Shortage of skilled workers in the manufacturing sector in Germany: results from the sector analysis

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Zusammenfassung:

Unternehmen klagen zunehmend über einen erheblichen Fachkräftemangel. Insbesondere in Bezug auf den Ingenieurs- oder Technikerbereich ist die Berichtlage eindeutig alarmierend. Doch wie sieht der Bedarf auf der Facharbeitsebene im produzierenden Sektor (Metall- und Elektroindustrie) in Deutschland aus? Werden auch hier schon explizit Fachkräfte gesucht?
Das Projekt »Shortage of Skilled Workers« greift diese Defizite auf und zielt darauf ab, gemeinsam mit Betrieben Konzepte zur Vermeidung des Fachkräftemangels zu entwickeln. Um geeignete Personalentwicklungsmaßnahmen und Qualifizierungsprozesse gestalten zu können, ist es notwendig, die Arbeitswelt im Sektor inhaltlich zu erschließen. Dazu wurde im ersten Schritt der Fachkräftemangel auf der shop-floor Ebene innerhalb des produzierenden Sektors mittels des berufswissenschaftlichen Instrumentes der Sektoranalyse analysiert. Im vorliegenden Bericht werden die Ergebnisse der Sektoranalyse für Deutschland beschrieben.

Abstract:

Enterprises are increasingly complaining about a considerable shortage of skilled workers. In particular with regard to the need of occupational group of engineers and technicians the reports are exceedingly alarming. However, what is the need for the level of skilled work in the production sector (metal and electrical industry) in Germany? Do these sectors already look explicitly for skilled personnel?
The project »Shortage of Skilled Workers« deals with these deficits and aims at developing concepts for the avoidance of a shortage of skilled workers in cooperation with the enterprise. In order to design adequate personnel development measures and qualification processes it is necessary to access the world of work in the sector in terms of contents. In a first step the shortage of skilled workers on the shop-floor level within the production sector was therefore analysed with the occupational scientific instrument of the sector analysis. In the present report the results of the sector analysis will be described for Germany.

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1 Initial situation

Enterprises are increasingly complaining about a considerable shortage of skilled workers. Above all with regard to the need for engineers or the occupational group of technicians the reports are clearly alarming. However, what is the need for the level of skilled work in the production sector (metal and electrical industry)? Do these sectors already explicitly look for skilled personnel? Some experts already state a considerable shortage on the shop-floor level in some German regions and say that this is only be beginning of a still more dramatic development. Above all the smaller and medium sized companies (SME) are concerned. It is often difficult for SME to lure skilled workers into their companies, to continuously further develop the qualifications of their employees and to identify the current and future needs as there are neither adequate instruments nor corporate resources available.

The project »Shortage of Skilled Workers« deals with these deficits and aims at developing concepts for the avoidance of a shortage of skilled workers in cooperation with the enterprise. Partners from six European countries are cooperating in this Leonardo Project[1]. The project's concern is the development of personnel economic instruments in enterprises for the level of well qualified skilled workers in order to prevent and/or remedy the shortage of skilled workers. Apart from personnel development concepts as well as career and qualification plans, the in-firm transfer of experience know-how transfer, the initial and the further training in the company as well as internal and external personnel recruitment strategies are the most important starting points. The instruments which will be developed within the framework of the project will facilitate to timely identify deficiencies and potential needs of skilled workers in the companies and to take target oriented action.

In order to design adequate personnel development measures and qualification processes it is necessary to access the world of work in the sector in terms of contents. In a first project step the shortage of skilled workers on the shop-floor level within the production sector is therefore analysed with the aim to exactly identify whether the existing qualificational profiles of the employees are sufficient for their work, where the congruence between the situation of skilled workers and corporate requirements reveals gaps or how such gaps are likely to emerge in the future. On the other hand it is to be assessed which measures and initiatives in order to prevent or reduce a shortage of skilled work have already been successfully implemented in companies.

In order to meet these analysis objectives, an occupational scientific research design with the following mix of methods is applied:

- Sector analysis (Identification of sector structures, employment and technological structures, situation of/ shortage of skilled workers, economic developments, qualification models, initiatives against the shortage of skilled work in the sector)
- Case studies in enterprises of the metal and electrical industry (survey of corporate work places, work processes, forms of work and company organisations; analysis of corporate structures and entire processes, innovation and change processes, recruitment strategies, identification of a need for qualification, situa-

[1] The project is supported with funds of the European commission and own resources of all partners participating in the project.

tion of skilled workers, measures to prevent/ to reduce the shortage of skilled workers).

The present report will describe the results of the sector analysis for Germany.

2 Methodology of the sector analysis

The sector analysis is an occupational scientific instrument for the exact access to a sector (cf. Rauner/Spöttl/Olesen/Clematide 1993; Blings/Spöttl/Windelband 2002; Windelband/Spöttl 2004, Spöttl 2005, Windelband 2006). Sector analyses are above all necessary to secure the information available on the organisational structure, the economic importance, employment, the delimitation of a sector, the structure of skilled work, the situation of the occupations and/or the domains. In addition, information has to be gathered in terms of training occupations (genesis, training figures, training development, training environments etc.), the special situation of skilled workers and the relevant actors (experts, researchers, associations, trade unions). Furthermore data on interesting research objects (»best practice« company, innovations) are necessary in order to systematically prepare deeper investigations and to safeguard the representative character of samples for the application of qualitative research methods (cf. Becker/Spöttl 2006, p. 10).

Sector analyses first and foremost call for an accurate definition and delimitation of the sector. Prior to the exact analysis of the work tasks of the employees as well as of the specific situation in the companies, the sector must be delimited with the aid of criteria allowing for the determination of marked fields of action. With the aid of the criteria, similar structures in terms of production and service are identified. Data, statistics and studies covering – in a national and an international aspect – the same (specialist) field are analysed if they are suitable to assess sector specific developments. However, products, customers, know-how, service installations and the structure of work tasks must not differ considerably (cf. Becker/Spöttl 2004).

Within this project focus is laid on the »metal and electrical« sector. Consequently the relevant survey sector is defined as follows:

> In the project, the sector of the production trade encompasses the metal and electrical sector including the manufacturing of products, the marketing and delivery as well as the putting into operation of components or plants at the customer's.

The following survey criteria for the characterisation of the sector form the basis of the analysis (cf. Windelband 2006, p. 113):

- Structure and characteristics (sub-sectors, employment figures, type of companies),
- Vacancies, unemployment figures in the sector according to regions and the field of sub-sectors,
- Economic development (trade, profits and losses etc.),
- Situation of skilled workers in the sector,
- Regional development of the sector;
- Industrial and economic facts as well as relationships between enterprises and business areas (cooperations etc.),
- Network structures,
- Business fields (niche products, special services etc.),

- Personnel development and recruitment,
- Qualification strategies, concepts for initial and further training (qualification models),
- Change of tasks of the employees in the sector,
- Role of the Social Partners and associations in the sector,
- Innovations (new technologies, laws, Internet etc.) and future development (new business fields).

An analysis along these survey criteria allows

1. the preparation of a detailed sector overview,
2. the presentation of the sector's position in the economy and its importance for the labour market
3. a survey on the situation of skilled workers and the shortage of skilled work respectively,
4. the identification of the reasons for and the impact of the shortage of skilled workers.

Interviews with key persons and the Social Partners as well as the evaluation of statistics (employment and training figures, vacancies, situation of skilled workers) as well as scientific publications on the shortage of skilled workers allow the identification of crucial developments and the formulation of advanced research questions for the further research process.

The access to the sector sketched here allows the selection of companies, business and work processes as well as cases which may be further studied with the aid of case studies in order to identify approaches and measures for the reduction of the shortage of skilled workers and specific qualification deficits on the shop-floor level.

3 Denomination of the sector and its characteristics

The metal and electrical industry (M+E industry) can be named a key industry in Germany. With more than 22,000 companies and almost 3.5 million persons engaged the turnover figures are about € 805 billion (2005). Goods worth € 444 billon are exported to other countries. The industry concentrates in the production of investment goods (80 %). Only 20 % of the production are consumer goods (cars, household appliances etc.).

Compared to other countries, the German metal and electrical industry and its production value ranks third behind the USA and Japan. In no other big industrial country – with the exception of South Korea – the metal and electrical industry has a similar economic importance with regard to the value-added and the employment.
The metal and electrical industry is influenced by the middle-class. The better part of the companies (70 %) employs less than 100 persons. Around a third (28 %) has between 100 and 1,000 employees on their payrolls, only 2 % of the companies have more than 1,000 persons engaged. The sector is represented in the DAX-100 by 22 shareholder companies including the biggest enterprises with employment figures in the six-digit numbers. Almost half of the work places, however, can be assigned to companies with less than 500 employees.

As per May 2007, around 8.9 % of the total of 39,400,000 persons employed in Germany are working in the metal and electrical industry (Statistisches Bundesamt[2] 2007).

The following table summarizes the most important key data of the metal and electrical industry:

Companies	around 22,000
Employees	3,408 million
Total of wages and salaries	143.9 billion Euro
Turnover	876.6 billon Euro
Exports	552.9 billion Euro
Size of companies: Companies with up to 99 employees up to 1000 employees over 1000 employees	 69.6 % 28.3 % 2.1 % of all M+E-companies

Table 1: Key data of the metal and electrical industry in an overview (Source: Gesamtmetall, 2007).

Table 2 gives an overview of the number of companies and employees in the metal and electrical industry in the individual Federal States:

Federal States	**Companies[1]**	**Persons engaged[1]**
Schleswig-Holstein	551	60,809
Hamburg	235	59,930
Bremen	173	35,393
Lower Saxony	1,507	278,186
North Rhine-Westphalia	5,281	663,827
Hesse	1,358	223,345
Rhineland-Palatinate	888	115,806
Saarland	262	56,178
Bavaria	3,155	713,217
Baden-Wuerttemberg	4,764	841,907
Berlin	418	54,549
Mecklenburg-Western Pomerania	310	23,320
Brandenburg	445	36,018
Saxony-Anhalt	625	45,911
Saxony	1,447	135,134
Thuringia	909	79,729
Total[2]	**22,278**	**3,408.451**

[1] Average p.a.

[2] The differences between the added sums and the stated total figures result from reasons for confidentiality and/or regionally different sector delimitations. (Source: Fachserie 4, Reihe 4.1.1/4.1.4; Beschäftigung, Umsatz und Energieversorgung der Unternehmen und Betriebe im Bergbau und im Verarbeitenden Gewerbe, Ed.: Stat. Landesämter, Statistisches Bundesamt

Table 2: Companies and persons engaged in the metal and electrical industry in the Federal States (Source: Gesamtmetall 2007)

The distribution of the companies and the persons engaged to the individual Federal States reveal big differences. Thus around 65 % of all persons employed work in the

[2] Statistisches Bundesamt = Federal Statistical Office

Federal States of Baden-Wuerttemberg (25 %), Bavaria (20.9 %) and North Rhine-Westphalia (19.5 %). The new Federal States only contribute 9.4 % to the total employment figures. Only the metal and electrical sector of the Federal State of Saxony with its approximately 135,134 persons engaged has a major importance for the labour market.

4 Sector structure

The metal and electrical industry encompasses a number of individual sectors, among others:

- Machine building,
- Automotive industry,
- Electrical technology,
- Metal processing,
- Fine mechanics, optics, watches,
- Aviation and space technology,
- Foundries,
- Non-ferrous metal production, semi-finished products,
- Information and telecommunication industry,
- Rail vehicle construction, other vehicle construction,
- Shipbuilding,
- Drawing shops, cold roll plants.

The five biggest branches are machine building, the automotive industry, the electrical technology, the metal working and fine mechanical, optics, watches branches. They encompass 90.8 % of all employees and 93.2 % of all companies in the sector (cf. Table 2).

Sector	Companies	Employees
Machine building	6,000	914,000
Automotive industry	1,300	780,000
Electrical industry	3,300	602,000
Metal working	6,800	571,000
Fine mechanics, optical, watches	2,200	230,000
Aviation and space technology	108	76,000
Foundries	415	70,600
Non-ferrous metal production, semi-finished products	239	59,000
Information and telecommunication industry	193	26,000
Rail vehicle construction, other vehicle construction	200	42,000
Shipbuilding	122	23,000
Drawing shops, cold roll plants	151	16,000

Table 3: Branches of the metal and electrical industry with number of companies and employment figures (Source: Gesamtmetall 2007; Statistisches Bundesamt 2007).

4.1 Employment figures

During the last decade, the sector was only marginally affected by a staff reduction compared to other German industrial sectors.

	2007	2006	2005	2004	2002* with A.D.	2002 without A.D.	2000	1998
I[st] Quarter	3,438,327	3,388,028	3,415,788	3,442,305	3,563,290	3,523,488	3,473,179	3,444,543
2[nd] Quarter	3,457,373	3,391,082	3,403,682	3,437,102	3,541,537	3,499,399	3.487,150	3,466,312
3[rd] Quarter		3,425,939	3,416,793	3,454,749	3,553,964	3,507,815	3,538,902	3,517,912
4[th] Quarter		3,428,757	3,410,352	3,446,211	3,525,898	3,480,373	3,547,830	3,504,536
Year		3,408,451	3,411,654	3,455,092	3,546,172	3,502,769	3,511,765	3,483,326
Year with HwZ		3,408,451	3,411,654	3,455,092	3,546,172	3,502,769	3,511,765	3,483,326

HwZ = Handwerkszählung (trade census)
A.D. = Administrative data (update of the companies' register), 2002* = with extended reporting area

Table 2: Development of the employment figures in the metal and electrical industry (Gesamtmetall 2007)

Table 4 shows the development of the employment figures for the entire metal and electrical industry in Germany. The overview underlines that the employment figures have been comparatively stable during the last decade and without major fluctuations. It is remarkable that the German M+E industry is the only industry in the industrial countries with a growing number of persons engaged since the 1990ies – approximately 120,000 workplaces from 1999 to 2001. This development is contrary to the forecasts of the *Institut der deutschen Wirtschaft Köln* (Institute of the German Economy Cologne). After surveys into employment potentials in the metal and electrical industry conducted in the year 1999, the institute had stated that the reduction of employment in the core area of the M+E industry which started in the early 1990ies would continue in the medium-term (Gesamtmetall 2004, p. 5).

The pace of the increase in personnel has remained unchanged up to the beginning of 2007. Within 10 months, from a low in April 2006 to February 2007, the number of persons employed in the M+E industry increased by 54,000 to the now highest level since the beginning of 2004. The rate of change compared to the precedent year climbed to + 1.5 per cent. The companies also realize their higher need for work with the aid of time accounts, extra work and temporary employment (Gesamtmetall 2007).

