Cultural, Social and Institutional Differences in the Professionalisation of Engineers in Germany, France and Japan

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In contemporary societies wage labour became the most important form of work. Employees must have therefore an interest in the market value of their qualifications. This is ensured by occupations, i.e. by "permanent, standardized forms of labour supply" (Beck, 1980: 25). Occupations are characterized by special fields of activity, special abilities and competences, a systematized professional training, a higher or lower occupational prestige and characteristic career ladders. For employers and employees, occupations facilitate the orientation at the labour market. Moreover, the occupational structuring of competences facilitates the acknowledgment and the inter-organisational transfer of qualifications. Academic occupations (physicians, lawyers, theologians, engineers...) are in general called professions.[1] In the process of professionalisation, the knowledge base of specific occupational domains is systematized, a structured professional training is developed and the specific fields of activity are reserved for the members of a profession.[2]

The emergence of occupations or professions can be explained in three different ways: A *functionalistic perspective* explains the emergence of occupations as a result of the social and organisational division of labour; the occupational division of labour reflects the specialization on certain activities. A second perspective focusing on *power* explains the emergence of an occupation as a result of a successful strategy of social closure, by which the access to privileged occupational positions is monopolized (generally by public educational certificates; Freidson 1986). A third, *a neo-institutionalist perspective* (DiMaggio/Powell 1991) points to the fact that processes of social closure are accompanied by specific mental and knowledge orders, which enable the development of autonomous problem definitions. Processes of professionalisation are therefore analysed as bargaining processes over the "correct" definition of the relevant problems and the way in which they can be solved. Professions cannot only be analysed by focussing on power and exchange relations, but the cognitive dimension of occupations must also be taken into consideration. These three perspectives, their achievements and their limits are discussed in the following taking the example of French, German and Japanese engineers. A detailed historical reconstruction of the three national paths of their professionalisation is not intended (see for this Gispen 1990,

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1 Kocka (1990: 62) remarks however: "... the concept 'akademisches Berufe' (academic occupations) excludes those nineteenth century professionals who were not trained in universities or similar institutions (like the English barristers), and it does not carry with it the notion of autonomy and self controlled clusture which usually defines the 'professions'."

2 Hitzler/Honer/Mäder (1992: 15) prefer another definition, which points to the systematisation of a field of knowledge, on the length of a formation, the certification of the acquired competences and the respective occupational prestige. For Daheim (1982) it is problematic to call the institutionalising and formalizing of occupations generally „professionalisation“, because this neglects the difference between different forms of occupations in the USA and Great Britain on one side and in Continental Europe on the other. The role of the state for the institutionalisation of occupations and professions is much higher in Continental Europe than in Anglo-Saxon countries.

Lundgreen 1990, Lundgreen/Grelon 1994 and Grelon/Stück 1994); my aim is only to discuss by these examples the explanatory power and the limits of the previously sketched perspectives, which are explained in more detail in Heidenreich (1999).

I. The professionalisation of the engineering education: A functional necessity?

A discussion of the functionalist perspective has to start with the question in which ways the postulated functional necessities of an academic training of engineers is articulated and in which ways it becomes relevant in a society. If not all existent professions are to be declared as functionally necessary, then the criteria for a functional necessity must be specified. Good indicators for such a necessity are articulated demands from prospective employers, from the state and especially from private industrial enterprises, which became the most important labour market for engineers. The systematic training of technical specialists would therefore be explained by the demands of their potential employers in the economy.

In a historical perspective, however, the training of engineers in specific technical schools was not the result of such requests. The initiative for such a training of technical specialists was taken in *Prussia and Germany* in the nineteenth century by the state (Lundgreen 1994: 26). This could be taken as an indirect expression of functional necessities - however with the special feature that the functional necessity of a systematic training in technical schools has to be detected and implemented first by enlightened public officials. The academic training of German engineers (which was accompanied by the prerequisite of a high school examination qualifying for university entrance and the graduation right for technical schools) cannot be explained in such a way. Entrepreneurial demands for formally high-qualified technical employees are not articulated in the nineteenth century in Germany:

> "What were the driving forces behind the development of the engineering schools, in particular the higher vocational schools (*höhere Gewerbeschulen*), to the technical university? Rising demands of the economy are difficult to detect... The experienced craftsman and the autodidact, which made its inner-organisational career from craftsman/foreman to the engineer, competed successfully with the theoretician " (Lundgreen 1994: 28f.).

