Franz Hofer

The Improvement of Technology Transfer

DUV

Franz Hofer

The Improvement of Technology Transfer

WIRTSCHAFTSWISSENSCHAFT

Franz Hofer

The Improvement of Technology Transfer

An Analysis of Practices between Graz University of Technology and Styrian Companies

With a foreword by Univ. Prof. Josef W. Wohinz

Deutscher Universitäts-Verlag

Bibliographic information published by Die Deutsche Nationalbibliothek
Die Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at <http://dnb.d-nb.de>.

Dissertation Technische Universität Graz, 2007

Published with the support of the Styrian government, Department for Science and Research

Das Land Steiermark
Wissenschaft

1st Edition November 2007

Readers: Frauke Schindler / Anita Wilke

Deutscher Universitäts-Verlag is a company of Springer Science+Business Media.
www.duv.de

Cover design: Regine Zimmer, Dipl.-Designerin, Frankfurt/Main
Printed on acid-free paper
Printed in Germany

ISBN 978-3-8350-0904-2

Without the support of my wife, Elvira, I would not have finished my doctoral thesis. She helped me to keep on with my work.

To borrow from Lee Iacocca: Yes, I am proud to have finished my doctoral thesis. But next to my family, it really doesn't matter at all.

For my wife Elvira
and my son Oliver

Foreword

The positive impact of technology transfer on universities and companies in my opinion is undisputed. Driving factors for technology transfer are the complementary nature of research, the increasing specialization and the available vast resources outside companies' settings.

In that sense I welcome the work done by Franz Hofer which provides recommendations to further facilitate technology transfer. He has done a remarkable work in examining technology transfer between Graz University of Technology and Styrian companies. As the author shows, the results presented in this book are not only valid for the specific setting in Styria, one of nine states of Austria, but also for other regions dealing with this specific topic.

He based his results on detailed empirical examinations which allowed the introduction of target groups of university researchers and companies defined by a set of characteristics. Thus the work enables parties involved in technology transfer to act according to the specific needs of the participants.

Formerly, this knowledge was available at best implicitly, i.e. experienced university researchers or managers used to deal with each other thus knowing well the others' expectations. Inexperienced fellows had to build up this knowledge gradually. Due to his research Franz Hofer set a landmark for university researchers and managers, representatives of governmental agencies as well as for companies dealing with technology transfer.

I recommend this book to everyone working on technology transfer and willing to further improve the respective framework. It is my well-founded belief that while we are already doing great things in cooperation with each other, there is still plenty of room for improvements. The results presented herein are an essential element to further improve current performance and understanding of technology transfer.

Univ. Prof. Josef W. Wohinz
Head of the Institute of Industrial Management and Innovation Research
Graz University of Technology

Table of contents

Figures

Tables

1 Executive Summary

Technology transfer between universities and companies is important for both parties. Universities profit through additional financial means, feedback regarding their competencies and research performance and input to identify new research areas. Companies profit by getting access to external knowledge for the development of new products and processes or support to build up specific competencies with the help of universities. Such benefits can occur. However, they are not automatically granted.

The spectrum of technology transfer is rather large. The willingness to participate in technology transfer can be rather different. Specific types of companies and university researchers are unwilling in getting in contact with each other. Others are very well networked with each other. This bandwidth leads to the assumption that different existing needs of companies and university researchers result in different recommendations to increase and improve technology transfer.

The present book is based on a doctoral thesis, which examined technology transfer between university researchers at Graz University of Technology and companies in Styria. Based on the results of an empirical study a typology was set up, which grouped university researchers and companies according to their current technology transfer extent and barriers. For the given typology, recommendations for actions to improve technology transfer were identified.

The recommendations for actions enable universities, university researchers, companies and other parties like i.e. technology transfer offices at universities or chambers of commerce to improve technology transfer between universities and companies. In some cases, single organizations can realize the recommendations. The realization of others depends on the commitment of more than one party. Thus, the time for transition of research results to applications should decrease further. Experts see this as one of the major weaknesses of Europe in regard of the USA. The book also provides empirical data to compare technology transfer in Styria with other regions. This leads to new knowledge about the influence of regional conditions in technology transfer.

2 Introduction

Easy access to external knowledge becomes increasingly important for companies to innovate (Schmoch, Licht, and Reinhard[1]). Universities as part of the knowledge-generating infrastructure are ever more involved in the development of global economy and many recent innovations could have only been achieved through interdisciplinary teams of industrial and university researchers (Tornatzky[2]; Business-Higher Education Forum[3]). It is widely acknowledged that companies and universities can benefit from such activities. Still, difficulties arise from the nature of R&D and *moral hazard* problems (Howells[4]), i.e. sharing jointly developed knowledge with third parties, intentionally or not. This might work against the exploitation of the full potential. Studies like the ones realized by Blume and Fromm[5] or inno-regio styria[6], a subsidiary of the federation of Styrian industry, show the fallow lying potential to increase technology transfer. Blume and Fromm identified in their study about technology transfer between *Gesamthochschule* Kassel [University of Kassel] and companies that 30 % of companies not having contacts to the university were interested in establishing such. The survey of 24 large companies located in Styria, one of nine Austrian states, by inno-regio styria showed that more than 50 % of companies want to extend technology transfer with regional universities. More than 70 % plan to extend technology transfer with national and international universities. None of the 24 companies wants to reduce expenditures for research with universities. Another survey by Adametz, Gruber, and Ploder[7] amongst the most innovative companies in Styria revealed that the majority of participants plan to increase expenditures for collaborations with R&D providers like universities.