A comparison of the Federal States (for the period of time between September 2005 and September 2006) shows an increase of the employment figures in the metal and electrical industry above all in the new Federal States. Figure 2 reveals that the Eastern states showed a clear plus in September 2006 whereas the majority of the Western German Federal States fell behind the figures of the year 2005 in spite of the recent upswing. As for the year 2007, the economic growth in the East is still slightly bigger (+ 3 per cent) than in the West (+ 2.7 per cent), a fact that diminishes the East-West divide. »Due to a modernized production technology and free capacities, Eastern Germany is stronger than ever participating in the upswing« (Bach, H.-U. et al. 2007, p. 6). Thus the gainful employment in the East is clearly increasing by 2.0 per cent whereas the West only registered an increase of 1.5 per cent.

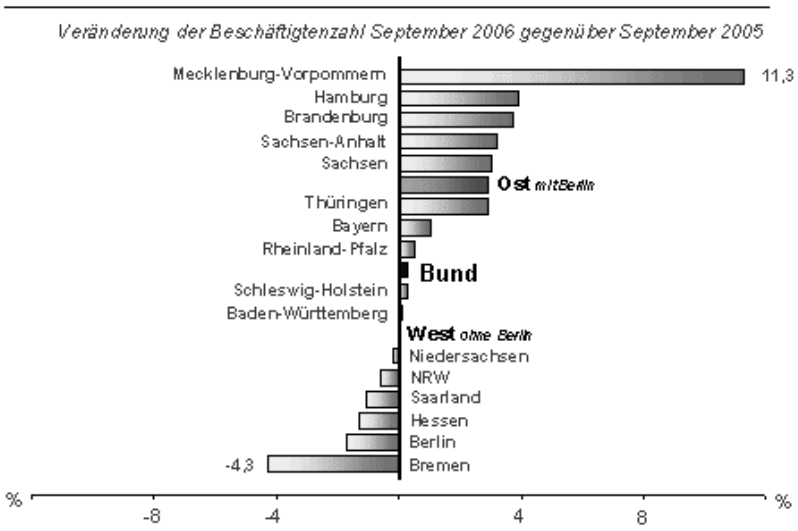

Figure 1: Change of the employment figures between September 2005 and September 2006 in the different Federal States (Source: Gesamtmetall, 2007)[3].

4.2 Employment structure

The qualification structure of the employees in the M+E industry has strongly changed during the past two and a half decades. There is a clear correlation between the qualification level and the employability: The higher the qualification the better the development (cf. Figure 3).

While the number of the highly qualified employees – with the exception of cyclical fluctuations – has continuously increased by nearly a third, the number of unskilled workers has decreased by more than a half. Almost 40 per cent of the jobs for unskilled employees and semi-skilled workers ceased to exist. On the other hand the middle qualification levels (employees working autonomously, skilled workers) stood their ground comparatively well.

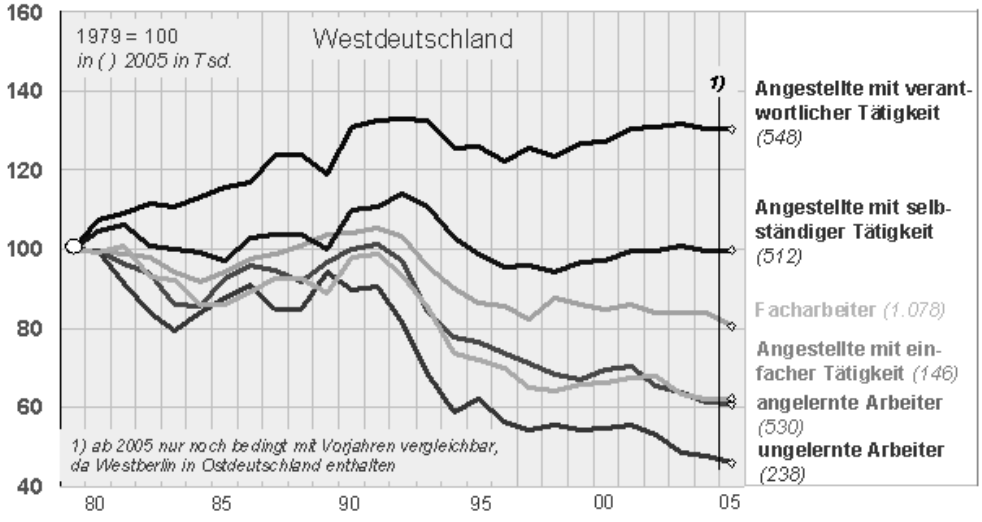

Figure 2: Persons engaged in the M+E industry according to their qualification (Development since 1980 (Source: Gesamtmetall 2007)

[3] Glossary: Ost mit Berlin = East with Berlin; West ohne Berlin = West without Berlin; Bund = Federation

Overall the metal and electrical industry reveals a trend towards higher qualifications: With regard to the occupational qualifications, the following development can be described: The share of unskilled employees dropped from 21.4 per cent in the year 1995 to 18.3 per cent in 2002. The share of employees with an occupational training has slightly decreased in the same period of time (1995: 66.1 per cent; 2002: 65.1 per cent). On the other hand the share of employees with university graduation has increased between 1995 and 2002 from 7.6 per cent to 9.4 per cent (Source: IW Consult, quoted according to Gesamtmetall 2004, p. 11).

In the year 2002, the M+E industry employed 13 per cent more engineers than in 1995 as well as 30 per cent more technicians and master craftsmen. With regard to these development trends Gesamtmetall (2004, p. 11) summarizes: »The increase in employment in the occupational field of technology and natural sciences of 5 per cent can clearly be accounted to academics (+ 16.2 per cent) along with a decrease in employment of persons with occupational initial and further training (- 4.1 per cent).«

This general development trend has currently the clearest impact on the electrical industry: A massive personnel cutback in the field of unskilled workers (- 26.1 per cent) and a current cutback of jobs for trained personnel (- 5.4 per cent) was opposed by a clear increase in employment for the group of highly qualified personnel (+ 22.1 per cent). Above all with regard to another integration of product accompanying services the sector is likely to mirror the development of the structures in other areas.

On behalf of Gesamtmetall (2004), the working group »Future of the Metal and Electrical Industry« has also included trends with regard to the qualification structure in their forecasts for the year 2015. Thus the trend to higher qualifications will continue until the year 2015. The need for semi-skilled and unskilled workers will further decrease, the need for academics, on the other hand, will clearly increase (ibid, p. 12).

The situation on the labour market for metal and electrical occupations (in industry and handicraft) has clearly improved during the last 12 months. In April 2007, there were 261,000, unemployed persons in the industrial metal and electrical occupations i.e. 157,000 (- 37.5 per cent) less than the year before.

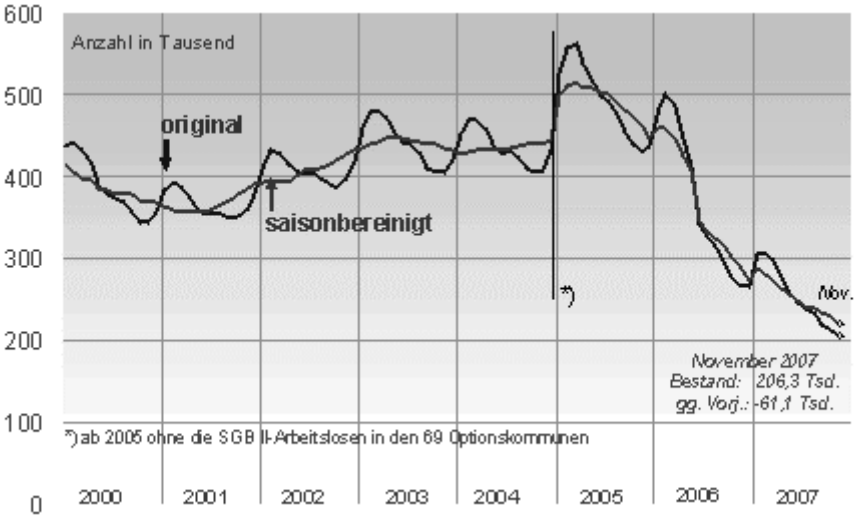

Figure 3: Development of the unemployment figures in the industrial metal and electrical occupations (Source: Gesamtmetall 2007)

The favourable trend on the labour market is also expressed by the job situation in the metal and electrical industry: There was a clear increase of vacancies in the metal and electrical industry reported to the labour agencies – 108,900. This development corresponds to a plus of 57.4 per cent within a year.

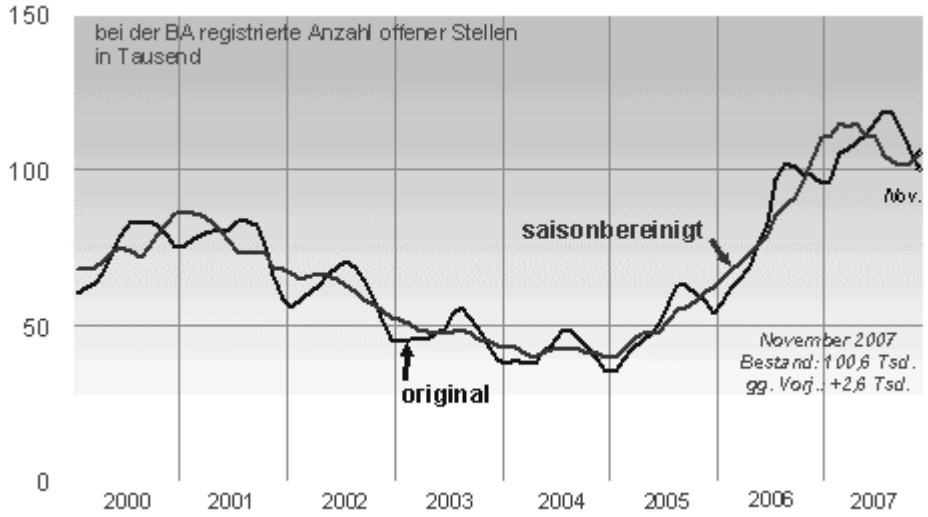

Figure 2: Development of the number of vacancies of industrial jobs in the metal and electrical industry (Source: Gesamtmetall 2007)[4].

According to Gesamtmetall (2007), the increase in personnel in the M+E industry is currently undiminished. Seasonally adjusted there were another 24,000 new employment contracts signed in the first four months of the year 2007. Since the low of April 2006, the number of persons employed increased by 60,000. The Eastern German M+E industry has a higher-than-average share with a third of the new jobs. The rate of change compared to the precedent year climbed to + 1.8 (West + 1.3 per cent; East + 5.6 per cent). Only vehicle construction, rail vehicle construction and aviation score a minus. Engineers and other skilled personnel are getting scarcer and scarcer. Already 10 per cent of the M+E companies are hampered in their production due to the shortage of skilled workers (cf. Gesamtmetall 2007).

With regard to the future development of the metal and electrical industry, an increase of flexible employment is expected. Due to the rebirth of labour division structures and the higher share of employed women, Gesamtmetall (2004, p. 7) expects an increase of the number of flexible employment contracts. This development would be applicable for all qualification groups.

4.3 The situation of skilled workers

The shortage of skilled workers is so far still considered little relevant at a national economic level. IG Metall (Trade Union for the metal sector in Germany), for example, considers the shortage a »phantom« with regard to the debate on the shortage of staff from a national economic point of view (IG Metall 2007a, p. 7). Nevertheless it admits that this is no statement regarding the concrete situation in the individual companies

[4] Glossary: bei der BA registrierte Anzahl offener Stellen in Tausend = vacancies in thousands registered at the Federal Labour Agency; original = original; saisonbereinigt = seasonally adjusted; Bestand = actual figure; gg. Vorjahr = compared to precedent year.

and in the different regions. The situation is indeed different for individual economic branches, occupational groups and regions. There are currently more unemployed persons compared to vacancies in all occupational groups. Regionally seen, however, this ratio is no longer valid. Bottlenecks can above all be stated in the group of chip removal mechanics. Above all the North of Germany but also the Federal States of Hesse, Baden-Wuerttemberg, and Bavaria report a shortage of staff (IG Metall, 2007a, p. 8).

Thus the metal and electrical sector selectively already complains about a shortage of skilled workers. According to the Institut für Arbeitsmarkt und Berufsforschung – IAB (Institute for Labour Market and Occupational Research), around one fifth of all vacancies could only be filled with difficulties in the year 2006, above all in the metal, electrical and vehicle industry as shown in the table below:

Branch	**Number of immediately available vacancies in 2006**	**Share of vacancies difficult to fill**
Metal, metal products	20,800	31 %
Machines, electrical/electronical technology; automotive	38,000	30 %
Commercial services (e.g. IT; real estate, consulting)	335,000	23 %
Traffic, telecommunication	50,000	20 %
Banking, insurance companies	10,500	19 %
Hotel and restaurant industry	51,400	17 %
Social services (e.g. churches, associations/societies, disposal companies)	140,000	8 %
Other services companies (e.g. textile cleaners, funeral homes)	74,600	7 %
Public administration	47,000	4 %
Total	**1,033,800**	**19 %**

Table 3: Shares of vacancies that could only be filled with difficulties (Source: Kettner 2007, p. 5)

With regard to the development of the situation of job vacancies the sub-sector metal and metal products on the whole shows a clear increase. The number of job vacancies for the target group of skilled workers has more than doubled in 2006 (16,100) compared to 7,400 vacancies in 2005 (cf. Figure 6).

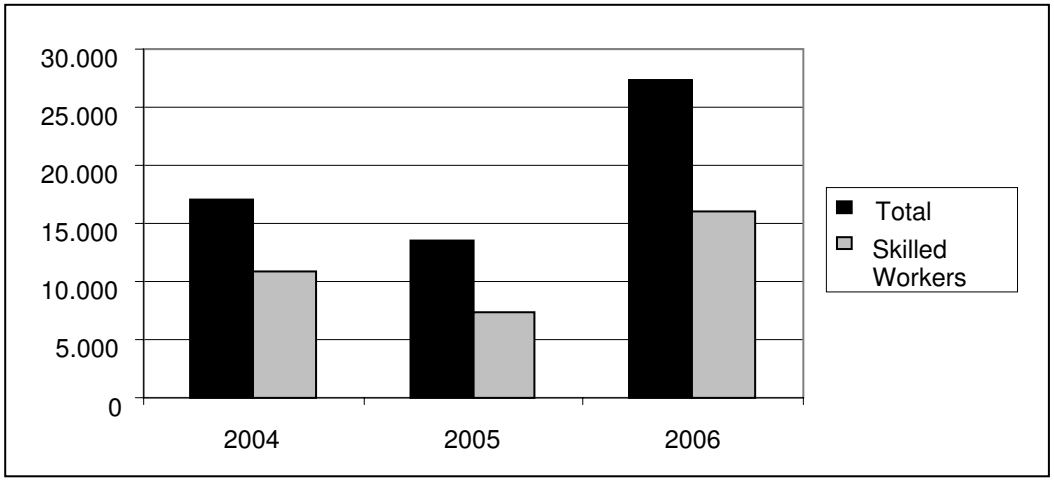

Figure 5: Development of job vacancies in the economic branches metals and metal products (Source: IAB, n.d.)