In *France* the professionalisation of the engineering education ran likewise independently of entrepreneurial interests. Decisive was here the interest of the state in the abstract, mathematical training of technical specialists at the highest levels of the public service. The interests of private companies were insignificant, as indicated by the limited commitment of private firms for the training of technical specialists. Another indicator is the wage structure: Still in the 1930s the remuneration of younger engineers hardly differed in the first years from the usual foreman incomes:

> "In the firms many graduated engineers are not assigned to engineering positions from the beginning. That is even usual practice in some industries (as in the automobile industry)... graduated engineers are employed as foremen or technical designers. They must pass through all hierarchical levels and gradually take over ever-larger areas of responsibility. In contrast to present practices, the first job of an engineer did not differ significantly from the jobs assigned to other workers - even if an engineer diploma opened of course substantially larger career chances" (Grelon 1986: 9f.;).

E. Mattern (a director of Peugeot, who has been responsible 30 years for the "white-collar" politics of his firm) in 1941 expressed himself explicitly against the tight coupling of school diploma and organisational status and income hierarchies:

> "In no case a diploma may be automatically recognized within the company; only the real performance in different tasks, the capability, the devotion should be relevant for the remuneration

> and the promotion of an employee ... Social ties between graduates of the same school should have no impact within the company, because this will result in unfair decisions. This must not happen in any case, if one does not want to discourage all the good employees, who form the backbone of an enterprise... The graduate of a ‚high-level school of engineering' (*grand école*), who wants to advance within a manufacturing enterprise, must start with simple manual tasks - not in order to acquire the abilities and the routine of a worker but to become acquainted with the practical difficulties of work. He must start from the bottom; afterwards his adaptability will surely enable him to advance faster than others" (Cohen/Mattern 1986: 76-77).

The primacy of organisational criteria of remuneration and promotion determines even today the position and career paths of *Japanese engineers*. Academic education is not recognized directly within a company - even if more qualified employees have the possibility of acquiring a higher status within their professional career – a status that is awarded to them in western enterprises from the very beginning. After the entrance into a Japanese enterprise the school certificates - as in the France of the 30's - have only a limited impact on the initial task and remuneration. The organisational rang of an employee is not primarily based on his or her education or vocational training. For the position within a company, seniority and the regular, for example half-year personnel appraisals are crucial.

There are clear income differences between workers and engineers also in Japan. But these differences develop only in the course of a long working life. They are not established at the beginning of a career as in the case of France and Germany (see Lanciano et. al. 1992). This refers to the primacy of organisational knowledge. The social and organisational status of an engineer is less determined by the type of graduation than by the reputation of his or her employer and its position within the company – even if in the last years a trend from the classical company-dependent status hierarchies to professionally defined status positions can be observed. The advantage of an organisational structuring of technical knowledge is that non-hierarchical and interdisciplinary forms of co-operation are much easier. By diminishing the internal impact of diplomas, by centralized personnel evaluations and seniority rules, the communication barriers, the „lines of demarcation“ between different departments, functional areas and hierarchical levels can be weakened.

It can be concluded that the professionalisation and academic education of German and French engineers cannot be explained by the functional demands of the firms. The Japanese experience even demonstrates a limited functionality of personnel policies based on a close coupling of academic diplomas and organisational career patterns.

II. The academic education of engineers: A result of strategies of social closure?

Thus, the professionalisation of engineers cannot be sufficiently explained by the functional needs of industrial firms. In a historical perspective, the status interests of engineers and their teachers were decisive for the development of academic forms of professional training. In France and in Germany as well engineers employed in the private sector and their teachers were influenced by the example of the highly qualified technical specialists in the public sector. According to Lundgreen (1994: 29), this is the lesson from the *German example:*

> "Nevertheless the professional interests of engineers and their teachers became crucial for the development of academic forms of professional training ... the point of reference of these efforts were the technical officials in the public service and their education. For the teachers in the mechanical-technical classes, the tradition of the early, mathematically based civil engineering sciences represented a paradigm, whose attractiveness for the other engineering sciences was irresistible. For the engineers in the private sector, in their majority technical employees, technical

> officials were the role example in their fight for social promotion as a group... If one wanted a comparable professional and social position, it was obvious for them to start with the strategic redesign of the professional training following the model of the academic education in the public service. "

The professionalisation of German engineers started with the revaluation of the schools of engineering to technical universities (starting from 1865), with the award of the graduation right to these universities (1899), with the introduction of the engineering diploma for all technical disciplines and with the legal protection of the engineer title (since 1970).

