

**Medical Technologies:
Case Studies
Bayern and Baden-Württemberg
Preliminary Draft**

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1. Bayern

1.1. Sample of case studies

Six companies were interviewed within the case study exercise for Bavaria. The selection was made to cover a wide range of companies according to company size, products and location. The selected companies are presented in Table 1.

Table 1 Selection of companies - Bavaria

Company	Interview partner	Size of company (employees)	Product
Instrumentarium Imaging <i>Nürnberg</i>	F. Klein <i>HR-Manager</i>	155	Diagnostic imaging devices based on X-Ray technology.
JAEGER/VIASYS Healthcare <i>Höchstberg</i>	I. Arnold <i>HR-Manager</i>	320	Respiratory technologies Sleep diagnostics Electrophysiology Clinical services
P.A.L.M Microlaser Technologies AG <i>Bernried</i>	G. Schuller <i>HR-Manager</i>	70	Micro-laser systems for cell manipulation with light. Laser micro-dissection and pressure catapulting technology (LMPC)
Rupp & Hubrach Optik GmbH <i>Bamberg</i>	H. Kniec <i>HR-Manager</i>	550	High quality ophthalmic lenses
Scanditronix Wellhöfer <i>Schwarzenbruck</i>	R. Plompen <i>Managing Director</i> M. Arold <i>Quality Manager</i> K. Hensen <i>Marketing Manager</i>	60	Dosimetry systems for radiotherapy and radio-diagnostic devices; Software and application services.
Siemens Medical Solutions <i>Erlangen</i>	F. Schwalb <i>HR-Manager</i>	7000	Diagnostic imaging devices (X-Ray technology); Computertomographs; Magnetic resonance imaging; Radiotherapy applications; Hearing devices; IT services; Clinical services;

All companies were interviewed personally by staff members of Economix. The interview partners were HR-managers in general. In one case the managing director gave the interview, accompanied by members of the managing staff. The interviews were prepared on the basis of the information provided in the telephone

interviews, and in addition by Internet research and company reports. The interviews lasted for two hours on average.

The companies can be introduced by the following stylised facts:

Instrumentarium Imaging

The company has a long history going back to the beginning of the 20th century when first X-Ray devices were developed. Today it produces diagnostic imaging devices for mammography, dental and surgical imaging, based on X-Ray technology. The company was part of a Finnish holding which was taken over by General Electric in 2003. Already before takeover the company was represented globally.

The German subsidiary had a turnover of 30m € in 2003. Overall sales stagnated in comparison to the previous year but a strong increase is expected for the next two years. The export share is about 75 %.

The company employs 155 workers, most of them as production workers. The share of scientists and engineers is about 8 %, 10 % holding a university degree. Skills shortages are a problem for the company.

JAEGER/VIASYS:

The company was founded in 1956 to produce high quality medical devices. It specialised on lung function diagnostics, sleep diagnostics, electrophysiology, and clinical services. In 1963, the first industrially-produced body plethysmograph and in 1965, the first complete laboratory for lung function diagnostics were introduced. The first microprocessor systems were finally used in 1978. Since 2001 JAEGER is part of VIASYS Healthcare Inc. (Conshohocken, Pennsylvania, USA).

The company rates itself as a technology leader with an export share of 50 %, exporting to 80 countries worldwide. The company is strongly growing.

Employment is expected to expand slowly during the next three years. Skills shortages occur but are of minor importance. About two thirds of the staff holds a university degree in natural or engineering science.

P.A.L.M Microlaser Technologies AG

The company was founded in 1995. It produces micro-laser systems which provide the laser micro-dissection and pressure catapulting (LMPC) technology, a modern technology for "non-contact" precise laser micromanipulation to isolate and transport biological matters with light. The laser system is used for non-contact micro-dissection, micro-surgery and micro-injection. The company provides laboratory and training services.

The company holds the patent for the technology and assess itself as the technology leader. The export share of turnover is 60 %. Turnover is strongly growing. For technology and export development, cooperation with Zeiss was established.

The company employs 60 workers and expects stable employment during the next three years. 20 % of the staff are scientists (biologists, engineers), and 15 % are engaged in R&D activities.

Rupp & Hubrach

The company was founded in 1922 and – until recently – managed by family members of the founders. In 2003 the company was taken over by BBGR, a French producer of ophthalmic products. In addition to glass lenses, the company produces light-weight lenses out of plastic and polycarbonate. The company is a technology leader in lens refinement (broadband anti-reflective coated spectacle lenses) and hard-coat lens protection (GHnc). It was awarded for innovative products and HR-management practices for several times.

The company was continuously growing during the past and expects stagnating turnover for the next years. Sales are concentrated on the German market (export share of 6 %).