---

1 Schmoch, Ulrich; Licht, Georg; Reinhard, Michael (Eds.): Wissens- und Technologietransfer in Deutschland [Knowledge and technology transfer in Germany], Stuttgart 2000

2 Tornatzky, Louis G. (Ed.): Building State Economies by Promo ing University Industry Technology Transfer, Washington DC 2000

3 Business-Higher Education Forum (Ed.): Working Together, Creating Knowledge: The University Industry Collaboration Initiative, Washington DC 2001

4 Howells, Jeremy: The Knowledge Boundaries of the Firm and Sourcing for Innovation, in: Hosni, Yasser; Smi h, Richard; Khalil, Tarek (Eds.), 13th International Conference on Management of Technology, Washington DC 2004, Paper ID 1296

5 Blume, Lorenz; Fromm, Oliver: Wissenstransfer zwischen Universitäten und regionaler Wirtschaft: Eine empirische Untersuchung am Beispiel der Universität Gesamthochschule Kassel [Knowledge Transfer Between Universities and regional economy: An empirical study at the University Gesamthochschule Kassel], in: Vierteljahreshefte zur Wirtschaftsforschung [Quarterly economy research journal], 69. Jahrgang, Heft 1/2000, pp. 109-123

6 inno-regio styria: F&E Kooperationen von forschungsintensiven Unternehmen der Steiermark [R&D collaborations of research intensive companies in Styria], presented at a workshop for members of the platform for R&D managers of Styrian companies organized by inno-regio styria on the 7th of February 2005 in Graz

7 Adametz, Christoph; Gruber, Markus; Ploder, Michael: Innovationsmonitor Steiermark 2004 Endbericht [Monitoring innovations in Styria, final report 2004], www.innoregio-styria.at/Projekte/Innovationsmonitor/Bericht%20Kurzfassung.pdf as of 11th of May 2006

The present book aims at providing recommendations for actions to initiate and further improve technology transfer. This includes facilitating companies and university researchers to get in contact with each other and ends with increasing the extent or improving the quality of technology transfer. An example for the latter two cases is the provision of support for companies already collaborating with university researchers, which want to do technology transfer more effectively and efficiently.

Current typologies for companies and university researchers are too broad to introduce specific recommendations for actions. A ready to use typology has to be more detailed than existing ones. In parallel, the applicability has to be considered. A typology, which depends exclusively on publicly not available data or requires in-depth interviews up front does not serve the need of a broader auditorium.

This book addresses different types of readership. Primarily university researchers and company employees, but also other organizations playing a determining role regarding the success or failure of technology transfer. Examples are technology transfer offices at universities supporting university researchers in matters regarding IPRs, negotiations and funding issues or companies in finding the right expert for their enquiry. Funding agencies consulting technology transfer partners in applying and setting up funding proposals or chambers of commerce with close contacts to companies recommending university researchers.

Such a detailed technology transfer study is new to Styria. It provides new insights and data to compare technology transfer in Styria with other regions. Thus, the potential impact of regional characteristics can be examined by comparing similar studies in different geographic regions. As the comparision with other studies show, the results can be used as input to improve the effectiveness and efficiency of technology transfer in other regions being confronted with similar obstacles. The recommendations can also be used by others preparing to start with technology transfer as guideline for development. Such a detailed examination of interdependencies between university researchers' and companies' characteristics, their current technology transfer features, barriers and motives is rather the exception than the norm.

3 Research approach

The overall objective is to provide recommendations for actions customized for specific, homogenous groups of companies and university researchers. Current schemes do not provide possbilities to approach companies and university researchers with a well defined portfolio of recommendations. This results in the need to set up a typology, which allows the identification of such recommendations. Suited criteria, which the typology depends on, have to be determined, i.e. size of companies, age of university researchers, barriers and motives, location of companies and others. Additionally one has to bear in mind the usability of the typology. The typology should be feasible with as little information as possible to keep efforts to gather relevant data as small as possible. Based on such a typology, recommendations for actions can be worked out.

It is assumed that a suited typology as basis to work out recommendations for actions has to comprise a measure for the current extent of technology transfer. An assessment of the importance of barriers regarding technology transfer forms the extension of currently existing typologies. Thus, the typology is divided into smaller, from each other distinct classes. This is supposed to increase the success of support actions. This approach makes it necessary to gather empirical data to understand the connection with university researchers' and companies' characteristics and their technology transfer specific features. Figure 1: Major research steps shows the major research steps.

