills, business skills and abstract thinking. One implication of this for initial VET is that such skills may best be taught in combination and in context. This is one factor behind arguments for the development of complex learning environments within apprenticeship training in Germany. Elsewhere there are similar arguments on the need to focus in initial VET on the core problems of practice that have these mixes of skills embedded in authentic problems. Such arguments emphasise that an occupational identity needs to be forged in engagement with the complexities of practice, not something that is developed prior to such engagement. The latter approach seems to store up trouble for many individuals because of its naive model of skills transfer and development. In the longer term, it may be that people with 'modern' skill sets able to undertake a range of work may look for horizontal mobility across occupations or sectors rather than vertical mobility. This can be facilitated by allowing individuals greater access to careers guidance and personal skills auditing such that they are encouraged and supported in looking across the labour market for opportunities to use their skills, rather than necessarily remaining within particular sectors and specific patterns of thought. Overall then, if individualisation is a trend, it is important to develop guidance to support the individual in successfully responding to demands for flexibility and mobility and to enable the individual to move between occupations. The intention would be to give individuals confidence in their own abilities and to empower them to become agents of their own professional development (aspects of the French 'bilan de competence' may be relevant in this respect).

The foregoing is not an argument against the initial development of a strong technical knowledge base - this remains important. Indeed it was noticeable that most employees in the German sample stated that they had no problems in keeping up with technological innovations and the required technical learning processes. This capability is surely rooted in the advanced technical skills that the German skilled worker acquires during her or his apprenticeship. [Indeed in a slack labour market, as in Germany, employers can stipulate a formal skilled qualification is required even for less skilled work. The rationale for doing so is that such employees are quick learners and are easier to motivate.] Employees working in engineering predominantly identify with their work tasks and related skills, the company and the professional community. However, the very strong identification

and attachment of a generation ago are less common with the realisation that you are no longer effectively guaranteed a job for life. Identification with the 'output', as in the aerospace and automobile industries, or the 'process', if their work was particularly challenging and required specialised skills, could be important. Challenging work can still generate identification and commitment - significant numbers of people still want work-related identities that give them a sense of control, purpose and direction. States have traditionally been reluctant to intervene in what happens inside a company, but maybe public policy should seek to support companies that do offer challenging work.

As businesses have come to realise the benefits available from integrating functions and co-ordinating actions, they have sought to build and manage linkages both internally and across organisational boundaries. Integrated supply network management involves crossing organisational boundaries and dealing more intensively with customers and suppliers. Some firms have established a new paradigm in supply chain management, where they are taking a holistic, fully integrated approach incorporating the dynamic flow and management of products, information, cash and even ideas. The shift towards networked thinking has increased the complexity of the total system, placing even higher demands on the integration and management systems. Some companies believe that in future networks of inter-linked firms will be more important in meeting specific customer needs. This would mean employees should see the network as their crucial frame of reference rather than offering commitment to a single organisation. While companies can be expected to invest significant resources of their own, it may be helpful if public policy were to support the development of and learning within supply networks, including through support for forms of learning and socialisation that implicitly and explicitly favour increasing individual attachment to the network.

The temptation in considering policy recommendations is to focus almost exclusively upon the requirements of organisations and the economy as a whole. However, the calls for employees to respond to demands for flexibility, mobility, and new patterns of working and learning present significant challenges for individuals. The relationship between individuals and their occupational roles could be represented in terms of their patterns of strategic action across a range of structural, cultural and social contexts. Individuals developed characteristic repertoires of strategic action and these included identification; long-term adjustment; short-term adjustment; adopting a strategic career perspective; and re-definition. What those making policy often assume is that identification and strategic career development are the states that can 'normally be expected' from those working in a particular sector. In practice, for a variety of reasons, many workers will see themselves as adjusting to work, over a shorter or longer time frame, rather than identifying with it. Any form of state-supported learning and development should therefore take cognisance of the need to give the individual a significant 'voice' in choosing the direction in which this should go, rather than assuming development should be aligned to their current work. We should pay particular attention to individuals using re-defining strategies operating at the cutting edge of norms and expectations of employers, colleagues and others, typically leading their peers in some respect. We need to know more about the process of how work-related identities are

transformed and such individuals could play a key role in helping us increase that understanding. Other forms of re-definition occurred when individuals wanted (or saw themselves forced) to change direction. Much more could be done to support individuals in this process, rather than regarding this more or less as an aberration. Access to impartial advice and guidance could be critical in this respect.

References:

Abreu, A., Beynon, H. and Ramalho, J. (2000) "The dream factory: VW's modular production system in Resende, Brazil". *Work, Employment and Society* 14, 2, 265 - 282.

Department for Trade and Industry (1999), *Quality, Cost, Delivery: seven measures for improved competitiveness in manufacturing industry*, London: DTI.

Gray C (1993) "Stages of Growth and entrepreneurial career motivation". In Chittenden, F., Robertson, M. and Watkins, D. (eds.) *Small Firms - recession and recovery*. London: Institute for Small Business Affairs / Paul Chapman, London. Pages 149 - 159.

Gray C. (1998) *Enterprise and Culture*. London: Routledge.

Mason, G. and Wagner, K. (2000) *High-level skills, knowledge transfer and industrial performance: Electronics in Britain and Germany*, London: Anglo-German Foundation.

Senker, J. and Senker, P. (1997) "Implications of industrial relationships for universities: a case study of the UK Teaching Company Scheme". *Science and Public Policy*, 24, 3, 173 - 182.