In comparison to the professionalisation of French engineers, practical and theoretical competences in Germany were more strongly interrelated. By the revaluation of technical specialists to engineers (1933), to graduated engineers (1964) and since the 70's to engineers („Fachhochschulingenieure“) on the level of universities of applied sciences, these practically experienced specialists became formally equal to the rather theoretically qualified TU/TH engineers from the technical universities (Lundgreen 1994). By assigning the engineer title also to the former technical specialists, the separation between practical and theoretical knowledge characteristic for the French engineers, was reduced in Germany. The "almost singular German tradition of a second way of becoming an 'engineer'" (Lundgreen 1994: 43) and the symbolic integration of the more practically-oriented and the theoretical engineering education can be explained by the importance of the vocational training system in Germany. The trade unions, the enterprises and the business associations are interested in keeping open the career options for professional workers and foremen. This includes also the possibility of acquiring an engineering title on the university level. This refers to the inertia of existing institutions, which shapes the respective national patterns of professional strategies for social closure.

In *France*, the professionalisation strategies of technical specialists (and of managers in general) are shaped to a large extent by the national engineering education (Lundgreen 1990, Shinn 1978). The first engineers were employed exclusively in the public service - particularly in the military domain. After the foundation of the first national schools of engineering in the 17th century (1679: Ecole d'Artillerie), from 1783 to 1846 further schools of engineering were created. These special schools prepared exclusively for the mainly administrative tasks activities in the elevated and highest public service. These schools required the attendance of the *Ecole Polytechnique*, which was created in 1794 and taught rather abstract, predominantly mathematical knowledge as opposed to experimental or practically oriented abilities. The students of these national schools of engineering were predominantly recruited up to the French revolution from the aristocracy, since then particularly from the French bourgeoisie. Up to the end of the 19th century, there were practically no common traits between the state engineers from the „grands écoles“ and the technical specialists, who were trained for the private economy (the so-called "gadzarts"). The state engineers belonged to the highest social layers, while engineers in the private economy originated from a workers or lower middle class environment.

Only since the 1880‘s, a group of academically trained engineers emerged between these two groups of public and private engineers. Since 1829, this intermediary group was trained at the "Ecole Centrale des Arts et Manufactures". For a long time, their status was rather low. This changed only in the 1870‘s - in connection with the development of more "science-based" industries like the chemical and electric industry and later the automobile and aircraft industry. Thus, the industrial demand for academically trained engineers increased and overhauled the so far dominant state demand for engineers. In 1897 the universities obtained the right to issue for the first time also nationally recognized engineering diplomas. This right

was an important prerequisite for the higher social recognition of technical qualifications. Decisive factors for the academic acknowledgment of engineers in the private sector were the professionalisation strategies of engineers and their associations (in particular "the society of the civil engineers of France“). By their academic recognition, the industrial engineers could improve their status in comparison with the engineers in the public service - who looked down with a certain aristocratic attitude on the industrial engineers who were oriented according to their opionion too much towards the solution of practical, concrete problems (Shinn 1978: 67).

A further important step on the way to the professionalisation and institutionalising of French engineers was the legal protection of the engineer title in the year 1934. This facilitated the demarcation from below, for example from autodidacts and from the graduates of the *Ecoles d'arts et métiers* and other technical schools. This demarcation from below was fixed since 1937 also in the collective agreements, as engineers and managers now were classified separately from technicians, draughtsmen and other technical specialists. Thereby the "cadres" as "intermediate class" between "capital" and "labour" was established and thus removed from the influence of the communist trade unions.