The size of the company staff is actually 550. Only 2 % are scientists or engineers. Skill requirements concentrate on opticians which is an occupation trained within the dual system.

Scanditronix Wellhöfer

The company emerged from a Siemens subcontract. Today it develops and produces dosimetry systems for radiotherapy and radio-diagnostic devices, including software and application services. As a family owned company it was recently taken over by IBA (Ion Beam Applications, Louvain-la-Neuve, Belgium), one of the worlds largest companies providing services and equipment for nuclear medicine and cancer therapy and other related products.

Turnover was growing rapidly during the last 12 months and the expansion is expected to continue. Exports have a share of 85 % of turnover.

At the German location 72 workers are employed. 20 % are scientists and engineers. 10 % have university degrees. Employment is expected to grow rapidly during the next three years.

Siemens Medical Solutions

Siemens Medical Solutions is part of the Siemens holding. It started in the 1930ies with the takeover of a X-ray producer (Reiniger, Gebbert & Schall) at Erlangen. It developed to one of the leading companies in diagnostic imaging, and radiotherapy devices. In addition to the X-ray technology, magnetic resonance and ultrasound technologies are applied. In addition to the wide range of products in

these fields the company provides IT services and clinical services (workflow consultancy and administration).

The company turnover is 700m € with an export share of 80 %. Markets are expected to stagnate over the next three years. The company assess itself as a market and technology leader. It has a dominating role in the region of Erlangen.

It employs 7000 workers. 40 % are scientists and engineers, and 7 % are engaged in R&D activities.

1.2. Market conditions and business development

- All of the companies interviewed operate on growing product markets and expect further growth or at least no downturn for the future.
- The majority of companies have a long tradition, having been founded decades ago and having developed their technological competences and their market position over long periods.
- All companies are technology leaders, even if some of them are operating on narrow and specialised product markets.
- Most of the companies are export oriented with export shares well above 50 %.
- Most of the companies have a strong financial background belonging to big manufacturers in Germany or abroad. If they are not part of a holding they cooperate with big companies in their technology segment.

1.2.1. Growing markets

Market conditions for medical technology products are favourable in comparison to other manufacturing markets. This was already the result of the telephone survey and is now reflected in the case study interviews. Only one of the companies had a decline of sales revenues during the last 12 months, for two companies turnover stagnated and the remaining three were growing – two of them were strongly growing.

This can be assessed as exceptional condition because the market is burdened by two negative factors: Firstly, the cyclical downturn of the German economy resulted in stagnating nominal turnover of the manufacturing sector in 2003 after a decline in 2002. Secondly, the reform of the health care system in Germany restricted expenditures of the public health insurance system (which covers 95 % of the population). This led to negative adjustments of investment plans of hospitals and surgeries. Both factors, however, were at least partly compensated by high exports and technological strength. Market prospects are therefore assessed positively by the companies.

The effects of the health care reform in Germany were not considered as a serious problem by the companies. By contrast, some of the companies expected positive effects due to the need of clients to search for cost-effective devices particularly provided by smaller companies. The termination of long-lasting policy debate on health care reform was also considered as a factor reducing the uncertainties of

investors and consumers. In the long-run companies expect further growth of the private health care market. However, there are no tangible plans to develop these segments as the major part of domestic markets is still strongly relying on the public health care system.

1.2.2. Technology based long-term business development

Medical technology markets appear as sophisticated technology segments which open business opportunities for a large number of highly specialised producers. The precondition for market entry is the development of a unique technical solution and the achievement of technological leadership rather than cost effective production and competitive pricing through economies of scale. The medical technology sector therefore is not characterised by large scale producers. As far as they exist, they are operating on specialised markets, like Siemens on health imaging, leaving – even within their own market segment – a wide scope of market activities for other producers. The whole medical technologies sector provides the pattern of a combination of numerous and differentiated market segments which are complementary rather than competitive. Technological leadership and international competitiveness can be achieved in these small but nevertheless profitable market segments by a variety of small and large scale producers.

Market entry is strongly related to the invention of new technologies and applications which can be characterised as functional high quality products. The same is true for survival in these technology driven markets. A leading technology concept and continuous product improvement are addressed by all companies as very important success factors for business development. On the other side, the length of R&D periods is a serious barrier to market entry. As shown by the example of computer tomographs (Siemens) this can take up to 5 or 6 years while longevity of products is not significantly longer. This certainly limits competition by new market entrants and safeguards long-term profitability. The importance of R&D is underlined by the fact that many of the companies interviewed were established decades ago based on a principal invention of their founder.

