Learning while working in the aerospace industry in England and Germany

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1. Introduction

The European Fifth Framework Participa project involves an investigation into the factors influencing the participation of technical workers in continuing vocational education, training and learning (CVETL) activities in six countries. The initial findings have suggested that participation in continuing vocational education and training (CVT) is more influenced by individual agency in Portugal, Spain and Greece, whereas structural factors (in terms of forms of provision of CVET and learning) are more influential in Germany, Italy and the UK. This paper focuses upon the comparison of CVETL in case studies of aerospace companies in England and Germany. The data was collected by semi-structured interviews and non-participant observation and the case studies were intended to deepen results from the previous phases in order to understand more fully the participation of technical workers in CVETL activities. The German 'case' is a single company, while in the UK because the CVETL for a number of SMEs was organised collaboratively in an aerospace components supply chain learning network the 'case' will be the responses of **three** SMEs to the challenges of facilitating continuing learning, development and continuous improvement. The German case will be presented first, then the UK network and finally comparative conclusions will be drawn.

2. German case study in the aeronautics sector

2.1 Short introduction to the case

This case study presents the results of investigations within a case study selected from the aeronautic sector within the Bremen region. In the Participa project ITB has carried out research on participation in CVET and learning in SMEs and the aeronautics sector was selected for two reasons: it is a sector which is of significant importance for the Bremen regional economy and it allows for comparisons with the Engish results. During the project, qualitative and quantitative methods have been applied including expert interviews, a standardised questionnaire and case studies to illustrate and deepen the research of the prior qualitative and quantitative investigations. In this case study the results of in-depth interviews with two members of a company, an aircraft sales and maintenance enterprise, are presented and synthesised. The case was chosen based on the following criteria:

- Aeronautics is a sector of particular significance to the Bremen economy;
- The company can be seen as representing a case of particular "good practice" because of its market position and/or its learning policies;
- The company has a significant proportion of full-time technical workers.

When developing the case study the following characteristics played a significant role:

- The case study was developed around the factors influencing technical workers' participation in CVET and in learning.
- The considered participation factors follow the major dimensions of the ISSTAL model or can be related to that.[1]
- The case study serves the purpose to deepen and illustrate the findings from the prior periods of research. With regard to the ISSTAL model it was found within the investigations on the IT as well as the aeronautics sector in Bremen, that there is a number of variables, which would be categorised as "situational" within the ISSTAL model that seem to have a major influence on CVET and learning participation. Those situational variables are being explored through this study.

The case study investigated the following aspects of the company's policies and practices: business fields; the more formalised aspects of training policies and practices; and the support for learning and learning and HRD policies and practices. Interviews were conducted with two employees at two different levels of the company: the general manager (key account manager) and a high-level technician fulfilling technical management functions within the company as well as shop floor functions (see below). The interviews followed a semi-structured questionnaire made up around the ISSTAL dimensions. An additional module of the questionnaire was related to ambiguous results of the prior phases of research. In addition the Internet profile of the company was analysed. The main focus was laid on formal and more informal activities with regard to participation in training and learning. However, around that, substantial information was gathered about specific traits of the company with regard to its market position and its internal structure as important explanatory variables. In the next section the general traits of the company are being described.

2.2 Business fields, structure and employees of the company

The case study in the aeronautics sector was carried out in an SME 25 km away from Bremen, specialising in the maintenance, repair, sales and chartering of small airplanes and private jets (usually for business use with up to eight seats maximum). The company is located at a small sports airfield, which is rented from its private owner and makes use of three other airports: Hamburg (one service technician is based there), Paderborn and Cologne. This extension was established because of the restrictions of the runway of the local airfield for some of the planes in service. In addition the company runs a small hotel and restaurant at the airport. It is a limited company belonging to four partners and some 10% of the shares belong to the

[1] The ISSTAL model is the common ground of the PARTICIPA project. All the regional research designs relate their findings and methods to this "psychometric" model of factors influencing participation in CVET processes.

managing employees. Since 2003 the company also has a workshop specializing in flight electronics (avionics) at Bremen airport, taken over from a competitor, which went bankrupt mainly because of delivery problems of a major airplane manufacturer. This workshop is employing 25 persons, technical staff taken over from the prior enterprise. According to one of the owners there is only one competitor to the company in Germany specialising in the same business field, i.e. airplanes of that size. The main vendor for our case is Cessna. The most substantial part of the revenue is generated through the sales department. However, as in the car sector, this presupposes the infrastructure for continuously servicing the clients in technical and maintenance issues. Also similar to car business the dependence of the SME to its major aircraft vendor is extremely high. Altogether the company employs 86 persons, of which 6-7 are employed as apprentices. Apprenticeships only exist for the occupation "*Fluggerätmechaniker*", although the company is about to introduce apprenticeship training in the field of warehousing. Former apprenticeship schemes in aircraft and flight electronics had to be cancelled because of the lack of an offer in VET school courses in that domain in the Bremen region. At the top of the company structure there are sales and business management and technical management. The technical management is run by a half time employed senior aircraft supervisor (*Prüfer*) who is at the same time with the other half of his working time in charge of the position of the "nominated post holder" of the German Federal Aviation Department (*Luftfahrtbundesamt*, LBA). Beside a small number of administrative staff the company employs staff for the operation of the charter airplanes (four employed and four freelancing pilots). The rest of employees belong to the technical staff. Broadly clustered

Figure 1: The electronics/avionics workshop

the technical staff (aircraft mechanics) can be divided into two groups: quality supervision (30%) and shop-floor mechanics (70%). The retention with regard to employed staff is very high. In summary there are the following characteristics of the specific sector and enterprise relevant to questions of initial training and HRD matters: business fields and activities are strongly determined through the specific vendor and the regulations of the Federal Aviation

department. The high skills necessary to work in this sector results in comparatively stable employment perspectives. Work on the shop floor is polarised into repair and maintenance and quality supervision, which itself is strongly determined through safety regulations of the aircraft business. The main strands of activities of the technical staff are: controlling, maintenance and repair and quality supervision and auditing.

2.3 Initial and continuing education and training

Box 1: Typical apprentice training sequence

„In the first year they don't work at all, they spent the whole time within the training workshop and learn the fundamental skills and knowledge of metal technology. The apprenticeship is carried out under the supervision of our junior Meister craftsman. They learn aluminium bending and curving, sawing, drilling, filing, just everything what is fundamental to mechanical engineering and working with metal. After the first year they start in slow mode with things like cleaning bearings, opening lids, greasing, cleaning washers. At some point they begin to join controls, of course they are not allowed to sign. This, they are only allowed, when they are finished. Then they get a stamp with their staff number. Each single assignment has to be stamped when it is finished. In order to make it possible to track who changed the bolt even after ten years. Apprentices are taking over such tasks and assignments but then they have to be stamped by someone else."

Initial VET in the company

Since initial education plays a significant role for entering work in this particular field it will be analysed and described in the following section. It is mainly the high safety regulations that strongly shape the initial vocational education. The apprentices are not involved in the work process before the second year of training. Therefore, they spend the first year of apprenticeship training within the learning lab, where they learn the fundamentals of metal engineering (see Box 1). Apprenticeship in aircraft mechanics takes three and a half years.