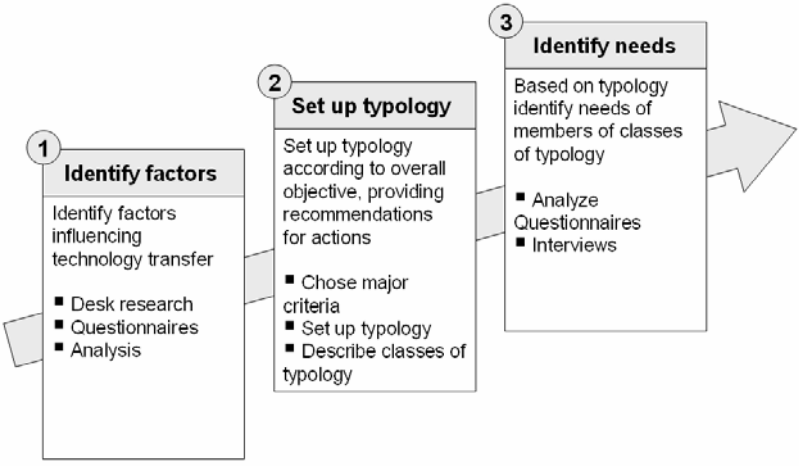

Figure 1: Major research steps

The first step is multi-layered. It examines the interdependency of factors influencing technology transfer. Factors were grouped in four types: University researchers' and companies' characteristics, technology transfer characteristics, barriers and motives. Identifying relations lays the ground for the two following steps. Desk research is one of the cornerstones. The results form the base for the first empirical part, the questionnaires for university researchers and companies. The existing work already done in the area of technology transfer is taken as guideline to formulate questions and limiting possible answers. The quantitative empirical part identifies the influence of characteristics of university researchers and companies, current extent of technology transfer and respondents' assessment of the importance of specific barriers and motives out of their own view and the one of their (pot.) partners on technology transfer. The questionnaire is used as research tool because the results enable to set up and describe a typology for university researchers and companies. SPSS as a standard statistic software program is used to analyze answers.

The second step focuses on the typology. It is necessary to define criteria to distinguish the different classes from each other and describe them. The resulting typology serves as frame for the definition of recommendations for actions to facilitate technology transfer by offering customized support for homogeneous groups of companies and university researchers.

The third and last step is based on the prior achieved results and defines recommendations for actions for the different classes of typologies. The major assumption is the different support needs of companies and university researchers. Thus, also support should be offered accordingly. The qualitative empirical part, personal interviews with representatives of the previous identified classes of typology, build on results of the quantitative empirical study and examine the history and current status of technology transfer, and recommendations for actions to (further) increase and improve technology transfer. This part is supplementary to the first empirical one and provides additional insights. It is important to keep in mind that some of the recommendations for actions will aim at single organizations or individuals like university researchers. Others will need inter-organizational efforts to be realized.

4 Desk research results

This chapter summarizes the results of the desk research. During the desk research phase more than 70 art kels, books and reports on technology transfer were examined. The majority focuses primarily on technology transfer between universities and companies. Some deal with technology transfer between public and private research centers others than universities and companies or even technology transfer between companies or intra-organizational technology transfer. The geographic dimension varies too. The majority deals with regional technology transfer, but also literature concerning national and international technology transfer was considered. The majority of literature was written by US authors followed by contributions from Germany, other European countries, and other parts of the world.

The succeeding empirical work tries to gather an as complete as possible picture of university researchers' and companies' characteristics, technology transfer features, barriers and motives. However, not all of the desk research results can be considered. This would exceed the scope of the thesis. Only the ones perceived as most important for reaching the research objective were considered for the following examinations. The following figure provides an overview of the major factors identified with the help of desk research and used for the technology transfer survey between Styrian companies and Graz University of Technology.

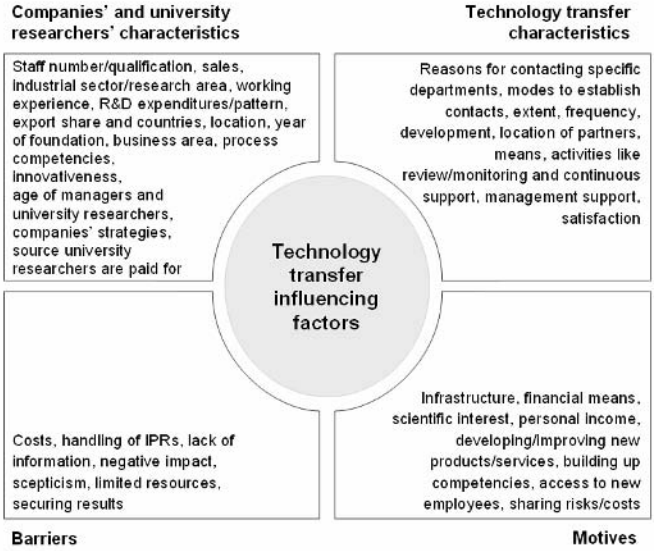

Figure 2: Overview of major characteristics, technology transfer features, barriers, and motives chosen for the questionnaires

Personal relations between university researchers and company employees seem to be of major importance for technology transfer. Personal relations are more likely if companies employ academics, who take with them their existing network. Personal relations are also supposed to influence companies' decision to contact specific university departments in case of needs. Companies are supposed to contact previously unknown university researchers only in case the ones already known cannot provide the needed knowledge.

The influence of companies' industrial sectors is assessed controversial. Some studies conclude that industrial sectors influence the likelihood of doing technology transfer. Others deny the influence of industrial sectors on technology transfer. High-tech sectors, defined by high R&D expenditures, seem to be more likely to do technology transfer. This is supposed to depend amongst others on factors like readiness to change, higher absorptive capability, higher R&D expenditures, and higher pressure from customers.

