Abstract

Ever since its foundation at the end of the 1960s the University of Dortmund has been regarded as a motor of structural change in the region. Exchange and co-operation with industry are essential aspects of this strategic orientation. The organisational unit within the university in charge of this kind of activities is the Office of Public Relations and Technology Transfer. Nevertheless, in the vast majority of cases contacts to industry are made decentrally that is, on the level of the single chairs. “The university” appears as an actor only in infrastructural matters. In the article, forms and the importance of interaction between (members of) the university and third parties are discussed, and the network of competencies that has developed around the university is outlined. Using the example of microstructure technology, we sketch the role the university plays in the local program for the development of future lead industries at the business location Dortmund.

Zusammenfassung

Die Dortmunder Universität gilt seit ihrer Gründung Ende der 1960er Jahre als ein Motor des regionalen Strukturwandels. Austausch und Kooperation mit Unternehmen sind wesentliche Momente dieser strategischen Orientierung. Eine Zentralinstanz der Universität, die solche Aktivitäten fördern soll, ist das Büro für Öffentlichkeitsarbeit und Technologietransfer. Tatsächlich werden Industriekontakte, die zu Kooperationsprojekten führen, aber hauptsächlich dezentral auf der Ebene der einzelnen Lehrstühle geknüpft. „Die Universität“ tritt als Akteur nur da in Erscheinung, wo es um die Etablierung von Infrastrukturen geht. In dem Artikel werden Formen und Bedeutung der Interaktion zwischen (Mitgliedern) der Universität Dortmund und Externen angesprochen, und das um die Hochschule angesiedelte Netzwerk von Kompetenzträgern unterschiedlicher Art wird umrissen. Am Beispiel der Mikrostrukturtechnik wird schließlich skizziert, welche Rolle die Universität für das kommunale Programm zur Entwicklung künftiger Leitindustrien am Standort Dortmund spielt.

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Playing Without Conductor: the University-Industry Band in Dortmund – Networks, Spin-offs and Technology Centre[1]

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1. Activities and programmes in support of university-industry interaction (regional and university level)

1.1 The university as an agent of change in its region

The University of Dortmund (UniDo) is a mainly technically and scientifically oriented university sited in a region that once was the German centre of coal and steel industry, the Ruhr district. Its sixteen departments host approximately 2,000 researchers and 25,000 students. In 1999, about 20 per cent of the university's total budget of € 125 million came from third parties (foundations, industry, German ministries, EU).

UniDO was founded in 1968 as a so called reform university. But in contrast to other German reform universities of the late sixties, UniDO was "designed as a university of a new type and of a special kind" (Structural Development Report (SEB), p. 2; Krieger/Stratmann 1999). The concentration on some key scientific areas with corresponding departments is essential for the concept. Not only the demand for vocational training of the surrounding industry was to be covered by these main areas, but at the same time an impulse for innovation in the region was to be given. That is to say, right from the start profile and activities of the university were not only supposed to contribute to scientific progress but also to reflect regional requirements. UniDo was – and still is – meant to work as a lever for structural change in the Eastern Ruhr district (cf. Image Brochure, p. 1). And, according not only to its self-portrayal, it did so quite successfully:

"The University of Dortmund has strongly influenced its regional economic environment and, vice versa, obtains valuable impulses. Not without consideration of the university's research competency did the City of Dortmund select application software, micro technology and logistics as the main fields of innovation to give itself a clearer image as an economic site. Meanwhile, Dortmund is the most important location in software in North-Rhine Westphalia. And the information and communication technologies have evolved into a field with today more than 8,100 jobs." (SEB, p. 68)

In spite of UniDo's launch as a scientific service provider for the region, in the lowly spheres of everyday life initiation and enhancement of interaction with industry do not belong to the prior objectives of the university management. This is due to the decentralised structure of the university which prevents the senior staff from taking decisive action on the level of the chairs and departments (see below). Its primary obligations are to ensure good working conditions for excellent academic research and teaching and to represent the university as a whole.

1.2 The Office of Public Relations and Technology Transfer

Seemingly, there is a central co-ordination unit at the University of Dortmund for activities concerning the interaction with industry. It is the Office of Public Relations and Technology

Transfer. Its main objective is to “increase the regional and supra-regional demand for the scientific know-how of the university” (Report of the Rectorate 1998, p. 55). The head of the Office is directly responsible to the rector of the university, he participates in the meetings of the rectorate on a regular basis. But, as the tasks of the Office are rather at the edge of the rectorate’s core business, namely to guarantee good research and teaching, it enjoys a relatively high autonomy.