According to Mrs. Kunstmann, General Manager of the *Arbeitgeberverbandes Gesamtmetall* (Employers' Association for the Metal and Electrical Industry), the upswing of the conjuncture makes the staffing of vacancies in the metal and electrical industry increasingly difficult (cf. Gesamtmetall 2007b). Thus vacancies in the automotive industry meanwhile stay unstaffed for 19 days – i.e. 50 per cent longer than two years ago whereas in the remaining vehicle construction industry the periods of re-staffing of vacancies have almost doubled compared to 2005. With regard to the machine building sector, an average of 45 days were necessary in 2005 to find new employees. In the meantime the re-staffing of vacancies takes 72 days, as Mrs. Kunstmann put it. The number of vacancies in the sector has swiftly increased during the past twelve months. The electricians with 24,600 vacancies (compared to 15,400 in 2006) are on top of the pile. Mrs. Kunstmann urgently demands to clearly improve the quality of school education. At the moment 20 per cent of an age-group fail to enter an apprenticeship or to start their occupational career. At the same time Mrs. Kunstmann demands that the curricula should be more oriented to natural sciences. The current share of just 19 per cent of all students in the engineering sciences is insufficient (cf. Gesamtmetall 2007b).

Obstructions of the production due to a shortage of staff have also dramatically increased in recent times. In March 2007, this was the case in 10 per cent of the sector's companies (Gesamtmetall 2007a). In some areas clearly more companies are affected by this phenomenon. There is above all a shortage of engineers, technicians and well-trained skilled workers (Gesamtmetall 2007a).

In four out of five case studies conducted in Germany, a considerable shortage of skilled workers on the shop-floor level could be identified. Above all occupations such as chip removal mechanics, industrial mechanics, toolmakers, mechatronics and electricians were highly in demand. Some of the companies also reported considerable problems to find apprentices for these occupations. Due to this lack of workforce the four surveyed companies have already suffered a considerable loss in production. »We cannot operate two shifts in the company if we lack the personnel« (Quotation of the Production Manager (f.) of a medium-sized machine building company). »Partly the production has to be stopped as the suppliers themselves have a shortage of skilled workers and therefore are sometimes not able to meet the delivery dates of the orders. This is the reason for a lot of delivery problems« (General Manager of a medium-sized enterprise of plant engineering).

Three points were identified in the case studies with regard to the difficulties with the recruitment of new skilled workers and the commitment of funding agencies:

- The salary spiral is continuously rising. SME with – compared to big companies – only limited financial power cannot compete against their competitors with higher salary levels. In addition there is already a trend towards »head hunting« in the sector.
- The attraction of a job offer is being influenced by the company. SME can often not keep up with big enterprises as the latter are better known and have a positive employer image. This makes it easier for them to attract more skilled staff.
- Companies also face problems with respect to their location. If the region is e.g. considered rather provincial and little attractive, skilled staff from other regions is difficult to recruit.

In spite of the stated company related findings a shortage of skilled personnel can so far not adequately been proved at the national economic level. However, more and

more indicators become evident that point at a shortage of skilled workers on regional levels and from the point of view of the enterprises.

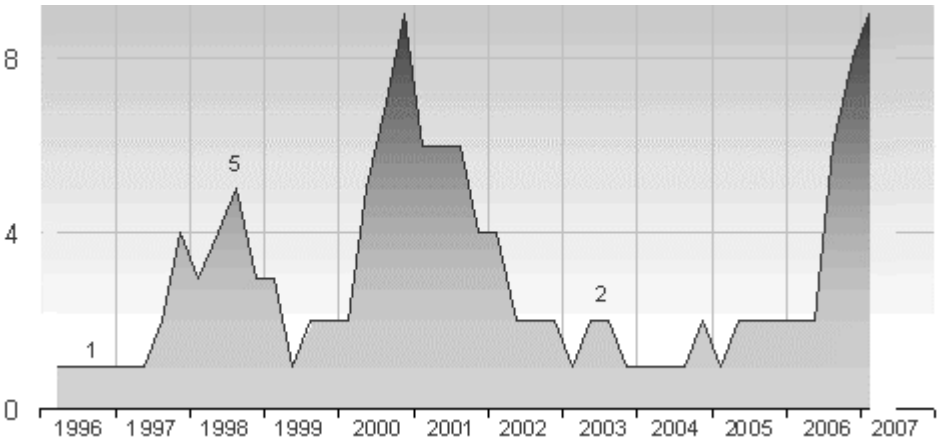

Figure 6: Shortage of staff in the metal and electrical industry - share in per cent of the M+E companies with obstacles in production due to a shortage of staff (Gesamtmetall 2007)

The findings on the shortage of skilled workers must also be seen in connection with the topic »education and training«. IG Metall criticises that the better part of the imminent deficit problems are »home-made« by companies and associations as they had not been prepared to take care of the training of qualified junior staff. In the year 1990, 70,000 new apprenticeship contracts had been signed for industrial metal and electrical occupations, compared to just 59,000 in the year 2006. This is a minus of 16 per cent (cf. IG Metall 2007a, p. 13).

With regard to individual training occupations in the sector the following picture can be drawn: The number of training positions for chip removal mechanics has been reduced by 12 per cent in the past three years. Thus only half as much training positions are offered compared to offered vacancies (IG Metall 2007a, p. 13). The number of training positions for toolmakers was also clearly reduced (minus 20 per cent). As for the electronical technicians, the number of vacancies has doubled between the years 2003 and 2006 whereas 17 per cent less persons have been trained in the same period of time (ibid, p. 13).

4.4 Economic development

During the industrial conference of the German Institute for Economic Research in November 2006, a growth in production between 5,5 and 6,5 per cent for the year 2007 was forecasted for the metal and electrical industry (IG Metall, 2006).

The figure below shows the prospect for the growth in production of the individual branches within the sector. The biggest growth is expected for the field of the production of office machinery and data processing equipment (+ 10 per cent). The field of radio, TV and communication engineering ranks second with + 6 per cent. The branches fine mechanics, optics, watches, aviation and space technology as well as the production of equipment for the power generation and distribution were forecasted to increase by 4 per cent each in November 2006.

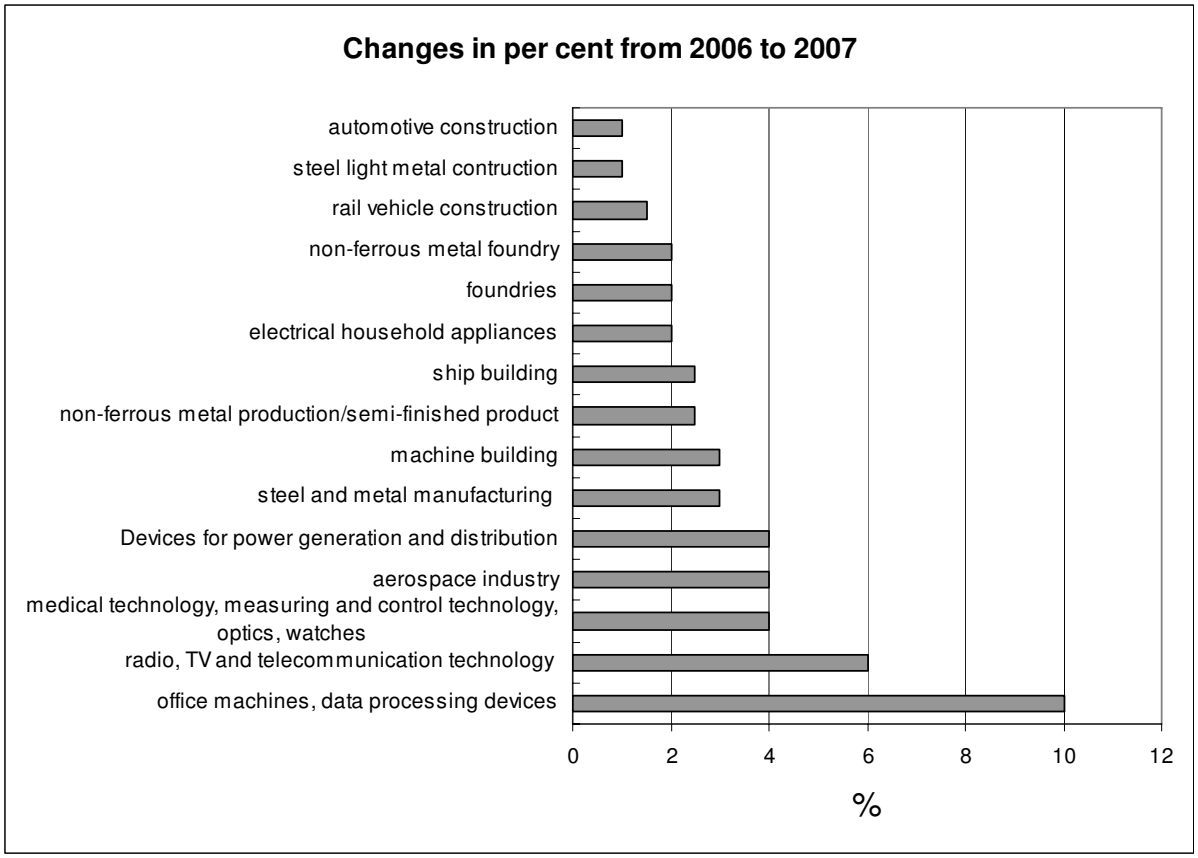

Figure 7: Expected growth in production of the branches in the M+E sector in per cent (Source: Gesamtmetall, 2007)

According to the report »On the economic situation of the M+E industry in the early summer of 2007« (Gesamtmetall, 2007a), the sector is currently witnessing a boom which is higher than expected. With respect to demands, there were 3 per cent more orders booked in the first three months of 2007 compared to the 4th Quarter of 2006. In April and May, another 3 per cent per month added to these figures. The companies were successful on both the domestic and the foreign markets. The domestic business increased by 5 per cent since the beginning of the year, the export market even by 7 per cent. Investment goods with a plus of + 6,7 per cent are on top of the pile whereas intermediate goods and consumer goods revealed a gain of 4,5 and 4 per cent respectively. By comparing the first five months of 2007 with the same period of time of the precedent year, the total figures, the domestic figures and the export figures, the figures for intermediate goods and consumer goods show the same increase rates between 10 and 11 per cent. Consumer-close fields of the M+E industry clearly lag behind with a growth rate of just 2 per cent (cf. Gesamtmetall 2007a).

The production output in the metal and electrical industry is growing along with the order development although the new orders will only be finished in a number of months due to the well-filled order books. The production during the first three months of 2007 beats the level of the fourth quarter of 2006 by 3 per cent. In April and May, the production remained at the attained level which is likely to be just a reprieve on its way up. Compared to the precedent year, a growth in production of 9.5 per cent for the first five months of 2007 has been emerging.

In March, the grade of capacity utilisation of the production facilities was 90.4 per cent and reached a peak since the German reunification (cf. Gesamtmetall 2007a). The M+E business cycle is better than forecasted at the beginning of 2007. Therefore the growth forecasts of economic associations are currently scaled up. M+E production during the first five months was 9.5 per cent more than the year before. Even with a stagnation in the further course of the year, the M+E industry has already reached a yearly plus of 6 per cent. In case production is further increasing – as presumed by Gesamtmetall (2007a) – the growth rates could even reach 7 to 8 per cent. The expenditure of the companies for innovations differs considerably within the M+E sector. Based on the turnover, they are highest in vehicle construction and in medical technology, measurement and control technology and lowest for manufacturers of metal products. In 2004, the field of vehicle construction had considerably increased their expenditure for innovations as shown in the figure below.

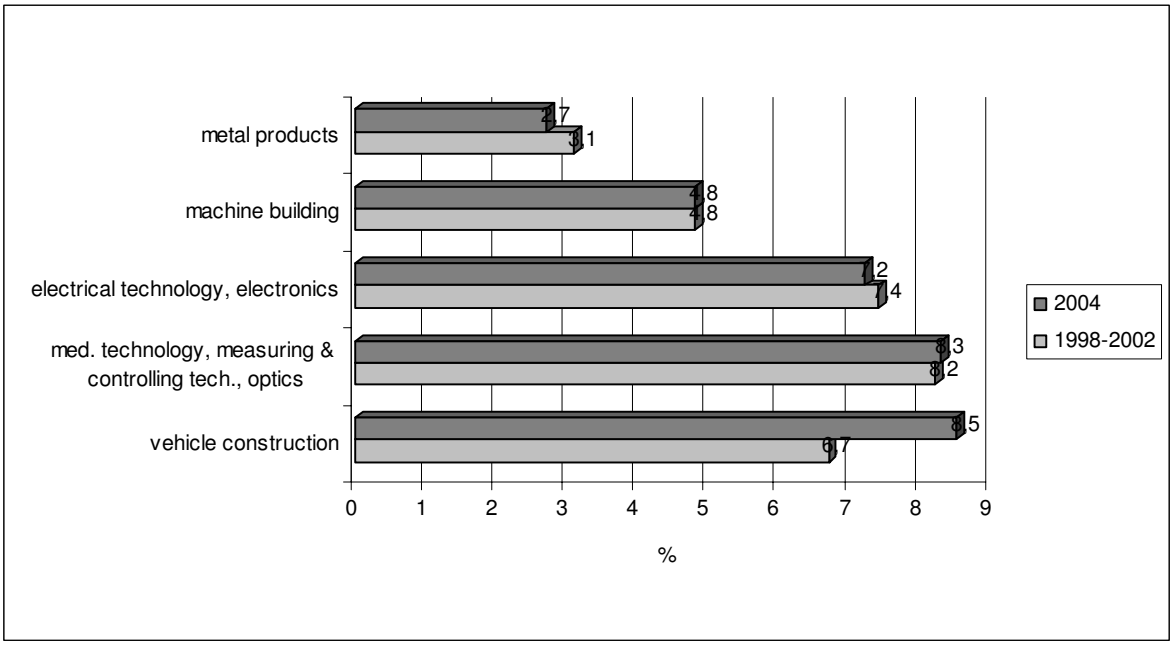

Figure 8: Expenditure for innovation in the metal and electrical industry in per cent of the turn over (Source: ZEW, Mannheimer Innovationspanel, 2005)

4.5 Company organisation

Total-Quality-Management, Lean-Management, the Fractal Enterprise and the Business Re-engineering count among the marketing structures which also have characterized the production structures in the metal and electrical sector in the past 10 years (cf. Hahn, Buske, Mayer & Willms, 1999).