In Germany and in France thus the public technical officials and their education defined the pattern according to which the professionalisation of industrial engineers was shaped. The social closure of the engineering profession succeeded particularly by the official acknowledgment of the schools of engineering as academic institutions and by the legal protection of the engineer title. In this state-driven process of professionalisation, in Germany also the middle technical specialists were included into the group of engineers by the establishment of the universities of applied sciences (*Fachhochschulen*). In France instead, the social exclusivity of the technical elite remained protected; the equivalence of different forms of technical training could not be established on the university level. In France still applies: The younger and the more practically oriented a educational institution is, the smaller is its prestige.

In *Japan* engineers could not separate themselves against other technical specialists. An indicator for the lower degree of professionalisation is, that the Japanese expression for engineers ("gijutsusha") means not only engineers, but also skilled workers and other technical experts and managers (McCormick 1988: 592). There is also no separate group representing the interests of engineers. They are organized in the company unions responsible for all status groups. Further the remuneration differences between engineers and workers are substantially smaller than for instance in Great Britain and France. This failed professionalisation is surprising, since the establishment of an academic engineering education began for the private sector at nearly the same time as in Germany and France (into the 1870‘s; see Okamura 1993). The technical universities established at that time also enjoyed an extraordinarily high reputation owing to national support. Therefore the question arises, why the Japanese engineers neither succeeded in a professionalisation "close to the state" (as in Germany or France) or a predominantly market-driven professionalisation (as in Great Britain or the USA).

An answer to this question must start with the system of lifelong occupation in Japanese large enterprises (a system whose erosion began only recently). This company-centred system is the expression and the basis of an alternative form of social closure. In contrast to the patterns of social exclusion in France and Germany (where mostly unqualified employees are marginalized), the Japanese patterns of exclusion are based – besides the gender and age discrimination, which exists in all three countries - on the demarcation between successful

global companies and smaller supplier companies and their employees. Strategies of professionalisation had no priority for Japanese engineers, since a substantial part of them were employed in the prestigious large enterprises. They had thereby alternative possibilities for monopolizing privileged occupational chances. Instead of a vocational and professional segmentation of the labour market, their strategies were based on an organisational segmentation of the labour market. This is also reflected in the different contents of the Japanese engineering education: General education, humanistic and social sciences and language takes a substantially broader place than for instance in Great Britain:

> „Strikingly absent from Japanese discussions are the current English concerns of ‚engineering applications'. There is relatively little attempt to pervade the curriculum with industrial relevance: the overwhelming concern is in teaching engineering principles in the confidence that training will be given in the large companies ... While Japanese engineering has been developed in highly prestigious institutions this has not been followed by the development of an integrated curriculum (McCormick 1988: 591).

In view of internal labour markets, the technical training does not have to become "overloaded" with practical subjects, since the practical competences are guaranteed anyway by their later employer and his in-house training. Therefore, the remuneration differences between graduated and other employees are small in the first ten years - particularly compared with France, where engineers are promoted substantially faster (Maurice 1995). Since the organisational patterns of recruitment und promotion could start (at least in the past) from the assumption of a lifelong employment, not the concrete technical, as fast as possible usable knowledge of the young engineers was decisive, but the long-term development potential of the applicants (and the best indicator for this was a renowned university). Due to the former lifelong employment system, enterprises did not have to be afraid the loss of their investments. This justified comprehensive training programs within the company.[3]

It can be concluded that different strategies of social closure can explain the different professionalisation processes of French and German engineers. The professionalisation of Japanese engineers has been blocked for a long time, because an alternative form of social closure was more successful – the establishment of closed internal labour markets especially within the big companies (see overview 1). Substantial differences between the national patterns of professionalisation can be stated. Their result summarizes Sorge (1996: 82) as follows: "The Japanese engineer is more of a multi-specialist, the German engineer a specialist who extends his domain into other specialisms, and the French engineer is a potential generalist who tries to escape the specialism into which he initially finds himself."

In this discussion the focus was on bargaining and exchange relations between state agencies, technical specialists and their associations, schools and teachers. In concentrating on power relations, we neglected however the different technical qualifications and competences, which were "produced" in the process of the different national patterns of professionalisation. We will now concentrate on these cognitive dimensions.