The Office was established in 1998 through the amalgamation of the former Press Office and the Transfer Unit that had originally been founded in 1983. This formal change of organisational structure also had consequences with regard to the contents of the Office’s work. Technology transfer is now only one of various tasks. Summarised, its main responsibilities are:

- Public relations and marketing. This includes as diverse activities as the organisation of press conferences, several regular publications and the maintenance of the university’s web pages.
- Internal services, e.g. training and support of the departments with regard to public relations.
- Technology transfer, including brokerage of contract research and expert’s reports; consultation concerning patent and intellectual property rights issues, possibilities of research funding etc.

The overall impression is that marketing activities represent the main task of the Office. Special attention is attributed to larger projects and events with a high degree of public attention (presentation at fairs, open university days etc.) and to internal tasks such as training for members of the university staff to improve their competencies to handle contacts with industry.

Representatives of the Office describe themselves as intermediaries between the university scientists and external parties. However, the PR and transfer unit is obviously not the pivot of UniDo’s interaction with the outside world. Interchange and co-operation are mainly carried out decentralised at the level of the individual departments and chairs. This is due to the organisational and legal situation of the university that grants the chairs maximum independence. In terms of flexibility this can be a great advantage, but it can also backfire: it increases the difficulties to cross disciplinary and departmental boundaries (see below, p. 10).

One centralised activity the UniDo’s transfer unit conducts is the regional transfer project "Wissenschaft vor Ort" (Science on Site) which started in 1997. *Wissenschaft vor Ort* is an association with the aim to transfer university know-how to the companies of the region. Partners in this consortium are three regional technology centres, four industrial development corporations and seven universities and technical colleges from Westphalia.

The Office of Public Relations and Technology Transfer co-ordinates the project on behalf of the association, the project manager is member of the staff of the Office.

The *Wissenschaft vor Ort* consortium develops and tests a new form of science and technology transfer using new modes of communication and information. Via an internet portal (www.wvo-online.de) access to a wide range of information is available, e.g. on starting up a business, private and public support programmes for start-ups and for R&D, legal advice and further training. In eleven innovative fields “virtual competence centres” offer sector-specific additional information on products and suppliers. The portal aims at making relevant information quickly accessible. It gives “an overview of products, services, research- and development-activities” (Transferbrief 4/99, p.13). “Both sides profit from this: the companies can use the know-how and the capacities of the universities, the universities receive impulses for application-oriented research and an education that meets the requirements of the labour market.” (www.wvo-online.de; 7 Nov. 2001)

With this project, valuable experience has been gained in the field of internet-based transfer of know-how. In the four years of its existence, the web site has evolved to such an extent that it contains approximately 8,000 documents accessible directly or via a dedicated search engine.

Summarising, it may be said that *Wissenschaft vor Ort* is a broker-service equipping potential users with a necessary tool to find providers of knowledge and expertise but leaving it to the partners to make contact and handle the details.

1.3 Decentralised activities within the University

Within the university, the chairs, especially in the science and engineering departments, are the prime movers and the dominating level of action with regard to university-industry interaction. Driven by the need to raise funds they act like small enterprises implementing their own strategies. The regular budgets of the chairs are in many cases so tight, that additional earnings are absolutely necessary for somebody who wants to do work exceeding the most basic research and teaching. Since there are hardly any effective means – incentives or sanctions – on the overall management level to influence professors’ activities, interest and commitment of the individual academics must be regarded as the decisive factors influencing these activities.

At the level of the single chairs, we find different orientations with regard to

- the importance attributed to external collaboration;
- the integration in the overall strategic orientation of the chair (e.g. with regard to basic/applied research);
- the objectives of the activities;

- the organisational implementation (under the auspices of the chair, within a private institute/company founded by university staff or as a sideline activity); and
- the forms of co-operation (collaborative research projects, training services, consulting or business development).

R&D-projects financed by third-party funds are the main source of extra-income for the chairs. In 1999 third-party funds amounting to about € 30 million were attracted including 3.7 million directly from industry. Moreover, collaboration with firms is in many cases also a pre-condition to get funding from other sources than industry. As for the University of Dortmund this applies to ca. € 3 million from private non-profit institutions, to 1.5 million from the Federal Ministry of Research and Education (BMBF), and to another 1.5 million from programmes launched by the European Union. According to estimates of the responsible department of the university, the total sum of third-party funds either granted directly from industry or issued for co-operation projects with industry amounts to approximately € 10 million. This is roughly one third of the total budget of third-party funds.

