Transformative Capabilities in the “Very Old Economy”: Intersectoral Innovation Networks and Learning Alliances

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Network society, distributed knowledge bases and transformative capabilities

- 1 The internationalization of manufacturing and the globalization of trade relations in combination with activities of enterprises to restructure global value chains have far-reaching effects upon the well-known forms of economic organizations that characterized the fordist phase of capitalism. Within the context of a transformation of national economies towards a knowledge-based society (Castells 1996), economic and social sciences nearly exclusively focus on economic sectors that are termed '**high-tech sectors**'. They are considered the main **drivers of knowledge creation and innovation and prototypes of new collective forms of organization**. However, from this perspective it is neglected that new forms of organizations – and related re-structuring of the labor process – are of growing importance not only in high-tech sectors, but in the low-tech sector (like in the paper & pulp industry, textile industry, food industry and wood industry) as well. In fact, in mature economic segments of the so-called Old Economy manufacturing as well as innovation processes are increasingly performed in global, national or local **innovation and training networks**.
- 2 During the 90's the sociological discourse was amongst others shaped by the influential thesis of the forthcoming of a “network society” (Castells 1996). It was argued that the

vertically-integrated large-scale company, which was characteristic for the fordist phase of capitalist societies (see Porter 1985 ; Jürgens *et al.* 2003), is losing importance. In the age of "post-fordism" (Aglietta 1979 ; Lipietz 2001 ; Jessop 2001) or "flexible mass-production" (Piore/Sabel 1984) such enterprises seemed to be too slow for the accelerating innovation cycles and the heightened global competition. The so far dominating mode of structuring production and business is challenged by the idea of the much more flexible "network company." Accordingly, the integration of all functions into one single company becomes out-dated. As a consequence, functions not considered to be strategically important, are sourced out to other companies with which network-style relationships are established. In the course of that development the classical company is replaced by a network of a multitude of companies, whereas the boundaries of the single enterprise are becoming more and more blurred (Schmierl/Pfeiffer 2005 ; Lüthje *et al.* 2002).

- 3 The central starting point of the paper is that well-known classical patterns of creating innovations are changing. Innovation processes aren't originated exclusively within 'knowledge intensive' (high-tech) companies any more, but rather mutually between companies of different sectors. This has twofold consequences : On the one hand, the so-called high-tech industry influences non-high-tech branches as well as important suppliers of innovative solutions. On the other hand, the particular requirements and conditions of so-called low-tech branches affect companies of high-tech industries as specific drivers of innovation, too. Considered as a productive force, **intersectoral cooperation** becomes a main source of innovation, further growing in importance ; innovation processes are more and more organized along "**distributed knowledge bases**" across economic sectors.
- 4 Therefore, the **main thesis** of the paper is that today's knowledge isn't located within one company originating from one industrial sector any more, but is distributed along the respective value-chain and various sectors. At the same time, the "network" is not only relevant in technology-intensive branches such as IT industry or automotive industry, but becomes also a relevant analytical category for exploring "low-tech" industries and their innovation processes. "Network" is understood as a special form of regulation of inter-company relations beyond market structures or hierarchies (Sydow 1992). The relevant questions are : What kind of relations are built between „low-tech“-companies and "high-tech" industries ? And how are these co-operative links maintained ? In this context it is of special importance to understand how cross-company innovation processes are structured and organized.
- 5 At the same time these 'intersectoral innovation processes' do have crucial prerequisites on the company level – especially in the sense of a strategic re-evaluation of knowledge management and personnel policy. With special regard to matters relating to the work force the paper discusses distinct features and strategies of low tech companies which allow them to generate and reproduce a competitive and innovative knowledge base by means of a **strategic establishment of innovation and training alliances**. Therefore, it addresses one main question : How are innovative capacities in these companies created, organized, managed and mobilized in the long run by building cross-company networks ?
- 6 Both knowledge management and personnel policy of a company are activities of major importance for the development of what we call "**transformative capabilities of a firm**" (Bender/Laestadius 2005 ; Schmierl/Köhler 2005). "*Transformative capabilities* constitute enduring ability to transform available general knowledge and competence into plant,

firm or task specific knowledge and competence. This is a core competence particularly in LMT industries : the general knowledge on traditional industrial techniques like welding etc. is spread all over the world. The ability to transform it into specialized and economically competitive 'high class zero defect' competence separates the profitable firms from the rest" (Bender/Laestadius 2005, p. 9, italics in original).