Overview 1: The professionalisation of engineers between schools, occupations and

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[3] In the discussion of this paper professor Yoshimi Ito, Tokyo Institute of Technology, suggested a more differentiated analysis of the current situation in Japan. He pointed to the current transition from company-dependence to professionally oriented engineers; the bottom-up fostering system is too obsolete and dependent upon the industrial sector. He also suggested the incorporation of the classification of Japanese universities according to their historical background. Implicitly, the double-decker like status of the engineers exists also in Japan. He also mentioned that the universities are very influential concerning the Continuous Professional Development of the engineers. I am very grateful for these suggestions.

companies

	School-based professionalisation	Professionalisation based on vocational training	Professionalisation based on internal labour markets
Example	France	Germany	Japan
Central principle of social closure	Status groups with higher and lower educational certificates; close coupling of educational diplomas and organisational status	Occupational groups with different specialisations versus unqualified employees	Companies of different size and success
Social organisation of experience-based knowledge and practical learning	Limited recognition of practial knowledge; limited career chances after finishing the national system of education	Integration of practical and theoretical knowledge by special vocational schools and universities	„Learning on the job" and job rotation and trainings within one company
Social organisation of systematic, „science-based“ knowledge	Technical elites with a superior social status ("noblesse d’état“)	Symbolic integration with practical experience by professional universities	Comprehensive general education and loose coupling of educational diplomas and organisational status
Problems of the respective structuring of technical knowledge	Insufficient integration of practical and theoretical knowledge; hardly co-operation beyond status boundaries	Frictions between different occupational groups; latent tensions between engineers from vocational and technical universities	Recruitment and inno-vation problems in small supplier firms; erosion of internal labour markets in big companies; problems of knowledge transfer from science to enterprises

III. National patterns of technical knowledge: The cognitive dimension of professionalisation strategies

The professionalisation of engineers is only insufficiently explained by the monopolizing of privileged occupational chances. In this perspective, it is neglected that the different socio-cultural and institutional environments in Japan, France and Germany shape the interests and strategies of the different actors.

The influence of historically grown institutions can be illustrated by the example of the different national education systems. Without the vocational training system in Germany, the symbolic integration of application-oriented and theoretically oriented engineering educations would have hardly occurred. The strict separation of practical and theoretical competences in France refers to the strictly hierarchical structure of the French education system, which is shaped by a highly centralized bureaucratic state. The French research system also reflects this logic; the proportion of business-financed research and development activities is substantially smaller in France than in Germany and Japan (overview 2). This institutional separation between public research and private production becomes a problem when new, transdisciplinary forms of knowledge production (Gibbons et. al. 1994) become an essential prerequisite for economic success. The special combination of company-specific training and general education in Japan refers to the internal labour markets within large-scale enterprises being at the centre of the Japanese industrialization strategy of the post-war period.

Overview 2: National innovation systems in Germany, France and Japan. Some indicators

	Gross domestic expenditure on research and development as a percentage of the gross domestic product (1998)	Gross domestic expenditure on research and development financed by industry (1998)	Gross domestic expenditure on research and development financed by government (1998)	Total Business Enterprise R&D personnel as a percentage of national total (1998)
Germany	2,29 %	61,7 %	35,6 %	62,2 %
France	2,18 %	50,3 % (1997)	40,2 % (1997)	51,9 % (1997)
Japan	3,06 %	72,6 %	19,3 %	66,2 %

Source: OECD. *Main Science and Technology Indicators. Paris*

The different institutions in a country do not only shape the power and exchange relations, which result in country-specific patterns of the engineering profession. They also shape the competences and the knowledge base of engineers. In each country engineers have developed distinct cognitive identities and qualifications. Different national patters of technical competences and different strategies of mechanization and computerization are the consequences of these different cognitive identities of French, German and Japanese engineers (see Soskice 1999 for the broader discussion on the "varieties of capitalism").

National profiles of technical specialization are a first indicator of these different styles of technical development (Schumacher/Strassberger 1997). The French economy puts a special emphasis on research-intensive, nationally promoted high-tech products. The strengths of the German and Japanese economy are less research-intensive products (vehicles, machines, electrical equipment, chemical products). This refers to rather incremental innovation styles based on experience and accumulated technical knowledge, while the French economy is rather based on large technical systems, which are the result of radical technical innovations (atomic energy, high-speed trains, airplanes, telecommunications, space and missile technology; see Lundvall 1992).