During the last years the financial inflow from third-party funds has been increasing steadily (1997: € 24.5 million, 1998: 26 million, 1999: 29.6 million). With reference to the total budget of about € 127 million the earnings from third-party funds meanwhile amount to more than 25 per cent. (Report of the Rectorate 1998, annex)

However, the proportions of third-party funds vary strongly as to their distribution among the individual faculties or schools. The ones with traditionally close contact to industry rank first. These were in 1999: mechanical engineering (€ 9 million), computer science (3.4 million), electrical engineering (2.5 million), chemical engineering (2.2 million) and physics (2.2 million). Top ranking with regard to direct financial means from industry were: electrical engineering (€ 0.9 million), mechanical engineering (0.7 million) and civil engineering (0.45 million).

Consultative activities take place either in connection with the above-mentioned research projects financed by third-party funds, or outside the structures of the university within the framework of private institutes, spin-offs or as sideline jobs of professors. The university itself is not active in this field. The same applies to the field of *business development*. Both issues do not have a regular basis within the academic and legal structure of Dortmund University.

1.3.1 Further training

Up to now, there is a considerable lack of training courses offered by the engineering and science faculties to third parties. This is mainly due to the legal conditions that make it difficult for the departments to charge for these services. However, this does not mean that there are no further training activities at all in engineering and science. But most of them are carried out outside the structure of the university.

To counteract this, the *Verein zur Foerderung der wissenschaftlichen Weiterbildung der Universitaet Dortmund* (Association for the Promotion of Scientific Further Training at the University of Dortmund) was founded in 1999. Situated at the university's *Zentrum fuer Weiterbildung* (Centre for Further Training and Education) this association is able to conduct training measures under private law conditions.

The Centre for Further Training and Education itself (cf. www.zfw.uni-dortmund.de) was founded in 1998 as a central service unit offering internal services and training courses in collaboration with faculties of UniDO. In addition, it organises courses for companies and individual customers from outside the university. The main activities of the Centre can be grouped into four clusters:

- General further education with women and the elderly as main addressees.
- Job-related further training for teachers and for professionals working for the elderly.
- Further training for employees of the university.
- Courses related to the world of work in general ("social academy").

Strategic objectives of the Centre for the coming years are:

- the development of measures to better meet the regional demand for training, particularly in the fields of information and communication technologies, logistics and labour-related questions;
- an internationalisation of the measures;
- the development of tailor-made offers to industry and other organisations.

1.4 Linking-up with others

The university is in the true sense of the word surrounded by a cluster of companies, institutes and other institutions that are linked to it more or less tightly. The range is quite remarkable: a multitude of institutes for basic (e.g. the Max Planck Institute of Molecular Physiology) and for applied research in various fields (FTK-Research Institute for Telecommunications, Federal State Institute Sozialforschungsstelle), spin-off companies of graduates who collaborate with their former professors, institutions like the Technology Centre and the Technology Park that were established with the explicit objective to promote the transfer of technology and knowledge deriving from the university, and private institutes founded by members of UniDo staff who want to bypass their complicated legal situation as part of a university.

In direct vicinity of the campus two institutes of the *Fraunhofergesellschaft fuer angewandte Forschung* (Fraunhofer Society for Applied Research) have been established during the recent years, the Fraunhofer Institute for Material Flow and Logistics and the Dortmund branch of the Fraunhofer Institute for Software and System Technology. The

Fraunhofergesellschaft has an excellent reputation in collaboration with industry. The institutes are not formally connected to the university, but the heads of both hold a professorship at UniDo.

Of major importance for the university's interaction with industry are the Dortmund Technology Centre and Technology Park, both adjoining the campus.

Originally initiated by an alliance of the City of Dortmund, the local Chamber of Industry and Commerce (IHK) and a local bank incorporated under public law (Stadtsparkasse Dortmund) the *Technology Centre* was founded in 1985. One of the basic ideas was to increase the effectiveness of the scientific potentials at the university and to make it usable for entrepreneurial activities, thus creating jobs and establishing new industries in order to foster structural change in the region. Dortmund's technology centre is not only one of the first institutions of that kind in Germany, up to now it is one of the most successful ones too. Since its opening, 173 enterprises have been established here, many of them university spin-offs. Most of the companies in the Technology Centre are active in software development, electronics and logistics respectively – this corresponds to major research areas of the university.