- 7 This concept regarding crucial competencies in low tech companies is closely linked with the terms „absorptive capacity“ (Cohen/Levinthal 1990 ; Palmberg 2002), “organizational learning” (Lam 2000) or „dynamic capabilities“ (Teece/Pisano 1994 ; Teece *et al.* 1997 ; Zollo/Winter 2002). Additionally, in the actual mainstream in the field of strategic management these topics are discussed in the Resource Based View of the firm (RBV) and a Competence-Based Theory of the firm (see Frieling 2004). Teece *et al.* (1997, p. 516), for instance, define “dynamic capabilities as the firm’s ability to integrate, build and reconfigure internal and external competences with which to address rapidly changing environments. Dynamic capabilities thus reflect an organization’s ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions”, whereas Zollo/Winter (2002) suggest this definition : “a dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness” (p. 340). In both definitions and approaches the aspect of interorganizational learning via experience accumulation and integration or exploitation of available external knowledge sources plays a predominant role. The same holds true for the concept of „absorptive capacity“ by Cohen/Levinthal (1990), who “argue that the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities” (p. 128).
- 8 One crucial key element of these **transformative capabilities** is, in our understanding, the ability and willingness of an economic actor to establish systematic linkages to actors and institutions who may serve as important sources of knowledge and know-how. This concept additionally refers to processes of adaptation, use, and recombination of available knowledge, which are shaped internally mainly by a company’s technological or organizational means of knowledge management and by its dominant personnel policy (including training and the use of skills and qualifications). Primarily human labor and work-force is the moving force of these transformative capabilities. Within that transformation process low-tech companies create new adaptable knowledge especially via human resource management (HRM) and **vocational education and training (VET)**. Training-related aspects of transformative capabilities therefore include a static and a dynamic profile. In the static dimension vocational training enables the work force and enhances the firms’ ability to transform external knowledge sources into usable internal knowledge and company-specific know-how. In the dynamic dimension vocational training improves the further development of transformative capabilities of the firm in itself. So the basis for a dynamic perspective on transformative capabilities lies in a permanent creation, recreation and transformation of qualifications and skills. The building and running of intersectoral innovation networks as well as of training networks and learning alliances, as described in this paper, are thus strategic investments of a company into the firm’s transformative capabilities.
- 9 The author presents evidence from European company case studies¹ that although low-tech firms are characterized by predominance of incremental knowledge accumulation and of informal, unsystematic and incremental training on the job, at the same time they

rearrange and refine creative solutions for building and developing vocational training networks and learning alliances.

Network Structures and Intersectoral Innovation Processes—The Example of the Paper Industry

- 10 Scholars within sociological research widely agree that the “company” is being supplemented by new supra-company network structures as an additional “place” of processing and realization of capital and value.² Trends such as increased outsourcing as well as the fragmentation and global re-structuring of international value-chains are important indicators of this process. Thereby central modes of economic control and regulation are removed from the sphere of the single company and become re-embedded more and more within vertical and horizontal network relations (Schmierl/Pfeiffer 2005).
- 11 Within innovation research a similar descriptive model became widely accepted. According to that model, technological innovation processes are increasingly organized within networks consisting of many different agents (Rammert 1997). Additionally, the idea of linear and sequential models of innovation is replaced by new analytical concepts stressing the cyclical phases of innovation and the importance of the network (Weyer 1997 ; Hirsch-Kreinsen/Bender 2001). The process of innovation itself is characterized by overlappings of each single phase of innovation. The development, application and regulation of new technologies are pushed forward in the interaction of these mutually linked phases. At the same time these innovation processes are increasingly organized along “distributed knowledge bases” across economic sectors (Smith 2000, 2003).³
- 12 Hence innovation processes increasingly develop within networks. However, these networks are not always and not as a matter of fact located within one narrow economic region, as the “industrial district” debate may suppose. Regional proximity and associated close relations between companies may encourage the inter-organizational “flow” of practical knowledge and lead to competitive advantages, as transaction costs are minimized (von Hippel 1987, 1988 ; Crevoisier/Maillat 1991 ; Porter 1998 ; Staber 1998 ; Asheim 1999 ; Jacobson *et al.* 2002 ; Heanue/Jacobson 2002 ; Dahl/Pedersen 2003 ; Garibaldi *et al.* 2003). Nevertheless, according to neo-institutionalism it is much more important for an economic actor to become embedded into a shared cultural and functional “organizational field” in order to accumulate social capital and to increase the innovative capabilities of the company (DiMaggio/Powell 1983 ; Powell/DiMaggio 1991 ; Powell/Smith-Doerr 1994). The emerging “organizational” proximity of co-operating companies is result and precondition of collective learning-processes and associated innovations at the same time.
- 13 The **paper industry** is a rather paradigmatic example for these networking procedures. The paper industry is organized in well established long-term networks including research institutions (foundations, university institutes), transport and IT companies, engineering and chemical suppliers, and customer industries like graphics, packaging, publishers or woodworking.⁴ As a highly networked branch it seems to be rather appropriate in terms of our research questions. To understand the specifics of the value-chain properly a brief recapitulation of the sector and its characteristics is useful. First of all it must be considered that the production process is quite complex and characterized by capital intensity – although the product appears to be a rather simple one. Within the

process the paper-machine plays an outstanding, central role. Modern ones are up to 140 metres long, up to 25 metres high and can produce 2.000 meters of paper per minute. Of course the claim of the centrality of the paper machines refers not to its size or production speed, but means that nearly all other elements and phases of the process are determined by the functionality of this machine. Hence the key challenge in this industry is not to arrange a multitude of equally important productive factors (such as other machines, models of work organization etc.) in a mutual way, but to hierarchically adapt all other productive factors to the paper-machine.