In parallel the quality of products and services is assessed as a key success factor. All companies underline that this is not only the basis for market success but restricts competition from low cost countries. Medical doctors as the main clients demand for high quality products which allow optimal medical services. (“Quality is very important if human life is concerned” – Scanditronix Wellhöfer.) Functionality, stability and efficiency are therefore important criteria for client decisions. In addition, medical devices are in many cases supplied in combination with services, beginning with investment planning and covering services like business process consulting, monitoring and administration of processes, maintenance and repair. In very sophisticated and new technologies, like cell beaming (P.A.L.M. Microlaser Technologies), the services of expensive devices are provided by the laboratories of the company.

The prevailing favourable market conditions created an exceptional environment for business and technology development. The continuity of growth during the last years improved the profitability of R&D investments and allowed for high invest-

ments in new products. Low price competition further contributed to profitability and improved the conditions for long-term investments.

The business development strategy can be exemplified by the case of *Rupp & Hubrach Optik* who predominantly operates in the protected German health care markets with ophthalmic lenses. Due to subsidised prices for spectacles, competition between several important producers concentrated on product quality rather than prices:

The company developed a R&D strategy which targeted at technological leadership. This was partly achieved through product innovation (silicate lenses, polycarbonat lenses, hardcoat lens surfaces, phototrope lenses etc.). Being aware that such a leadership can only be established for limited time periods (two years at maximum) innovation was integrated as a continuous business process. 8 to 10 new products are launched every year. The innovative strategy included investments into a new factory in 1998 ("one of the most modern production facilities in Europe"), the introduction of a "Total Quality Management" system, the development of an internal programme for continuous training, and flexible working time schemes. The target is to achieve delivery of the 19,000 standard lenses by just in time production within one day. Bespoke lenses are delivered within a few days. Marketing and sales activities are concentrated on superior market segments (quality conscious opticians). This requires a strong customer orientation of all workers. TQM is "lived rather than practised"¹.

The example shows how the overall company strategy to be a technological leader was strongly linked to investments into production technology, the reorganisation of the business process and – in particular – investment into human capital. In common these elements allowed approaching the market under the label of an innovative and high value producer. This strategy was profitable enough to keep large parts of production in Germany – or vice versa – its profitability depended on the supply of skilled workers on local labour markets who are flexible enough to adjust to technical and organisational changes.

A similar strategy is followed by the large scale producer *Siemens* who located the production of medical devices mainly in Germany and the USA. However, the company states that there are significant incentives to relocate production due to lower wages and an improving skills basis in other countries. Parts of software production are relocated to India; hearing aids are produced in Malaysia etc.

1.2.3. Export orientation

Almost all of the companies interviewed developed an export oriented market strategy independent from the company size². Through technological specialisation a unique market position was achieved not only on the German market but internationally. While market volumes are limited exports allowed both extending sales and raising the profitability of R&D investment. In addition, exports reduced the risk of cyclical demand fluctuations.

¹ The company's motto is: „Who stopps trying to get better will soon not be good“.

² This is confirmed by the telephone interviews where the correlation between export shares and size of the company is insignificant.

Thus all of the Bavarian companies are exporting products with shares between 6 and 85 %. The company with the lowest export share operates on consumer oriented markets (ophthalmic lenses), which are more difficult to enter compared to professional medical markets even by a medium-sized company.

Export strategies were developed over decades rather than years. Generally, it started with exports to the German speaking countries Austria, Switzerland and Luxembourg as language barriers are still a problem to some of the companies. Similar product regulations in the countries were also important. The entry into the US market was a major step for several companies as the approval by FDA standards opens markets world-wide.

Export strategies can be developed without important obstacles as far as national product approval is available. Other trade barriers are not substantial. Distributive networks can easily be established either through own sales representatives or in co-operation with other companies. The activities of the companies are now concentrating on the new Member States of the European Union and on China.

1.2.4. Financial background

Long and expensive R&D investment periods create substantial financial risks which were covered in different ways by the companies interviewed. Three principal strategies can be discerned:

- Financial resources for R&D budgets are (mainly) from the company's own cash flow. This is the case if the company holds its market position since a longer time period and if R&D investments concentrate on product improvement rather than principal inventions.
- The company is a spin-off from a university or another company. Around Siemens Medical Solutions there are various cases in which former employees founded new companies (Instrumentarium Imaging e.g.). Also subcontracts for large companies can be the stimulus for the creation of a company. The time period for inventing and developing new products is thus partly financed by other stakeholders.
- R&D activities are (partly) financed through co-operation with other big companies (P.A.L.M. Microlaser Technologies has a co-operation with Zeiss). Similarly Siemens Medical Solutions is part of the Siemens holding who compensated critical financial losses of its dependent some years ago.