Schneeberger and Petanovitsch[8] showed differences in the share of academics on the total number of employees for different industrial sectors. These differences in the qualification of employees are likely to affect the absorptive capacity and thus technology transfer. This would again hint towards the importance of industrial sectors.

The size of companies plays a major role in technology transfer. It is usually measured in number of employees or sales. It seems to influence the extent of technology transfer, i.e. number of companies' contacts with university researchers and adopted technology transfer means. It is also supposed that it influences modes how technology transfer is established. Previous studies show that intermediaries are especially important for smaller companies. Size is also supposed to influence motives and barriers. Also in case of university departments, size seems to influence technology transfer.

Export quotes and geographic markets of companies are used as indicators for competition. It is supposed that companies with higher export quotes are more likely to do technology transfer. Companies active in highly competitive markets like western European countries are likely to depend more on external stimuli than companies realizing the majority of their sales in countries economically less developed.

R&D is considered as the most important driver for technology transfer. Internal R&D is important for the absorptive capability of companies and seems to positively influence technology transfer with universities outside the region companies are located. For regional technology transfer R&D does not seem to be that important. R&D is likely to lead to different motives, i.e. valuing access to graduates, and barriers, i.e. fearing knowledge spillovers to competitors. Universities have to offer high quality knowledge to support companies. This is especially important for companies heavily active in R&D. In case of universities, it is supposed that specific departments are more likely to do technology transfer than others because their research areas are closer to immediate applications in companies.

Companies' location seems to influence technology transfer. It determines the distance to knowledge sources and other companies providing business services. It is shown that innovation activities and technology transfer depend on each other and

[8] Schneeberger, Arthur; Petanovitsch, Alexander (Eds.): Innovation und Hochschulbildung: Chancen und Herausforderungen einer technisch-naturwissenschaftlichen Qualifizierungsoffensive für Österreich [Innovation and academic education: Chances and challenges of science and technology oriented qualification offensive for Austria], Vienna 2003

both are related to environmental factors like quality of life issues, existence of companies providing business services and the like. Limits set by cultural issues, i.e. different languages and norms, lead to special importance of regional knowledge sources. Regional collaborations are supposed to be better suited for companies without previous experience in technology transfer. Face-to-face meetings, which facilitate the transfer of knowledge, especially important in case of universities' technologies and leading edge knowledge, are easier to realize because of short geographic distances. The ability to collaborate with partners located more distantly seems to be influenced by various characteristics like technology transfer experience, size, R&D capabilities, and export quotes. Studies show an evolution pattern of technology transfer with companies firstly collaborating regionally and then start to integrate knowledge from more distant sources to increase their competitiveness further.

Technology transfer is also likely to be influenced by the type of products and services offered by companies. It seems to make a difference if companies are manufacturers or service providers. The respective categories are likely to influence needs for external knowledge, the openness to approach universities and the probability to be approached by academics.

Companies' age is likely to influence technology transfer. Younger companies are supposed to be more likely to do technology transfer. There are several possible explanations like the higher availability of funds for younger companies, the increasing share of science in products and services, the increasing knowledge intensity of younger companies or the increasing consciousness of younger business managers of the value of universities' knowledge.

Management support is important for technology transfer, independently if at companies or universities. Managers have to create a pro-active culture towards technology transfer. In case of companies, the formal qualification of managers is supposed to be important. Company managers with university degrees are likely to be more apt to assess potential benefits and risks of technology transfer. Management has to champion technology transfer and must support and enable their employees accordingly. For both partners it is important that they understand each other's needs and barriers. Therefore, experiences in both environments should support technology transfer.

Managers are also in charge to design organizations for technology transfer. This comprises creation of a suited culture emphasizing innovations, supporting

technology transfer by providing resources and in case of universities stressing the importance of interdisciplinary research and overcoming publishing inertia. Especially processes seem to be important. Organizations structured in processes are supposed to have higher absorptive capabilities. The reasons might be a higher degree of planning capability or a higher differentiation resulting in higher specialization.

Companies have to be aware that university researchers are rather autonomous and their personal motivation is likely to differ. Influencing factors might be i.e. age of university researchers, their previous working experience or their type of contract, i.e. paid for by regular university budget or third party funds from companies. Therefore, it is important to pay attention to the specific individual situation of university researchers, whose knowledge companies want to tap.

Communication is often mentioned as critical in technology transfer. Both sides, university researchers and companies, often blame each other to provide insufficient information.

Companies' strategies are supposed to influence technology transfer. It determines the major motivation of companies to do technology transfer. It is supposed that companies following a technology leadership strategy are more likely to do technology transfer because of the importance of up to date technologies for their own businesses. Companies focusing on cost leadership strategies on the other hand are more likely to keep their hands off technology transfer because they focus rather on incremental improvements of their processes and not on developing new products or processes.

The share of newly developed or markedly improved products and processes will be used to indicate the lifecycle of products and processes but also the innovativeness of companies. It is supposed that companies with a higher share of newly developed or markedly improved products and processes are more likely to do technology transfer than other companies.