- 14 This specific productive structure also exerts its influence upon the **innovation patterns** that are characteristic of the paper industry. There are **periodic fundamental innovations**, which are always connected with extremely high investment, as such forms of innovation can usually be equated with the development and purchase of a new paper-machine. Such a 'break-through' is usually followed by a series of **incremental innovations**. Apart from improvements of paper quality, innovations oriented towards an enhancement of productivity or to lower costs are largely prevailing in the dominating field of mass paper production.
- 15 In order to cope with the challenge to be innovative, the paper manufacturers try to intensify the extent of **co-operation regarding innovation with important suppliers**.⁵ Roughly spoken, the suppliers of the paper-manufacturers can be divided into three important sub-groups. These are the suppliers of raw material, the chemical industry and, most important, machine-builders. As a growing share of innovative activities is shifted to the machine-building and the chemical industry, they even become the main source of innovation within the paper segment, while the suppliers of raw material (water, pulp or waste paper, energy) don't play any role for strategic innovations in this sector. The resulting **collaborative pattern of innovation** and the related specific division of labor can be illustrated by two empirical examples: inter-company innovations of paper manufacturers and the chemical industry and joint innovation projects of the paper industry and the machine-building industry.
- 16 (1) The **chemical industry** is an important source of incremental innovations – in terms of product as well as process innovations. Usually existing chemical additives are modified and optimized to the effect that they become cheaper or to the effect that they work "better" within the paper production process. Pioneering process innovations – which means the production of completely new products – are conducted not very often, because of the characteristic long innovation cycles (up to five years) and high costs.
- 17 For that reason, **close relationships** between the paper manufacturers and the chemical industry are indispensable. Each paper-machine is unique, which means that standard chemical solutions don't work properly. Thus each chemical additive must be tuned and adjusted individually. For this reason, it is necessary that chemical engineers and technicians know the respective productive conditions of the client, and they must gain 'experience' with the characteristics of the production process and the paper-machine in use. As a matter of fact, an **exchange of personnel** and temporary assignment of employees of chemical manufacturers to the paper companies is a common feature. The chemical supplier visited by us even established an own 'department' called 'Technical Field Service', which is responsible for on-site customer-service. This field of activity is supposed to grow in importance in the future.

- 18 Apart from that technology-oriented co-operation, there is also a strong **collaboration** in terms of **inter-company logistics**. For instance, chemical suppliers frequently install tanks and mixing facilities at the site of the paper manufacturer. Sometimes the tanks are even equipped with an automated level monitoring system. So, if the stock of the respective chemical is running low, an automatic order is sent to the supplier. At the same time so-called consignment stocks are gaining importance, too. This means that the client has to pay the actually used material only, while the supplier is responsible for the management and control of the stock-keeping. Moreover, modern state-of-the-art **network technologies** like a standardized B2B-platform are often employed to organize business processes and to tighten the links between the paper-manufacturers and their chemical suppliers.
- 19 (2) The **machine-building industry** is, in contrast to the chemical industry, the main source of periodic **fundamental innovations** (see also for other sectors: Köhler/Schmierl 1992; Taplin/Winterton 1995; Taplin/Frege 1999; Maskell 1998; Lorenzen 1998; Laestadius 1998, 1998a; Schmierl 2000a, 2000b, 2005). There are three big paper-machine engineering firms – Voith (Germany), Valmet (Finland) and Beloit (France) – that supply the worldwide market for paper machines and have approximately equal shares in the market. Their comprehensive range of products is comparable as they produce machines for every production stage in the paper production process.
- 20 Our example in this area describes the collaboration of a major machine builder and a paper company that founded a completely new company site equipped with most modern machinery. The implementation of a new paper-machine can be understood as a pioneering innovation in itself. The capital expenditure amounted to a total of about 300 Mio. €. The most important sources of the innovations connected with this investment, however, are not to be found at the paper company. Not only innovations regarding technology and machinery, but also regarding the work organization were induced and pushed forward by the company's machinery and equipment suppliers. Their knowledge and experience constituted the major source of innovation. From the initial idea until the finalization the whole project was pursued in close collaboration with the supplier of the paper-machine. Therefore, a **joint project planning team** was established for two years, which developed the first concepts from the very beginning. Within this team different single innovations and the progress of the whole project were conceptualized and monitored. In a certain sense the content as well as the concrete proceeding of the innovation process are not controlled and conducted autonomously by the paper company alone any more. Hence the innovation process can be classified as an inter-sectoral innovation process. This kind of collaborative innovation enabled the paper company to conduct fundamental innovations such as the founding of a new company site – equipped with most modern machinery and characterized by a new innovative organization of the production process – without even maintaining an own internal R&D department.
- 21 Additionally, in the paper industry there exist a **well-established net of sector-specific technical consultancy agencies**. Apart from two university chairs concerned with the production of paper, there are several commercial consultancy agencies which are specialized in the production of paper. They provide relevant knowledge in terms of technical aspects as well as market-related know-how for the paper industry. Of particular importance is the non-commercial PTS ('Papier Technische Stiftung'), which is a leading research institute of the paper industry in Middle Europe. It has been founded

by the paper manufacturers employers' association and the respective organizations of the supplying industries, among others. The PTS organizes a 'knowledge data base' concerning all parts of the paper value-chain. At the same time they are maintaining a huge laboratory in which complex measurements and experiments can be conducted. Thus, they support innovation projects of paper manufacturers who don't employ an own R&D department or research facilities any more. Hence, they can also be considered as an important agent for innovation processes within the paper segment.

- 22 (3) To put it in a nutshell, in both cases referred here the suppliers are deeply involved in inter-company innovation projects which are a specific of the branch. This collaborative pattern of innovation is on the one hand a result of shrinking R&D budgets and a complementary outsourcing strategy applied by the paper manufacturers. On the other hand, it is a consequence of the singularity of each paper manufacturer's production process. During such inter-company innovation projects the boundaries of each individual company become at least temporarily blurred, as joint decision making and strong collaboration lead to important, strategical "gray areas" of co-operation and mutual interdependence between legally independent organizations. The innovations are developed more and more interactively within such organizational overlappings and gray areas. An example for these hybrid, cross-company organization structures are the aforementioned "joint innovation teams." Within these bodies, different forms of knowledge with different origins are exchanged and integrated into an "innovative whole." The basis for the resulting "surplus" of knowledge are mutual learning processes, in which the different competencies and experiences are not only simply added, but rather the knowledge is enriched and further developed in the interaction with their "knowledge counterparts" and by consideration of the respective environmental context. For example, during the creation of new chemical additives the scientific knowledge held by the chemical engineers must be combined with tacit and practical knowledge of workers and engineers of the respective paper plant.

