

Technology Diffusion through a Multi-Level Technology Transfer Infrastructure

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1. Introduction

Close to this conference site you can watch Japanese cars in the Streets of Soweto and German Airships over the mines of DeBeers.

It is easy to say what they have in common: Both kinds of products show foreign technology. They suck foreign currency and contribute just a little to the development of the local industry.

But how they differ? Cars and their components, mobiles and related products are mass products. They open up even a regional market everywhere and they create additional business for service, maintenance and accessory. Products like this should be produced here.

Flying sensors like the airship, sophisticated measuring equipment and related products need a world market to be successfully distributed and should be regarded as a tool to strengthen already existing industries. They open up a win-win situation when they are bought abroad.

When we talk about Technology transfer or how it is addressed in this conference Technology Diffusion ¹ the focus is how to establish local industries. Local technology orientated competitive and sustainable companies which develop, fabricate and sell products. Companies that earn money employ people and pay taxes.

With respect to the globalisation and the all-dominant position of international companies, the goal is mainly to establish technology orientated competitive Small and Medium Enterprises (SMEs) which create jobs and stay in the region.

2. Multi-level Technology Transfer Infrastructure

This contribution describes how technology driven SME s can be established and raised by the help of a Multi-Level-Technology-Transfer (TT) infrastructure and shows examples from Germany.

¹ *I like the term "Technology Diffusion" the most, because it illustrates much better the process of infiltration depending on the interior structure of the receiver as well as of the donor.*

The main components of this TT Structure are addressed and their interconnections are discussed: universities, public and semi-public research centres, transfer centres, joint venture-like project orientated cooperation of companies (consortia) and single companies. They are linked to a network by public funding and industry projects by pre-competitive joint company cooperation and Alumni structures.

As for any network the description soon can be confusing. Therefore we will regard it from the viewpoint of a person who wants to set up its own business – this person we call an entrepreneur.

The process is very similar regardless whether we look at the founding of a new company, the establishment of a new branch of an existing one or the further development of an old one including the taking over by a successor.

The process is even very similar if one must decide either to buy a technology or to produce it himself, as shown by the airship example.

The entire process will be analysed on a theoretical basis followed by sample company developments.

2.1 Level 1: University Education – Encourage the Idea of becoming an Entrepreneur

In the centre of a company founding process there must always be a skilled and well educated person who is not only a technical specialist but a real entrepreneur. An entrepreneur is a person, who wants to set up a business and who therefore regards it as a requirement to develop his special technical knowledge and his business skills.

Also one should be talented to become an entrepreneur, this ability can be trained.

The basis for all further steps is an excellent university education. It should develop the theoretical abilities and the practical skills.

One should consider that only the university has the chance to influence young people intensively and for a long period of time. Young people learn and develop without existence threatening competition. Later in business there will be no comparable situation.

This is a chance but also a responsibility for the universities. Focussed on our goal they need teachers that understand and transmit the idea of entrepreneurs.

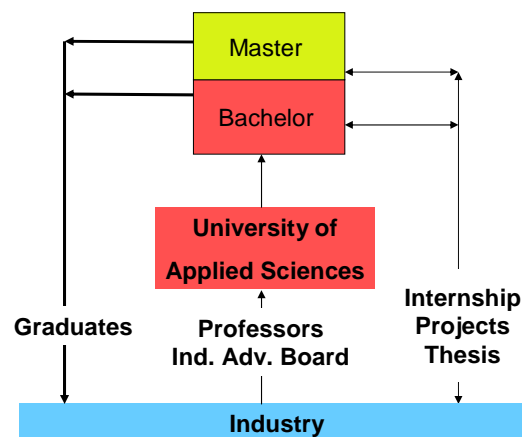
Today the German Academic Education has changed to an international Bachelor and Master Study system.

Focussing on a very practical education in the 1970s in Germany a special form of university education was established, called “Fachhochschule” or University of Applied Sciences. It differs from the Scientific University concept:

- The Bachelor study is designed as a job qualifying education.

In contrast to this the scientific universities offer a Bachelor study which is regarded as an intermediate qualification to finally earn a Masters degree or a PhD.