Scepticism to collaborate is likely to be one of the major barriers. This accounts for companies and university researchers as well. University researchers want to maintain the university a pure institution. They are afraid of potential negative effects on faculty and students, universities' mission, reputation and financing. It seems controversial but university departments already attracting a high share of third party funding might be afraid to pay for it by decreasing public funding. Companies not yet

experienced in technology transfer are likely to underestimate benefits provided by technology transfer. They might lack confidence in the ability of university researchers to solve specific in-house problems at reasonable costs. Other barriers are i.e. difficulties caused by limited resources at universities and companies or problems with translating acquired knowledge into new or improved products and processes. This is supposed to be a function of company employees' qualifications and continuous support provided by university researchers. Another critical point is confidentiality and securing research results for the own company. The danger of spillovers might keep companies far from universities. Finally, also costs are of major importance. Search and acquisition costs are estimated to be rather high especially for university research. It requires companies' expertise to identify potential benefits for the own business. This too depends on the qualification of companies' employees and internal R&D activities. Another barrier might be the handling of IPRs at universities and companies.

Motives are supposed to differ not only between different organizations like companies and universities but also within the same organization[9]. This is assumed to account primarily for universities where university researchers are rather autonomous. Companies' employees are more likely to be streamlined towards companies' motives because of the strong link between fulfilling companies' objectives and employment. Motives are l kely to depend amongst others on the size of companies. Larger companies might focus on learning and building up competencies, whereby smaller companies are likely to pay more attention on directly sellable outcomes like improving products and processes. Access to highly trained students, graduates, and university researchers is supposed to be important for companies carrying out R&D. Other motives are sharing risks and costs, ideas for new products and services, which might depend on the need to innovate, i.e. companies with a high share of revenues with products and processes being introduced to markets a long time ago, and ideas for further research. Closely related are the following motives: Provision of general and useful information, support in the development and innovation process and access to problem solving capacity, access to state of the art science, contemporary knowledge, and research networks. Furthermore, companies might be interested in research excellence, access to universities' facilities and the enhancement to companies' image and reputation by doing technology transfer with (specific) universities.

[9] Kremic, Tibor: Technology Transfer: A Contextual Approach, in: Journal of Technology Transfer, Vol. 28, 2003, pp. 149-158

University researchers will do technology transfer if they are satisfied with their up to date experience. This is also supposed to be valid for companies. For university researchers it might be important to fulfill society's expectation by demonstrating the economic return of investment in basic research. Additional motives are additive research funding for i.e. post-doctoral fellows, laboratory equipment and facilities, access to companies' technical expertise to provide i.e. students with latest methodologies, using companies for studies i.e. operations management or logistics, exposure of students and university researchers to practical problems, and opening up possibilities for internships and employment opportunities for students and graduates. The possibility to earn additional personal income is not likely to motivate university researchers strongly. However, this might depend strongly on other characteristics like i.e. age and function of university researchers at university departments. In general, university researchers are supposed to be motivated by intrinsic motives, i.e. personal prestige, curiosity of research projects and the recognition within the scientific community[10].

Technology transfer is a learning process. Experience and expertise can only be achieved by actually doing technology transfer. Gaining experience and expertise is necessary to learn how to exploit ideas and to get a better understanding of the partner's needs. Technology transfer is assumed to be influenced positively by introducing processes, i.e. monitoring and reviewing processes. Monitoring and reviewing processes are vital to understand how technology transfer is realized, which supports learning. Additionally important is the question how technology transfer is initiated. Companies perceive this as a task of universities and vice versa.

Means to do technology transfer are different regarding their purpose, costs, duration and the involvement of company employees, university researchers and students. Smaller companies are likely to rely on smaller projects like master theses, which are economically and less resource intensive than doctoral theses. Also the ways how companies finance universities and university departments influence technology transfer means, i.e. companies short time financing universities with clear objectives versus grants for universities with possibilities in co-designing the direction of research without clearly defined deliverables.

Finally, technology transfer is supposed to depend on continuous support. This goes along with a shift from linear to non-linear innovation processes. Continuous interaction is important to ensure that i.e. actions agreed during round tables and

[10] Frey, Bruno S.; Osterloh, Margit (Eds.): Managing Motivation: Wie Sie die neue Motivationsforschung für Ihr Unternehmen nutzen können [Managing Motivation: How to use modern research in motivation for your company], Wiesbaden 2000

workshops are actually realized. Focusing on steady interaction could also solve problems with i.e. translating research results into business success.

5 Technology transfer survey

This chapter provides an overview regarding general issues related to the survey and its results. The analyses were done with SPSS, a standard statistic software tool. The two major methodologies used are frequency and bi-variate analyses. The objective of the survey was the identification of relations between university researchers' and companies' characteristics, technology transfer features, barriers and motives and served to set up the typology for companies and university researchers as basis for identifying suited recommendations to improve technology transfer.

5.1 General issues

In the following, an overview of general issues related to the questionnaires is provided. It deals with target groups, data sources, and the survey's technical issues.