After the first year the apprentices begin to take over first real work assignments and gradually grow into working in control and maintenance. Only from the time of completion of apprenticeship are they allowed to sign their work themselves. Each member of staff has a stamp which documents who has worked on which assignment. About 80% of the mechanics have originally learned their trade, the remainder coming from neighbouring fields such as mechanical or electrical engineering. The apprenticeships in aircraft electronics within the company had to be cancelled because it was being carried out in co-operation with neighbouring companies both in economic trouble, so that they had to cancel their engagement and there are no complementary school-based offerings anymore within the local vocational schools. Besides the apprenticeship training provided, the company also hosts the final examinations of the regional apprenticeships in the aircraft mechanic sector. There is a tradition of cooperation especially with the other aircraft maintenance and repair companies

we had selected for our survey, but this is in danger because of the pressing economic situation. Before there was exchange of apprentices and most of the regional examinations were carried out at the case study venue, because according to our informants examinations are easier to realise on small airplanes than on bigger jets. One particular feature of the sector is the low turnover of staff. The average period employment is ten years. That means that our case site is training apprentices far beyond its own demand on the skilled labour market. This might be explained by two factors: one is the screening function of apprenticeships and the other is HRD pooling. According to one of the owners it is only two or three out of ten apprentices that become real candidates for further employment within the company. This can be due to various reasons such as educational aspirations of the apprentices or just because the company is not interested in their further employment. High educational and mobility aspirations are the basis for the company preference to employ graduates of the Realschule (after 10 years of schooling, without he entitlement for higher education) for their apprenticeships and then retaining them by gradually up-dating their knowledge.

Box 2: A career in aircaft mechanics

Mike, 53 years old, with only compulsory schooling, finished his apprenticeship as a car mechanic in 1971, worked as a car mechanic for half a year and then entered the company for the first time because they were advertising for staff trained in metal trades. Then he worked for three years with the company. During this time he was retrained to become an aircraft mechanic.

"It was easier to learn the trade during this time, basically through watching. At that time the company was only working with 2- to 4-seat-planes. It did not really matter if you were working with a beetle's motor or an opposed cylinder engine of an aircraft. After three years I was able to work on my own and wanted a change. I changed to a small sport flight school with stunt pilots and accompanied them throughout their tours across Europe. There I really learned to do independent and autonomous work, without having someone who could show me things. Afterwards, I went on the supervisors' course, that's like being able to give the M.O.T. for aircraft. Planes have to be checked regularly and the person who signs needs a supervisor licence. It's a theory course similar to a Meister qualification. I paid 75% of the course and the rest was paid for by the employment agency."

After this examination prospects in the air circus were not good anymore, so in 1978 he changed back to his former company. In between he also gained the pilot's licence.

The company manager summarises:

"He is one of our best men. Even though he has a family with four children, I can always call him, he is working weekends. The best: if there is a repair case in Düsseldorf, I just sit him in a plane he flies there does the repair, signs it, issues the release certificate and comes back. In other cases I would have to send two or three staff members. You can see this is a real high-technology occupation, you can achieve a lot, I don't understand why people want to study (in higher education) necessarily. You can make an interesting career with us."

CVET in the company

There is no formal system of HRD or guidance with regard to CVET introduced as typical for SMEs in this sector and in general. The main strands of relevant CVET for engineers are as follows:

- Regular vendor specific courses, when there is a new product line launched (new planes and new engines) and
- courses for the acquisition of supervisors' licenses (Type A and Type B) issued by the federal flight agency.

The vendor specific courses are mandatory, too, because they are required for the supervisor's certificate. For each new type the supervisor has to prove he or she has passed a course on the type and has half a year of maintenance and repair practice (apart from new models, where this is naturally not possible). Typical courses related to the introduction of new plane types take 14 days and cost 4000$ which when travel and opportunity costs are added makes 10.000 € per course and individual. When selling a specific type, usually the company gets one mechanic training for free, however sometimes clients negotiate with the company and then it is turned into pilot training on that type. Some of the engine courses are being provided for free by the vendor, but other costs have to be taken over by the company. Very few cases of CVET were documented with a more general focus, such as rhetoric or (technical) English, which in former times was more usual, but now is demanded as a necessary pre-requisite for employment in the sector. The technical courses are being carried out and offered by companies specializing in flight training. Sometimes logistical problems arise, because supervisors with the same competences (in the legal sense of the term) cannot visit courses at the same time, because there are no substitutes available with the low number of staff. Because of licensing requirements and the fast technological change, mechanical engineering in the aeronautics maintenance sector can be regarded as learning intensive. Box 2 illustrates a career of an aircraft mechanic. The person described is a very committed person with a high degree of occupational engagement. With all his additional qualifications he perfectly fits the needs of his employer. His engagement seems to be based on a strong interest in his trade and earlier in his career on his wish to gain a pilot's licence.

2.4 Learning and HRD Culture

Reading the prior sections one can see that aircraft mechanics is a very learning demanding business. There are two reasons for that, regarding the content of learning, the technological change combined with the security regulations. With regard to motivational aspects it seems to be mainly commitment to the trade and to some extent promotion aspirations that drive people. Those however can only be fulfilled for a low percentage of the staff, since 70% of them are working at the operational level. This fact plus the high costs for training leads to a much polarised structure in participation in CVET. Information on CVET courses is mainly

gathered through the supervisors and upper-level technicians themselves. In addition the possibility exists for mechanics to put their wishes into a list and wait for an enrolment on those courses, although not everyone gets their wish (see box 3).

Box 3: Business and work processes and CVET

"Some of them never enrol for a course at all. It really depends on the tasks you need those mechanics for. Someone who is basically assisting does not need those courses. I won't learn there how to exchange a module that can be done by any apprentice. What you learn there is troubleshooting and diagnostics or fine tuning. The pilot says: 'There is that and that problem, what could be the reason for that?' Only about 25 to 50% of the staff are able to help him. The other 50% carry out the tasks, exchanges of parts etc. Not everyone needs to be skilled for everything and not everyone can be skilled for everything. […] when it comes to our mechanics, we send them based on two criteria: is he suited to do that course, who is the one who will make most extensive use of it? You can enrol into a list, but the main thing is: basically the skills and knowledge are our capital and for us it is important to have kind of a 24/7 access time to our capital and not a 8/5."

Learning is described by our interviewee as self-steered activity especially for the diagnostics and troubleshooting part of the job profile. A fundamental principle in diagnostics is to start out with the less cost-intensive possible solution and if that does not prove to work the gradual increase to more sophisticated, and at the same time more costly, possibilities. It was reported that there are a lot of things that cannot be "learned in advance". An often used strategy is to go home in the evening and then, sitting at the computer, search the manuals for a possible solution in order to be prepared to advise colleagues the next morning and make sure where they have to have a look at. The supervisors are very powerful in the sense that they have to carry the ultimate responsibility for the results of their technical controls. They are in between the interests of the business management of the firm and the mechanics. It was reported that some of the supervisors play "power-games" with this function and that it is very difficult for the management to intervene because of their high degree of autonomy. This again often leads to polarised structures reinforcing the problem of possible de-motivation among the 'pure' technical staff.