Total Quality Management (TQM) according to DIN ISO 8402 is »a leadership method which relies on the participation of all members of an organisation putting quality and customer satisfaction in the centre and aiming at a long-term business success and at benefits for the members of the organisation as well as for society« (Scheib 2005). The consequent involvement of all employees into the quality management process is an important characteristic. This principle is valid across all hierarchies, down to the shop-floor level. This underpins the fact that this management concept entails new requirements also for the level of skilled work. An active cooperation of the em-

ployees becomes a maxim and is especially in demand within the framework of the continuous quality improvement processes. The core elements of a continuous quality improvement process have their own impact on the requirements for skilled workers: The required process orientation calls for communication and cooperation across all functions. This includes the shifting of the responsibility for a work process to the respective employees or working groups (cf. Heuser, 2002). The transfer of process responsibility requires that the employees are prepared to take over responsibilities and to carry out the work process in an extensively autonomous way. Thus the field of tasks of skilled workers is extended from the mere execution of tasks towards planning, control and evaluation tasks (cf. Scheib 2005, p.92). Moreover this development calls for the development of overview knowledge and knowledge of the complete work process and the process links (work process knowledge).

Lean Management (lean or saving management) aims at identifying superfluous costs and time-consuming procedures and behavioural patters, to remedy these costs and to avoid future costs. Lean Management is oriented to the following targets (cf. Stadelmann, Lux 1995 p. 74):

- Customer oriented lean production with continuous material flow and Just-in-Time-Deliveries, (→ slimming down of distribution),
- Improvement of quality across the enterprise,
- Acceleration of the development and introduction of new products, above all by Simultaneous Engineering,
- Proactive Marketing: Win new customers and keep regular customers,
- Ability to grow and to conquer new business fields by a strategic use of capital as well as
- Harmonic blend of the company into the society.

»Lean Management requires a way of thinking across the entire enterprise putting value-added and customer orientation in the centre of interest. Partly autonomous groups with a high motivation are the backbone of this management philosophy which has its origins in Japan and relies on a flat hierarchy. With Lean Management and Lean Production respectively, all reductions of costs are the product of a modern form of work« (Füser 2001, p. 74).

The fractal enterprise is a company philosophy which embraces a holistic solution. Not only partial fields are analysed but the entire enterprise with all its correlations and connections. The fractal enterprise is an open system consisting of autonomously acting units with similar targets – the fractals. Apart from the holistic approach, three characteristics are of special importance:

- Self-organisation,
- Self-similarity and
- Dynamics.

The approaches of the three above mentioned concepts rely on the employee as their essential potential. The transfer of the described management structures is often not stringent. As for the enterprises in the metal and electrical industry, team-, project- and process-oriented forms of work are becoming more and more important within the different company philosophies. The interface management as well as the cost, time and quality management are becoming more important as well. In the future (reference pe-

riod of time up to 2015) it is expected that the current rather holistic structures will be abandoned in favour of structures based on the division of work (cf. Gesamtmetall 2007).

4.6 The role of the Social Partners and the associations

Gesamtmetall as an umbrella association of regional employers' associations in the metal sector represents the interests of the employers of the metal and electrical sector in Germany. The existing collective agreement associations have partly emerged from autonomous associations of the M+E industry. This is why there are 21 pay scale areas in Germany today. A number of important issues such as wages and salaries are shaped differently in these areas. Figure 10 shows the individual pay scale areas with their respective associations.

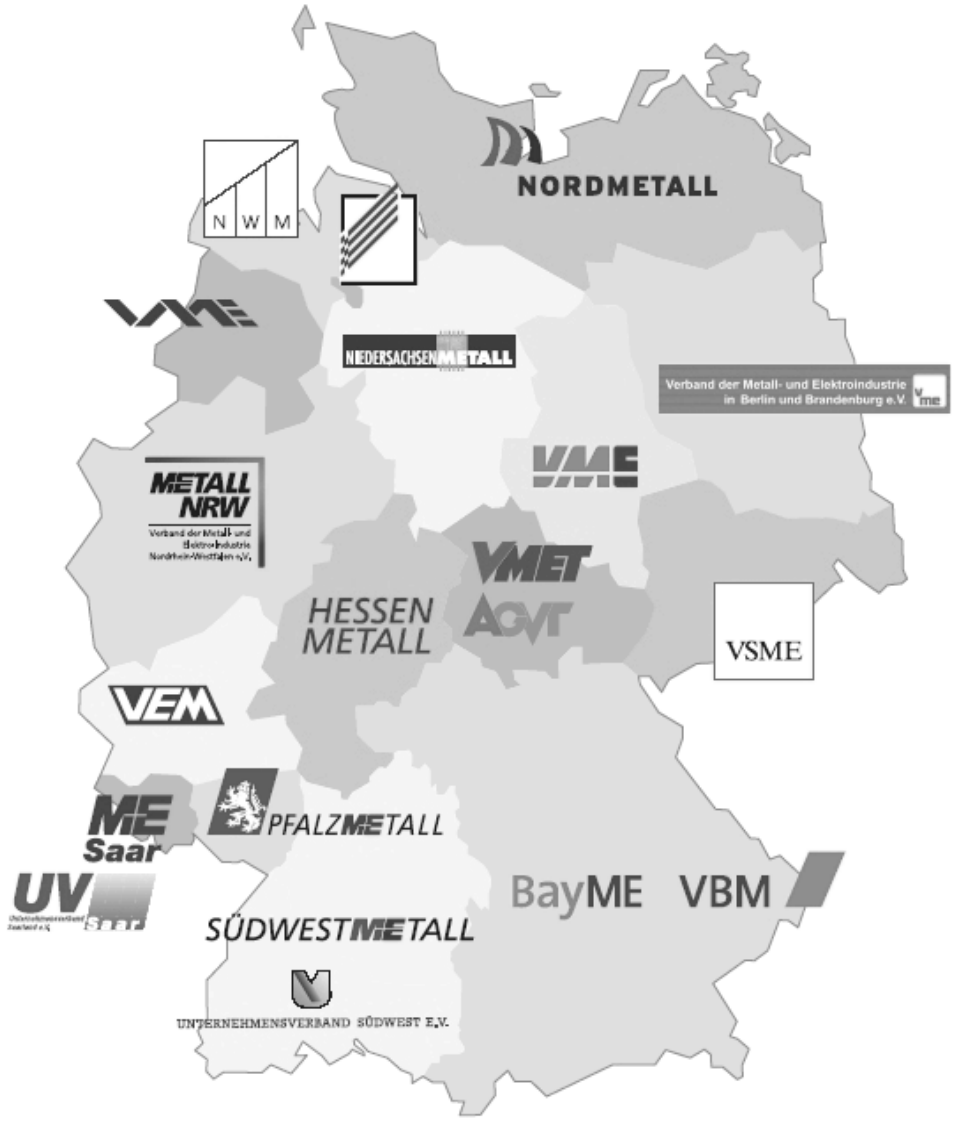

Figure 9: Pay scale areas and their associations in Germany (Source: Gesamtmetall 2007)

The majority of enterprises of the metal and electrical industry are organised in a regional employers' association. The following overview shows the number of companies that are members of Gesamtmetall associations, along with their employees.

Association / Pay Scale Area	**Companies**	**Employees**
Collective agreement associations		
Nordmetall[1]	198	71.501
Metall Unterweser[2]	44	25.275
Nord-West-Metall	36	13.060
Niedersachsenmetall	208	65.240
VME Osnabrück	39	17.664
Metall NRW	1.615	371.672
Hessen Metall	302	115.074
VEM Rheinland-Rheinhessen	97	30.459
Pfalzmetall	68	38.551
ME Saar	75	38.733
Südwestmetall[3]	848	478.576
VBM Bayern	358	416.599
VME Berlin und Brandenburg[4]	173	59.467
VME Sachsen-Anhalt	38	5.100
VSME Sachsen	65	17.924
VMET Thüringen	50	14.250
Total	**4.214**	**1.779.145**
Associations without commitment to pay scales		
Metall NRW	572	44.558
Hessen Metall	191	19.514
UV Saar	37	5.048
Unternehmensverband Südwest	318	47.960
BayME	774	106.396
Allg. Arbeitgeberverband Thüringen	7	494
Total	**1.899**	**223.970**

[1] Nordmetall: Schleswig-Holstein / Hamburg / Mecklenburg-Vorpommern
[2] Metall Unterweser: Bremen
[3] Südwestmetall: Baden-Württemberg
[4] Berlin: Berlin-West; Berlin-Ost; Brandenburg
Source: Data provided by the associations, status: at the end of each year

Table 6: Number of member companies of the associations of Gesamtmetall and their employees (Source: Gesamtmetall 2007)

IG Metall is the Social Partner on the side of the employees of the M+E industry. Around 2.4 million gainfully employed persons in the metal industry, the metal trade, the textile and clothing industry, the wood and plastics industry as well as in the information and communications industry have joined forces in the IG Metall in order to better put forth and achieve their interests. IG Metall is a democratic organisation with a voluntary membership. The basic unit of the organisation is the administration office. There are more than 170 administration offices catering for more than 10,000 members. IG Metall is organised in 7 districts, each of them with its own administration: District of North Rhine-Westphalia, District of Lower Saxony and Saxony-Anhalt, District Coast, District Frankfurt, District Berlin-Brandenburg-Saxony, District of Bavaria and

District of Baden-Wuerttemberg. IG Metall considers the collective bargaining policy as one of its most important targets, in detail:

- to safeguard and improve wages and salaries,
- to reduce working times and to shape them according to the interests of the employees,
- to create and safeguard workplaces,
- to support qualification (IG-Metall 2007).

In addition to that there is a number of economic associations in the metal and electrical industry:

- Verband Deutscher Maschinen- und Anlagenbau (VDMA)
  (German Engineering Federation)
- Zentralverband Elektrotechnik- und Elektronikindustrie (ZVEI)
  (German Electrical and Electronic Manufacturers' Association)
- Verband der Automobilindustrie (VDA)
  (German Association of the Automotive Industry)
- Deutscher Gießereiverband (DGV)
  (German Foundry Association)
- Bundesverband der Deutschen Luft- und Raumfahrtindustrie (BDLI)
  (German Aerospace Industries Associations)
- Wirtschaftsvereinigung Stahl (German Steel Association)
- Wirtschaftsvereinigung Metalle
  (German Metal Association)
- Verband für Schiffbau und Meerestechnik e.V. (VSM)
  (German Shipbuilding and Ocean Industries Association)
- Wirtschaftsverband Stahl- und Metallverarbeitung (WSM)
  (German Association of Steel and Metal Production).

A special feature in Baden-Wuerttemberg is the establishment of the so-called »Agentur der Förderung der beruflichen Weiterbildung in der Metall- und Elektroindustrie e.V.« (AgenturQ) (Agency for the Support of Vocational Further Training in the Metal and Electrical Industry e.V), a joint institution of the regional employers' association »Südwestmetall« and of IG Metall. The AgenturQ was created in order to consult mainly smaller and medium-sized enterprises and workers' councils of the metal and electrical industry of Baden-Wuerttemberg on the organisation of their in-firm further training. AgenturQ has the following tasks:

- Information on in-firm further training,
- Support with the development of adequate further training measures,
- Mediation in corporate conflicts resulting from in-firm further training (cf. AgenturQ 2007).

The services offered by *AgenturQ* are free of charge for member enterprises of the association of the metal and electrical industry as well as for IG Metall's work councils.

5 Interim Summary

Given its high production and innovation power, the metal and electrical industry can undoubtedly be considered one of the economic pacemakers of the Federal Republic

of Germany whose economic standing is underpinned by the current economic boom. This development is also reflected by the fact that the sector – compared to the recent development in the other economic branches – was more or less spared a decrease in personnel. During the recent years there has even been a clear increase in employment. This positive development leads, however, to a special hazard for the sector in terms of a shortage of skilled workers emerging in Germany. This is true for both the area of the highly qualified workforce (engineers, master craftsmen, technicians) and the group of skilled workers.

In spite of the fact that on the national economic level the shortage of skilled workers has not yet reached an explicable level, a differentiated view nevertheless reveals a correlation to a shortage of skilled workers on the following four levels:

1. The level of individual occupations: Above all the occupations of chip removal mechanics, industrial mechanics, toolmakers, mechatronics, and electronic technicians are concerned. Company actors as well as experts of the associations have already identified considerable deficiencies;
2. The level of individual regions: Above all Bavaria, Baden-Wuerttemberg but also individual regions in the North and in the East of Germany are concerned;
3. The level of individual companies: Above all SME — caused by a number of factors such as salary and wages structure and image — have problems to recruit and to keep skilled workers.
4. The level of the labour market: Apart from an increase of vacancies in the sector the re-occupation times of open positions are partly dramatically prolonged.

Based on the interrelationship of these correlations it is not amazing that according to surveys already 10 per cent of the M+E companies have reported losses in production due to the shortage of skilled workers. Experts consider this just the beginning of a long-term development which will further acuminate.

The mentioned phenomena reveal a (both current and future) hazard for the sector. The following chapters will show the development of the sector and the forecasts for the future.

6 Development of the sector

The major trends of globalisation along with the digitalisation, the structural change and the service and knowledge society as well as the aging of the society have a deep impact on the work of world in the metal and electrical industry. Gesamtmetall has initiated a working group »Future of the Metal and Electrical Industry« and has surveyed the development of the sector, has analysed changes and has derived the future employment structure and the relevant requirements for qualification (Gesamtmetall 2004).

6.1 Demographic change

The demographic development has already been extensively discussed in politics and society for many years. It is also the shortage of skilled workers in many sectors which gives this discussion a new momentum.

While the population of 1910 still resembled a pyramid, it had taken the shape of a fir tree by 1990, also due to the two World Wars. The forecasts for the year 2030 stipulate an upside down pyramid. This clandestine development process has two basic

causes: First a continuous increase in life expectancy and second a clear decline of birth rates.

According to forecasts and model calculations of the *Deutschen Instituts für Wirtschaftsforschung (DIW)* (German Institute for Economic Research) the average age of the gainfully employed persons will clearly increase. »Against this background the group of the older employees (so-called 50Plus) will increasingly gain importance« (Kordey, Korte 2006, p. 11). In the year 2003, a third to a quarter of all gainfully employed persons were workers of 55 years of age and older while the number of persons employed decreases with the age. In the age group of 60 to 64 years, approximately the same number of persons are self-employed (22.1 per cent) or are employed as workers (24.4 per cent). Defined according to economic fields and factoring out the self-employed persons, the producing trade (21.9 per cent) accounts for employment figures of 50-year-old employees which are slightly higher than the average (21.6 per cent).