- At least 12 weeks practical training in the industry before and during the study
- Around 50% of the study consists of practical orientated projects and lab-training
- One practical semester to be done in industry
- Final thesis to be done in industry
- Around 20% of the study contains “soft skills” like business and management, law and related non technical courses, language training, presentation techniques.
- The professors have to prove at least 5 years practical experience in industry
- Establishment of an industry council as advisory board for the university



The University of Applied Sciences (“Fachhochschule”) is a practical orientated Element of the German Academic Education. It is closely linked to the Industry in many ways.

All in all the university education is framed by Industry. As a result, the Graduates do not only get a rich technical knowledge and necessary “soft skills” but much more important they learn to work with the industry.

This mixture of theoretical knowledge and applied practice allows the future entrepreneurs to clearly detect their abilities and develop their skills.

Most of the future entrepreneurs do not decide to set up a company in this phase. This phase better could be called the mental preparation of a latter entrepreneur. Very often in this phase the basic idea of creating a company is born.

In Table 1 the six phases (level 1 to 6) of founding a company are listed together with the professional and the business elements. Additionally it is listed which Technology Transfer Network Partners (TT) contribute to each level.

Level	Phase of Setting up a Company	Elements of Founding a Company		Technology Network Partner, Contribution
		Professional	Business	
L 6	Continuous Innovation	Monitoring of technical Processes	Monitoring of Management Processes	TT Organizations University, Alumni Industry Cooperation
L 5	Development, Consolidation	Definition and Establishment of an own market segment	Publicity, Advertisement Financial Negotiations MBA	TT Organizations
L 4	Foundation of the Company	Develop special know-how for own product range	Marketing Concept MBA	TT Centers, Research Institutes Infrastructure
L 3	Detailed Planning, Definition of Branch Business Plan	Own Projects in a joint University – Research Centre Cooperation, PhD study	Practical Experience in Project and Staff Management, Business Plan	Industry, University Research Centre, Joint Projects
L 2	First Idea of Founding a Company.	First Job, Specialized Education (Master, PhD)	Special Management Courses, Own Experiences	Industry, University Research Centre, Governmental Funding
L 1	Mental Preparation Practical Internship	Basic Technological and Scientific Education	Basic Education in Business, Management	University Industry

Table 1: The six Phases (level 1 to 6) of founding a company, the professional and the business elements and the contribution of Technology Transfer Network Partners (TT).

In Level 1 the TT network is governed by a practical oriented education based on a close link between university and industry

2.2 Level 2: Post Graduate Education – Improve your skills and focus it on a product family.

After graduation most future entrepreneurs do not set up a company, but start their career as an employee. Due to the person and the research topic this might be a job in the university or in the industry. It has to be focussed on the further development of an invention, a process or a product.

Sometimes it can be combined with a master course or a PhD study. Although many aspects are the same as in most other countries, there are some interesting details in the German multi level TT system.

- **Industry Oriented Funding**

Besides the traditional governmental funding which is mostly concentrated on Scientific Universities there is a special funding program designed for Universities of Applied Sciences. It is closely linked to the industry and their needs. To assure this, evaluators from industry are members of the board. A project will only be funded, if a contribution from industrial side is assured.

- **Semi-public Research Institutes**

In Germany there are well equipped independent semi-public research institutes like Fraunhofer Institutes or the Steinbeiss Foundation. They are closely linked to universities, mostly by appointing a professor leader of the institute. Most institutes get a basic funding, which covers 10 to 20% of their expenses. Consequently they are forced to earn the most of their budget with projects. Projects are initiated and financed or co-financed by the industry.

- **Industrial Research Infrastructure**

Attractive conditions are granted by the state and the region to settle industrial research centres close to the university campus. In Aachen for instance among others there are the Nokia Lab, Ford Research Centre, Philipps Research all of them doing research and none or very little production on the site.

In such an environment, the future entrepreneur gets the best conditions for a very specific further education. More he gets contacts to the entire community, the peculiarities of the branch and the characteristics of the market segment.