2.5 Validation and feedback on results acquired within prior research within the PARTICIPA study

The links between the quantitative survey and the case study

The quantitative survey had been conducted between 1 December 2003 and 31 January 2004 in two other enterprises in the Bremen region. Unlike with the survey in the IT sector, this survey was carried out by means of a "traditional" paper questionnaire since we did not expect many of the prospective respondents to be familiar enough with online surveys. In the whole, 18 employees of the two enterprises participated in the survey. As regards some of

their basic characteristics such as age, civil status and educational background, the respondents differ remarkably from their counterparts in the IT-sector. All of them are male and are in possession of German citizenship. The age distribution ranges from 27 to 64 years with an average of 45.6 years. It was our intention to approach at least twice as many respondents, but the biggest enterprise (about 100 technicians in the maintenance area) we had established contacts to, fell into an economic crisis (see above). Differences with the IT sector become particularly obvious with respect to the respondents' educational attainments as well as their social background. Most respondents come from families whose socio-economic status in terms of educational qualifications and type of work appears to have been relatively low. Employing a rather traditional model of social stratification, one would have to conclude that the sample consists predominantly of quite typical members of the working class, an assertion which is supported by the responses regarding the respective levels of qualification of the respondents' parents and moreover of the respondents themselves. This was shown by the educational credentials of the parents' as well the respondents' generation and is being reaffirmed by the recruitment policy in our case. All respondents had completed a vocational education programme within the German dual system and that holds too for the case investigated. The major occupation is the aircraft mechanic. The big need for English language was stressed in our case as well as through the questionnaire. Among the vocational qualifications obtained after completion of the initial vocational training there is a clear dominance of the certificates CAT A and CAT B1 (n=7) and *Luftfahrzeugprüfer Klasse 1* and *Luftfahrzeugprüfer Klasse 2* (n=6). This is about one third of the respondents of the quantitative study and is in line with the structure and organisation of work in our case. The same holds for the high retention in the company which in case of the quantitative study was more than twenty years on average (n=13).

When asked about their current position in the company hierarchy, respondents provided partly inconclusive answers, and it appears that they found it difficult to locate themselves within the four-level scale proposed in our questionnaire. It can be observed, however, that the majority of respondents conceive of themselves as standing on a relatively advanced level of their occupational career. This is to say that 6 of them indicate to be currently "in a phase of growing abilities" and 7 of them either are in a phase of "stabilisation" or have reached the peak of their career. The problem of locating themselves within the four point scale of hierarchy in the questionnaire might be explained through the strongly polarised hierarchy in our case which might be typical for the sector.

Where do respondents learn their skills?

According to nearly all respondents the most important means of obtaining the qualification necessary for their current job was their initial vocational education (n=16). As was to be expected from a rather traditional industrial sector with a long-established system of qualifications such as aeronautics. However, measures of continuing vocational education and

training (n=9) and learning on the job (n=9) are also highly rated as important factors. As regards overall participation in formal CVET, the majority of respondents indicate that they have been participating in training activities since the beginning of their occupational career (n=13). This shows – as in the case study - that there are many reasons why CVET and learning are integrated into work processes in aeronautics. The primary source of information on CVET programmes for technical workers in the aeronautics sector are the work superiors (n=10), followed by the *Luftfahrtbundesamt* (German Federal Aviation Authority) (n=4). What is remarkable is that especially those sources of information that would indicate a more active search on the part of the prospective course participants, e. g. the Internet, are mentioned by relatively few respondents and that three of them even declare to have no access to information on CVET whatsoever. Two reasons brought up by the case study might be responsible for that: the low participation of some of the respondents might be explained by the strong division between those formally under constant pressure to update their skills and those who are not; the low use of channels of information usually connoted with self-steered learning activities might be due to the high formalisation of the sector in how it is structured.

Attitudes towards learning

All in all the rather positive but "reactive" orientation within the sector as regards CVET identified in the quantitative survey can be explained through the high degree of formalization and the strong tie to changes induced by the major aircraft vendors. The data collected in the survey provided some further evidence on the reactive learning orientation. A clear distinction could be drawn between the aeronautics sector and the IT sector with regard to more informal types of learning as well as the strategies respondents apply for the solution of practical problems at work. It was quite obvious that technical workers in the aeronautics sector are less inclined towards informal learning than their colleagues in the IT-sector, for all those items that indicated learning activities outside formal training programmes and also to some extent a sense of individual responsibility for one's own educational development it can be said that they received distinctly lower ratings.

This, however, might also be caused by the fact that the "learning awareness" of the respondents is not as high as in the IT sector. At least the results of the case study hint towards a quite learning intensive work environment under the proviso of the "reactive" learning orientation. Many of the findings of the quantitative survey can better be interpreted now, especially those relating to learning through outside firm contacts and direct contact with vendors. Those strategies seem to be of specific importance to the minority who are working at higher levels, doing work that involves technical control and supervisory functions.

2.6 Conclusions

Summarising the conclusions for the case

The case study brought up further results with regard to the "situational" variables of the ISSTAL model. The high relevance of those situational variables is illustrated through this case study. In fact, the case study shows how complex the relationship between the different personal and situational variables is. The following conclusions can be drawn from this case:

- The aeronautics maintenance sector is a very learning intensive and learning demanding field of work. This is not reflected through the educational credentials of the employees working in the sector, but rather through a constant process of learning in and parallel to work processes.
- This learning is a necessity to perform the job because of formal reasons (security regulations and fixed competences in the legal sense), but the formalisation is also by technological change in the sector. Therefore, the aeronautics sector is an interesting case for the combination of work on the intermediate level while at the same time demanding lots of learning and knowledge acquisition from the individual worker.
- Due to the flat hierarchy within the SME a particular individual commitment to the "trade" and a high amount of engagement are the necessary pre-conditions to turn the learning intensive work into personal advancement within the company structures. However, retention in the company is also quite high and an important strategy of the management, since prior learning and experience of the whole staff is a key success factor to the company.
- Because of the strong division of formal competences between the staff, the CVET culture in this company might be called *dualised, rather reactive and stable over time.*

Outlook and generalisability of the case

The overlap with the findings of the quantitative survey reinforces the idea that the case is giving a valid in-depth account of the factors contributing to the CVETL activities of individuals within the sector. The reactive and dualised CVET culture observed is not a huge problem for a "sustainable" employability as long as there are such stable working conditions and retention possibilities as in our case. However, there are potential risks for employees working in this sector: the strong ties to aircraft vendors and the increased international competition in the aircraft maintenance sector, which affected two potential case study candidate companies severely in the Bremen region. In the long term such a polarized HRD structure and CVET learning culture might risk overlooking certain innovation potentials with regard to competitive advantages of regional networks in the sector. The former co-operation with regard to apprenticeship between different companies is an example of such a strategy that at the same time suffered from global competition. Comparisons across Europe and comparison across fields within the aeronautics sector will result in a deeper picture of CVET cultures across different branches of skilled work.