When dividing the sector of the producing trade into its different occupational groups it clearly shows that there are very few occupational groups with employees of 50 years of age and older. In the occupational groups of technicians, metalworkers, electricians, and mechanics only between 18.2 and 27.9 per cent belong to the age-group 50Plus. »These occupations are typical occupations for men where the workers are heavily strained and therefore often do not work in their occupation up to their statutory retiring age«. (Kordey, Korte 2005, p. 22). With respect to the ties to their companies it was found out that above all younger employees are rather inclined to change their employers and the region they are working in than older employees.

In general it can be stated that the age structure in enterprises is noticeably changing. Enterprises and their personnel policies are therefore confronted with a number of challenges. These challenges in terms of the changes of the age structure of the society are manifold. Given the comparatively small number of young gainfully employed persons, the strong middle aged group of employees and a longer period of employment due to the discontinuation of state funds for early retirement, both economy and society are facing major problems. The problem fields are above all personnel recruitment, personnel placement and personnel reductions. The companies are therefore generally confronted with the following challenges:

- Handling of recruitment problems with the younger workforce,
- Consequences of the aging personnel,
- Consequences of the retirement or the withdrawal of older employees and thus a loss of know-how as well as
- Challenges in connection with the changed age structures of the customers (product development, innovation etc.).

Further fields of actions can be derived from these problem fields. As already mentioned earlier, the recruitment of skilled personnel is becoming increasingly harder as less young skilled workers are entering the labour market. With the retirement of older employees there is the threat of a loss of know-how, performance, and productivity. With a parallel shortage of junior staff, the innovative power is in jeopardy. An adaptation of the corporate culture to these demographic developments is as crucial as the consideration of an aging customer structure. A natural fluctuation – the retirement of older employees and their substitution with young staff – is being postponed.

The changed age structure in enterprises therefore calls for action. Regional differences of the companies as well as differences in the size of the companies must also be considered. These problems were explicitly confirmed by the case studies, above all in small and medium-sized enterprises which fear to suffer a partly considerable loss of know-how with the retirement of older employees. Many of the companies, however, do not yet have any solutions for keeping this loss low.

6.2 Trends and forecasts for the future development

The diversified metal and electrical industry in Germany currently exerts a far bigger economic influence than the respective sectors in other industrial countries. According to Gesamtmetall (2004, p. 2), this high share will be reduced during an – albeit mild – adaptation process in the years to come due to the structural changes towards a service society and as a result of outsourcing. A slightly slower economic growth of real value-added (1.5 per cent) compared to the entire economy (1.8 per cent) is expected. With regard to the individual metal and electrical branches a differentiated picture can be drawn: A higher-than-average growth is above all expected for the fields of »data processing machines« as well as »metal production/ metal processing«. A slightly slower growth is being forecasted for the automotive sector, some fields of machine building and for the electrical industry (ibid, p.2).

The high expenditure in innovations and a differentiated range of products of the German metal and electrical industry rely on the world market as sales market for the safeguarding of profitable lot sizes and a high capacity utilization. Gesamtmetall (2004, p. 2) expects that the metal and electrical industry will be able to stabilize their position as the exportation sector No. 1 and that exports will increase at a clearly swifter pace than the value-added up to the year 2015.

A higher-than-average growth is decisive for the sector to stand its ground in the international competition. So far, the productivity of the M+E industry has on average been increasing more quickly compared to the overall economy. According to a forecast of Gesamtmetall (2004, p. 3), this trend is likely to further continue up to the year 2015. A plus of an average of up to 3 per cent (compared to the overall economy: 1.5 per cent) is being forecasted.

Competition is also reflected in the form of ever shorter product and process life cycles. According to Gesamtmetall 2004), the overwhelming majority of the company managements and employees in the metal and electrical industry expects further increasing requirements, a further acceleration of the necessary time of reaction of the enterprises, with continuous innovation processes and a still more far-reaching flexibilisation of production. Apart from a high product quality and the service, the offer of ever new products represents a decisive, promising competition strategy.

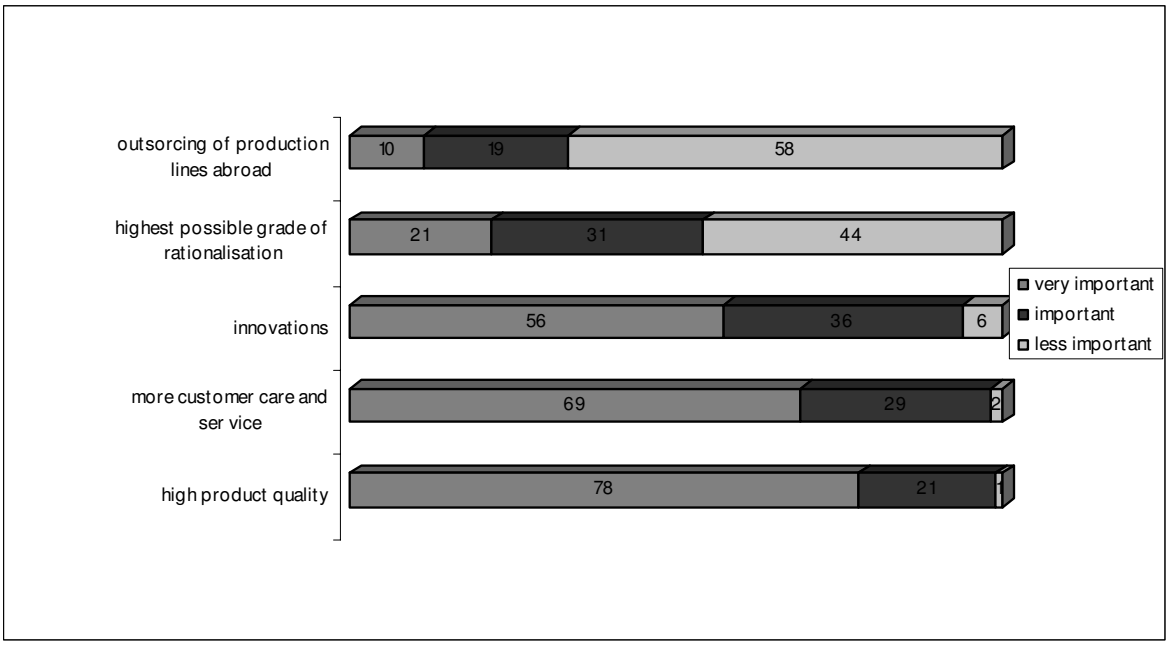

Figure 10: Assessment of corporate success factors (Gesamtmetall 2004, p. 6)

Another development with an immediate impact on the production conditions can be observed: the often discussed increase of variants. The basis for this thesis is the fact that customers more often demand the individual shaping of their products. The production must therefore increasingly be planned for the economic production of this growing number of variants. A survey of the Fraunhofer Institute System and Innovation Research (*Fraunhofer ISI*) conducted in the year 2005 showed that three quarters of the companies in the metal and electrical sector offer more variants of their main product than in earlier times. One quarter indicated that the number of offered variants had considerably increased. The share of companies that reported a decreasing number of variants (4 per cent) can rather be neglected (cf. Kinkel 2005, p. 3).

The biggest dynamics towards a higher number of variants could be found in vehicle construction. The comparatively lowest dynamic was found in producers of metal products. But also in this sub-sector more than two thirds of the companies indicated that the number of offered variants had increased. Thus the trend towards a more differentiated offer of variants for all partial branches of the metal and electrical industry can be described as a relevant development (cf. Kinkel 2005, p. 3). The development dynamics towards a higher range of variants and its shaping also has an impact on the production systems: The production plants, their networking in the production process as well as the offer of supporting service tasks obviously suggest that a flexible adaptation or conversion respectively for different variants of a product are possible.

The technical availability of production systems is then no longer predominantly defined by short cycle times and unit costs for certain products but increasingly by the average acceptable working and conversion times for different variants and the respective life cycle costs of the production plants (cf. Kinkel 2005, p. 3).

Another aspect also reflected by the changed requirements for the qualification of the employees is the use and handling of new and additional materials. In the survey conducted by *Fraunhofer ISI*, 43 per cent of the total of 1,450 interviewed companies

stated an increase in materials used for production. The comparatively strongest dynamics was noted in vehicle construction.

The survey by *Fraunhofer ISI* also looked at the development of the requirements for accuracy in production. More than a quarter of the interviewed companies reported considerably higher requirements in production accuracy. Another 44 per cent had perceived at least slightly increased requirements for production accuracy (cf. Kinkel 2005, p. 8). Table 5 summarizes the developments of production requirements found in the survey of the *Fraunhofer ISI* in an overview:

Production requirements	Tendency
Development of the offer of variants	↑
Development of material mix	
Development of the requirements for accuracy	↑
Development of the size of the products	

Table 7: Development of the production requirements in the metal and electrical industry (based on Kinkel, 2005)

7 Development trends in the companies

Among the most prominent developments — in terms of corporate forms of organisation — with an impact on the emerging new needs for qualification count above all

- the creation of flat leadership and production structures,
- the decrease of the production depth and
- the emergence of network structures across the companies.

In order to meet these intentions, the companies look for solutions which are compatible with their corporate culture. Restructuring processes are therefore necessary in the companies which can differ considerably from company to company. Most of the time the organisational changes lead to a reduction of hierarchies.

Already at the beginning of the 1980ies, the performance of a successful enterprise was summarized under the term of learning aptitude[5] (cf. Lohrscheider 1996). Since then above all big enterprises have considerably changed. Groups or teams started to play a crucial role for the success of a company.

The advantages and disadvantages of group work, flat hierarchies, the dissolving of departments and their decentralisation have been discussed from different points of view such as quality management, lean management, simultaneous engineering, interface problems, flow of information, social and methodological competency etc. In practice different approaches for solutions influenced by the respective corporate cultures have been developed which have a more or less intensive impact with regard to the qualification requirements and the work tasks of the individual groups of employees.

Smaller enterprises are structurally shaped differently than big enterprises. Companies with up to 20 persons engaged mostly reveal handicraft structures. As soon as they go beyond this staff category, marked hierarchies or a heavy dissection within the narrow function and product related departments are often the usual practice.

[5] Learning aptitude in this sense generally means the ability of a company to develop in all relevant issues such as products, personnel, organisation, efficiency etc.

Big enterprises mainly aim at a decentralization of tasks from the middle management levels to the level of skilled workers. At the same time group or team structures would be implemented there in order to cope with extensive tasks by ensuring quality and showing self-responsibility. The restructuring processes in smaller enterprises are less resistant. In order to intensify the customer orientation, priority is given to the fact that the company management is willing to delegate responsibility to the level of skilled work.

As a tendency the restructurisation strategy of big and smaller enterprises is hardly differing:

- Big enterprises first and foremost concentrate on a decentralization of tasks in connection with a »thinning out« of structures (reduction of hierarchy!).
- Small enterprises focus on the shifting of responsibility form the »boss« to the level of skilled workers.

Thus we can talk of a »convergence with the reorganisation of hierarchical structures« in types of enterprises (cf. Figure 12). This is connected to the basic target of the enterprises to develop process models coordinating all tasks of an enterprise in a way, that the expectations of the customers are satisfied in any case. The areas and departments that have to be merged in medium-sized enterprises vary from company to company.

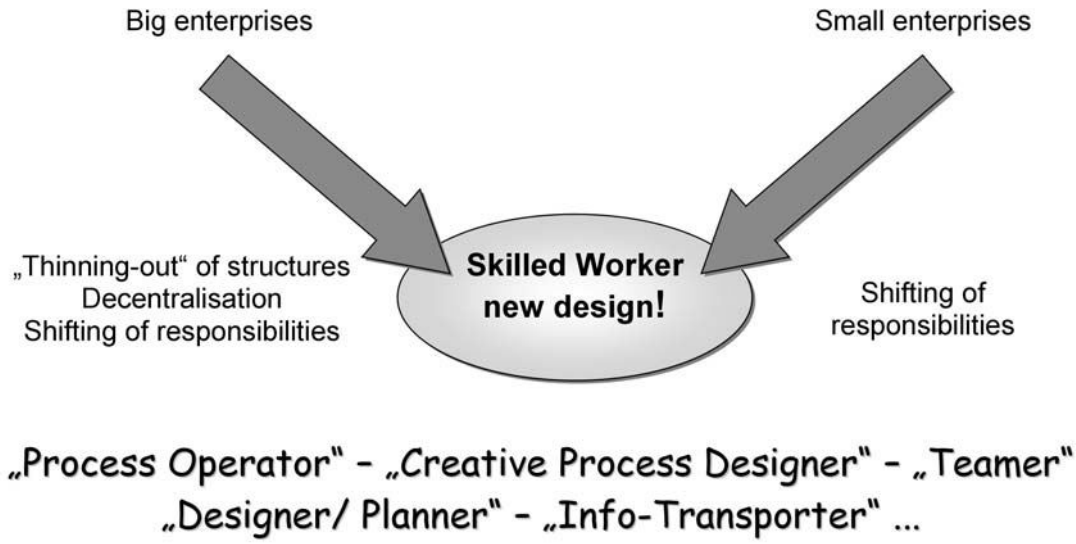

Figure 11: Convergence of a hierarchy reduction and the shifting of tasks (Spöttl et al. 2003, p. 76)

The changes in the enterprises of the metal and electrical industry are also perceptible on the level of the employees: In a survey on employees carried out by the *Institut für Demoskopie Allensbach* (Institute for Demography Allensbach) (2002, cf. Gesamtmetall 2004, p. 6-7), about 76 per cent of the M+E employees reported higher exigencies and two thirds spoke of perceptible consequences of a tougher competition. From their point of view the work processes have also accelerated (agree: 58 per cent) and the employees have more responsibility (agree: 49 per cent). At the same time the need for more flexible forms of work are deemed more important. Team oriented, project and process oriented work structures are highlighted (ibid.).

7.1 New Working and processing technologies

The use of new working and processing technologies allows to reduce the material and processing costs and an improvement in product quality. At the same time it is possible – e.g. by non-cutting techniques – to reduce the material and to avoid wastes. Among the most important new working and processing technologies count above all (Abicht 1999, p. 12)

- The laser technology (among others for separation, welding, hardening, and etching);
- Various adhesive technologies;
- New non-cutting and mostly finishing-free mould and transforming technologies such as e.g. isostatic hot pressing, superplastic evaporation moulding, or thermoforming.
- The ultrasonic technology with its various applications (impregnation, use for a better flowability in foundries as well as non-contact testing technology.
- The use of integrative processing technologies by merging several consecutive processing steps into one holistic process. Examples: continuous casting of strands and continuous casting of hoop steel.

7.2 Use of new materials and material combinations

The development and the use of new materials result in the saving of natural resources, energy and expenditure for work. Compared to the traditional materials, these new materials normally have better properties and are more adequate for the intended use.
It is likely that above all the use of industrial and glass ceramics as well as recyclable and/or biodegradable, pure and reinforced plastics will increase. Likewise highly refined steel and combined materials made of high-strength steel with light materials will become more important in the future (Abicht 1999, p. 12).