All six Bavarian case study companies selected alternative three. Five of them are part of German or foreign companies and the sixth established the co-operation mentioned above. This is opposed to the findings of the telephone survey where two thirds of the Bavarian companies are independent. However, most of the companies interviewed are mature companies who operate in their markets for a long time. Only one of the companies can be characterised as a newcomer applying latest micro-laser technologies (P.A.L.M. Micro Laser Technologies). This can be taken as an indication that in the long-run co-operation with or take-over by larger companies becomes part of the game.

1.3. Skill requirements

The example of Rupp & Hubrach revealed already that the technology-oriented business strategies of the companies are strongly skills-based. Similarly the representative of Instrumentarium Imaging stated: “We recognise that we are often one step ahead, and this is due to the skills and motivation of our workers.”

To achieve this level of human resource development, two conditions are considered to be important:

- Firstly, the German labour market provides a sufficient volume of trained workers in many manufacturing and commercial professions which avoids skills shortages. None of the companies reported on a general skills gap. Only partial problems arise in highly specialised areas (opticians, software development e.g.). The international comparison of skill levels still is in favour of Germany, however, other countries are recognised as narrowing the distance continuously (India in particular). Larger companies like Siemens Medical Solutions are recruiting internationally (Siemens employs workers from 20 nations).
- Secondly, the companies have established their own training programmes. They are all actively involved in apprenticeship training and support continuous education. Continuing training is used to adjust knowledge to changes in business processes rather than filling substantial knowledge gaps. A general lack of language skills is a problem to many of the companies.
- Thirdly, the organisation of team work and the creation of a corporate identity appear as important factors to foster the motivation of workers and thus the efficiency of the working process. Most importantly, however, it is the basis for efficient knowledge management and long-term technological leadership.

1.3.1. External labour markets

In general, external labour markets provide all kinds of skills and competences needed by the companies. Actually there is a high volume of professional job seekers like engineers, biologists, physicians etc. which allows companies to select the most qualified and experienced workers. Companies are also recruiting from abroad, from EU countries in particular. The bigger companies have relations to universities which they also use for recruitment purposes. The smaller companies, however, refer to the external labour market searching for experienced workers rather than newcomers.

Nevertheless the companies interviewed also reported on hard-to-fill vacancies. Difficulties in recruitment of staff are related to the location of the company, its competitive position on local labour markets, and to the specific skill needs. Siemens e.g. reported on difficulties to recruit qualified international staff to the less attractive region of Erlangen. Rupp & Hubrach had difficulties to be competitive against the high wages of the major local employer (Bosch), and to find the right amount of opticians in the region. P.A.L.M. Microlaser Technologies could not find secretarial staff with sufficient language skills.

Parts of the production workers have to be experienced in complex production techniques, like lens refinement, laser technologies or X-ray techniques. The ma-

jority, however, is engaged in assembling of specified devices which require a sound knowledge of industrial production techniques. This does not exceed the general manufacturing standards which are provided by apprenticeship training and professional working experience.

1.3.2. Continuing training

Most of the companies follow a top-down approach when skill requirements are defined. The starting point is the business plan which defines company targets, technological requirements and the organisation of the business process. Recruitment and training follow these plans. Generally, the individual needs for training are fixed by yearly talks with every staff member. These talks are used to assess the working results and achievements, and to define actions for competence adjustments.

Continuing training is also organised as project work, e.g. Rupp & Hubrach organised a project on information management in which 11 young workers were engaged. They developed a new concept for internal communication. The management level is involved in the project and results are presented to the top management. The project targets at both the training of content-oriented development and the training of customer-oriented team work.

1.3.3. Team work and multidisciplinary competences

The link between technical and medical science is established through interdisciplinary working teams rather than workers with multi-disciplinary knowledge. The companies prefer professionals, like engineers, software specialists, biologist and medical doctors and create development teams for specific purposes. Specialised knowledge is preferred to multi-disciplinary scientific knowledge which is expected to be less professional. Team competences, however, are a must and are actively supported through particular training programmes. Marketing and sales activities require a larger extent of multi-disciplinary knowledge than development activities.

Companies are thus reluctant to support multi-disciplinary university courses like the medical-engineering courses provided by two Bavarian universities. There is no urgent need for this type of training even if it might have some advantages for new entrants. The multi-disciplinary courses appear to be promoted by universities rather than the companies of the sector.

1.4. Regional development clusters

Similar to the creation of multi-disciplinary university training, the creation of regional medical technology clusters seems to be driven by politicians rather than companies. Most of the companies are located in the region since decades and there was no incentive to relocate. The only exception is P.A.L.M. Microlaser Technologies who moved from Wolfratshausen to the 30 kilometers distant Bernried (on the other side of the Starnberger See). This was due to active support by the mayor of Bernried who intends to attract a variety of medical technology firms.