University researchers working at the author's affiliation, Graz University of Technology[11], were chosen for the survey of university researchers. The university is active in technology and technology related research. It gives place to about 1,200 university researchers employed in more than 100 departments, which are grouped in seven faculties. The university earned in 2005 about a quarter of the overall budget with projects with third parties, i.e. with industry, but also taking part in EU projects and the l ke. Every single university researcher was approached to fill out the questionnaire because university researchers are rather autonomous in their research and the supposed dependency of technology transfer features, barriers, and motives on individual university researcher's characteristics. 1,511 companies[12] in Styria were invited to participate in the survey. The companies are active in different business areas. The questionnaire did not focus on specific knowledge intensive sectors but also on sectors usually considered as low- or medium-tech sectors. The individuals the questionnaire aimed at were either CEOs[13] or R&D, innovation, or collaboration managers. These employees are usually respons ble for collaborations with external R&D providers like universities. The necessary data to approach these companies were provided by Herold, a business data service

[11] See www.tugraz.at for further information on Graz University of Technology

[12] Company survey participants were asked to answer the questions only for the company location named in the invitation. Companies wi h more than one location in Styria were examined separately.

[13] Especially in case of smaller companies, which are not that differentiated regarding their organizational structure.

provider[14]. The industrial sectors, which were chosen for the survey, are knowledge intensive service providers[15], high- and medium-tech companies[16], companies being active in other industrial sectors likely to have potential to collaborate with universities and companies either already using services of the technology transfer office at Graz University of Technology or marked as R&D performing companies, i.e. taking part in regional, national or international R&D programs[17].

The questionnaire for Styrian companies was realized as online questionnaire[18] and MS Word document for download. For the online questionnaire companies had to enter individual access codes, which came along with the invitation e-mail. Thus, it was possible to link entered data with centrally available data like zip code and industrial sectors companies belong to. Answers sent back by e-mail or fax were identified with the help of the e-mail address, fax number or companies' name. The questionnaire for university researcher was realized as MS Word and PDF document for download.

Before the questionnaires were sent out four pretests were performed, two with university researchers and two with company employees. The pretests served to further improve questionnaires regarding time efforts to fill them out, clarity of questions and testing the invitation function and accessibility of the online questionnaire. The questionnaires were also discussed with colleagues experienced in setting up questionnaires and realizing surveys within and outside the university.

---

[14] Herold offers the Herold Business Marketing CD. It is updated regularly and provides the most comprehensive data of companies in Austria. The data sources of which Herold collects relevant data are insurance agencies, the Austrian Kreditschutzverband [credit assurance association], Telecom Austria, journals and newspapers. Prior to enter data every single company is contacted by phone to make sure the company is actually doing business and wants to be included in the database.

[15] According to the EU definition knowledge intensive service providers are companies active in the following NACE sectors: 72, 73, 741, 742, 734 and 744.

[16] According to the EU definition high- and medium-tech companies are companies active in the following NACE sectors: 24, 29, 30, 31, 32, 33, 34, 352, 353, 354 and 355.

[17] These companies were identified by checking industrial sectors of companies already having contacts to the central technology transfer office at Graz University of Technology, manual checks of additional industrial sectors and their potential interest in universities' knowledge and companies with entries related to participation in EU framework programs and national, regional and local R&D programs, which are regularly updated by the staff of the technology transfer office at Graz University of Technology. Companies active in the following NACE sectors were chosen: 10, 11, 12, 13, 14, 201, 202, 203300, 211, 23, 252, 2623, 2624, 2626, 264, 265, 2682, 27, 282, 283, 285, 2862, 37, 40, 41, 4521, 4523, 4524, 4525, 623, 624, 642001, 748705 and 851404.

[18] The online provider www.2ask.at was chosen because of the convenient features and the good costs/benefits ratio. The program is rather easy to handle, even for people not familiar with online questionnaires, and the customer support by e-mail quite good and fast. It also offers the possibility to stop filling out the questionnaire any time, close the browser window and to continue the survey without losing the previously entered data. Also other providers like www.equestionnaire.de or customized solutions like a self programmed questionnaire were taken into considera ion, but finally the convincing cost/benefit ratio favored www.2ask.at. The program was also recommended by other colleagues working in the area of statistics.

The questionnaires were also presented to the university management[19] and members of the university staff association for scientific employees. Finally, also Prof. Wohinz as the primary coach of this thesis examined the questionnaires before they were sent out to university researchers at Graz University of Technology and companies.

Companies' invitations for taking part in the study were sent out by e-mail on 31st of May and 1st of June 2005. Returned mails were checked and then sent again during the following days. A reminder was sent out on 28th of June 2005. Companies were asked to fill out the questionnaire until 8th of July 2005. The text of invitation and reminder mails was similar for all companies except for some individual parts[20]. The online questionnaire worked reasonable well. University researchers were approached by the staff association for scientific employees at Graz University of Technology. The staff association rejected the idea to invite university researchers using the online questionnaire out of confidentiality reasons. The author approached university researchers personally known on 26th of May 2005 announcing the forthcoming survey. The invitation mail for university researchers was sent out by e-mail on 2nd of June 2005 by the staff association. They sent out an e-mail attaching a MS Word document with the invitation text and the link to download the questionnaire. Some university researchers were not able to open the MS Word document because they did not use MS office programs. Therefore, an additional PDF file was created for university researchers using other software then MS office. Compared to the answers of companies the answers of university researchers contained more mistakes like wrongly entered data and taken convergences. On 23rd of June 2005, an e-mail was sent to department heads reminding them to take part and to forward the e-mail to their employees and colleagues.