The special qualifications of *French engineers* thus facilitate the development of large technical systems, which require a systematic long-term planning and the co-operation of different private and public partners (government agencies, research institutes and enterprises). Such co-operation networks can be based in France upon the close personal relations between the graduates of French elite universities. A special strength of *German engineers* is the production and gradual improvement of complex, technologically rather matured capital goods (for instance vehicles and machines). Much more difficult is the co-operation across professional boundaries which is essential to provide an integrated solution for customer needs. A specific strength of *Japanese engineers* seems to be the organization of manufacturing and development processes across professional boundaries.

These different styles of construction can also be demonstrated taking the example of the same technique - the *example of numerically controlled machines* (NC). This technology is a good example for different styles of engineering, since the integration of electronic and mechanical competences was the central challenge of the last decades for the machine tools industries. This integration requires the co-operation of very different competences, particularly engineers, hardware and software designers. The different national styles of

dealing with this challenge can be summarized as follows: In *France* enterprises and economic policy focused on a computer-centred strategy, which attached a high priority to the computer-aided modelling of manufacturing processes. Above all efficient single-purpose-machines were developed. Due to the higher social esteem of the mathematical competences – the so-called "Productique" - the connection between computerized manufacturing models and practical manufacturing processes was weakened. This primacy of computer-aided optimisation meant not only a large gap between programming and manufacturing activities, but also an insufficient technical integration of electronic control and mechanical equipment (Sorge 1996). Instead of a centralized programming, the *German* firms mainly followed a workshop-oriented design path, which allowed a partial integration of planning, programming and execution tasks (Hirsch-Kreinsen 1993). This facilitated the production of flexible, universally applicable CNC-Machines. This NC-strategy reflects the high qualifications at the workplace. The limits of this strategy lie however in the difficulty to combine new fields of competence with the traditional mechanical competences (for example, microelectronics, the computer and communications technology, new materials, microsystems technology). The small- and medium-sized enterprises in the machine industry tried not to leave their traditional mechanical engineering environment and therefore often concentrated on machines, which perfectly fulfilled the requests of a few customers (Widmaier 2000). These highly specialized solutions became too expensive for a broader clientele ("over-engineering"). This refers to substantial co-operation barriers between different occupations and disciplines (besides the small- and medium-sized structure of the German machine industry). *Japanese* machine tool manufacturers have chosen a different strategy. The concentrated on some standardized, modularised machines and sold them in large numbers in Japan and abroad. The individual modules can be bought from specialized suppliers; this is the basis for an efficient production and a high value added. Product and process innovations take place in close inter-company networks (especially in the case of numerical controls). Extraordinarily important for the commercialisation of standardized systems is the close co-operation with the customers; in these relations the manufacturers learn the specific needs of their customers. Likewise the customers (both the technical offices and the production departments) become acquainted with the possibilities of a new machine; thus, they can optimise the use of the new machine (Maurice et. al. 1988). This refers to the extraordinary importance of inter-company networks. These networks are facilitated by the less developed professional identities of the employees – but they should be obstructed by different corporate identities.

IV. Conclusion and outlook

The varieties of possible tasks and qualification profiles in modern societies are combined into a limited number of standardized occupational profiles. The emergence and institutionalisation of these occupations can be analysed in three different theoretical perspectives: In a functionalist perspective, the dominant value orientations and functional prerequisites of modern societies (rationality, functional specificity, universalism) are translated in occupations. In a theoretical perspective focusing on power and exchange relations, occupations are the consequence of successful strategies of social closure facilitating the monopolization of privileged job and career chances. Neo-institutionalist approaches stress that these strategies of social closure are accompanied by the development of special mental and knowledge orders, which enable the development of autonomous problem definitions and patterns of problem solving. The efficiency and the limits of these three

perspectives were discussed taking the example of German, French and Japanese engineers: The hypothesis that an academic engineering education is a functional necessity is contradicted by the fact that academically trained engineers were employed and paid in many German and French companies for many decades in the same way as other technical specialists. The status interests of engineers and their teachers were however central for the professionalisation processes of German and French engineers. The respective national patterns of professionalisation were at the origin of different forms of technical knowledge. An indicator for these different cognitive patterns are different styles of construction, which are at the origin of national patterns of specialization and innovation and specific technological trajectories (for example numerically controlled machines). Technical and economic trajectories are therefore shaped crucially by different national patterns of professionalisation - and vice versa.