Similarly, the region of Erlangen is strongly developed by the major of the city as a medical technology area (Medical Valley) based on the long-lasting presence of Siemens.

The companies themselves have a quite neutral position to the question of regional technology clusters. They all underlined that both their customer and sub-contractor relations are wide-spread in Europe and throughout the world. The local economy provides no basis for their activities. Even the local labour market has no great importance as professionals are recruited nation-wide or internationally. Manual work is recruited from a greater travel-to-work area and would be available in many regions in Germany or abroad.

The relation to hospitals, universities and other training institutions are also not restricted to the region of residence. Product development and testing of products is undertaken by specialised hospital departments. Connections are determined through specialisation and personal contacts. Some medium-sized companies promote universities through projects and funding of examination theses.

Company networks are the exemption. In general, co-operation between firms is difficult due to competitive relations and problems of intellectual property in particular. Firms prefer to co-operate with institutes of the Fraunhofer Gesellschaft (see Baden-Württemberg) in the area of product development and testing. This non-profit organisation is a service provider for R&D and has no direct market relations.

The reason why most of the companies did not move is that the incentives to relocate are too small. As Siemens stated for the Erlangen location, "there is no strategic advantage, and there is no political will to move." There are disadvantages caused by German labour regulation, by competitors on regional labour markets etc. but – considering the cost of removal – they are not exceeded by the advantages of other locations.

One important part of the cost of removal is seen in the association of a company and a region by the customers. In very general terms, the companies stated that "Made in Germany" still is a valuable argument for the market. This makes companies reluctant to relocate to foreign countries and makes German companies attractive for foreign competitors. More specifically, a company like Siemens is associated with its seats at Munich and Erlangen. Any removal might have uncalculated effects on customer behaviour. This does not prevent large companies like Siemens to relocate parts of production and marketing to foreign countries.

In sum, industrial clusters are marketing instruments rather than economic needs. Companies can profit from belonging to such clusters. However, their business does not depend on this fact. Even the regional labour market is no important argument to create such clusters as recruitment is done within wider national or international areas.

2. Baden-Württemberg

2.1. Sample of case studies

Six companies were interviewed within the case study exercise for Baden-Württemberg. The selection was made to cover a wide range of companies according to company size, products and location. The selected companies are presented in Table 2.

Table 2 Selection of companies – Baden-Württemberg

Company	Interview partner	Size of company (employees)	Product
BOSO Bosch & Sohn GmbH <i>Jungingen</i>	O. Wolff <i>Managing director</i>	95	Blood pressure analyser Heart frequency analyser Ergometers Wellness products
Erbe Elektromedizin <i>Tübingen</i>	E. Grimm <i>HR-Manager</i>	300	High-frequency surgical devices; Hydro-jet surgical devices; Kryo-surgical (low-temperature) devices; Endoscopic devices;
Hartmann <i>Heidenheim</i>	P. Horndasch <i>Director of HR Management</i>	9640	Wound care products, compressions, bandages Incontinence products, baby care, feminine hygiene Thermometers, blood pressure monitors
IPA - Fraunhofer Institut für Produktionstechnik und Automatisierung <i>Stuttgart</i>	J. Stallkamp <i>Head of new products division</i>	200	Research & development for surgical devices, sensors.
Kodak Health Imaging <i>Stuttgart</i>	B. Topuz <i>Head of service and support division</i>	150	Radiographic films Digital image processing Laser imaging systems Medical information systems
Welch Allyn (former Speidel & Keller) <i>Jungingen</i>	F. Gruski <i>HR Manager</i>	156	Blood pressures gauges Stethoscopes Thermometers other diagnostic devices

BOSO Bosch & Sohn

The company mainly produces blood pressure analysers for private and professional use. In addition, ergometers and wellness products are produced. It became prominent as supplier of the European Space Agency (ESA) for which BOSO developed specific blood pressure analysers. The company was founded in 1965 as spin-off from a local company (Welch Allyn, see below). It is a producer of a

“mass product” using a standard technology introduced by a Japanese inventor 25 years ago. Product improvement is the focus rather than innovation.

Annual turnover ranges between 10 and 50 m €. It stagnated during the last 12 months but is expected to grow in the future. The export share is comparatively low (25 %). On private markets it is faced with competition from large producers (Hartmann). On professional markets three of the four main competitors are located in Jungingen. Price competition is strong.

The company employs 95 workers, many of them are women. It mainly recruits skilled manual labour on local labour markets. Only 4 employees hold a university degree. All of them are employed in product development. Recruitment problems arise on the labour market only for highly skilled manufacturing mechanics (Meister).