3. English Case Study of participation in continuing vocational education, training and learning in an engineering supply chain network

3.1 Short introduction to the case

The case study was intended to deepen results from the previous phases of the Participa project in order to understand more fully the participation of technical workers in CVETL activities. The original intention was that the case to be studied may be a SME or constructed by parts of different SMEs according to the characteristics of the participating region and sector of activity studied. However, because in the English case the CVETL for a number of SMEs was organised collaboratively in an aerospace components supply chain learning network the 'case' will be the responses of **three** SMEs to the challenges of facilitating continuing learning, development and continuous improvement. The companies were chosen because they can demonstrate 'good practice' in improving people's engagement in training and learning related to competence development and meeting business needs and they all have a significant proportion of full-time technical workers.

The case study was developed around the factors influencing technical workers' participation in CVETL. The considered participation factors closely follow the major dimensions of the ISSTAL model. Results from the survey and focus groups phases highlighted the significance of supply chain learning, so the case study clearly builds on results from earlier phases of the research. The case study includes a description of the company's training and support for learning policies and strategies for technical workers.

The case study investigated the following aspects of company policy and practice and worker behaviour in the three companies participating in an aerospace supply chain network based in an area straddling the West Midlands / South West English regions:

- Training policies
- Support for learning (& competence development)
- Social background / roles of employees & organization of work
- Personality & intellectual flexibility (search for knowledge; helping learning of others)
- Attitudes
- Learning experiences
- Situational factors (barriers to participation)
- Participation in CVET / Learning
- ICT strategies & practices.

Interviews were conducted with employees at different levels and this was supported by non-participant observation and analysis of documentary and video sources. The three companies involved in the case study had 60, 100 and 204 employees respectively. Because some of the key CVETL activities took place in the lead company of the learning network (a major aerospace systems supplier) interviews were also conducted with employees from that company, even though it was not an SME. This was in order to provide a contextual background for activities across the supply chain as a whole. The data collected was analysed using the ISSTAL dimensions as an organising frame. The focus of the data collection was upon engagement in substantive learning rather than in participation in formal training per se. In this way it was possible to identify a more multi-layered approach to barriers to work-related learning for individuals and to consider a wider range of ways in which effective work-related learning may be promoted, especially for technical workers working in small and medium size enterprises. This also highlighted the interaction between formal and informal approaches to learning, skill development and knowledge creation.

3.2 Contextual background

Small and medium sized enterprises (SMEs) in engineering face intense pressures resulting from the strategies, tactics and operational methods of the large companies that dominate their markets, particularly where these are linked to supply chain restructuring. Yet stresses on SMEs and operational demands force them to deal continually with immediate tasks and problems, and they generally operate within extremely limited time horizons, leaving them with few opportunities to develop an overall strategic approach to their business. In the Participa project one focus of the engineering study has been upon organisations in advanced supply systems in the aerospace industry. The supply chains in the aerospace industry are not confined to a single region, but for the purposes of mutual learning, development and support supply chain learning networks do have a degree of geographical clustering. The three companies chosen for this case study are participating in an aerospace supply chain network based in an area straddling the West Midlands / South West English regions. Both these regions have clusters of both large and small companies that have been involved in precision engineering for well over fifty years.

The strategic and operational contexts of SMEs have been influenced by the changing patterns of innovation within supply systems for complex products in the automotive, aerospace and other engineering industries in the last decade. Recently large companies have sought to develop much stronger links with a smaller number of suppliers in ‘their supply chains’. In the case chosen the supply chain is clearly driven by large firm control that is facilitated by intensive use of information and communications technologies and is used to achieve tight co-ordination over all stages of production. On the other hand, the lead company (a Tier One supplier of complete aerospace systems) is seeking to develop more of a partnership arrangement with chosen suppliers. This changing contextual background of supply chains in

engineering gives an indication of the extent to which continuing vocational education, training and learning in the engineering industry needs to be considered across companies as well as within them.

The main capabilities sought in suppliers by the lead company include consistent product quality; manufacturing flexibility; continuous improvements in production methods to meet regular customer 'cost-downs'; inter-organisational capabilities to meet increasing pressure for tight integration and co-ordination of production, product design and development and other functions across the supply chain. One example of this process is that if a company is awarded the highest supplier ranking the components or sub-systems supplied by that company go straight into the production process of the lead company without further inspection or checking. The driver of this process is an attempt to improve manufacturing practice through a focus upon continuous improvement (and on quality, costs and delivery). This was linked with an explicit attempt to follow Japanese 'best practice' in this area, with an emphasis upon machine turn-round times, 'right first time', 'lean manufacturing' and so on. Changes are being driven by a desire to improve competitiveness and the major manufacturers and tier one suppliers have been pressurising their own suppliers, sometimes through the use of very aggressive year on year cost-downs.

The findings of the earlier UK Participa investigations, comprising the survey findings and analysis of interview and focus group data, lead to the following interim conclusions:

- In contexts where technical work itself is challenging, then most continuing vocational learning takes place outside formal training programmes.
- There is a need for employees not only to update their technical skills but also to develop further a range of more generic skills, including planning, problem solving, communication, IT and management skills.
- Learning to become more self-directed in your approach to learning can lead to significant work-related learning.
- Use of personal networks can be an effective way to critically reflect upon work and hence can be an important source of work-related learning.
- Learning how to support the learning of others (especially for those with management and supervision responsibilities) is vital to improve the likelihood of significant learning while working.
- Learning how to organise knowledge effectively and apply it appropriately is vital for technical workers development.

These were coupled with some ideas for recommendations for CVET policy and practice:

- The focus of strategies for skill development should be upon continuing vocational education, training and learning, rather than just upon participation in CVET per se.
- Greater attention should be given to helping employees become more effective in supporting the learning of others at work.
- There is a need to focus upon the development of hybrid skills rather than just technical skills development. Hybrid skills refer to the ability of people to harness technical skills in support of business development.
- Encouraging the spread and sharing of tacit knowledge, through a combination of individual mobility and formal and informal networks, will increase the competitiveness of companies in particular districts or sectors.

Both the interim conclusions and the policy and practice recommendations are particularly relevant to supply chain learning networks and can be further illustrated by consideration of the chosen case study.

3.3 Aerospace supply chain learning network

The aerospace supply chain learning network was set up to provide opportunities for collaborative learning and knowledge development across organisations and to facilitate improved performance within and between companies involved in the supply chain. The intention was to train 'change agents' in each of the companies who would then be responsible for learning, development and process improvement in their own organisations. The initial training and continuing technical support was provided by specialist tutors (Master Engineers) and learning support tutors (from the Open University) who were experienced at supporting distance learners in a distributed network.

The training was designed to generate organisational and inter-organisational learning as well as individual learning and development. In particular, the focus was upon supporting SMEs in adapting to demands for increasing knowledge as a foundation for supply chain relationships, and in extending their adaptive and innovative capabilities. The intention therefore was to stimulate economic innovation in SMEs through innovative learning. The learning network was process oriented, comprising workplace teams of operators, specialists and managers, that linked eight suppliers to the lead company (a Tier One supplier of complete aerospace systems). 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 companies were expected to use measurement and improvement tools designed to meet the increasingly demanding quality, cost and delivery standards of customers. It was recognised that this could also involve cultural change as the companies sought to adapt to an increasingly competitive environment.