Vocational training in low-tech companies

Predominant strategies of personnel policy in low-tech companies

- 23 The main strengths of the competitiveness secured by low-tech companies in European high-wage countries are the long-term and gradually optimized manufacturing processes and the permanently accumulated know-how for running these processes. Therefore, low-tech companies do not automatically employ workers with low skills. There is a broad variety of qualifications and skills in which transformative capabilities are located internally. In principle, we identified two different modes : one in which the general level of skills is high, and one with polarized, hierarchical layers with a concentration of more complex tasks among foremen or white collar workers. All in all, the analysis of the low-tech cases show that, in regard to the "progressiveness" of new forms of work organization, low-tech firms seem to be followers (of what is known from other, non-low-tech sectors) rather than trend-setters, incorporating new technologies, organizational concepts, designs and so on after they have been tested by others.
- 24 Nevertheless, many low-tech firms (and all companies of the paper industry) follow a **'high-road' strategy** regarding work organization, employed work-force and qualification. The investigated companies (from the paper industry, the metal working

industry and partially from the food industry) use a very modern, capital-intensive and highly automated production process. In these cases the tendency towards automation does not lead to a de-skilling of the work-force, but, on the contrary, to a stronger demand of skilled workers (see also Rumberger 1995 ; Spenner 1995). This is a result of the growing importance of a continuous and quick maintenance of the machines. Thus, it is not so much the operating of the machines but the ensuring of a friction-less production that forms the crucial challenge for the companies employing a modern production process. As these activities can hardly be standardized, automation in most cases of our sample is interlinked with the utilization of skilled workers. This challenge, i.e. to avoid frictions in the production process, is also reflected in the work organization. The strategy adapted is to reduce the division of labor so that the same workers who run the machines are liable for its maintenance and tasks within production planning and scheduling. Therefore, forms of semi-autonomous group-work were implemented. Such variants of work-organization, implicating an enhancement of the general skill-level, are intended to ensure a more flexible production process as well. Through job rotation, job enlargement and job enrichment, the work-force becomes able to fulfil a greater variety of work-tasks and thus to cope with sudden changes in a complex production process. The aim is often to enhance the companies' competitive advantage via an increased organizational flexibility : in a process of job enrichment workers shall learn to cope with a greater range of tasks, which enables quick changes in the production process and makes the company less dependent of single key workers. The laborer must be able to cope with new, so far unknown problems and situations flexibly and autonomously.

- 25 The strategy of adoption and adaptation of external knowledge by use and improvement of transformative capabilities does not imply that the companies buy strategic qualifications on the external labor market as a conscious personnel policy. On the contrary, they apply a personnel policy which heavily relies on the **predominance of internal training**, which is supplied mostly unsystematically during daily work and at the workplace. In most cases, forms of **vocational education and training (VET)** predominate with a great range in respect to their intensity (Schmierl/Köhler 2005).⁶ If there is a high level of training measures, this is often the result of inadequate regional or national educational systems which cannot provide enough adequately skilled workers. Internal vocational training – in terms of training on-the-job – predominates (see Bowman 1995). Low-tech firms therefore can be considered as exemplary types for strategies of personnel policy as they are described in scientific concepts on internal labor markets (Sengenberger 1981 ; Altmann *et al.* 1992 ; Doeringer 1995 ; DeFreitas 1995).
- 26 Concerning human resource management (HRM), forms of in-house promotion are relatively common in the investigated cases. Quite often the executive personnel are recruited from the ranks of the blue-collar workforce. In a few cases these labor market circumstances have led to a systematic training of apprentices, as when difficulties in recruiting workers with specific skills motivated firms to conclude agreements with the administration for employment for firm-related apprenticeship systems.
- 27 Process-related improvement activities like interactive learning and models to record, formalize and generalize existing knowledge within firms are also important in these low-tech companies, for example via continuous improvement programs. Apart from characteristic differences, as between sectors or certain types of enterprises, we found

three basic modes of vocational education and training in the sample – listed in order of importance :⁷

1. Internal training on the job and learning by doing,
2. External recruitment of key workers on the external labour market followed by an internal phase of training on the job,
3. Cooperative further training with other institutions and companies.
4. In this paper—as indicated by its title—the last aspect of training networks and cross-company learning programs will form the focus.