Erbe Elektromedizin

The company was founded in 1847 in Tübingen and developed as a market leader for surgical devices. It has a market share of 90 % in Germany and undertakes exports worldwide. The products are surgical devices using high-frequency, hydro-jet and kryo technologies. In addition endoscopic devices are produced. The surgical devices allow preventing treatment of patients with high precision of surgery.

Turnover ranges between 50 and 100m € and decreased during the last year. The company expects slow growth for the market. The export share is 90 %. The company is managed by a family representative and is financially independent.

At Tübingen headquarter 300 workers are employed. Worldwide staff is 450. 20 % of headquarter’s staff are scientists or engineers. 10 % are working in R&D. The recruitment situation in the region leads to partial skills shortages, in particular as regards highly specialised technical skills.

Hartmann

The company was founded in 1818 at Heidenheim. It is an independent company which has grown to a leading producer of medical supplies. The company produces wound care products, compressions, bandages, incontinence products, baby care, feminine hygiene, thermometers, blood pressure monitors, first aid devices and other products. Sales are split at almost equal shares among medical customers, patient care and consumer products. With the acquisition of Kneipp in 2001 the product spectrum was accomplished with herbal medicines and food supplements.

Total sales revenues were 1,3b € in 2002 – a 10% increase to the previous year. The company is represented in 36 countries and has an export share of 56 %. Markets are characterised by large producers (Procter & Gamble, Johnson & Johnson, Nivea), and competition is driven by both innovation and costs.

The company employed 9640 workers in 2002, a decrease of 2.5 percent to the previous year. There is a great need for sales and marketing specialists. There are no severe skills shortages.

IPA - Fraunhofer Institut für Produktionstechnik und Automatisierung

IPA is part of the Fraunhofergesellschaft, one of the big semi-public research & development bodies in Germany specialised on applied engineering science. The development of medical technology products ranges among a wide spectrum of activities like automation technologies, measurement engineering, production and quality management, technical consulting etc. In the area of medical technologies IPA concentrates on surgical devices, sensors and minimal-invasive robotics.

IPA had a turnover of 31m € in 2002. It has a strong position in applied engineering science and serves a wide range of manufacturing companies as research and consulting partner. It is supported by the Federal government and the government of Baden-Württemberg (40 % of total revenues). It is concentrated on German customers with minor relations to companies abroad.

The department for “New Products” employs 40 persons, mainly scientists and engineers. None of them hold a degree in medical science. Skills shortages are not a problem at all. Recruitment is mainly done among university students.

Kodak Health Imaging

Already in the late 19th century Kodak developed films for radiographic imaging. In addition to films, today the health imaging division of Kodak supplies digital image processing devices, laser imaging systems and medical information systems. The main product, however, still is film material, having experienced a multitude of innovative improvements. Technological competition concentrates on digital imaging, where Kodak is a late-comer in comparison to the main competitors (Minolta, Siemens). Kodak Health Imaging at Stuttgart concentrates on marketing and customer services for the German market. Production is located in the USA and the UK. Health imaging devices are produced in customer specified versions rather than mass products.

In 2003 turnover was 100 m € on the German market, 20 % of which were achieved with medical products. Turnover decreased during the last 12 months and will further decline in the next 12 months. Kodak Health Imaging in Stuttgart concentrates on Germany and therefore has no exports.

The Stuttgart site employs 150 employees, almost all of them with completed professional training. However, only two hold a university degree. The site lost 75 % of its production staff when the factory was sold in 1998. General problems of recruiting sales and service staff are discerned on the German labour market which forces the company to poach experienced workers from other companies.

Welch Allyn

The company is part of the US manufacturer Welch Allyn (Skaneateles Falls, NY) one of the big producers of diagnostic devices, ergometers, monitoring systems, micro-lamps and defibrillators. The site at Jungingen was taken over from Speidel & Keller in 1992. This company was founded in 1921 producing pulse and respiration frequency analysers. In 1965 one of founders (Bosch) separated to raise his own company (see BOSO). Today the company produces blood pressures gauges, stethoscopes, thermometers and other diagnostic devices. Moreover, it sells all Welch Allyn products.

The company turnover was 20 m € in 2003, with an export share of 75 %. Slow growth was experienced during the last 12 months, and stable turnover is expected for the next year. As a producer of mass products it faces severe price competition.

Staff size is 156 workers, most of them production workers. Half of the manual workers are unskilled. Two employees hold a university degree. There are recruitment problems for skilled workers on the local labour market.