In the network, the lead company persuaded their suppliers to identify key individuals with central responsibility for shopfloor innovation in supply management. These people, nominated as 'change agents', also became 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 lead company, led by the engineering tutor together with help from the learning support tutor. In the four week intervals between workshops, the change agents applied what they had 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 what they had learned. 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 company that sees 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.

Company A

Company A is a relatively small specialist engineering company that produces specialist parts for aircraft and nuclear submarines. The company employs 60 people and technically qualified workers play a key role in the company. The person most directly involved in the 'change agent' training has for the last six years been the chief inspector at the company. Previously he worked as an inspector at the lead company in the supply chain network for 10 years. The main benefits and highlights from the 'change agent' training and subsequent application of what has been learned involved:

> 'the improvements have included significantly better Overall Equipment Efficiency (OEE); weekly efficiency monitoring; reduced set-up times (90 minutes to 30 minutes because it has been possible to pre-set machines); the introduction of a kanban system with access straight into production line of lead company in the supply chain network - we receive a fax and five days later they have the parts. The value stream mapping has proved useful, particularly in being able to concentrate our efforts on upon loss-making jobs and find out in which areas we have problems and why. For example, we focused upon one support bracket behind the propellor that often warped - this was because of a heat treatment distortion. One example of focusing upon a problem was the amount of time team leaders were having to spend on rectification fabrication problems - analysis revealed the damage was being caused when the products were

moved within the factory, so we now have special foam boxes to transport products. The problems can be revealed by inspection or through problems with tooling - one key question is then what it costs not to take action. It is also useful to involve more people in the work of the improvement teams - it can be particularly helpful to talk to workers and team leaders. On the other hand, we are a small company so we are conscious of the human resources being used.'

Problems were encountered, however.

'The main problem was to get management to accept that these approaches were valuable in the first year. They need the OEE evidence that the approach is working. So in the first year I was a bit of a one man band - I kept getting knocked down, but I kept coming back. Improvement days, continuous improvement plans, monthly meetings have all been useful in convincing management one peg at a time. There have been no problems with the shop floor. Balancing the two roles (inspection and improvement) has been a challenge as I tend to spend one or two days a week on 'problem jobs'.'

The technical workers quickly appreciated the value of the new techniques and were willing to learn new ways of working. In fact it was harder to convince the management: 'at monthly meetings I would produce charts and evidence of the improvements. For example, in our non-destructive testing unit we had a first-in first-out system, but we have adapted this through the introduction of priority cards that has resulted in a reduction in the lead time from four days to two days. I adapted the idea from the lead company in the supply chain network.' One reason for the positive response from the workers was their work was less pressured, instead of always having to respond to immediate pressures and apparent crises, the flow of work was much better planned: 'we have continuous roll-out plans, whereas previously we were responding much more day to day. There is now a more regular flow to the work: with fewer large batches.'

Sustaining long-term continuous improvement could be difficult, but the 'change agent' felt that at least it should be possible to build on what had already been achieved:

'The visual aid charts have played a role in convincing the directors as has the change in the relations with our major customer that takes 80% of our work. Previously we were rated a category C supplier, but now we are category A and our products go straight into their lines as a result of increased quality and we are meeting targets of cost reductions of 30%. We use Pareto analysis, action plans and data monitoring to ensure we stay on track.'

Involvement in the 'change agent' training led to personal development for the chief inspector:

'I have become more interested in problem solving, and I have involved departmental managers more. The problem is I have my own job to do as well, but people appreciate the value of this so I can get cover for my job. I still want to carry on learning and gain further qualifications, either with the Open University or maybe go down the NVQ4 route. If I want more training I will take it a step at a time to the directors, but if I want to I will continue anyway.'

The training did not just lead to individual development, as one of the key aspects of the training was the need to facilitate the learning of others when cascading the approach within the company:

'I teach the approach to others regarding, for example the application of the 5Cs, and we also have a notice board for our achievements. Although I have had no formal training in helping others I am used to it, because I teach chess. The change agent training was the first formal training I had had since completing my initial five year engineering training - which reached the equivalent of A level standard.'

Company B

Company B is a precision engineering company that makes specialist parts that are used in aircraft sub-assemblies and in other industrial settings. It has about 200 employees, with considerable numbers of technically qualified workers many of whom work on the shop floor. The person most directly involved in the 'change agent' training had responsibility for personnel and business development. He had worked for the company for 20 years since leaving school. After completing his apprenticeship, he had worked on machines for two years and then switched to planning production. Then he was quality manager for seven years, before combining roles as business development and quality manger for a year, prior to being given his current job. After involvement in training at the lead company he was charged with cascading the training to employees involved in production and/or technical activities in his company. He considered the main benefits and highlights from the 'change agent' training and subsequent application of what had been learned to include:

'success in developing people: so far 54 people have been involved in business development. There have also been improvements in communications and team ethics. The improvements have included 28% higher Overall Equipment Efficiency (OEE) (sustained for over six months); the creation of multiple manning areas where two people work five machines; and machine set-up reductions from 5 hours to 2 hours that have given us extra capacity. We have had greater management involvement at directoral level and we can now measure business performance at shop floor level. The shop floor are pleased too, because they had become frustrated that their ideas had not been taken up

previously. We are also working more closely with a major customer (the lead company in the supply chain network), and we have more idea of the problems and solutions of other companies. We have been swapping development ideas: for example, about ladder racking. Personally this has given me a new lease of life and a new learning focus. It has also led to recognition in my own company.'

However, introducing major changes in manufacturing processes and practices also generate problems. The main difficulties were:

'Negativity from some people: some with good reasons and some without. The latter 'well poisoners' can be very disruptive, so all you can do is concentrate upon the positive people. There is also the issue of time constraints: the fact that change does take time and the fact that there are no 'quick fixes' often leads to frustration.'

The 'change agent's' response to these difficulties was 'to seek to educate people as to what we were trying to achieve, put much emphasis upon communication and to have my own personal objectives and mission statement.' In order to sustaining medium-term continuous improvement 'we are focusing upon delivery performance targets. We also have a training plan to try to ensure the momentum is maintained.' Sustaining long-term continuous improvement was likely to be harder: 'this becomes more difficult. We do have director support and direction, not least because the company needs the financial benefits. We do though need to give greater emphasis to training and development and we should form a dedicated performance improvement unit. We could use more people in the business improvement teams. We are looking at our own suppliers too - they are at the crux of some of our own non-delivery problems. The improvements will pay for themselves if we can sustain 80% OEE.'