The variety of new non-metal or higher refined metal materials is steadily increasing and calls for a permanent adaptation of the users' knowledge and skills with regard to the specific properties of the materials and the corresponding working and processing technologies. This is above all true for surface treatment as well as for coating and joining technologies.

7.3 Trend towards increased use of pre-fabricated components and modules and thus trend towards a higher customer orientation

The development of an increasing number of components and highly complex modules has a crucial impact on industrial production processes. Apart from a simplification of assembly tasks there are dramatic changes of the preparatory structures in connection with the production of such modules.

The latest developments in this field are mainly taking place in the area of microtechnologies and are above all characterized by the fact that mechanical control units are being replaced by micro-electronical control elements. At the same time the continuous increase of the function depth per chip surface unit meanwhile allows the integration of sensor and evaluation electronics in a chip. With the use of micro-system technology and nanotechnologies the depth of integration will surge up and the range and variety of the application fields will further increase. Experts expect that the need for employees will jump up above all in these areas within the next few years (Abicht et al. 1999, p. 13).

Another trend in the field of production is the ever higher customer orientation in the enterprises. Consequently stand-alone machines loose their importance and are replaced by machining centres and complex machine systems. Thus the production and manufacturing processes become more complex from the development to the delivery of the goods and require a close cooperation within the enterprise. The change towards more complex machine systems additionally increases the relevance of product supporting service tasks.

- Engineering,
- Software development,
- Maintenance and
- Training

have an increasingly higher share of the total turnover and thus of the company tasks. On average the pure share of mechanical components in the value of a machine has decreased to around 40 per cent today. Another 40 per cent are integrated software, the remainder of 20 per cent is made up of electronics/ electrical components (cf. IG Metall Wirtschaft-Technik-Umwelt 2001, p. 7).

In the course of a greater internationalisation of the sales markets, both service and sales flexibility are becoming increasingly important. Two developments are mainly pursued:

- Closing the gap to the customer by new service tasks beyond the maintenance of a machine and
- delimitation of other products by a comprehensive service programme.

Apart from predominantly conventional service tasks such as repair of machines and the supply of spare parts, the range of service tasks also encompasses (Windelband/Spöttl 2002, p. 154)

- Consulting,
- Project planning,
- Technical documentation,
- Maintenance/inspection,
- Instruction/training,
- Customer support/Hotline and
- Software/ programming

These tasks are more and more carried through by skilled workers. Often the thesis can be formulated: »The more complex the product the more product supporting service tasks are being offered.«

A very new product innovation in the field of product related service tasks is the teleservice, i.e. the maintenance, inspection and partly even the repair of machines and tools is done via a network. The aim is to reduce downtimes and service costs. At the same time a constant service quality must be ensured.

7.4 Development of technology

As early as the 1970ies, the introduction and swift dissemination of numerical and later computer aided numerical controls (CNC) was introduced to the world of production. Due to the continuous further development of information technology, not only a direct control of the production machines is possible today but also a support of prepara-

tory, secondary and subsequent fields such as construction, work scheduling, production planning and control as well as assembly. At the beginning of the 1990ies, more than 80 per cent of the machine building enterprises already made use of NC or CNC machines. This ratio has been increasing up to today. This development also entailed the increasing use of multifunction machines or multi-machine plants compared to single function machines.

Whereas the development in the field of production is already far advanced, there seem to be still greater opportunities for development in the fringe areas of production such as in construction (CAD systems) and production planning and control (PPS and SPC) (cf. Widmaier 2000). Nevertheless it is obvious that in all fields technology should serve as an auxiliary means which cannot replace people.

Along with these technical developments the tasks of the skilled workers are continuously changing. Due to frequent product innovations and the variety of combinations of components and individual systems for complex plants, skilled workers today have to master a »considerable know-how« in order to have an overview of the product variety and to correctly produce, assemble and test the products. This can mostly be achieved with the use or the supplement of detailed documentations. Therefore the amount of objectified knowledge for »shop-floor« employees is considerably increasing.

The skilled worker is no longer confined to the operation of a machine but also has to take care of the adjustment, the testing, the monitoring, the use of adequate tools and of programme optimizations etc. Due to constant changes in production and the recurrent integration of the latest technology, the skilled workers must be prepared to handle various plant technologies, their operation and programming and above all a high variety of tools.

The following trends are e.g. expected for the field of machine tools (cf. Dispan et al. 2006, p. 45):

- High performance processes such as e.g. High Performance Cutting (HPC), dry processing and minimal quantity lubrication,
- Micro technology,
- Laser technology in beam sources and plants,
- Complete machining by integration of processes,
- Reconfigurable production systems (modularisation),
- Direct drives such as linear and torque engines,
- Rapid Prototyping,
- Innovative controls,
- Continuous CAX production chains,
- Simulation, Virtual Reality,
- Responsible resource management.

Flexibilisation and modularisation are the basic trends in the sector. This trend towards flexibilisation and modularisation eventually aims at the philosophy of »standardisation«, i.e. the goal is as much standardisation (serial production) as possible and as much individual production as necessary (cf. Dispan et al. 2006, p. 47).

7.5 Change of the production processes

The industrial production is changing away from mass products in favour of customized products with specific problem solutions. Consequently the variety of the products is increasing and the needed quantity is decreasing. The target of »productivity« is pushed back in favour of »quality« and the new target of »flexibility«. Given the swift transformation of the markets and the customer demands, the enterprises are under a constant pressure to make changes. Flexibly and quickly responding employees and forms of organisations are in demand (cf. Baumgarten, Schramm 1999, p. 28).

In order to cope with the described market developments and demands, two different strategies are emerging. On the one hand the so-called »Neo-Taylorism« is marked by a »return to« and/or the »further development of an efficient deepening of the hierarchical, functional, and specialist division of work« (Hirsch-Kreinsen 1990, p. 37; Springer 1999, p. 28). This means a restriction of the freedom of decision and co-shaping for the employees on the shop-floor level. The correspondent competencies are (again) loosing importance. There is also less need for the range of specialist skills and abilities of the individual employee. The employees carry through very limited and exactly (pre)defined work processes. Skilled workers with a broad and varied occupational acting competency are only required for special tasks.

On the other hand the concept of the »qualified cooperative production work« (cf. Hirsch-Kreinsen 1990, p. 37 f.; Bullinger 1990, p. 42) which — compared to the first concept — is based on the abolition of the Tayloristic separation of »mental work« and »manual work« and holistically relies on the human resources. The employee has an extensive freedom of disposition, decision making and shaping. It is expected that he or she fills these open spaces within team structures and contributes his or her entire knowledge, preparedness and skills for the further development of the project.

The holistic occupational acting competency which — apart from broad specialist skills and abilities — also encompasses methodological, social and above all individual competencies is the basis for the majority of the employees. The need for skilled workers with an (initial)training oriented to occupations is clearly on the rise in this development approach.

8 Change of work tasks

The substantial changes in the companies such as decentralisation of vertical hierarchies and more autonomy as well as taking over responsibility by skilled workers are mirrored by the qualitative enrichment of the work tasks.

Companies focussing on assembly tasks have different tasks and task levels than traditional production companies.

In assembly companies, the current new shaping of work entails a stronger polarisation of the deployment of personnel:

- More unskilled staff with temporary contracts and
- Regular staff as highly qualified and specialized skilled workers.

Today the share of trained skilled workers in the new, less flat production structures in assembly is estimated at just 20 per cent (estimations taken from surveys and expert interviews). This staff is preferably deployed for

- dealing with difficult tasks within assembly groups, e.g. check of the entire electrical wiring of a vehicle or of the entire vehicle including the documentation of

the »vehicle life cycle« in production. »Process knowledge« is highly relevant to cope with these tasks.

- or in areas of pre-assembly as technical skills, product and system knowledge or detailed assembly knowledge are a big advantage.

Unskilled workers must have a certain technical knowledge and conscientiousness for safety and they have to be able to handle simple tools. Everything else is subject of the training-on-the-job process.

In small, medium-sized and bigger production enterprises — they are strongly relying on decentralized production concepts — the lower hierarchy and employment level is upgraded. Apart from their specialist tasks, employees in production have increasingly been assigned tasks for the control and shaping of newly organised production processes.

This shifting does not remain without consequences. The safeguarding of processes, the coordination of parts, the cooperation with customers within the company, the coordination of delivery times etc. is no longer restricted to higher hierarchy levels. Moreover skilled workers and other employees in direct production are confronted with these tasks. A qualification level safeguarding the coping with these tasks is a prerequisite.

The reorganisation measures in industry result in considerable vertical and horizontal diffusions of competencies. »Shop-floor« employees take over know-how from higher hierarchical levels (vertical diffusion) and from related occupations (horizontal diffusion, cf. Figure 15). The directly productive employees are expected to extend their specialist qualifications — which have so far accounted for 90 per cent in the occupational profiles — by »soft competencies«.

A delimitation of traditional work task profiles of skilled workers (cf. Meyer 2000) towards

- Complementary competencies,
- Service dimensions as well as
- Complex and abstract specialist contents can be clearly identified.

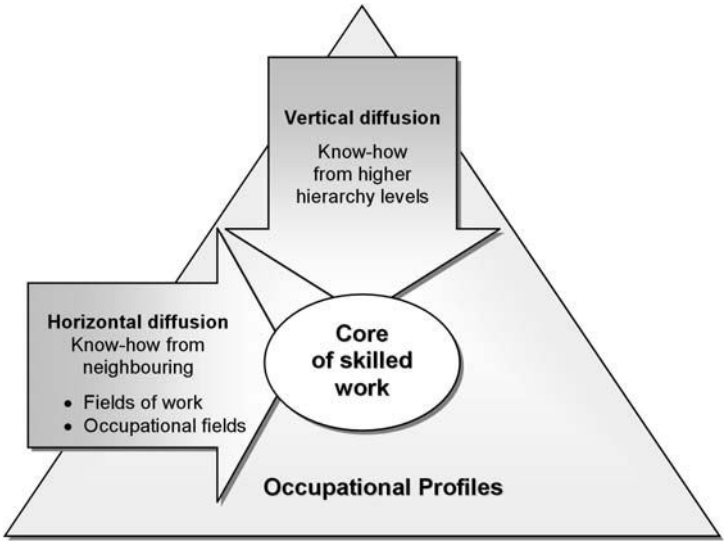

Figure 12: Horizontal and vertical diffusion of »know-how« due to structural changes (Spöttl et al. 2003, p. 153)

The complementary competencies often result from other occupations and migrate down to the »shop-floor« level (horizontal diffusion) whereas service dimensions from other occupations result from former higher hierarchy levels and from traditional production structures. They also migrate to the level of skilled work (vertical diffusion). Meyer (2000, p. 188 ff.) states that this »know-how transfer« results in a new role for skilled workers, entails a considerable need for qualifications and goes far beyond specialist qualifications.
Furthermore mechatronic competences are more and more in demand. Mechatronics work at the interface between machine building, electrical technology and information technology. They deal with machines, plants and systems with mechanical and electronical functions. Mechatronics as »all-round skilled workers« are preferably deployed for maintenance and repair.
The safeguarding of quality is one of the most important tasks for the skilled worker today. This is the result of an extreme orientation of the companies towards the clients. Each employee, each skilled worker is confronted with the »produced« results in terms of acceptance and quality. Thus each individual employee has a different access to production *per se*, to product organisation, to optimization issues and to colleagues.
One special characteristic is the fact that skilled workers today have to master up to five different machine control systems. Programme optimization and the use of PPS-systems are taken for granted as well as the perfect reading of complex drawings and the corresponding determination of cutting data, engine speeds, starting points etc. According to the field of application, the start-up of machines as well as function tests are additional tasks.
The organisation and the preparation of the production processes as well as the safeguarding of the production are self-evident responsibilities for skilled workers. This means that they have to take over more or less all tasks involved in the preparation of the production (planning of order processes, setting-up, adjustment of machines, machine scheduling, delivery of parts …). In addition they have to make sure that the production is carried through without restrictions. This calls for the care of the machine pool, cooperative relationships to other departments, problem solving and consulting tasks.
These are challenges going clearly beyond the traditional image of skilled work and underpin the extended tasks. The participation in optimization measures in production, detailed coordination processes and company-oriented responsibilities are further duties for skilled workers apart from their traditional fields of tasks.
The new tasks for skilled work strikingly underpin the fact that activities with a service character in a Tayloristic division of work have meanwhile changed into skilled tasks. This is true for all performances which — under traditional forms of work — had been taken over by other departments in favour of a direct production (Spöttl/Hecker/Holm/Windelband 2003, p. 157) such as

- Safeguarding of quality including quality assurance measures and quality checks;
- The organisation of production and work scheduling;
- The safeguarding of production including taking over maintenance tasks and minor repairs;
- The optimization of the production processes;

- Taking over responsibility.

Today, these former service tasks are the core tasks of skilled work. The range of technical tasks is also much wider than it was a decade ago. Tasks such as

- the use of PPS software,
- the use of several production procedures,
- the modernisation of plants and
- the diagnosis of cases of damage

count among the challenges which are assigned to different groups of employees in traditional production.
Today these tasks contribute to safeguard the production and process competency. First and foremost they help to guarantee a successful product infrastructure. This means that costs, cooperation, organisation, planning and the business processes must be guaranteed and optimized.
These tasks should mainly support the production; they start where the direct product manufacturing ends. As soon as a skilled worker has finished with the cutting process of a milled part and then also takes care of its storage, further transport, data transfer and sales, these services have taken up a production and process orientation.
The new industrial structures offer chances for the shaping of work. Skilled workers can only successfully contribute to this process if they are aware of the entire process. As underlined above this is only feasible if the process category in the sense of a process competency is in the centre of interest. This encompasses the in-firm production process of a product with all its dimensions: as process and customer oriented service tasks, as knowledge management, as technical, work organisational, social, economic component which always requires work process knowledge.

9 Initial and further training

9.1 Qualification structures

9.1.1 Initial training

Almost 190,000 young people are trained for a skilled work occupation in the metal and electrical industry. From 1993 to 2005 the number of training contracts signed per year has increased from 49,700 to 67,000. In the year 2006 the number of training positions fell back to 59,000. Some of the Social Partners in Germany are convinced that the declining training figures are one of the reasons for the shortage of skilled workers.

In the years 2003 and 2004, the industrial metal and electrical occupations were rearranged. The rearrangement involved a basic revision of the so-far training contents. The new occupations are characterized by learning and working within business processes. Specialisations have been abandoned in favour of a training in corporate deployment areas which moves the training closer to the business fields of the companies. Apart from a revision in terms of contents, also the training design and the examination structure were adapted. The rearrangement was also carried through by considering the shaping principles »process orientation«, »flexibility«, »occupational acting competency« and »learning in the work process«.