The following part compares survey participants with all invited university researchers and companies according to chosen stratification criteria. Figure 3 shows the composition of the group of survey participants compared to the overall composition at the university w.r.t. the major participating personnel categories. Professors, assistant professors, and assistants (doctoral students) are the ones contributing over the average to the results. The highest response rate is within the group of professors. This group might have the highest response rate because they are in charge for the strategic direction of the department, which includes technology transfer. Therefore, their interest in improving technology transfer is assumed to be

[19] Rector, vice rectors and head of the rector's office of Graz University of Technology

[20] I.e. in case the person of the company responsible for technology transfer was known by name to the author the e-mail addressed this person personally. Additional individual parts were related to the access code for the online questionnaire and the company's name and loca ion.

rather high. Especially project and third party funded employees have rather low response rates. It was assumed that especially project and third party funded employees would be interested in providing suggestions because of their dependency on technology transfer. In total 81 questionnaires were answered out of 1,207 invited persons giving an overall response rate of 6.71 %.

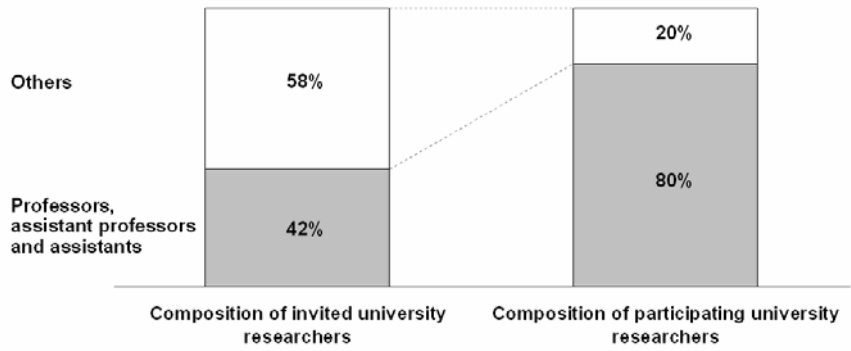

Figure 3: Comparison of composition of invited and participating university researchers w.r.t. major participating personnel categories

The faculties beginning with the largest ones in number of heads are: Chemistry, process engineering and biotechnology, civil engineering, mechanical engineering and economics, mathematical and physical sciences, electrical and information engineering, architecture and computer science. University researchers of the faculties *Mechanical engineering and economics*, *Chemistry, process engineering and biotechnology* and *Civil engineering* provided the majority of responses. Together these three faculties provided 59 responses. The faculties for *Architecture and Computer science* provided the lowest response rate[21].

[21] Note that responses are headcounts but he reference to calculate the participation rate for faculties is measured in full time equivalents (FTEs). The total number of FTEs is 937 5, the number of invited university researchers 1,207. Thus, on average one person accounts for around 78 % FTEs. There might be differences between faculties but it is not possible to account for them because of missing data. An additional restriction is the time of reference. The number for FTEs is referenced to 2004, the number of heads to end of May 2005. However, it seems valid to compare both values on a percentage base, especially because during 2004 and 2005 major changes in the employment structure of faculties were not reported.

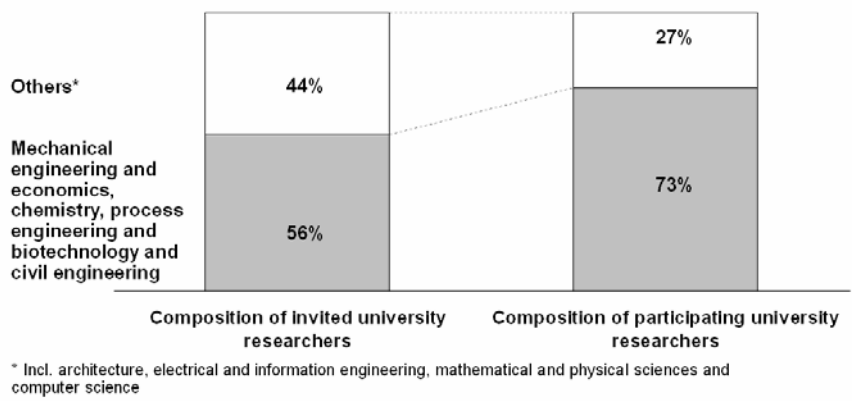

Figure 4: Comparison of composition of invited and participating university researchers w.r.t. university researchers' faculties

Even though the majority of the more than 100 university departments of Graz University of Technology have more than 20 employees (including administrative staff) University researchers working at departments with 6 to 20 employees have a far higher than average response rate. This is in line with the previous examination of the response behavior according to the personnel categories taking into account that larger departments are likely to have a higher than average share of project and third party funded employees.