This phase is backed up by special management courses held by universities or the chamber of commerce. The FH Aachen runs an own MBA course “Entrepreneurship” which is designed for people in the job: The courses are offered in the evenings and on weekends.

In this phase the definition of the technical segment and a first planning of the company take place. Often this is the phase where the final decision is made to found a company (see Table 1, Level 2).

In Level 2 the TT network is governed by the integration of independent research institutes into the university – industry link and back it up with business education

2.3 Level 3: Birth of a Company – Focus your skills on a product and a market segment.

In the moment one decides to set up his own company, he suddenly is alone. His employer as well as his colleagues are not only potential partners but latent competitors as well.

In this phase the state is more interested in a success than his environment.

It is the busiest phase in the life of an entrepreneur. The company’s profile must be developed and sharpened. Product development, market exploration and staff acquisition and training require time and money respectively.

The entrepreneur has to find the right niche and to provide samples. Therefore a broad technical infrastructure is needed to a much more extent than it will be needed by the later company who will focus on a certain product range.

Again university research centres or semi- public research centres like the Fraunhofer Institutes are very supportive. But now the entrepreneur has a different view. He is no longer co-worker but partner and client. He is interested to use the technical infrastructure, skilled specialists on request and the good contacts to the “community”.

To create a win-win situation, the research centres mostly are partners within a joint project and offer specialised support.

Public funding allows a young company to afford this phase and to concentrate on the business. This funding as well allows entering the market by first projects.

Supporting measures are public funded marketing projects such as presentations on fairs and congresses that mostly are organized in cooperation with professional consultants or universities.

In this phase or at least in the next (Level 4) the company is founded

In Level 3 the TT network is governed by joint projects with state co-funded research institutes who provide a specialized technical and personal infrastructure on a temporarily basis (see Table 1, Level 3).

2.4 Level 4: Ready to stand alone – Set up your own business

The developing company needs space, but no one can neither exactly plan what kind and how much of space nor can one predict the further demand of additional space. The company needs an organisational infrastructure, a fully equipped welcome desk, conference rooms, communication infrastructure and many more things. Most of them are either not affordable for a young company or it does not make sense to establish it for an unpredictable period of time.

This is the phase where Technology Transfer Centres are needed. They act like business parks and support the first steps of the developing companies.

They are supported by the state in many ways. The buildings and the initial operational phase are funded in by a major amount. The companies who use it are funded temporarily with a decreasing amount of money, mainly by subsidized rental fees.

This helps the young and still weak companies to concentrate on their products and their business.

In very promising new business sectors the state is willing to support a pre-competitive cooperation of companies in order to generate information for potential industrial users and provide samples for them.

In Level 4 the TT network is governed by a decreasing state support, which is designed to help the company to help itself. Temporarily usable TT Centres, subsidized rental fees, support of company cooperation and joint participation in fairs and sales show are examples (see Table 1, Level 4) .

2.5 Level 5: Grow to be Strong – Develop your business

When the company once has found its market, it needs money and experienced support in order to develop to a fully autonomous company.

Transfer companies, often in charge of or in cooperation with universities, such as the Aachen Institute of Applied Sciences (ACIaS) which is a Ltd. Company set up by the FH Aachen, help to acquire projects, partners and funding and help to find investors.

As are well known, reliable and decent partners. They have excellent contacts to potential investors and risk capital donors who address them to get contact to

promising young companies. This is a very effective way to grow without depending only on banks.

In Level 5 the TT network is governed by cooperation with TT companies which provide investors and help to establish a stable business and sustainable growth (see Table 1, Level 4).

2.6 Level 6: Competitive and independent – Stay innovative.

When the company reached level 6 (see Table 1) it has found its market and developed its products.

In the TT network it developed more and more from a receiver to a donor.

Within the Alumni network it contacts the university staff and the former co-students.

It offers internship and thesis, joint research work and jobs.

But, as no business is stable over a long period of time, the company must be aware of all changes concerning the market and the technology. A close link especially to the universities helps to monitor the development. This also helps to find the right time when action is required.