2.2. Market conditions and business development

2.2.1. Growing markets

Like in Bavaria the Baden-Württemberg companies also operate on growing markets, however, their specialisation is less favourable. Their product strategy is stronger related to standard technologies, their markets are more price-sensitive, and competition from low-cost countries is stronger. As a result growth expectations are less optimistic, as was shown by the telephone survey. These findings are confirmed by the case study interviews: None of the companies expects rapid growth during the next two or three years, three expect slow growth and the others calculate with stagnating or shrinking activities. Nevertheless, this can be assessed as favourable economic condition compared to other manufacturing branches in Germany.

The effects of the health care reform in Germany were partly considered as a problem to the companies. Beyond the rise of economic uncertainties among customers, hospitals will be forced to specialise more narrowly, a fact which restricts total market volumes. Profit-oriented behaviour of hospital management will raise competitive pressure among suppliers. However, high export orientation of the companies will open opportunities to compensate losses in Germany. The health care reform will change the market structure and thus the relative advantages of individual suppliers. In particular, X-ray diagnostics will be restricted and thus lead to a smaller volume of sales in this market. The development of a larger private health care markets will give individual patients a stronger influence on demand on medical technology markets. None of the trends, however, is expected to change economic conditions on medical technology markets substantially. Health technology will further profit from rising demand on domestic and international markets.

2.2.2. Quality based long-term business development

Even in product segments which are more related to standardised technologies, the competitive position of companies is based on continuous technological improvements. Long-term business development targets at high-end market segments with high quality standards and continuous product innovation. As the representative of the IPA Fraunhofer stated, “the German medical technology industry has an excellent reputation due to the quality of its products, however, it is not very innovative.”

This strategic orientation is exemplified by ERBE Elektromedizin, the producer of high-frequency and hydro-jet surgical devices. While this company has a leading technological position (market share of 90 % on the German market, export share of also 90 %), its product strategy is concentrated on optimising the existing technologies rather than new products. The technological advantages are assessed to be big enough to keep potential competitors in safe distance. Former competitors on the German market failed due to the lack of technical knowledge. Foreign competitors in the USA and Asia approach low-cost market segments. This allows following a long-term business strategy based on quality improvements of existing technologies and targeted at high-end market segments.

Similarly, BOSO reports that the principal innovation for digital blood pressure analysers happened 25 years ago through a Japanese invention which is applied by the company. Technical optimisation therefore determines product development of the company, particularly concentrated on precision and handling. However, this raises price competition on the particular markets.

Kodak who was the market leader for X-ray film material was rather late in approaching digital imaging where the number of competitors is estimated to be 10 times higher than on the traditional film markets. It therefore lost its leading position. This was associated with the closure of production facilities in Germany and the restriction of business activities to distribution.

Welch Allyn (and the former company Speidel & Keller) holds principle patents for blood pressure gauges and other devices which gives a significant advantage over competitors. The speed of innovation however is limited as the company states. With the take-over by Welch Allyn the company is also distributing the products of the mother company.

Hartmann, finally, operates on consumer-oriented markets more than the other companies. On these markets the company tends to be strong in high-end segments in which product quality and customer service and a bundle of medical supplies creates competitive advantages. The company is convinced that this type of products and services can hardly be relocated abroad. Nevertheless, it feels strong competition from low-cost countries in some market segments. It has various production facilities in foreign countries, in particular where trade barriers are high.

The medical technology sector in Baden-Württemberg has a longer tradition than the Bavarian counterpart. Nevertheless, or even due to that fact, it shows some features which might explain its somewhat weaker position: As the telephone sur-

vey revealed companies in Baden-Württemberg are smaller on average, produce less complex products, use a higher degree of automation, and in particular are operating on more price-elastic markets. But there are also these big players in the medical technology sector like Kodak and Hartmann. Compared to Bavaria, the structure of producers seems to be more segmented between large and small scale producers. Sales to distributors or distribution activities have a higher weight. This might be due to the life cycle of the sector which leads to declining R&D activities, standardisation of products and rising distribution activities over time. It might however also be the effect of regional specialisation existing from the beginning.

2.2.3. Export orientation

The companies in Baden-Württemberg have a stronger export orientation compared to the Bavarian companies, as the telephone survey showed (export shares: 46 % compared to 25 %), and they are represented in the markets which are more difficult to access. Among the companies interviewed export shares move up to a maximum of 90 % of turnover. ERBE has the USA as its most important export market and is approaching China and Japan. The Welch Allyn subsidiary at Jungingen estimates its world market share at 10 %. Hartmann is an international company who exports high-end products from Germany but runs production facilities in many other countries. BOSO concentrates on Germany and some of the European countries. Kodak as the German representation of the US holding is an import rather than export oriented company, but nevertheless highly trade-oriented.