Vocational training networks and learning alliances

- 28 Due to the fact that a more and more important element of vocational training and further training for low-tech companies is **vocational training cooperation** with external institutions or companies in the same sector and region (see also Holmqvist 2003), the argumentation will focus on that pattern.
- 29 Particularly because of rapid technical developments and organizational restructuring taking place within the companies, there have been changes in occupational requirements at increasingly shorter intervals, in low-tech companies as in other firms. As a result, the importance of permanent vocational training continues to grow. This is also due to the fact that educational systems are often merely able to deliver the most basic qualifications and key skills and need much more time to adjust the curricula of educational and vocational training systems. The gap between extended and increasingly rapid technological innovations and organizational change processes has to be closed via short-term vocational training within the companies (see Altmann *et al.* 1992 ; Rumberger 1995 ; Spenner 1995 ; Carnoy 1995).
- 30 **Summarizing** the empirical results : what many firms of the low-tech industry **have in common** are more or less severe recruitment problems. Many cases in our sample—especially from the metal working sector and the paper industry—reported serious problems in recruiting adequately skilled workers. Reasons for the lack of trained people in the low-tech sector seem to be on the one hand national education systems which do not provide even a proper basic education ; on the other hand, recruitment difficulties occur when there is a special demand for distinct vocations (i.e. smiths, foundry workers, paper makers) in spite of unemployment, due to inadequate or mismatched skills. Furthermore, an actual problem, which will be aggravated in the future because of technological and organizational innovations in some low-tech companies, could be that the vocations and the curricula provided by the public education systems will no longer correspond to the actual requirements of industry and their modern production processes. As an example, paper-makers today do not rely on practical skills as much as they did in the past, but now need more technical skills and hybrid qualifications (of mechanics, electronics, hydraulics etc.) to run modern paper-machines. Many classical skills of the paper-maker such as the measurement of paper quality are no longer required, as these tasks are done automatically by the machinery. On the other hand, as the mechanical and electrical parts of the work process grow in importance, new skills, such as the operating of computer-controlled machines, are increasingly required. However, so far there exists no vocational training which corresponds to these new requirements for hybrid qualifications, incorporating a mixture of sector specific metal working, electronic and hydraulic skills as well as ICT competences. In the metal working

sector, too, similar trends towards new hybrid types of qualification profiles can be identified, which are seen as recruitment constraints. An additional barrier for low-tech companies is their low prestige and bad image. Many low-tech firms find it difficult to recruit local production/operative workers because many local laborers do not want to work in factories any more. Moreover, there is often regional competition for persons with the skills required. Additionally, some companies experience limitations in available manpower that come from being situated in a smaller community and not in a bigger city. Some companies face substantial problems in recruiting qualified skilled and semi-skilled workers because of the competition for qualified personnel in the area by big multinational companies (e.g. from automotive engineering and ancillary industries).

- 31 All in all, such problems in recruiting skilled workers occur when specific aspects of the production processes require qualifications that are not adequately catered for by the national systems of vocational education and training. In addition, vocational profiles in the low-tech sector are often largely unknown to young job seekers and trainees. The companies respond to the recruitment difficulties with different initiatives. Most of them simply intensify their on-the-job training to incorporate and qualify new staff. Other companies of the sample employ distinct apprenticeship systems.
- 32 For our purpose in this paper the most interesting companies follow an **innovative cooperation strategy** regarding personnel policy which helps to close the supply-demand gap by establishing common long-term training networks with municipalities or other companies. All in all, we find three distinct, sometimes complementary strategies for founding, structuring and use of **learning alliances** :
 1. establishing of officially assessed vocational training centres via a definition of curricula and certificates together with employment agencies and municipalities,
 2. co-operation and common training programs and networks with other companies,
 3. participation in sector-specific vocational training programs.
- 33 (1) Several companies created—together with national or local employment authorities—**vocational training and apprenticeship centres**. In these centres, achieved skill levels are officially assessed, examined and certified. This type seems to be common practice in Sweden and particularly in Spain.
- 34 Facing the lack of skilled workers for their particular foundry process, a Spanish metal working company has created its own, officially recognized, vocational training centre and started to train their own people. Its vocational training centre was officially approved by the National Employment Office INEM, and since then, ten to fifteen apprentices per year have received theoretical and practical training in the firm. The first group finished in 1998. The best apprentices are usually hired afterwards. The INEM subsidizes the training programme provided that the firm offers labor contracts to at least 20 % of the graduates. Since 1998, about 40 % of the plant's labour force has received their training in the factory's centre.
- 35 A shortage of skilled personnel resulting from a generational transition was also mentioned at a Swedish furniture manufacturer with 100 employees. The company predicts a forthcoming change of generations of personnel, which entails the risk of losing valuable competences and knowledge residing in its employees. Adding to the problem is the fact that several of the qualifications are difficult to recruit because formal education is scarce, forcing the company to provide much of the training and knowledge itself. Some collaboration with the local employment service agency is taking place. The

employment service offers one-year courses where new staff can receive the basic training and knowledge. Then the company uses apprenticeship systems for the further education of new recruits.