Today sixteen employees work for the Technology Centre. The services provided range from communication facilities like phone, fax, internet etc. to reception and telephone service, catering service, presentation at trade fairs, support in networking as well as comprehensive consulting services (e.g. on financing issues). The Centre is an independent private limited company (GmbH), and various businesses have joined its founding institutions since 1985. The University of Dortmund has been shareholder of this company only since 1999[2] – up to then, it was not legally possible for a public university to take a share in private businesses – but it was nevertheless involved right from the start (cf. Fingerhut 2001).

The Technology Centre rents premises and laboratory space including facility management services at non-subsidised rates customary in Dortmund for a limited period of time (as a rule three to five years). Currently it hosts more than fifty companies with together about 1,300 employees. The four buildings of the Centre are property of the City of Dortmund. The turnover in 2001 amounted to about € 5.6 million. As the GmbH is a non-profit organisation gains have to be re-invested.

Enterprises that intend a long-term settlement on site may make use of the *Technology Park*. A working relation with the University is of course not a condition to be on the park. Up till now 220 enterprises have started up their business here, employing approximately 6,000 people (plus many students) – with increasing tendency. About 60 per cent of the workforce of the companies at Dortmund Technology Park are graduates of UniDO.

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2 Together with the City of Dortmund, the Chamber of Industry and Commerce, the Society for Process Automation, seven public credit institutions, the Chamber of Crafts and Dortmund Polytech (Fachhochschule).

It is difficult to determine the number and the importance of *university spin-offs* precisely. Estimates are in part contradictory. According to an official source – the municipal authority's Report on Structural Development in the Region of Dortmund – about fifteen technology-oriented business start-ups derive from the university each year. Most of them are active in logistics or software development: "Solely 50 enterprises in the field of logistics and 75 software enterprises are known as university spin-offs" (loc. cit., p. 69). These companies differ very much in structure and size. They range from small one-man enterprises to companies with some hundred employees. Among the most successful examples is UUNET GmbH. This supplier of internet services with currently 200 employees originated from a third-party funds project of UniDo computer scientists (loc. cit., p. 70) and is today a part of Worldcom.

An important "link between enterprise and university" (loc. cit., p. 69) is the *F&E-Managementgesellschaft mbH in NRW* (R&D Management Corporation) which describes itself as "the bridge between business and science" (www.fuedo.de; 7 Nov. 2001). It comprises four institutes headed by professors of the University of Dortmund:

- the *Dortmunder Initiative zur rechnerintegrierten Fertigung*, RIF (initiative for computer-integrated production),
- the *Informatik Centrum Dortmund*, ICD (centre for informatics),
- the *Gesellschaft fuer innovative Energieumwandlung und -speicherung*, EUS (society for innovative conversion and storage of energy), and
- the *Zentrum fuer Beratungssysteme in der Technik*, Dortmund, ZEDO (centre of consulting systems in technology).

The R&D Management Corporation is the "central service-, sales- and marketing-company for a multitude of market-oriented research institutes and technology-oriented small and medium enterprises" (www.fuedo.de; 7 Nov. 2001). The institutes involved offer their services (application-oriented, product-related research and development) to private as well as public customers. On many occasions the institutes take on responsibility for the commercial exploitation of products or patents developed at the University of Dortmund – a function which the university finds hard to perform due to its legal situation.

1.5 Some basic obstacles to university-industry collaboration

Notwithstanding the rather vivid scenery portrayed so far, our interview partners also described obstacles to a more intensive interaction and exchange between the university and industry in some detail. Most of these are, however, not specific for the University of Dortmund alone but for – at least German – universities in general. The comments given can be summarised into six problem-clusters:

- The complexity of the services potential customers ask for often exceeds the scope of possibilities of a single department. It requires a continuous interconnection of disciplines and expertise which is usually not supported by the departmental structures of a university.
  This is one of the reasons why the UniDO management intends to establish interdisciplinary so called *Forschungsbaender* (research-lines) – though with quite varying success so far.

- To foster an effective use of the expertise the university can offer it needs to be more transparent for "outsiders". Today the university is to a large degree a black box and it is hard for potential customers (in particular for small and medium sized enterprises) to find competent contact.
  In the Dortmund region this problem is addressed by the project "Science on Site" mentioned above.

- Especially in highly innovative areas university departments compete with industry for experts. Notwithstanding that the move of personnel to industry is a successful means of knowledge transfer this seems in some cases to be experienced as a threat to loose the best heads for the university. And this may dampen some professors' enthusiasm to collaborate with enterprises.