The development of export strategies had to overcome barriers, particularly in the USA where difficult patent disputes had to be passed. FDA approval was also an important obstacle. Nevertheless, exports are at high levels and represent a core element of business strategies.

2.2.4. Financial background

Following the dichotomy of companies in Baden-Württemberg, both can be found, the independent German company who uses its own resources for R&D investment and business development, and the foreign owned company who has a financial background through the mother company.

Hartmann, ERBE and BOSO are the cases of the first type. Hartmann developed as a big player, even not big enough to operate as a global player as the company states. ERBE and BOSO are the small specialists being more similar to the Bavarian companies.

The other two companies Welch Allyn and Kodak Germany are parts of bigger holdings operating internationally. These companies either make use of product developments and patents held by the German subsidiary or sell products developed abroad. IPA Fraunhofer, finally, is part of the Fraunhofer Gesellschaft who provides a strong financial background for the IPA activities, and who is partly financed by the German government.

2.3. Skill requirements

In general, skill requirements are strongly defined within the business strategy. The technology oriented company ERBE prefers university graduates whose scientific knowledge is state of the art. Other companies need sales and marketing skills. There are also voices which warn not to overestimate the skill needs. As BOSO stated, "there are two or three clever persons in our R&D department who give the orientation. For the majority of workers, however, qualification is not so important." The assessment of skill requirements is obviously wide spread.

2.3.1. External labour markets

In general, external labour markets provide all kinds of skills and competences which allow companies to select the most qualified and experienced workers. Bigger companies are recruiting internationally, smaller companies locally. The bigger companies have relations to universities which they also use for recruitment purposes. The smaller companies, however, refer to the external labour market searching for experienced workers rather than newcomers.

Nevertheless the companies interviewed also reported on hard-to-fill vacancies. Difficulties in recruitment of staff are related to the location of the company, its competitive position on local labour markets, and to the specific skill needs. Hartmann e.g. reported on difficulties to recruit qualified sales and marketing staff. The company decided to co-operate with the international school at Reutlingen in order to recruit workers.

Companies prefer exchange between companies of the same sector as they provide a greater extent of practical experience and knowledge.

2.3.2. Continuing training

All of the companies follow a top-down approach when skill requirements are defined. The starting point is the business plan which defines company targets, technological requirements and the organisation of the business process. Recruitment and training follow these plans. Generally, the individual needs for training are fixed by yearly talks with every staff member. These talks are used to assess the working results and achievements, and to define actions for competence adjustments. At Kodak, until recently, every worker had to pass 40 hours off-job training per year. Now this was changed to 70 hours on-job training. New entrants are accompanied by tutors during the first half year.

Apprenticeship training is organised in two blocks: One year theory and one year practical experience. This solution is preferred to shorter blocks of three months as usual.

2.3.3. Team work and multidisciplinary competences

Companies are reluctant to support multi-disciplinary university or training courses. There is no urgent need for this type of training, in particular not for development engineers. Sales and marketing staff requires knowledge about the specific markets, customers and the treatment process. This can be acquired through practical work rather than theoretical training.

2.4. Regional development clusters

Baden-Württemberg is an industrial region with a great number of manufacturing companies and was subject to various industrial crises. In particular, the textiles and clothing industries were concentrated in the region south of Tübingen where two of the companies interviewed are located. The region developed medical technologies as one of the alternatives to the declining textiles and clothing business and used the competences of the large amount of qualified workers. Particularly the strong precision mechanics tradition in the region helped to develop the medical technology sector. It appears as an accidental event, that an inventor from Baden-Württemberg received an award for a blood pressure device at Strasbourg by the turn of the 19th century. This event, however, has not yet lost its impact.

In Tuttlingen the University for Applied Science established a department for medical technologies. A network of suppliers developed over time which provided significant economic advantages to the great number of small producers. Regional contacts appear to be important. In addition, the government of Baden-Württemberg supports the medical technology sector through its State Foundation (Landesstiftung). A competence centre MITT (minimal invasive medical treatment – Tübingen/Tuttlingen) was established. This works as a network between research institutions, hospitals and private companies.

The advantages of the Tuttlingen region are relatively low wages and the traditional immobility of workers. The development of the medical technology business therefore was an employment opportunity for workers which they accepted at reduced wages. The disadvantage however is the difficulty to recruit highly skilled professionals who in general are reluctant to move to rural areas. To compensate these disadvantages at least partly, Hartmann actively supports an international school in the region.

Compared to the Bavarian companies, regional networks seem to be more important for the Baden-Württemberg firms. This can be due to the greater importance of distribution activities which rely more on networking. However, it can also be the consequence of regional behaviour which shows a preference for local relations and identities.