- 36 One company even started an upper secondary school in an alliance with its local municipality. A few years back, the Swedish hand tool manufacturer with nearly 400 employees experienced difficulties in recruiting new shop-floor workers because of an economic upswing. Production is highly labor-intensive and, in order to assure its future labor supply, the company started its own upper secondary school education, "Industriprogrammet", in collaboration with the municipality of Enköping. The school has its own premises within the factory and some of the firm's personnel work nearly full time as teachers at the school. Apart from Industriprogrammet, the state-owned company "Lernia" resides in the same building. Lernia is dedicated to skill enhancement and vocational training for adults. The tool manufacturer recruits personnel using recommendations from the school. Aside from being a source of new personnel, Lernia also offers education for the employees on a continuous basis.
- 37 (2) A second type of innovative learning alliances is long-term co-operation with other companies and the institutionalization of common training programs and networks within an industrial region:
- 38 An Irish producer of metallic precision components with about 40 employees is part of the North Mayo Skillnet Training Network. This network was devised as an approach to fill skill gaps and training needs for a group of nineteen companies in North Mayo/South Sligo. The companies range in size from five to 300 employees and they are engaged in widely different sectors of industry and business. The network was first established in 1999 and has grown from an initial group of four member companies to its current number of nineteen. The objectives of Skillnet are to sustain employment in the region, enhance competitiveness, create added-value, make training more innovative and available locally and become the recognized training centre of excellence. The associated metal working firm is also involved in the Mayo Engineering Association—another training body linked with the National Training and Employment Authority for Ireland (FÁS). Currently, this firm is also examining the idea of APL-accreditation of prior learning—that would be carried out in conjunction with FÁS. The idea is that the existing skill level of those without formal qualifications is assessed, examined and certified, and courses are devised for any areas where there is a need for improvement. This proactive personnel policy ranges from the development of training plans in order to facilitate APL to the promotion of soft skill initiatives and team building exercises. In 1991 the company won the FÁS Regional Award for Training Policies.
- 39 A Polish company (a producer of steel platform gratings, stairs and similar products with 140 employees) participates in training programs by delegating 20-25 employees every year to take part in training sessions organized for groups of workers in German plants of business partners (customers) and in other companies belonging to the company group. Administrative workers participate in training programs, concerning administrative and accounting issues as well as changes in legislation. The training programs are organized on a rotation basis, i.e. within a given period of time the whole personnel directly involved in production, participates in a cycle of training sessions. A similar scheme of learning from more experienced Western partners is chosen by another Polish manufacturer of parts for aeroplane engines and pipelines with 100 workers.

- 40 Last but not least, the participation in an EU funded ADAPT project provided support in upskilling and improved the quality and type of internal training. Because of difficulties in getting adequate labour, an Irish furniture firm with about 50 employees participated in an EU-funded ADAPT project⁸. The impetus to become involved in this project arose as a result of two main changes in the wider environment that had begun to pose significant challenges for the firm and the furniture industry as a whole. First, competition from furniture firms in other countries was becoming increasingly aggressive, particularly regarding price. Second, new employment opportunities in high-tech firms in close proximity to the company were offering increasingly attractive pay and additional benefits that made it difficult to recruit labour. Moreover, the training regime in existence in furniture firms at that time – an on-the-job four-year apprenticeship – was considered too long and unattractive by potential trainees. All of these features conspired to make employment in what was perceived as a low-skill, low-wage traditional manufacturing industry very unattractive. Moreover, due to the increased competitive pressures from firms based in low-wage countries, an increase in pay to entice recruitment for the firm could not be sanctioned, as it was perceived that sales could not be expanded sufficiently to generate the extra finance needed. Although the company could not hope to compete for workers on the basis of pay or additional benefits, it was believed that it could compete on the basis of the quality and type of training that would be developed for its employees, partly by making the employees more employable but also by making their work more interesting. Furthermore, upskilling was seen not so much as an optional extra for the company, but as a vital aspect of its survival prospects and future growth. Therefore, the company focused on the specific training and skills needs of its craft workers, and more generally on the development of ICT and systems capability within the organization.
- 41 (3) Especially in several industrial sectors in Europe, there seems to exist a well established **system of training and further education agencies**, which are initiated, coordinated, monitored and financially supported by sector-specific employers' associations or foundations. These agencies offer sector relevant training courses and further vocational training activities. The courses are organized by a wide variety of organizations, trade associations, technical institutes or specialized education companies.
- 42 First, in the paper segment in Germany a multitude of different external institutes and associations is in charge, which offer important vocational training services directed towards their paper mills. Apart from two university chairs concerned with the production of paper, the above-mentioned PTS is a major provider of further education and training measures. The training situation in the paper industry is directed at two job outlines : paper production (paper maker, foreman of paper production, paper engineer) and paper processing (packaging maker). The companies of the paper industry mostly provide internal training in form of apprenticeship places for package makers with about three years of training. Besides this, complementing forms of paper training are provided mainly by the training centre of the paper industry, the Papiermacherzentrum Gernsbach, the only national Paper Maker School (PMS) in Germany. The PMS Gernsbach is the industrial vocational school and also the master school. The PMS industrial vocational school is visited by all trainees that are in a vocational training situation as paper makers in Germany or in Switzerland. The master school is visited by paper specialists from the Paper industry and is concluded with an exam as foreman, for either paper manufacturing or paper processing. The division Bildungswerk Papier (vocational

training centre for paper) of the PMS Gernsbach is responsible for the advanced vocational training of all paper-technical areas in the field of management. The main possibilities in the range of academic training are the study courses 'paper engineering' (paper technique) and 'packaging technique.'

- 43 A similar example is to be found at a German producer of electrical heating elements with 55 employees, who sends his skilled workers to a training agency of the plastics industry. The Kunststoff-Institut Lüdenscheid was established in 1988 and provides services in the field of plastics processing. Since 1992 it has been financed exclusively through the services which it provides to industry. In the state-of-the-art laboratory, facilities for material testing and fault analysis are available. In addition, they offer training and further education particularly on mechanical engineering with a focus on special aspects of plastics technology.
- 44 **To synthesize** the empirical results, these innovative forms of cooperative vocational training may be found in every country and are in fact not characteristic for a certain type of companies only. What these firms **have in common**, are more or less severe recruitment problems, which they tried to solve via innovative, cross-company paths of personnel policy. In the herewith reported cases these initiatives look like success stories. It should not be concealed that company networks in a highly competitive economic system often bear also the possibility of conflicts, cheating and quarrel. As Holmqvist (2003) has already shown, joint learning between organizations indeed has a highly innovative and explorative character ; while it increases the store of knowledge in the participating companies, interorganizational collaborations at the same time are often marked by conflicts and instability as a result of the lack of formal authority (p. 104). But in the present paper, this was not the subject.