Action means the complete upgrade or new design of the product – innovation in the very sense of the word which means to cut old branches and allow new ones to grow. Seen from the theoretical point of view this means to get back to level 1 (see Table 1)

In Level 6 the TT network is governed by strong ties which allow to monitor the technical development, to continually improve the products, and to find to optimal time for upgrading the business (see Table 1, Level 6).

3. Samples

The structure described above lead to a fairly high number of new technology orientated companies. Two of them will be described in detail, the Laser Processing and Consulting Centre, LBBZ and the Prototyping Centre (CP). Both of them are GmbH (Ltd).

3.1 Sample 1: Laser Processing and Consulting Centre, LBBZ

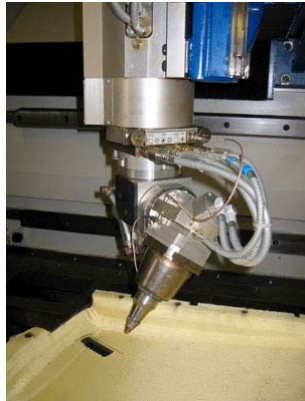
The Laser Bearbeitungs- und Beratungszentrum LBBZ as it is called in German, was established in 1991. After my university study and a first job in the industry (engine rebuilding) I was one of the founders.

Starting with a joint industry – university and Fraunhofer project on a special problem that occurred in my job, the hardening of crankshafts, a three employee start-up was established within the labs of the Fraunhofer Institute of Lasertechnology.

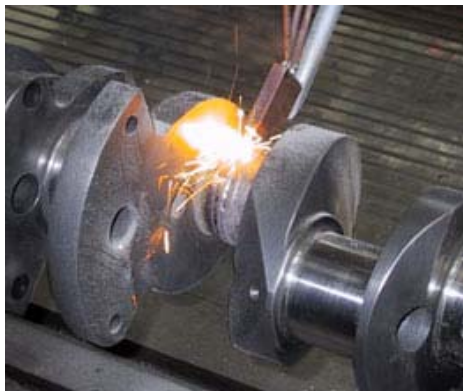
Using this specialised infrastructure gave us the opportunity the gain experience and make samples to acquire clients and projects.

With the help of successful projects, publications and show up at fairs and exhibitions the business increased. Risk Capital was acquired via TT company AClaS of our university and own infrastructure was installed.

With increasing business the staff was raised to over 30. Today we have a stable company which is specialised on various aspects of laser material treatment.



LBBZ: Laser Cutting



LBBZ: Laser Cladding and Laser Hardening

3.2 Sample 2: Prototyping Centre, CP

The Centrum für Prototypenbau CP as it is called in German was established in 1997.

The company idea was a result of the multi level TT structure mentioned above. Monitoring the innovations on the field of laser technology (Table 1, level 6) we detected Rapid Prototyping as a new technology, closely related with our business (Table2, level6)

As an action we tried to find out everything about the technology and the economic boundary conditions. Within a cooperation with the university we started to run one of the first machines in Germany and prepared the business and the market.

First we run the Prototyping business as a branch of LBBZ. When we recognized that the technological problems as well as the economic could be solved, we acquired capital, did investment and set it up as an own company called CP. The whole process is shown in Table2 according to the multi level TT structure (Table 1).