Company C

Company C is an aviation engineering company that company makes parts for aircraft sub-assemblies and jet engine components and has about 100 employees, 55 of whom work on the shop floor. The quality manger was the person most directly involved in the 'change agent' training. After involvement in training at the lead company he was charged with the subsequent application of what he had been learned back in his own company. All employees involved in production and/or technical activities have been involved in learning, training and development associated with the attempt to introduce processes of continuous improvement. Many of the techniques learned in the workshops and subsequent training at the lead company were applied in company C, although some required considerable adaptation. The quality manager pointed out:

'the improvements themselves have included higher Overall Equipment Efficiency and the analyses have shown that many of the issues raised are common. Adapting the value stream map has proved useful, as has the use of video because it produces irrefutable facts. Indeed one worker requested the video in order to show what people in the office make me do! The shop floor workers have been really involved, because it makes their lives easier and targets become easier to achieve.'

'The use of the measures have been important in giving people ownership and a focus for tackling their problems. We do have an awareness of the cost of maintaining the measures too. The work with the teams has meant that management have identified a number of 'rising stars' and management have included them in management development plans. This is designed to cope with skills shortages and involves eight people [technical workers] being given one day a month training for six months.'

The diffusion of responsibility for training and implementation of these practices from management to the technical workers themselves was seen as a crucial step in getting people committed to the processes of continuous improvement: 'ownership of the process is important, as is visual impact. It is also a question of delivering some improvements while managing expectations (as to the limits of what can be achieved).' Sustaining continuous improvement in the medium term is important and:

'involving the supervisor and the work team are crucial. So that you get a critical mass supporting the change, not just a single person. It helps if they can see 'rungs on a ladder', so that they can see where they are and what has been achieved. Of the four supervisors three have now been on the training [organised by Master Engineers]. So there are two improvement teams and a third is being established.'

In order to achieve and sustain long-term continuous improvement (CI) 'the change programme needs to be viewed as a top-down imperative and a bottom-up pressure in relation to Overall Equipment Efficiency and so on.' However, application of the CI processes was not unproblematic, not least because of the challenge of adapting 'flow' tools (most applicable to assembly line and similar processes) to non-flow processes. For example:

'the conventional value stream map would take ages to develop in our context, but we can adapt it to a product family approach. At one work centre there would be many different products, typically coming through in small batches, so it is important to look at the processes in terms of common threads. For us an order of 10 is a lot, but each component may have between 500 and 3000 features. Only 300 aircraft may have been produced, so we may have to wait 18 months before we get our next lot of 10.

The average price of one of our components is £3,000 and we are working with aluminium, titanium and so on.'

3.4 Supporting learning and innovation in SMEs through participation of technical workers in continuing vocational education, training and learning: interaction between training policies and creating opportunities for significant learning experiences at work

It is too early to identify whether cultural shifts have been fully embedded, but achieving such change was one of the long-term goals of the work with the change agents in the companies. The intention of the formal part of the CVET was to encourage both formal and informal learning in the participating companies. One way to achieve this was to encourage a decentralised view of the processes of knowledge creation within the network. The focus upon SME skill needs in supply chains was the stimulus for organisational and inter-organisational learning and knowledge management across supply chains, as well as supporting individual learning. One implication of this approach is that it might be worthwhile considering a reshaping of the boundary between higher education, continuing education and training and organisational development. The underlying pedagogical idea is that there is considerable value in attempting to link processes of knowledge creation with approaches to tackling the core problems of manufacturing practice as a means of engaging learners (in SMEs) that have traditionally been difficult for formal education and training institutions to reach.

It is also clear that innovation and learning within organisations are essentially social processes. Hence within the network particular attention was given to building relationships to support innovation that went across companies in the networks. The support for change agents was itself designed so that they would be able to support process innovations within their companies. This means that the networks offered not only a mechanism for technology and process transfer and exchange of ideas about development and practice, but also a means of supporting those interested in acting as change agents in support of development and innovation. Networks, such as the one exemplified in this case study, have the potential to grow as a general means of innovation transfer in supply chains. The network sought to give people not only access to innovative ideas, but also to give learners opportunities to shape these ideas in ways that were directly useful to them in their work. This applied particularly to the work with company change agents.

A major concern with the development of much learning in continuing vocational education and training that is supposed to support practice is that the knowledge generated is often decontextualised. This may then mean it is of relatively little use to employees in coping with

many of the problems they face in practice. This potential problem in this network was overcome through focusing closely upon what the Master Engineers and those involved in the network saw as the key problems of manufacturing practice in the workplace itself. This ensured attention was given to problems and dilemmas that are central to manufacturing practice. These problems and dilemmas have significance both for individual and organisational performance. The problems are likely to contain combinations of practical concerns, organisational issues and socio-cultural problems.

The approach to process improvement using Master Engineers who ran workshops and gave practical demonstrations of how to analyse and improve work processes by following the work flow was underpinned with an inter-locking series of products that covered a range of important topics. These included workshops and support materials that examined aspects of Value Stream Mapping; Supply Chain Organisation; Team Leader Training; and so on. Details of this approach, together with case studies of their implementation are given in the DTI (1999) publication 'Quality, Cost, Delivery: seven measures for improved competitiveness in manufacturing industry'. This approach also means that employees are directly involved in processes of active knowledge creation.

This particular network also benefited from additional mechanisms for support of participants to make them more effective learners and offered support too for work-based learning as a process. The formal learner support was delivered through a system of learning support tutors and NVQ assessors, but peer support throughout the network organisation also played an important role in supporting learning and reflecting upon the learning and development that had been achieved. The substantive support for learning and development of change agents within the companies also resulted in an increase in the capacity of those companies to support other forms of work-based learning. As some of the learning was grounded in improving manufacturing processes and practice there was little doubt that this contributed to improvements in efficiency. The competitiveness of SMEs may also have been improved insofar as a consequence of these developments the companies were able to operate more effectively within supply chains. This is particularly important as major manufacturers (including Tier 1 suppliers) are expecting greater independence in ways of working with suppliers and are expressing an increasing commitment to processes of quality training (Abreu *et al*. 2000). The number of suppliers the large companies wish to deal with has also been significantly reduced and many of these companies now explicitly grade their suppliers. Hence there is a premium upon smaller companies showing that not only do they produce quality price competitive products, but also that they are able to operate effectively within integrated supply chains.

More generally, what is of particular interest is the way that training policies are operating here. That is, formal training in process improvement techniques for technical workers are

being combined with creating opportunities for the application of these processes in a collaborative manner which in turn generates significant learning experiences at work. Indeed in many cases the roles of those undergoing training were broadened, for example through participation in improvement teams, and the organisation of work itself was often changed as a direct consequence of participation in these activities.

3.5 The significance of organised learning support for learning, knowledge and competence development at work

The discussion so far raises the general question of how best to support learning at work. Eraut et al. (1998) highlight the importance of organised learning support for learning at work, but also draw attention to its relative rarity. This case is an example of a highly structured approach to the provision of organised learning support. On the one hand, the case may be thought to have limited generalisability because of the amount of time and other resources poured into the development and implementation of a structured system of learner support. On the other hand, it could be regarded as illustrative of the scale of the effort required if companies and individuals are serious about the implementation of significant change based upon a transformation of the relationship between working and learning. The more specific contributions to this issue are as follows:

- The involvement of Master Engineers and their established processes designed to embed performance improvements in quality, cost and delivery (with consequent promised effects on organisational effectiveness more generally) acted as a strong catalyst to galvanise the interest of companies. Once the initially narrowly focused learning approach was underway it was often (though not always) possible to broaden the interest of companies and participants in learning.