However, occupations and professions are only one possible form of structuring labour market processes. Labour markets can also be organized – as demonstrated by the example of Japanese engineers - on a company level. In the internal labour markets of successful large enterprises, employees can acquire a high social status, which is relatively protected against external competitors. This is a strategy of social closure equivalent to professional labour markets; it also facilitates the access to privileged jobs. The increasing impact of organisational forms of further training and the increasing role of company-wide industrial relations may indicate that internal labour markets will become also in Germany more important in the future - at the expense of vocational job markets. This shift can be easily overlooked, since internal labour markets can be combined with an increasing importance of professional and general diplomas. At the points of entry into an internal labour market, educational diplomas are crucial. But in project groups, semi-autonomous working groups and other post-bureaucratic forms of organisation, specialized organisational knowledge become extremely important. Therefore, in Germany a decrease of professionally organized labour markets can be expected. Even the German engineering associations stress that the past forms of the engineering education are no longer adequate in front of the globalisation of production and development, the increasing project orientation of engineering work and the increased importance of interdisciplinary work (BMBF 1996). In contrast to this stronger impact of the company level in Germany, in Japan a stronger professionalisation of engineers can be predicted (especially as the result of the decline of lifelong employment patterns and an increasing impact of radical technological innovations).

References:

Beck, Ulrich; Brater, Michael and *Hansjürgen Daheim*, 1980: Soziologie der Arbeit und der Berufe. Grundlagen, Problemfelder, Forschungsergebnisse. Reinbeck bei Hamburg: Rowohlt

BMBF (Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie) (ed.), 1996: Zum Ingenieurwesen in Zeiten der Globalisierung. Ergebnisse des Ingenieurdialogs des BMBF (8.11.1996). Bonn: http://www.bmbf.de.

Cohen, Yves, and *Ernest Mattern*, 1986: Titre d'entreprise contre diplôme d'ingénieur. Les ingénieurs gèrent les ingénieurs entre les deux guerres. pp. 73-97.In: André Grelon (ed.): Les ingénieurs de la crise. Titre et profession entre les deux guerres. Paris: EHESS.

Daheim, Hansjürgen, 1982: Zu einer Zwischenbilanz der soziologischen Berufsforschung. pp. 372-384 in: *Gert Schmidt, Hans-Joachim Braczyk* and *Jost von dem Knesebeck* (Ed.): Materialien zur Industriesoziologie. Kölner Zeitschrift für Soziologie und Sozialpsychologie. Sonderheft 24/1982, Opladen: Westdeutscher Verlag.

DiMaggio, Paul J. and *Walther W. Powell*, 1991: Introduction. pp. 1-38 in: *Walther W. Powell* and *Paul J. DiMaggio* (eds.): The New Institutionalism in Organizational Analysis. Chicago/London: University of Chicago Press.

Freidson, Eliot, 1986: Professional Powers. A Study of the Institutionalization of Formal Knowledge. Chicago/London: University of Chicago Press.

Gibbons, Michael, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and *Martin Trow*, 1994: The new production of knowledge. The dynamics of science and research in contemporary societies. London/Thousand Oaks/New Dehli: Sage.

Gispen, Kees, 1990: New Profession, Old Order: Engineers and German Society, 1815-1914. Cambridge: Cambridge University Press.

Grelon, André, 1986: L'évolution de la profession d'ingénieur en France dans les années 1930. pp. 7-32 in: *André Grelon* (ed.): Les ingénieurs de la crise. Titre et profession entre les deux guerres. Paris: EHESS.

Grelon, André, and *Heiner Stück* (Ed.), 1994: Ingenieure in Frankreich, 1747-1990. Frankfurt a.M.; New York: Campus.