- Involvement in collaborative projects with firms often interferes with the usual work rhythm of a university department. As an industry representative put it (admittedly a bit exaggerated): "During term you can forget it! They're just too busy with teaching."

- The realisation of such projects requires a type of scientist with a special interest in the development of practice-related, "mundane" technologies. This attitude is not characteristic for the "typical" academic you find in universities.

- The university as a whole is not provided with central regulatory and incentive systems for the promotion of university-industry interaction. The departments are to a large degree free to define their research agenda and their relation to practitioners outside. This too is not peculiar to the University of Dortmund. The relations between chairs/departments in German universities are in general network-like rather than hierarchical (usually less so within the departments). As far as the higher ranks are concerned the university is something like a Commonwealth of Independent Scientists (occasional similarities to a different CIS not excluded). Therefore, the set up of collaboration between academics and firms is largely left to the initiative of individual professors and/or their assistants.

Most of our interview partners stressed that an "interlocking with practice" exceeds the prevailing self-image of Dortmund University which is based upon (basic) research and teaching. With regard to the promotion of a service-oriented, enterprise-related and application-oriented project type, the traditional framework of the university seems to be too

narrow. “It gradually turns out that under prevailing circumstances, the current facilities of the university cannot meet the demands of the local industry for research and development” (Bußmann 2000). Only one interview partner asked to consider that this is probably not the main obligation of the university as societal institution for basic research and higher education.

Interviewees from both the university and firms considered it desirable to create individual financial incentives for application-oriented projects. According to them, performance should not be measured mainly on the basis of the number of candidates for diploma and doctorates and publications on basic research findings but also on the ability to build up co-operation with industry and to maintain it in the long run.

2. Digging deeper: Dortmund University as part of an emerging network in micro-technologies?

The description in this section is meant to complement the explanation of structures and programmes in support of university-industry interaction on the university and regional level given in the previous chapter. By this we intend to give further details and to reveal some of the difficulties for this kind of collaboration that are a bit under-emphasised in the rather programmatic statements we refer to in the first part of this paper.

As mentioned above, the University of Dortmund plays an important role in and for the structural change the Ruhr district is currently undergoing. In January 2000 “Dortmund.Project” started (cf. www.dortmund-project.de). This ten years development scheme set up by the municipal authority in co-operation with Thyssen Krupp AG and McKinsey aims to speed up the transformation of Dortmund from the city of steal, coal and beer into a centre of high-tech, media- and service-industry. Among the identified prospective lead-industries are software and e-commerce, information technologies, logistics and microsystems technologies. For the development of all of them the university is supposed to play a considerable part. The subsequent discussion will focus on the field of micro-technologies.

The following excerpt from an internal paper of the university’s Department of Microstructure Technologies gives an insight into the already existing local micro-technology scene: “Due to the establishment of numerous enterprises active in the field of microelectronics and micro-technologies, Dortmund has meanwhile become the most important site for microelectronics in North-Rhine Westphalia, in parts even in Germany and in the European Union. Firms like Elmos, STEAG microparts or HL Planartechnik stand for the mass production of microstructured products. The activities of these companies are supported by the *Interessengemeinschaft zur Verbreitung von Anwendungen der Mikrostrukturtechnik NRW e.V.* (IVAM) (Interest Group for the Application of Microstructure Technologies) and by the *Technologiezentrum* (Technology Centre) Dortmund, which also

accommodates the newly-established *Zentrum für Aufbau- und Verbindungstechnik* (AVT) (Centre for Packaging and Interconnection Technology)."

Microsystems technologies (MST) are one of the main topics of Dortmund.Project, too. Related activities include among other things a prize competition for MST start-up companies and the "MST-factory" (cf. www.mst-factory.de). The latter project started in early 2001 as a joint venture of Dortmund.Project (the dopro-Beteiligungs GmbH) with the above-mentioned IVAM. It is planned that the MST-factory will offer three kinds of services from 2002 on: an incubator service for start-up companies, development of components and products from design to prototyping and a so called idea lab offering consulting services, feasibility studies, market studies etc.