- It is relatively easy to have an immediate impact on quality, cost and delivery in companies that have been primarily concerned with immediate operational issues. In contrast the process of embedding sustained continuing improvement is much more challenging and could take years to achieve. This is not to decry the value of the process outlined here, rather just to acknowledge that in organisational terms it is the ideally the beginning of a longer-term process.

- The focus of the Master Engineers and the group of learners upon making real improvements in manufacturing practice and process at one level could fit with ideas about the collaborative creation of new knowledge. However, at another level their understanding of learning was formulaic: improvements were achieved by following a very particular approach to improvement based upon what the Master Engineers had

themselves learned from Japanese Master Engineers. Hence in practice the Master Engineers themselves learned more about the processes of learning through the involvement of the Learning Support Tutors. For example, they learned more about how to link what they had been doing in terms of performance improvement to broader learning and assessment processes in the networks.

- The approach to learning through networking could be seen as an example of an active model of learning whereby learners are engaged in the creation of 'new contextualised' knowledge, not recipients of a largely passive process of knowledge transmission. This is in line with the theoretical framework developed to explain processes of organisational knowledge creation by Nonaka and colleagues (Nonaka & Takeuchi 1995; Nonaka & Konno 1998). This approach makes use of a social model of knowledge creation and transformation. The key process for genuine knowledge transformation to occur is that knowledge has to move from the individual level into wider communities of interaction that cross organisational boundaries as happened in this network. It is worth expanding upon the link between learning in the network and organisational knowledge creation in more detail.

Nonaka and Konno (1998) use the idea of *ba* as shared spaces for emerging relationships that provide a platform for advancing individual and/or collective knowledge and of generating collaborative processes that enable the transformation of that knowledge to other contexts. This fits with the approach adopted in this network, as does the idea that active involvement and collaboration in the network allows participants to transcend their particular (traditional) perspectives. In supporting people in their attempt to bring about change in manufacturing processes opportunities have to be given for practitioners to transform information from written or broadcast material into practical individual and collective knowledge. It may also be that the analytically rational world represented in learning materials may be too 'cold' for many people: they may need a richer form of engagement. The processes of socialisation, externalisation, combination and internalisation that underpin Nonaka and Takeuchi's (1995) model of dynamic knowledge conversions gives insight into why this lack of engagement may occur. It is therefore worthwhile viewing the approach of this network in the light of these processes in more detail.

Socialisation (through originating *ba*):
Nonaka and Konno (1998) point to the need for an originating *ba* (or space for socialisation) where individuals can share feelings, emotions, experiences and mental models. This is necessary not only to generate initial commitment (the value of which has long been recognised), but also because genuine knowledge transformation also requires a 'magic synthesis' of rationality and intuition that requires a greater depth of human engagement than

just thinking. Within the network the originating *ba* occurs during the initial face to face network meetings.

Externalisation (through interacting *ba*):
The creation of space for active reflection by groups can be seen in the way in subsequent network meetings groups would jointly examine a range of problems commonly associated with manufacturing practice. The groups would comprise individuals with a mix of backgrounds, knowledge and capabilities. Individuals could share their own ideas and understandings (although this phase was led by a Master Engineer), and through processes of reflection and analysis, seek to generate some common understandings of how to improve manufacturing practice.

Combination (through cyber *ba*):
This stage involves creating space for combining the ideas generated in the previous stage with existing information about how work is organised in a particular workplace. A group would jointly examine the problems in a particular workplace of one of the SMEs. The network group would again comprise individuals with a mix of backgrounds, knowledge and capabilities. This time individual ideas and understandings would be combined through processes of discussion and analysis in order to generate shared understandings of how to improve the manufacturing process in that particular workplace. This involves the generation of new forms of explicit contextualised knowledge.

Internalisation (through exercising *ba*)
The exercising *ba* is a shared space to facilitate the conversion of the (newly generated) explicit knowledge into the tacit knowledge of individuals and groups. This will involve active consideration of how to apply that knowledge in different contexts and the use of strategies to support the knowledge conversion process. This was the task of the change agent, trying to embed new ways of thinking about manufacturing processes and practices in her or his particular workplace.

This approach involves the spiralling of knowledge creation and transformation through continuing cycles of socialisation, externalisation, combination and internalisation. The structure of support for learning in the network was designed to allow material and ideas to be fed into the change processes over time. The essence of the *ba* of the learning community as a whole is that it does not involve a static accumulation of different materials, documents and information, but rather when it works well it possesses the dynamism continually to create new knowledge.

This approach to the development of practice is reflective, forward-looking and dynamic and works best within a culture that acknowledges the importance of developing practice,

expertise and analytical capabilities in an inter-related way so as to be able to support the generation of new forms of knowledge. Those involved in such developments need to have a continuing commitment to explore, reflect upon and improve their practice (Schön 1987). The initial key to going beyond competent practice lies in the ability to transfer skills, knowledge and understanding from one context to another (Eraut 1994). Increasingly those working in complex supply chains are expected to perform effectively when they work in teams or task groups with colleagues with different backgrounds and different kinds of expertise. The network approach was predicated upon the idea that those engaged in particular work practices and processes have a key role to play in how new knowledge is generated and applied in practice (Engeström 1994).

An individual's knowledge of practice can itself regarded as a personal synthesis of received occupational knowledge and situational understandings, derived from experimental learning, which are capable of being further transformed through a process of critical reflection. As expertise develops, and new contexts are utilised in the performance of practice, so the processes of analysis, review and reflection can lead to the creation of new forms of knowledge (Engeström 1994). Additionally Eraut (2000) points to how people have to deal with contextual variables, such as the time available and the volume of information to be processed, that mean they have to produce appropriate responses in situations where the conditions for 'best practice' are not present. Approaches such as those adopted in the network therefore constitute an important way in which to develop contextualised knowledge of how to effect continuing practice and process improvements. These practices and processes are dependent upon the active participation of a full range of employees, with technical workers having a particularly important contribution to make.

3.6 The role of individual agency in participating in training, learning and knowledge development at work

The benefits of participation in the network to companies and for individuals performing their work roles was evident in improved organisational effectiveness. However, what personal advantages might an individual gain from participation in the network? Also how far do personal variables and attitudinal factors come into play in decisions whether to participate in the learning networks? In relation to participation it was interesting that nearly all participants in the network had taken only rarely participated in any formal continuing vocational education and training since completing their apprenticeships. However, **after** participating in the network many did express an interest in investigating ways in which they could continue their learning. So involvement in this network clearly represented a different type of learning to that previously on offer and participation in the programme of CVETL acted to change the attitudes of the participants towards learning.

This means it was structural factors (the nature of the particular provision of the combination of formal CVET and opportunities for learning at work) that were much more influential than factors associated with individual agency in the decisions whether or not to participate in CVETL opportunities associated with this network. Virtually all technical workers approached in the small SMEs expressed a willingness to participate in the improvement teams. Indeed change agents reported that managers were often more difficult to convince. This was understandable in that the focus was upon processes that were problematic for the workers. Crucially participation in the improvement activities often contributed to a transformation of the workers' learning identities: as a consequence they saw themselves as willing to engage in other learning activities in future.