Conclusion

- 45 (1) We firstly tried to present empirical results on manufacturing structures and change processes going on in classical and mature "low-tech" industries – with a strong focus on the example of the German paper industry. Within the rise of terms like "knowledge society" and the (past) boom of the new economy, such non R&D-intensive branches disappeared from the analytical focus of many academic disciplines as e.g. also in the sociology of work. In terms of our research findings the OECD expression "low-tech" is quite misleading. On the one hand, the production processes are quite complex and indeed rather technology-intensive, as mostly modern, highly automated machinery is applied. As a consequence, the employment of skilled workers is largely prevailing. On the other hand the branch is innovative as well-in spite of the assumed simplicity and maturity of the final product. Market pressure forces the paper companies to permanently optimize their processes and to innovate the product 'paper'. Conceptually we summarize these competencies of paper producing firms in the term "transformative capabilities" (Schmierl/Köhler 2005 ; Bender/Laestadius 2005) in order to highlight the fact that low-tech companies primarily must become able to incorporate knowledge which was formed outside their boundaries. In this respect, we follow innovation researchers who characterize such competence generating processes within a firm as "absorptive capabilities" (Cohen/Levinthal 1990 ; Palmberg 2002) or „dynamic capabilities“ (Teece *et al.* 1997 ; Zollo/Winter 2002).

- 46 (2) Secondly, we tried to answer the question how these innovations are pursued and where the sources of innovation and knowledge can be located, as the paper companies—as low-tech firms by definition—usually don't maintain relevant R&D departments. This "knowledge gap" is closed by intensive forms of co-operation with the most important suppliers (chemical industry and machine-building industry). The resulting collaborative links are so tight that we can speak of a well-established long-term network structure within the paper industry. Within these networks innovation is organized as "interactive learning" (Asheim 1999). The suppliers are a vital part of the paper value-chain. Indeed, the success and competitiveness of the paper manufacturers are heavily determined by the competencies of the machine-building and the chemical industry. Hence, they are sources of knowledge of utmost importance. In a certain sense, the technical knowledge regarding the production of paper is not only located at the paper manufacturers, but is distributed along the supply chain. In order to make this knowledge applicable and profitable, usually very close relationships between the suppliers and the paper manufacturers are established. For example, the temporarily, or even permanent, assignment of workers from the supplying companies to the paper plants is quite common in this branch. The relations between the companies are sometimes organized by a collaborative principle beyond market and hierarchy, while the boundaries of each individual company become blurred. Within the emerging networks the company's boundaries are not dissolving completely, as the companies stay independent in many fields of activity—but these borders become more and more permeable. In terms of responsibilities and competencies "gray areas" come into being, in which none of the single companies can act autonomously any more. Within such strategical zones of co-operation and mutual interdependence joint decision making and planning processes are becoming vital. The resulting networks can be classified as polycentric. Neither the paper manufacturers nor the suppliers can maintain such a strong strategic position within the network that we could speak of "hierarchical networks," which are, for example, characteristically for the German automobile industry (Jürgens *et al.* 1988 ; Windeler 2001).
- 47 (3) Thirdly, it is not only possible to identify an increasing relevance of inter-company and interactive innovation projects. More than that, these joint projects can also be understood as forms of intersectoral innovation processes, as we find forms of collaboration between a so-called "low-tech" sector (paper manufacturing) and sectors such as the machine-building and the chemical industry, which can be classified as medium high-tech. The innovative pattern described shows that within the paper segment major innovation processes aren't located (only) in high-tech companies, but rather mutually between companies of different sectors. Changed products of "knowledge intensive" sectors, such as the chemical or the machine-building industry, influence the innovation processes of the paper mills and contribute to more efficient processes and improved (simple !) products within the classical „low-tech“ sector paper manufacturing. As pointed out above, these innovation processes can be described as "interactive learning". However, the term "inter-action" not only refers to different companies (inter-company innovations), but at the same time to different industrial sectors. In particular we found in the paper industry joint innovation processes including agents from "high-tech" and „low-tech“ companies. Consequently, we arrive at the conclusion that so-called intersectoral innovation processes are of great importance here. From this relationship mutual impulses for new innovations emerge. At the same time, however, the particular

paper manufacturer's needs and productive conditions decisively affect the innovation processes of the supplying companies, too. Thus, the specific requirements of a "low-tech" sector become a crucial driver and impulse for the innovation processes in "high-tech" industries (Schmierl 2004 ; Hirsch-Kreinsen *et al.* 2005).

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NOTES

1. The presented research results were conducted within the multidisciplinary European research project "Policy and Innovation in Low-Tech – Knowledge Formation, Employment and Growth Contributions of the 'Old Economy'" (PILOT) (Contract No. HSPE-CT-2002-00112), which was funded by the European Commission, ran from 2002 to end of 2005 and consisted of 11 European research institutions. Altogether 43 case studies were conducted in several low-medium-tech branches in 11 European countries (see Schmierl 2004 ; Schmierl/Köhler 2005 ; Hirsch-Kreinsen et al. 2005).
2. According to Jörg Sydow, we understand 'company networks' as a distinct organizational form of economic activities (1992, p. 79). A network is characterized by complex reciprocal, more co-

operative than competitive and relatively stable relations between legally independent companies which are usually dependent from each other in terms of business, however.