Not least its involvement in the MST-factory indicates that IVAM is a central player in microsystems technology in the region. Situated in Dortmund, it has been expanding its activities during the last years in terms of content and also locally. Meanwhile, its membership comprises companies from five European countries and the USA.[3] Nevertheless, it still has a strong regional emphasis. IVAM works as technology broker, conducts public relations- and marketing-activities for its members and offers consulting services. Its marketing and brokerage function makes IVAM an interesting environment especially for small and medium sized enterprises with limited resources (and all MST-companies in Dortmund belong to this category). But this is only one advantage of IVAM. Taking into account that the MST-scene in Dortmund is only just developing and that this formation process is accompanied by a considerable degree of mistrust between the companies, this (regional) association offers a platform on which knowledge can be exchanged and contacts can be cultivated. And this is absolutely necessary, as larger and more complicated orders often cannot be served by a single company.

IVAM is strictly industry-oriented, the influence of the academic side is deliberately kept low. One reason for this rather restrained attitude seems to be a general suspicion concerning the ability of university institutes to work in an industrial manner (cf. the "problem clusters", p. 10). Another reason may be that a university institute can well be a powerful competitor especially for small service-providers in the field.

On the academic side, micro-structure (or micro-systems) technologies are a research topic in different faculties and departments of Dortmund University and the neighbouring Dortmund Polytech (Fachhochschule). Among them are the university department of micro-structure technologies in the faculty of electrical engineering and information technologies and, though only partly active in this field, the chair for high-frequency technologies, chairs and/or departments in the faculties of chemical engineering, of mechanical engineering and of computer science. There is a certain amount of bilateral collaboration between these

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3 "IVAM is an international industrial network with more than 100 members – companies and research institutions – who are at home in all important fields of microsystems technology [d]edicated to serve industrial needs in the field of Microsystems Technologies, MEMS, and Micromachining." (www.ivam.de; 7 Nov. 2001)

units but up till now not a network. This is in part due to the fact that micro-structure technology is a relatively new and rapidly evolving field.

There are plans, pursued by the head of the department of micro-structure technologies, to establish a new, semi-commercial institute in this field.[4] "The main task of a new institute – its foundation is also supported by the local Dortmund.project – is to take on and to co-ordinate research and development for companies in the region" (Bußmann 2000). In the view of its protagonists this institute could also have advantages for the university itself. It may contribute to "give Dortmund University a special position as a research centre for micro- and nano-technologies and to make it stand out from other universities in North-Rhine Westphalia." Moreover, the orientation of such an institute on practical demands is not only considered as prestigious for the university but also as a means to attract more third-party funds (ibid.).

In principle, the senior staff of the university is receptive to the foundation of new institutes if – as it is in this case – they meet the interests of more than one department. First discussions with the rector and other professors working in the field of microstructure technologies have already taken place. If this institute or something with an equivalent function comes into being it may give reason and opportunities to network the relevant expertise within the university. But it seems to be a long way to go. Nevertheless, going it looks worthwhile – for the region too because it may also lead to an increased demand to link up with the surrounding micro-technology scene.

3. Brief description of a collaborative R&D Project at the University of Dortmund (the MAS project)

In this section we will describe some features of an R&D project in which the Department of Microstructure Technologies of the Faculty of Electrical Engineering and Information Technologies (cf. www.mst.e-technik.uni-dortmund.de) collaborates with an industrial partner. We selected this specific project because it aims at of one of the techno-economic sectors which are taken to be strategic fields of innovation for the Dortmund region, namely microstructure technologies. A further reason was that on the side of the participating representatives of the university increased efforts are perceptible with regard to an intensification of interaction with industry as we showed above.

Head of the Department of Microstructure Technologies is Prof. Neyer, a physicist whose research activities focus on the development of technologies to design and produce microstructures in plastic substrates for applications in micro-optics, integrated optics and micro-fluidics. The collaborative R&D project "Miniaturized Analytical Systems" (MAS) was part of the work of his department's micro-fluidics group.

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4 The idea is inspired by the Mesa+ Institute at the University of Twente (cf. Eijkel 1999).

3.1 Objectives of the project

The MAS project focused on a technology with high innovative and economic potential. The development of miniaturised analytical instrumentation has moved rapidly forward in the last few years. This is particularly true in the field of electrophoresis where plastic-chip based miniaturisation has now matured to the stage where fully functional analytical instruments are being built to be tested on real world applications in the chemical industry, pharmaceutical industries and in bio- and genetic engineering. Compared to alternative materials the use of plastic reduces (production) costs. Future demand for such systems is expected to run into hundreds of millions or even billions of Dollars world-wide.