As for the metal sector, the following occupations were newly arranged: industrial mechanic, toolmaker, chip removal mechanic, plant mechanic and construction mechanic. Three metal occupations are described below and should serve as an example for their fields of work and the required occupational skills (cf. BIBB 2007).

1) Industrial mechanic

- Duration of training: 3.5 years;
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Approved by Ordinance dated 9th July 2004
- Field of work: Industrial mechanics are deployed for the production, the maintenance and the control of technical systems. They work on the installation, refitting and the set-up of production plants. Their typical fields of deployment are maintenance, machine and plant building, production technology and fine tool building.
- Occupational skills: Industrial mechanics …
  - take over their tasks autonomously by adhering to current stipulations and safety regulations, coordinate their work with preliminary and subsequent departments, work in a team,
  - equip work places,
  - organise production processes and control them,
  - communicate with internal and external customers as the situation requires,
  - control and document maintenance and assembly work by taking into consideration the quality management systems of the company,
  - produce components and modules and assemble them into technical systems,
  - identify faults and their causes in technical systems and document them,
  - repair technical systems,
  - retrofit machines and systems,
  - carry out maintenance and inspection work,
  - choose testing methods and testing tools,
  - hand over technical systems and products to the customers and familiarize them with the plants,
  - safeguard the operating ability of technical systems
  - check and extend electro-technical components of control technology,
  - consider business processes and apply quality management in their area of work.

2) Toolmaker

- Duration of training: 3.5 years;
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Approved by Ordinance dated 9th July 2004
- Field of work: Toolmakers predominantly work in industrial companies in the fields of mould technology, instrument technology, pressing technology or fixture

technology. They work above all in industrial serial production of products made of plastics and metals, as well as in the production of instruments for operative medical technology.

- Occupational skills: Toolmakers …
  - plan and control work processes, work in a team,
  - control, assess and document work results and apply methods of quality assurance,
  - manufacture individual parts of different materials with tools and machines,
  - programme and operate machines with numerical control, manufacture above all moulds for die-casting, pressing and embossing as well as tools for die-cutting and forming
  - build fixtures and operational aids for the support and/or the construction of industrial production units,
  - assemble components and modules to tools, instruments, fixtures, or forms
  - manufacture form surfaces with fine finishing techniques,
  - carry through maintenance work,
  - check and optimize the functions and processes in terms of quantity and quality,
  - apply technical documentations and make use of information and communication systems, also in English language.

3) Chip removal mechanic

- Duration of training: 3.5 years
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Approved by Ordinance dated 9th July 2004
- Field of work: Chip removal mechanics work in areas of industry and handicraft where components are manufactured with chip cutting procedures. The typical deployment fields are turning lathe systems, milling machine systems, automatic lathe systems and grinding machine systems of individual and serial production.
- Occupational skills: Chip removal mechanics …
  - assess and analyse production orders on their technical feasibility, select information sources and technical manuals for the execution of the production,
  - select production systems according to order,
  - plan manufacturing processes, set up and optimize programmes for numerically controlled production systems and adjust them,
  - make use of data sheets, descriptions, operation manuals and other information typical for the profession, also in English language,
  - equip the work place and organize work processes by taking into consideration delivery and economic stipulations,
  - manufacture components according to qualitative stipulations with the aid of chip removing production procedures and monitor the production process,

- apply quality management systems, document and assess work and test results and derive measures for the optimization of the production and the products,
- control and check the safety devices, maintain and inspect production systems,
- work in a team, familiarize others with the operation of production systems, coordinate their work with preliminary and subsequent departments, adhere to customer requirements.

The following seven training occupations have been determined in the electrical/ electronical industry since the rearrangement of August 10, 2003: Electronic technician for automation technology, electronic technician for industrial engineering, electronic technician for buildings and infrastructure systems, electronic technician for appliances and systems, electronic technician for aviation technology systems, electronic technician for machine and drive technology as well as the system information technician. Three of these occupations are described below and serve as an example for their fields of work and the required occupational skills (cf. BIBB 2007).

1) Electronic technician for automation technology

- Duration of training: 3.5 years
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Approved by Ordinance dated 3rd July 2003
- Field of work: Electronic technicians for automation technology ...

  … integrate, put into operation and maintain automation solutions. Typical fields of deployment are e.g. automation of production and manufacturing, network automation, traffic management systems, building automation systems. Electronic technicians for automation technology carry out their tasks autonomously by adhering to relevant stipulations and safety regulations and coordinate their work with preliminary and subsequent departments. They often work in a team. They are skilled workers of the electrical trade in the sense of accident prevention regulations.
- Occupational skills : Electronic technicians for automation technology …
  - attend to automation systems;
  - analyse functional correlations and process courses; design alterations and extensions of automation systems,
  - install and set parameters for pneumatic or hydraulic as well as electrical drive systems,
  - install and adjust, configurate and set parameters for sensor and actor systems as well as for modules of electrical control technology.
  - programme automation systems,
  - install, configurate and set parameters for components and devices, operation systems, bus systems and networks;
  - apply user programmes for the compilation, transfer and processing of measuring data as well as for production, machine and process control,
  - combine components into complex automation installations and integrate them into superordinate systems
  - hand over the systems to the users and familiarize users with their operation,

- supervise, maintain and operate plants, carry through regular checks, optimize control loops, analyse malfunctions, apply testing software and diagnostic systems, apply urgent measures and repair plants;
- also work with English documentations and communicate in English language.

2) Electronic technician for industrial engineering

- Duration of training: 3.5 years
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Approved by Ordinance dated 3rd July 2003
- Field of work: Electronic technicians for industrial engineering ...

  … assemble systems/ plants of energy supply technology, measuring and control technology, communication technology, signal technology, drive technology and lighting technology, put them into operation and maintain them. Further tasks are the operation of these plants. Typical fields of deployment are power distribution plants and networks, building installations and networks, industrial plants, production and process technological plants, switchboard and control plants as well as electro-technological equipments. Electronical technicians for industrial engineering carry out their tasks autonomously and coordinate their work with preliminary and subsequent departments. They often work in a team. They are skilled workers of the electrical trade in the sense of accident prevention regulations.
- Occupational skills : Electronical technicians for industrial engineering…
  - take over electrical installations;
  - design changes and amendments of plants;
  - equip work places/ building sites and clear them;
  - organise the installation of the plants; supervise the work of service personnel and other trades;
  - assemble and install wiring systems, information and energy lines including general supply lines,
  - install and adjust machines and drive systems including their pneumatic/ hydraulic components,
  - assemble control units and automation systems and wire them,
  - programme and configure systems, check the function and the safety devices of the systems,
  - supervise and maintain plants, carry through regular checks, analyse malfunctions, apply urgent measures and repair the plants,
  - hand over plants, familiarize users with the operation and carry through service tasks,
  - also work with English documentations and communicate in English language.

3) Electronic technician for building and infrastructure systems

- Duration of training: 3.5 years
- Entry prerequisite: Graduation of a Secondary Modern School (*Realschule*) or Extended Elementary School (*Hauptschule*)
- Recognized by Ordinance of 3rd July 2003
- Field of work: Electronic technicians for building and infrastructure systems …

realize technical and organisational services. They maintain, monitor, control and safeguard building and infrastructure systems and can also be deployed for the design of building and infrastructure systems. The typical fields of deployment are residential buildings, commercial premises, plants, functional premises such as hospitals, infrastructure plants, industrial plants. Electronic technicians for building and infrastructure systems carry out their tasks autonomously according to the relevant stipulations and safety regulations and coordinate their work with preliminary and subsequent departments. They often work in a team. They are skilled workers of the electrical trade in the sense of accident prevention regulations.

- Occupational skills: Electronic technicians for building and infrastructure systems
  - analyse the requirements of the users and identify danger potentials, conceive alterations of plants and changes in the use of technical systems (energy and communication systems as well as supply systems), coordinate the alterations with the users and consult the latter,
  - calculate the costs, submit orders and inspect third party service tasks;
  - install building and infrastructure systems, carry through or initiate conversions;
  - configurate the control equipment of technical systems, check the function of the systems as well as of the safety equipment;
  - hand over the systems and familiarize the user with the operation of the technical systems,
  - inspect and maintain the plants and systems according to the manufacturer's operation stipulations and contribute to a higher availability and efficiency of the plants; record fault reports, carry through fault diagnoses, assess hazards caused by malfunctions and apply urgent measures.
  - operate building and infrastructure systems according to regulations, manufacturer's stipulations and the wishes of the users,
  - monitor building technological systems with the aid of automation and control systems, optimize the operation of technical building systems,
  - carry through systematic trouble shooting, delimitate faults, carry through or initiate the repair of technical devices by the respective trades,
  - monitor the adherence to safety regulations by users and above all when services of external trades are involved, take action in order to safeguard the safety of buildings,
  - also work with English documentations and communicate in English language.

The rearrangement of the metal and electrical occupations is a reaction to the increasing importance of process oriented forms of work, an increasing complexity and the networking of new technology as well as to extensive customer oriented service tasks (cf. Chapter 4 and 5). The orientation to the business and work processes makes the realisation of these occupations very flexible and allows a proximity to the real world of work.

9.1.2 Further training

The companies are facing ever new challenges triggered by changes in their organisation and/or restructuring, by new fields of tasks for skilled work and by new machines, plants or production procedures with a high grade of permeability of ICT (information

and communication technologies). In order to enable the staff to close the gap of the new know-how, the sector offers a wide variety of further training to its employees.
In the year 2004, the better part of 87 per cent of the M+E enterprises engaged in further training. Thus the participation in further training by M+E industry is nearly three percentage points above the total economic average.

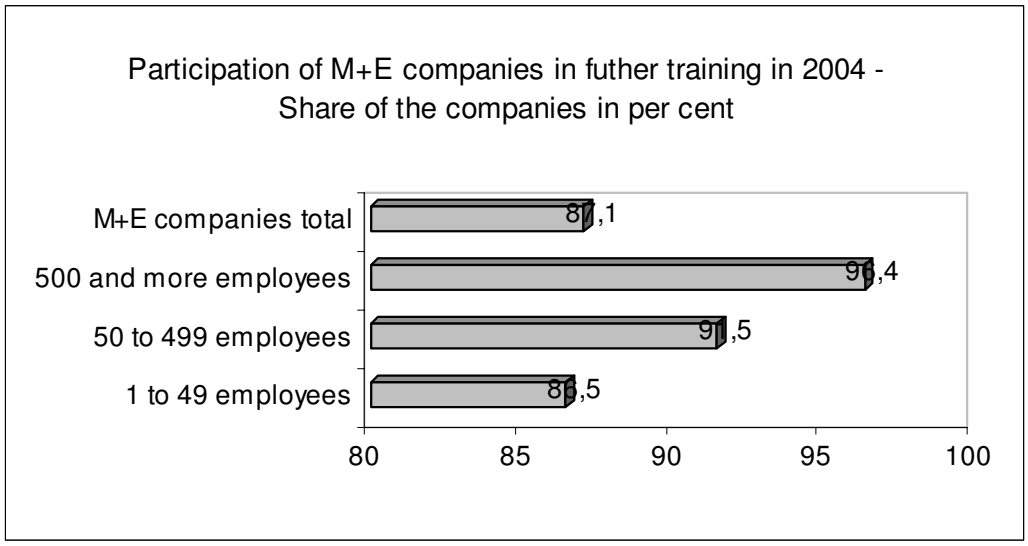

Figure 13: Further training in the metal sector (Source: Gesamtmetall 2006, p.73)

Almost half of the industrial expenditure for further training of € 8 billion (Gesamtmetall 2006, p. 73) in the M+E industry are dominated by more work place oriented and self-organised forms of learning (cf. Figure 15). Around 84 per cent of the companies make use of this form of further training. They have e.g. moved a part of the further training from in-firm seminars to the work places. This underlines the trend towards flexible, work place oriented and above all efficient further training measures. The product and situation-related briefing is still widespread, above all in small and medium-sized companies. It is always practised as soon as the employees have to take over new tasks or if adaptations to changed processes become necessary.

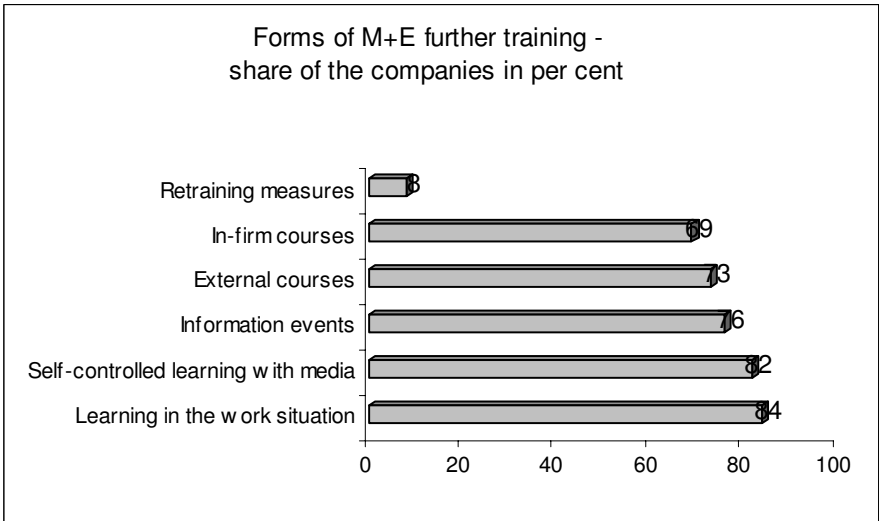

Figure 14: Forms of M+E further training (Source: ME Argumente 2006, p.1)

Based on the concrete need, the briefings are either carried through by the suppliers of the machines or goods or by a colleague or other employees of the company (cf. Table 7). Nevertheless many M+E companies are facing problems in setting aside working time for the further training of their employees as the productively used times have already been reduced by an increasing expenditure in information, consultation and coordination.

	Requirements	**Character Emphases (Examples)**
Learning at the workplace	Take up, master and co-shape continuous changes	Learning of production and assembly methods according to assembly optimization plans, Standard working methods … Learning with the aid of multipliers in teams or groups. Learning on demand (On-the-job)
Product oriented briefing	Mastering of new plants, new production techniques (be able to operate)	Situation and product oriented briefings at the work place, in the company on - new plants/machines/ products, - changed processes, - current problem solving situations, new tasks.
Product related seminare	Learning of new functions, interrelationship of new developments	Learning in traditional seminars, separated from the corporate world of work. Predominant topics: - Control an digital technology, - SPC/BUS systems, - Hydraulics, pneumatics, electrical technology, - CNC/CAD, - FMEA/ quality assurance. - Overall topics: - Technician at the customer's - Team leader training - Work safety
Holistic further training philosophy	Further training as a continuous instrument for the improvement of the qualification level of the staff in connection with a emuneration concept	Establishment of an overall interrelationship between team/ group performance and remuneration system via - Intellectual capital reports, - Qualification matrix.