3. "A distributed knowledge base is a systematically coherent set of knowledges, maintained across an economically and socially integrated set of agents and institutions. (...) These (...) take two forms, 'embodied' and 'disembodied.' Embodied flows involve knowledge incorporated into machinery and equipment. Disembodied flows involve the use of knowledge transmitted through scientific and technical literature, consultancy, education systems, movement of personnel and so on" (Smith 2000, pp. 15-16).

4. Our findings about the paper industry are based on intensive case studies of four German paper manufacturers, a chemical supplier, a paper whole-saler and a paper research institution. Half-standardized guideline-based interviews were conducted with representatives of executive management, marketing department, personal department, sales and the shop-floor. These case studies were accompanied by interviews with branch experts – e.g. from employers' associations and the Bavarian ministry of economics.

5. About five regional agglomerations of the German paper industry can be identified: North Rhine-Westphalia (NRW), Middle Rhine (Hessen), Black Forest, the region around Dresden and southern Bavaria. Quite remarkable are regional differences in the production of paper, pulp and mechanical pulp. In NRW mainly paper manufacturing firms are located, but also a certain amount of board producers is based there. Typical for the region is also the processing of mechanical pulp, whereas the end product may be hygiene paper as well as higher quality paper (e.g. coated magazine paper, schoolbooks, calendars). In the area of the Black Forest, the composition of the paper industry is quite similar, but proportionally more board producers are located there. The Middle Rhine region shows a differing picture, as there are many pulp processing firms, which attach great importance to R&D activities. The area around Dresden does not show a comparable variety in ways of paper processing: there mainly paper is manufactured and normally no products entailing pulp or mechanical pulp are processed. The paper industry in Southern Bavaria predominantly concentrates on paper manufacturing and on mechanical pulp processing. Subsequently, some regional distinctions in product sorts are striking, too. The relative shares of main paper products are nearly equivalent in NRW, Dresden, Black Forest and Southern Bavaria. The situation is characterized by mainly newsprint and printing paper production and, in the second place, carton and board for packaging, though in the Bavarian region there is a slight overbalance towards printing and newsprint paper. This is caused by the accumulation of media enterprises in the Greater Munich area. These regional clusters and agglomerations do exist indeed. However, they are not a source of significant agglomerative economies anymore. They should rather be understood as a 'traditional holdover' of a past when the structuring of the branch was still characterized by a multitude of small and medium-sized companies. Then localization was a strategic option, by which synergies between different smaller paper mills and associated suppliers could be made profitable – e.g. by economies of scale in terms of intermediate inputs and raw materials.

6. This trend seems not to be an exclusive specific of low-tech firms. A representative survey of the VET situation in Germany for the Federal Ministry of Education and Research concludes that in 2003 26 percent of the total workforce took part in further education as well as in advanced vocational training activities (BMBF 2004, p. 15). Regarding different age cohorts, younger people (between 19 and 34 years of age) participate in VET above average (29 percent), while the first rank belongs to people between 35 and 49 years old, of whom 31 percent completed VET courses (p. 26). Regarding the education level of trainees, a linear progression of participation in VET is prevalent. While only 16 percent of people with a low education (lower secondary level) participated in these courses, the figure for people with middle education (upper secondary level) was 32 percent and rose to 38 percent for people with abitur (grammar school =A-level) qualifications (p. 28). The same holds true for the relationship between participation rates and

occupational position : 22 % of the unskilled and semi-skilled workers, 38 % of skilled workers, 34 % of white collar workers and 63 % of managers took part. A high and growing proportion of all categories of the work force (61 percent) participated in different activities of informal vocational training on the job – like coaching by colleagues or supervisors, quality circles, job-rotation, learning by observation, etc.).

7. For an in-depth summary of the main project results regarding knowledge management, organizational reorganization and personnel policy see Schmierl/Köhler 2005.

8. ^[8] ADAPT was a European Human Resources Community Initiative supported by the European Union through the European Social Fund (ESF) between 1995 and 2000. Almost 4.000 projects were supported, jointly financed by the ESF and private or public sources in the member states. The program was directed at enhancement of the firms' ability (especially regarding small firms) to cope with the industrial change (see Employment & European Social Fund 2000, 2001).

ABSTRACTS

The central starting point of the paper is that well-known classical patterns of creating innovations are changing. Innovation processes aren't originated exclusively within 'knowledge intensive' (high-tech) companies any more, but rather mutually between companies of different sectors. This has twofold consequences: On the one hand, the so-called high-tech industry influences non-high-tech branches as well as important suppliers of innovative solutions. On the other hand, the particular requirements and conditions of so-called low-tech branches affect companies of high-tech industries as specific drivers of innovation, too. Considered as a productive force, intersectoral cooperation becomes a main source of innovation, further growing in importance; innovation processes are more and more organized along "distributed knowledge bases" across economic sectors. Therefore, the main thesis of the paper is that today's knowledge isn't located within one company originating from one industrial sector any more, but is distributed along the respective value-chain and various sectors. At the same time, the "network" is not only relevant in technology-intensive branches such as IT industry or automotive industry, but becomes also a relevant analytical category for exploring "low-tech" industries and their innovation processes.

INDEX

Mots-clés: réseaux d'innovation, apprentissage, alliances d'apprentissage, création de connaissances

Keywords: innovation networks, learning, learning alliances, knowledge creation