MAS aimed at the development of a microsystem to analyse the chemical composition of liquids (Lab-on-a-chip) for applications in the food and the pharmaceutical idustry. The core of the system is a plastic chip with tiny channels that can be manufactured in mass production at, therefore, a reasonable price. As one immediate result “a microfabricated device for low cost liquid ion analytics with the technique of cappillary electrophoresis was developed which contains microfluidic channels, electrodes for high voltage power supply and electrodes for detection. For all three major parts of the production – substrate, cover plate and bonding – new solutions are found. In opposite to commercial[ly available] products this device is polymeric and due to that mass producable and semidisposal. The integrated detection provides an easy to handle tool without usual optical calibration.” (Siepe et al. 2000, p. 483)

Besides the obvious goal to develop the microsystem Neyer mentioned a few further aspects that made collaboration within MAS attractive to him: The experience and contacts made here will allow to strengthen applied research as an additional strand of activities and thus broaden the profile of his department. This is likely to open up new options for students and also for funding. He also sees the project as a kind of test-bed for the planned institute for microstructure technologies mentioned above.

Access to expertise needed to develop an innovative product for a rapidly growing market had been the main reason for the industrial partner to start the MAS project. Collaboration with universities was not completely new for the firm, but the intensity characteristic for MAS was a novelty. The prospects of easy access to an academic environment in general and the perspective of further collaboration with a possible new centre of expertise on micro-technologies were taken into consideration but they played a minor role for the decision made.

3.2 Management of the project

The project ran over a period of three years starting in 1998. It was financed by the industrial partner Merck[5] at one hundred per cent. Other partners were the University of Bratislava and the non-university Institute of Spectrochemistry and Applied Spectroscopy (ISAS)[6] in Dortmund.

The MAS project was preceded by bilateral communication between ISAS and Merck. ISAS had introduced the idea to develop a minaturized analytical system for liquids in plastic. Due to the good prospects of such a product on the market Merck agreed to finance a collaborative R&D project. But none of the two partners had the competence to design and produce microstructures in plastic. As ISAS knew that he had built up design competence and production facilities for polymer micro-optical systems in the years before they got in touch with Prof. Neyer at the University of Dortmund.

The partners' responsibilities were split into different subjects according to their respective expertise:

UniDO's Department of Microstructure Technologies designed and produced prototype chips. In the course of the project the number of chips needed for the necessary tests exceeded the capacitiy of the department's facilities. Hence, the job to manufacture the chips was entrusted to Steag Microparts, the above-mentioned company in Dortmund Technology Park. That was only possible because the technologies used at the university are very similar to the ones employed by Microparts.[7] The Slovac University of Bratislava treated analytic questions in MAS. ISAS was responsible for the development of technologies for detection and measurement. The tests of the prototype chips were undertaken by the industrial partner. And Merck was also left in charge of the project management. In parallel to the MAS project Merck built up a production line for the system. For this purpose they hired a doctorate candidate employed at the University of Dortmund. He changed his employer at the outset of MAS, but the university agreed that his place of

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5 Merck KGaA is active in three markets: pharmaceutics (50% of the overall turnover), laboratory products (30-35%) and chemistry (15%) with 8,000 employees in Germany and 20,000 world-wide (see www.merck.de). The company's headquarter is located in Darmstadt in the state of Hesse.

6 ISAS, with sections in Dortmund and Berlin, is a scientific research establishment supported by the federal ministry for research and the appropriate state ministry of North-Rhine Westphalia and Berlin respectively. The Institute is governed by the *Gesellschaft zur Foerderung der Spektrochemie und angewandten Spektroskopie e.V.*, Dortmund (Society for the Advancement of Spectrochemistry and Applied Spectroscopy) with three members on the Executive Board. The Institute has been joined contractually since 1993 with the University of Dortmund and is a member of the *Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz*. It is led by two directors and currently has 108 posts including 36 posts for scientists (www.isas-dortmund.de). Among the members of the ISAS Advisory Board are representatives of UniDO, the City of Dortmund and the Dortmund Chamber of Industry and Commerce.

7 This points to a fundamental problem in the field of microsystems technologies. Because of the lack of standardised processes and technologies a system design is always tailored to a specific manufacturing process and technology.

work remained at UniDO. According to the involved project partners this facilitated a rather unusual intensity of collaboration which proved to be very effective.

Every partner assigned a responsible person for the project whose duty was to co-ordinate the local work. In addition to electronic means of communication bilateral face-to-face meetings took place approximately once a week. Interchange with the University of Bratislava was co-ordinated by the project manager. Project meetings with all partners were held twice a year.