Table 8: Further training approaches in companies[6]

9.2 Need for qualification

According to Gesamtmetall (2004, p. 13), 94 per cent of the companies of the M+E industry expect that the qualification of employees will continuously gain importance in the years to come as the increasing requirements can only be tackled in this way. 59 per

[6] Based on Becker/Spöttl/Stolte (2001, p. 13).

cent of the staff in the sector presume that they will have to undergo further training measures within a shorter period of time. The measures will not only concentrate on the use of new machines or the dealing with work processes but will focus on qualification in a much wider sense: The training of an overview of ever more complex production processes, the understanding of higher developed, more sophisticated technologies, the training of leadership competencies and communication skills.

An average of 4 per cent of the training positions remain open (Gesamtmetall 2007) as the companies cannot find adequate applicants in certain regions and for individual occupations or due to the fact that applicants do not even start with or later drop out of their training. Another general problem is the decrease of training prerequisites levels in school leavers. Many companies must offer additional schooling to applicants in major subjects such as mathematics and German. The number of the young people not ready to be trained is estimated to reach 20 per cent of an age group.

10 Initiatives and concepts against the shortage of skilled workers in the sector

10.1 Political initiatives

In the past, individual initiatives were taken on political level against the shortage of skilled workers. The best-known initiative was the *Greencard* offered within the IT sector as an incentive for foreign specialists to come to Germany. At the moment the government is planning an »Initiative of qualification to safeguard the need for skilled workers«. First talks on this issue are scheduled for autumn 2008. Above all some of the trade unions consider this to be insufficient. In summer 2007, IG Metall started e.g. an initiative for skilled workers in order to close the gap of skilled work in Germany (cf. IG Metall, 2007a). Although it is said that there is no overall shortage of skilled workers at the moment, problems are already emerging today: The shortage already shows in individual regions, in certain qualifications, e.g. with regard to chip cutting mechanics, machine building and electrical engineers and IT specialists. The stated reasons for this development are manifold: insufficient education, no prospective personnel policies in companies, increasing outsourcing or dramatic staff reduction. Training positions in companies for e.g. chip cutting mechanics and electronic technicians were cut down even when the shortage was already evident.

> »With the reduction of training the industry is biting in the hand that is feeding it. This means that the industry deprives itself – not only in terms of skilled work but also in terms of academic qualifications« (Görner 2007, p. 3).

The concrete proposals of IG Metall for the skilled worker initiative in detail (Görner 2007, p. 4ff.):

1. Further qualification of engineers
   Engineers are in the centre of the discussion on a shortage of skilled workers. The VDI (Verein Deutscher Ingenieure The Association of German Engineers) reports 24,000 open positions for engineers. In order to eliminate this bottleneck in the short term, further training measures tailored to the needs of the currently unemployed and elderly unemployed engineers have to be offered. Thus the reintegration into the labour market of as many as possible of the current 23,000 unemployed engineers is feasible.

2. Abolition of tuition fees
   The introduction of tuition fees increases the obstacles for a study course, above all for young people coming from poorer families. Children from working class families are already underrepresented in universities and universities of applied sciences. This is not only unjust but also economically counterproductive. An economy depending on the »raw material« education and training such as the German economy cannot afford such a bad exploitation of its potentials.
3. Reduction of drop-outs
   The engineering study courses witness a dramatic quota of drop-outs (up to 50 per cent!). This is also a consequence of a lack of quality of study courses and apprenticeship training. The universities and the universities of applied sciences must make great efforts instead of routinely putting the blame to the insufficient entry qualifications of the students. If the efforts to draw more graduates of the dual vocational training system to the universities are successful, the entry prerequisites will presumably drastically improve.
4. Opening of universities and universities of applied science for occupational competency
   The obstacles to take up a study course without a formal entrance qualification for people with occupational qualifications remain to be too tough. The existing regulations are obscure, the framework conditions insufficient and the prejudices at universities much too high. Transparency must be created, incentives must be given and prejudices have to be abandoned. The Federal Government should initiate a comparative survey of the different study entrance qualifications.
5. Realize a training quota of seven per cent
   A training quota of a minimum of 7 per cent across all sectors would sustainably safeguard the need for skilled workers in the future. There is a backlog demand everywhere, above all in the IT area. According to the Report on Vocational Education and Training 2006 (*Berufsbildungsbericht 2006*) the machine building sector with 6.5 per cent ranks best in our branches. The metal industry hardly attains 6 per cent, vehicle construction a mere 4.4 per cent. The electrical and data processing technology settles for 4.1 per cent of the apprentices and the IT area does not even reach 3.8 per cent — with a clearly declining trend.
6. Win women for technical occupations
   The low number of women in technical occupations and in engineering and natural sciences study courses is a waste of national economic resources. This is underlined by the Report on Technology of the Federal Government (*Technologiebericht der Bundesregierung*). The Report on Technology shows that there were two male graduates per female graduate of each engineering and natural sciences study course in Germany in 2003. The fact that the ratio in Sweden is just 1.6, in the United States only 1.45 and in Italy, Spain, and the UK even just 1.4 proves that the problem is not to be blamed to the women.
7. Systematic development of further training
   The further training of older employees must eventually move to the focus of corporate personnel policies. Opportunities for further training must be open for all employees. The financial funding of the offer has to be safeguarded. Compared to Europe, Germany shows a considerable backlog: Germany is only back-

bencher when it comes to important indicators such as expenditure in money and time, participation quota.

8. Introduction of a skilled worker monitoring
   IG Metall demands a systematic forecast and a better assessment of the need for skilled workers in the various sectors. Far too many companies cheat themselves: They do not train apprentices as they expect that qualified personnel can be recruited on demand on the labour market or hired as temporary staff. The question is, however, who is training staff for these needs?
   The practice of outsourcing has also blurred the overview of the real need for skilled work in the value-added chains. New regional and sector specific instruments must be developed and applied.
9. Also agencies for temporary employment must engage in training
   So far they are far from doing this at all. Agencies for temporary employment can either offer training at their clients', i.e. in the companies employing temporary staff, or in own initial and further training institutions. Five days of further training per year should be taken for granted for each temporary employee. And every employee must be entitled to a personal qualification interview. Abroad, e.g. in the Netherlands, this is financed via cost sharing systems.
10. Highest priority must be given to an active labour market policy at the *Bundesagentur für Arbeit* (Federal Labour Agency)
    The policy logic of the Federal Agency must be changed. A swift and cost-saving integration into the first labour market as the only business objective is only successful in the short term. The long-term occupational perspectives and the relevant required qualifications must be given priority.

During the past years we have indulged to the luxury to obstruct the way to vocational education and training for thousands of young people willing and able to undergo training and we have placed them in waiting loops.

At least 100,000 »old« applicants could be trained for a qualified skilled worker occupation within just three years. And young people who find training difficult could be granted the right for assistance during their training.

Gesamtmetall (2007d) also demands further action for the fight against the shortage of skilled workers. The following demands are stipulated in their Annual Report 2006/2007 (Geschäftsbericht, p. 53-56):

- Safeguarding a pool of junior M+E workers by securing and maintaining the ability and the willingness to undergo training,
- Communication of the occupational profiles and of the changes in the world of work,
- Safeguarding of an occupational information policy across all Federal States in terms of quality and contents,
- Transparency of the entire image of the companies/ sectors of the M+E industry (care for image),
- Win teachers as multipliers via a good image of the M+E industry,
- Presentation of the products and the techniques of the M+E industry,
- Proof of the commitment of the associations and companies for training (Public Relation policy),

- New models for a more flexible training (safeguarding the attraction of the dual training course),
- In-firm qualification and personnel development,
- Incite an enthusiasm for technology in young people.

Furthermore Mrs. Kunstmann, General Manager of Gesamtmetall, in a guest commentary in the magazine VDI-Nachrichten (cf. Gesamtmetall 2007c) demands the necessary re-design and improvement of the curricula and of didactical emphases during teacher training, the qualification of unemployed persons and the adequate further training of above all older employees. The recruitment of foreign skilled personnel is also an option worth considering in order to fight the shortage of skilled workers.

10.2 Entrepreneurial initiatives

The findings taken from the so-far conducted case studies reveal a great number of measures which have already been implemented or will be used in the sector in the years to come in order to avoid and/or to fight the shortage of skilled workers. The better part of these measures were not specifically developed and tailored to the shortage of skilled work but the majority of them have been developed in the surveyed enterprises within the framework of comprehensive personnel marketing or recruitment concepts. The measures and concepts can be allocated to five major fields of action. These fields of actions are presented below along with the individual measures:

1) In-firm training

In order to avoid a shortage of skilled workers, in-firm training can be a strategic field of action. The case studies clearly reveal that a lot of commitment is invested in training as a best-practice approach in order to train the required junior staff by in-term measures. A special advantage is seen in the fact that the prospective skilled workers cross the line towards a social and specialist adaptation to the specific framework conditions of the enterprise already during their training. The framework conditions for an optimal use of the means of in-firm training already begin some time prior to the start of the training course. Thus companies make great efforts to create a positive employer image and to encourage loyalty to the company as a potential training company in pupils and partly even in pre-school children. Here is a list of measures implemented by companies:

- Cooperation with pre-schools in order to incite enthusiasm for technology in children,
- Offer of special courses in schools (e.g. training for applications),
- Contacting and keeping in touch with the pupils' parents,
- Qualification of the teacher staff of the school (technology know-how),
- Offer of school internships in the company,
- Offer of electro-technologically oriented courses at schools,
- Award of a price for the best electro-technological innovation developed by pupils,
- Organisation of project weeks in the company for pupils,
- Participation in training fairs,
- Promotion of girls and women in technical occupations (e.g. Girls' Day).

Apart from measures ensuring the loyalty of pupils to the enterprise in order to sustainably safeguard the recruitment of good apprentices, companies also have the opportunity to co-shape the training courses. The aim is to design a customized qualification within the framework of the training in terms of the subsequent requirements for qualifications of skilled work. The case studies clearly revealed that SME have a major interest to integrate the apprentices as early as possible into the real production process. In that way the apprentice can acquire work process know-how crucial for coping with daily work tasks at a later time. The increasing specialisation in many corporate fields of production (e.g. increasing requirements for precision and qualifications) as well as the high complexity of a lot of plants lead to the fact — as skilled workers put it — that the traditional forms of training in a training workshop are no longer sufficient to prepare future skilled workers for their tasks in specialised production areas. Therefore it is deemed helpful to determine as early as possible the field of production where the apprentice will be working later. Practical know-how for this area can then be acquired during the training — also within the framework of real hands-on work.

2) Recruitment (external)

The companies consider the classical form of external personnel recruitment as rather problematic when it comes to satisfy the need of qualified skilled workers on the shop-floor level. On the one hand the inadequate number of skilled workers on the labour market is criticised, on the other hand this target group lacks mobility. Nevertheless the companies can use some helpful measures for external recruitment:

- As a best-practice strategy e.g. the explicit recruitment of older skilled workers can be named.
- Another instrument for the target oriented recruitment of skilled workers from the region is the participation in regional job fairs.
- A search via the internet or the recruitment via the company's webpage is increasingly replacing advertisements in regional journals.

3) Further training/ personnel development

The field of action further training/ personnel development holds further important potential for the company's dealing with the shortage of skilled workers at the shop-floor level. There are manifold opportunities:

- To qualify externally recruited employees for the specific requirements of the corporate fields of production,
- To keep in-firm skilled workers at a qualification level according to the requirements and to quality them for future developments,
- To »higher qualify« also semi-skilled or (in individual cases) unskilled employees for skilled work tasks.

In the case studies, some instruments could be identified which can be used in order to reach these aims:

- Employee appraisal and target agreement conversations,
- Application and use of a qualification matrix (documentation of the state of the qualifications of each skilled worker; use as a reference document in order to derive and to control the need for qualification),

- Training of new employees within a mentoring system
- Computer-aided administration of the competencies of the skilled workers and their further training measures (e.g. SAP),
- Close contact and communication of the seniors with the skilled workers in order to quickly identify acute qualification deficits and to derive adequate measures,
- Development of an in-house seminar offer realized by in-firm specialists (this ensures a quick on-demand access to and design of company-specific needs for qualification).
- Consideration of methodological and social competency development apart from the adaptation of the specialist qualifications of skilled workers.

4) Knowledge management

On all levels of the surveyed companies emphasis was laid on the necessity to document knowledge. First experiences with the »migration« and/or the loss of expert know-how on the occasion of experienced older employees leaving the company have underpinned the importance to keep such know-how in the company through documentation. Nevertheless no concrete best-practice examples for a successful knowledge management system could be identified yet. First ideas are still being developed in some companies. The main idea is to ensure that the special knowledge of experienced skilled workers with the handling of the plants and the production courses — so-called »tricks and tips« — should be documented in a problem-oriented data base which should be open for the younger skilled workers in the enterprise.

5) Regional sector networks

In one of the surveyed economically underdeveloped region, the regional sector network works as an innovation network for the support of the business location and promotes the regional image. The network is a joint venture of companies from the field of machine building. They aim at a cooperation with a regular exchange of information, experiences and knowledge in order to strengthen the economic and technological performance of the regional medium-sized machine building companies. Creative solutions and practical experiences for current topics are being exchanged. Eight regional enterprises have presented their successful concepts for the recruitment of employees and the company loyalty as activities against the shortage of skilled workers. Among other the impact of the demographic development on the labour market was discussed as well as methods for the assessment and the improvement of employer attraction, issues on the working atmosphere, on the integration of new employees into the company, further training offers, programmes to support junior staff and the improvement of family friendliness in the enterprise.

11 Conclusions

Based on the survey of the situation of skilled work on the shop-floor level conducted so far in enterprises of the metal and electrical industry in Germany, some first conclusions can be drawn:

- A shortage of skilled workers on the shop-floor level of the M+E industry can be identified, albeit so far just on a company-oriented and regional level.

- The requirements for skilled workers have clearly increased in the past years: This development is above all true for the handling of new technologies, forms of organisation, materials, requirements for accuracy and quality standards.
- Companies report problems with the recruitment of new staff based on a shortage in adequate specialist qualified skilled workers on the free labour market. The applicants' profiles are often not suitable for the specific requirements of the corporate fields of production, thus entailing prolonged on-the-job training phases – provided that personnel is found at all.
- Associations speak of a home-made problem of the companies: A lack of commitment in in-firm training is also responsible for the difficulties with the recruitment of skilled workers.
- Measures and strategies against the shortage of skilled workers can be observed in different fields of action:
  a) Future oriented personnel marketing in schools and shaping of in-firm training,
  b) Further training/ Personnel development (in-house and external, oriented to work process),
  c) External recruitment (e.g. focus on older skilled workers)
  d) Knowledge management in order to avoid a loss of know-how in the light of the demographic change,
  e) Regional sector networks.

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