Unusually those involved in this programme can demonstrate improvements in aspects of company performance and improvements in their own individual learning. The latter are evidenced through reflections upon work and learning in assignments and portfolios and in the increasing quality of the assignments themselves, as evidenced by the ability to communicate effectively in writing, to be self-reflective and so on. There is value in portfolio building being coupled with active reflection upon what has been achieved with the tutor and other students, rather than being a passive and often dispiriting individual process of just documenting what you already know (Grugulis 2000).

3.7 Concluding discussion

One key question is how generalisable are the findings from this case study, especially as the amount of organised learning support was high, with assessors and tutors offering considerable individual as well as group support. However, this particular example was very successful in its context. Hence it is worthwhile drawing out four lessons for supporting learning in SMEs. 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 traditionally been 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 (including 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 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). There was also 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 were 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 network 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 for technical workers, 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 key lesson for Participa is perhaps that well-designed provision that integrates CVET and opportunities for substantive learning in the workplace can overcome the potential reluctance of individuals in SMEs to participate in CVETL. On the other hand, such provision does require whole-hearted commitment of the company to a process of organisational development: that too represents a substantial challenge.

4. Anglo-German comparisons

The German aeronautics sector is an interesting case where the structuring and allocation of work makes great use of the combination of work and learning of staff formally qualified at the intermediate level, while subsequent development demands lots of learning and knowledge acquisition from individual workers. Due to the flat hierarchy within the SMEs in this sector a particular commitment to the “trade” and a high amount of engagement are necessary pre-conditions to turn the learning intensive work into personal advancement within the company structures. Mainly because of the strong division of formal competences between the staff, the CVET culture in this sector might be called a dualised and reactive one. This is not a huge problem for a “sustainable” employability as long as there are such stable working conditions and retention possibilities as in our case. In the long term, however, such a polarised HRD structure might risk to overlook certain innovation potentials with regard to competitive advantages of regional networks in the sector. The former co-operation with regard to apprenticeship between different companies is an example of such a strategy while at the same time having suffered from global competition.

The English supply chain network example shows that well-designed provision that integrates CVET and opportunities for substantive learning in the workplace can overcome the potential reluctance of individuals in SMEs to participate in CVETL. The whole-hearted commitment of the company to a process of organisational development seems much more likely if it is part of a network, especially if a major company is driving through an agenda of trying to achieve continuous improvement throughout a supply chain. The English exemplar is network-based and collaborative.

The two cases highlight very different issues and one obvious question is 'how do we take into account, that the English case is based on the introduction of exemplary practices, whilst the German case is much more based on the observation of "regular, everyday business"?' That the English case is exemplary can be seen from the fact that more typically English managers were less likely than overseas managers to use ‘networking outside the organisation as a key source of new ideas’ (Newell, 2004, p.28). In the absence of a structural solution that also generates high individual commitment the UK, if it wishes to be innovative, is forced to be more radical. That is, while the German system delivers continuous improvement because of how the system is organised around diversified quality production, the UK does not have such a system but it can seek improvements by implementing 'lean techniques', controlling costs, introducing team-working and by relying upon the particular efforts of individual employers or, as here, by companies linked in supply chain networks.

Our cases fit with a more comprehensive review of the role of employers in skill development in the two systems. Culpepper (1999) highlights the critical importance of well-functioning institutions of employer co-ordination in Germany (and France too, incidentally), if employers are to be encouraged to make substantive investments in skill provision. Whereas Parker and Rogers (1999) when considering sectoral training initiatives in the US, signal the value of regional partnerships, whereby targeted public training support underpins the commitment to training and development of a number of companies within a particular industrial sector. This could be seen as similar to our UK case and as such it could be one means to effect a shift whereby employers embark "on "high-road" (quality-centered, continuously improving) competitive strategies of the sort that require substantial ongoing training" of "frontline" production and non-supervisory workers (p.327).

Finegold and Wagner (1999) focus upon what was traditionally one of the strengths of the German economy and their approach to skill development: capital goods manufacturing built upon a system of diversified quality production, using the abilities of highly skilled workers and engineers. This would seem to have parallels with the German aerospace case, especially as they point out that this system was essentially based around individual performance. Hence the shift towards the multi-functional team as the basic organisational unit for work performance in lean manufacturing, typical of US practice and being adopted in our UK example, posed particular challenges in a German context. Finegold and Wagner in a study of the pump industry confirmed the thesis of Herrigel and Sabel (1999) that "most German assemble-to-order and customized plants had made relatively little use of multi-functional teams, at least in part because the personal identity of German skilled workers appeared to conflict with the blurring of individual roles and narrowing of some technical skill requirements that can accompany the move toward a team-based organization" (pp. 152-153).

German manufacturing companies continue to rely upon the fact that sufficient skilled workers opt to self-steer their career pathways within the firm in a way that builds upon the extensive initial training typical of the German VET system. This may be a sensible approach in those industries where competitive advantage can be extracted from knowledge and expertise that mainly resides within individuals strongly associated with particular companies. On the other hand, in more dynamic sectors it may be that tacit knowledge is generated and shared at least partly through individuals moving between companies in the industry (Mason and Wagner, 2000).

The report by Mason and Wagner (2000) underscores the different ways companies and industries can achieve effective performance based upon the use of highly skilled staff. It also links back to the well-attested failures of VET policies in the UK. Despite those shortcomings, the use of graduate labour, labour market flexibility and informal processes of knowledge transfer can lead to innovation and dynamic performance in newer high-technology industries in the UK. The superior economic performance of German companies in traditional manufacturing sectors, such as engineering and chemicals, contrasts with the less impressive performance in high technology industries such as electronics (Mason and Wagner, 2000).

In a highly dynamic environment, the exercise of responsibility at work, the experience of changing contexts and working with others on challenging tasks all lead to significant non-formal learning. Getting young graduates quickly into the labour market, and moving them through a succession of jobs early in their career, means they are likely to be more mobile, flexible and experienced than those following a lengthier period of initial training and service with a single company. The driver of the first system (the UK model) is learning through work, whereas the driver of the second (the German model) is preparation for work. Neither system can be judged better in absolute terms, rather they each have comparative strengths in some contexts and comparative weaknesses in other contexts.

Finegold (1999) maps out the policy options available to sustain the German skill-creation system in future. These contain carefully thought out proposals not only for the reformation of the dual system, but also on the need to reform higher education, enhance labour market flexibility, strengthen further training and support the development of new enterprises. This perhaps helps to place any changes in VET policy in a broader context. They are only one part of the mix of policies required to address the problem of sustaining comparative advantage in a global economy.

One final comment regarding learning and skill development at work is that the German system could be seen as collaborative at the institutional level (especially between employers) but dependent upon individual commitment for further development of intermediate skills. Whereas, by contrast, institutional collaboration is generally much weaker in the UK, but skill development is more likely to be collaborative at the level of individual workers, as they are more likely to be working in teams and there is less formal structural support.

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