Formal supervision of progress was carried out by monthly progress reports, target-oriented reports every two to three months and a time schedule for the supply of hardware (timely deliverance of a defined number of chips). Without questioning the relevance of these formal controlling procedures each of the interviewed participants of MAS emphasised that in practice communication and mutual trust were at least as important for success.

Contractual partner of the financier Merck on the university side was the budget director of UniDO. The Department of Microstructure Technologies was the payee. The research contract was renewed every year. Considering the contractual stipulations, three phases can be distinguished. Within the framework of research collaboration of heterogeneous partners these phases may claim an exemplary character.

Phase 1 (preliminary study): During this phase the basic ideas were developed. The enterprise and the research partners reached a “Material Transfer Agreement”, in which the partners committed themselves to treat the subject confidentially. Moreover, a transfer of material to third persons was excluded.

Phase 2 (feasibility study): During this phase first experiments in the laboratory were carried out and simultaneously (social) experiences with the partner were gained. In parallel, a market analysis was carried out and against this background it was decided that a further collaboration would be reasonable. Furthermore, the partners accepted that they were not allowed to work on the subject of the contract beyond the context of the project. That is to say that the partners committed themselves to exclusiveness, respectively partial exclusiveness.

Phase 3 (research collaboration/realisation): At the outset of this phase the modus operandi was laid down in a formal collaboration agreement. Among others, the following items were fixed:

- tasks of the partners,
- an annual work programme,
- a work plan and project milestones,

- resources, financial means and mode of payment (every six-month, when the results are delivered),
- rights of utilisation,
- saving clause for publications (papers must be submitted to the industrial partner; after a defined deadline has expired, the enterprise has to release the publication or apply for a patent).

4. Concluding remarks

We have argued that within the University of Dortmund, the science and engineering departments represent the main motor and the primary level of action with regard to the acquisition and practical realisation of contacts with industry. They act to a large degree on their own behalf. Accordingly, at project level the university as a whole does hardly appear as an actor in university-industry interaction. During the last years a ramifying network of different private, public and semi-public organisations has evolved. Some of these emerged from activities of the chairs and the departments, others stand in close co-operation with them. Manifold activities have been initiated and realised in this network – either, as it is the case for many research projects, within the framework of the university or in the context of other institutions of the network. Although the university itself is not an active party in all cases, it plays a central role as an essential node of the network. The core competency of the university regarding research and development and its scientists and students constitute an important basis for the performance of the whole network.

In addition to this, the management of the University of Dortmund tries – within the regulatory boundaries of its possibilities – to support interchange and co-operation with private firms by means of specific measures. These include:

- The establishment of central service units like the Office for Technology Transfer and the Centre for Further Training and Education to support and supplement the activities of the chairs and departments.
- “Midwifery” for and furtherance of regional service infrastructures for firms, in particular small and medium sized enterprises, in the immediate neighbourhood (*Wissenschaft vor Ort*; Technology Centre).
- Improvement of the general conditions for collaboration and interchange by networking expertise inside the university (*Forschungsbaender*) and by linking up with other universities in the region (*Wissenschaft vor Ort*; Network of Euregional Universities, NEU) and elsewhere in the Europe Union (ECIU) and abroad.

Neither a coherent target-setting policy nor any systematic scheme of incentives or sanctions to intensify collaboration with other parties are implemented in the university.

There is a distinct division of labour on this matter between the level of departments and chairs on the one hand and the university management on the other. The top-level does (can) hardly interfere in the departments' agendas and activities concerning university-industry interaction.

This might give rise to the idea that universities like the one of Dortmund need more central co-ordination to enhance their overall capability to collaborate with and serve actors in the world "out there". We do not want to reject this perception altogether. The value of a conductor for an orchestra cannot be denied. On the other hand, people like John Coltrane or Charles Mingus taught us that collaboration of autonomous players can produce excellent results. In view of calls for a strengthening of the senior staff's and/or the Ministry's authority at the expense of the departments' or individual academics' autonomy we would like to ask to keep in mind that organisation studies take decentralisation and self-organisation as a powerful means to enhance performance when tasks are complex. As the example outlined above shows, the relative independence of those who actually carry it out on the part of the university does not hamper interaction with industry or other parties. Independence alone does not secure it either. The aim ought to be to foster the individual actors' ability to link up with others rather than setting up a strong central control. Measures like *Wissenschaft vor Ort* and the establishment of the *Forschungsbaender* appear to be reasonable steps in this direction.

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