Heidenreich, Martin, 1999: Berufskonstruktion und Professionalisierung. Erträge der soziologischen Forschung. pp. 35-58 in: Hans Jürgen Apel, Klaus-Peter Horn, Peter Lundgreen and Uwe Sandfuchs (eds.): Professionalisierung pädagogischer Berufe im historischen Prozeß. Bad Heilbrunn/Obb.: Julius Klinkhardt.

Hirsch-Kreinsen, Hartmut, 1993: NC-Entwicklung als gesellschaftlicher Prozeß. Amerikanische und deutsche Innovationsmuster der Fertigungstechnik. Frankfurt a.M./New York: Campus.

Hitzler, Ronald, Honer, Anne and *Christoph Mäder* (eds.), 1992: Expertenwissen. Die institutionalisierte Kompetenz zur Konstruktion von Wirklichkeit. Opladen: Westdeutscher Verlag.

Kocka, Jürgen, 1990: ‚Bürgertum' and professions in the nineteenth century: two alternative approaches. pp. 62-74 in: Michael Burrage and Rolf Torstendahl (eds.): Professions in theory and history. Rethinking the Study of the Professions. London u.a.: Sage.

Lanciano, Caroline, Marc Maurice, Hiroatsu Nohara and *Jean-Jacques Silvestre*, 1992: Innovation: acteurs, organisations. Les ingénieurs et la dynamique de l'entreprise - Comparaison France-Japon (résumé de la recherche et synthèse provisoire des résultats). Aix-en-Provence: LEST.

Lundgreen, Peter, 1990: Engineering Education in Europe and the U.S.A., 1750-1930: The Rise to Dominance of School Culture and the Engineering Professions. In: Annals of Science No. 47/1990, pp. 33-75.

Lundgreen, Peter, 1994: Die Ausbildung von Ingenieuren an Fachschulen und Hochschulen in Deutschland, 1770-1990. pp. 13-78 in: *Peter Lundgreen* and *André Grelon* (eds.): Ingenieure in Deutschland 1770-1990. Frankfurt a.M.; New York.

Lundgreen, Peter, and *André Grelon* (eds.), 1994: Ingenieure in Deutschland, 1770-1990. Frankfurt a.M.; New York.

Lundvall, Bengt-Ake (ed.), 1992: National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter.

Maurice, Marc, 1995: The Social Foundations of Technical Innovation: Engineers in the Divison of Labour in France and Japan. pp. 317-347 in: Wolfgang Littek and Tony Charles (eds.): The New Division of Labour. Emerging Forms of Work Organisation in International Perspective. Berlin/New York: De Gruyter.

Maurice, Marc, Hiroshi Mannari, Yukiharu Takeoka and *Takenori Inoki*, 1988: Des entreprises françaises et japanaises face à la mecatronique. Aix-en-Provence: Lest.

McCormick, Kevin, 1988: Vocationalism and the Japanese Educational System, Comparative Education 24, No. 1: 37-51.

Okamura, Sogo, 1993: Engineering Education in Japan, International Journal for Engineering Education 9: 6-15.

Schumacher, Dieter, and *Florian Straßberger*, 1997: Wissensintensivierung der Wirtschaft: Wie gut ist Deutschland darauf vorbereitet? DIW-Wochenbericht No. 22/1997.

Shinn, Terry, 1978: Des corps de l'Etat au secteur industriel: genèse de la profession d'ingénieur, 1750-1920. In: Revue française de sociologie 19: 39-71.

Sorge, Arndt, 1996: Societal effects in cross-national organization studies. pp. 67-86 in Richard Whitley and Peer Hull Kristensen (eds.): The Changing European Firm. London/New York: Routledge.

Soskice, David, 1999: Divergent Production Regimes: Coordinated and Uncoordinated Market Economies in the 1980s and 1990s. pp. 101-134 in: Herbert Kitschelt, Peter Lange, Gary Marks and John D. Stephens (eds.): Continuity and Change in Contemporary Capitalism. Cambridge: Cambridge University Press.

Widmaier, Ulrich (ed.), 2000: Der deutsche Maschinenbau in den neunziger Jahren. Analysen zu Kontinuität und Wandel einer Branche. Frankfurt a. M.; New York: Campus.