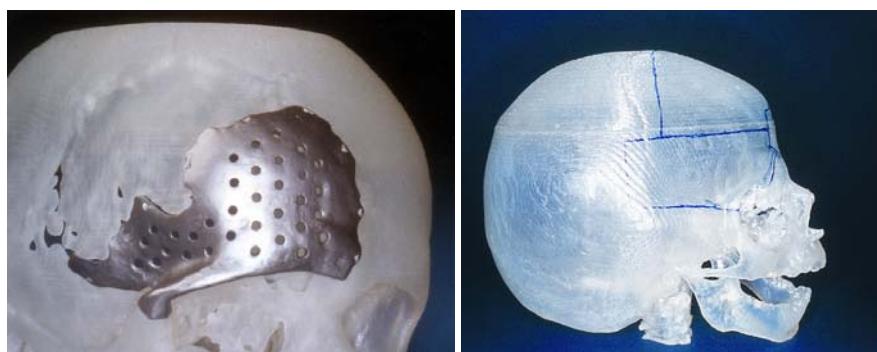
Level	Phase of Setting up a Company	Elements of Founding a Company		Technology Network Partner, Contribution
		Professional	Business	
L 5	Found a new Company: CP-GmbH	Definition and Establishment of an own market segment	Publicity, Advertisement Financial Negotiations MBA	TT Organizations
L 4	Establish the a brand name on the market	Develop special know-how for an own product range	Marketing Concept MBA	Research Institutes Infrastructure
L 3	Detailed Planning, Definition of Business Unit	Set up a technology Project	Own practical Experience	Industry, University Research Centre, Joint Projects
L 2	1st idea of diversification	Specialized Education	Investigate the market	Industry, University Research Centre, Governmental Funding
L 1	Be shure about the RP Process	Basic Technological Knowledge	Find out about the process and infrastructure costs	University Industry
L 6	Learn about Rapid Prototyping	Monitoring of technical Processes → Detect Rapid Prototyping	Find out Market Relevance	TT Organizations University, Alumni Industry Cooperation

Table 2: Phases of setting up a second company, initiated by the continuous technology monitoring (Table 1, level 6) which lead to the starting situation (Table 2, Level 6)

With increasing business the staff was raised to over 40. In 1999 an own company building was erected. Today CP is a stable company which is specialised on various aspects of prototyping and product development.



CP: Prototypes and Small Series for Automotive and Telecommunication



CP: Implants and Models for Craniofacial Surgery

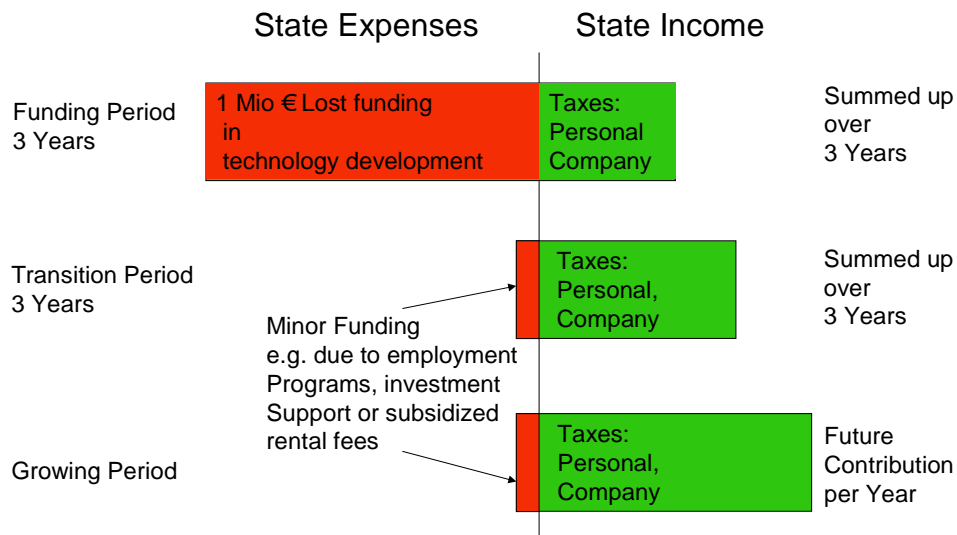


CP: Prototypes and Small Series for the White Goods Industry

4. Funding - Waste money or even lost Money?

Especially often politicians claim, that installing a TT-network and funding processes, structures and companies just sucks government-money. They are afraid to spend it without good results or even to lose it via funding. In Germany they even call it "Lost Grant".

For sure the funding costs money. But as you can see in the picture below, it pays back more money than it takes. In this picture "State Income" only sums up the company taxes including sales taxes and the personal income taxes of the staff.



Long Term Benefit of Governmental funded Technology oriented Companies

As one can see, within the 6 years of funding and transition period the initial funding already went back to the state. From that time the state generates a yearly income.