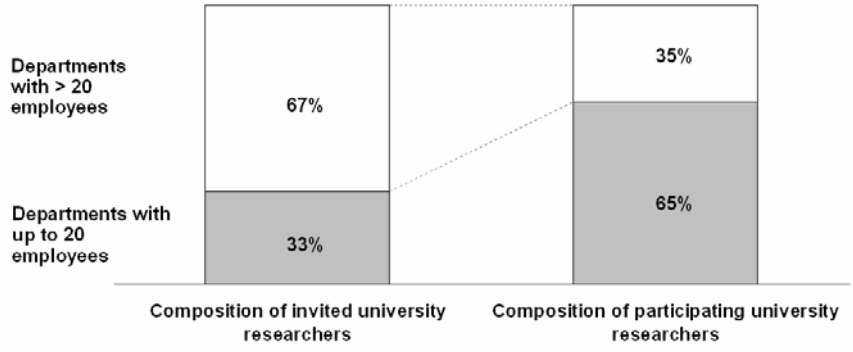

Figure 5: Comparison of composition of invited and participating university researchers w.r.t. department size

For the analysis of responses, companies were classified in four groups: The initial sample of all invited companies, survey participants, dropped out companies[22] and non-responding companies[23]. Companies' responding behaviour was examined according to the following centrally available characteristics: Zip code, industrial sector, size of companies measured in numbers of employees, year of foundation, sales, productivity as sales divided by number of employees and notes regarding the participation of companies in R&D programs[24]. Additionally responses were cross-checked with groups established for the invitation mails: Companies, where the author personally knew the representatives, companies having contacts to the technology transfer office at Graz University of Technology, large and well-known companies, and others. In total, 177 companies answered to the survey, giving a response rate of 11.71 % of the initial sample of invited companies.

Almost 40 % of all invited companies are located in or near to the city of Graz, the capital of Styria. The survey participants' quote is even higher with around 50 %. Graz University of Technology is also located in Graz. Companies within the same geographic area might have felt more obliged to respond. Furthermore, it is likely that due to the higher concentration of companies within the Graz region the need for collaborations with external partners like universities is higher than in the more rural areas of Styria.

[22] Companies that dropped out are companies which started the survey but did not finish and companies answering that i.e. they were too small or active in business areas without need to do technology transfer.

[23] These companies did not start the online survey and did not mention reasons why they were not interested in taking part in the survey.

[24] Remember that data regarding the participation in R&D programs were entered manually by the technology transfer office at Graz University of Technology. It is not exhaustive and therefore allows only a qualitative examination.

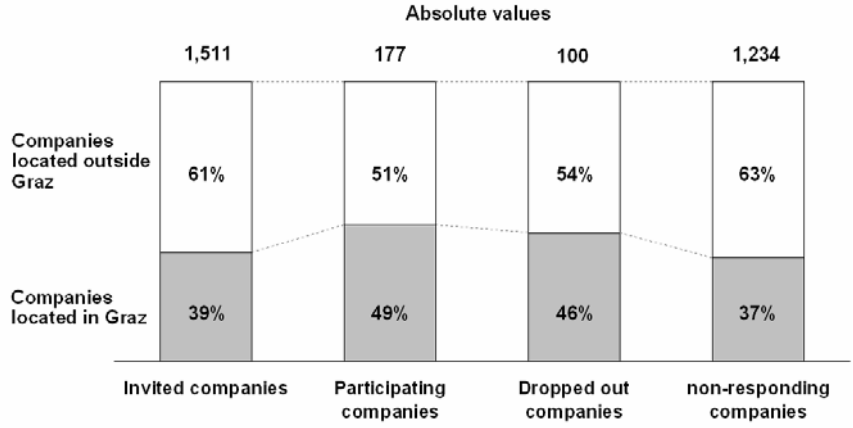

Figure 6: Distribution of companies of the respective groups according to their zip codes

The analysis regarding industrial sectors does not show major differences. Industrial sectors were examined very detailed. This was necessary to identify companies potentially being interested in technology transfer with universities and to not include companies obviously being uninterested in technology transfer. Note the number of entries of industrial sectors (1,698) is not similar to the number of invited companies (1,511). This is because some companies are active in more than one industrial sector.

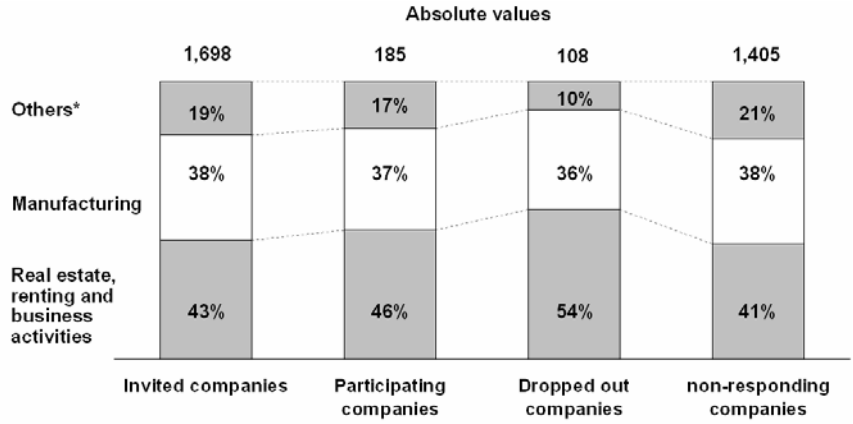

Figure 7: Distribution of companies of the respective groups according to their industrial sectors

The participation of small enterprises is lower than expected due to their share in the initial invitation sample. Larger companies were more willing to answer. The reasons could be manifold like increasing interest in technology transfer or a greater openness towards such kinds of surveys with an increasing size.

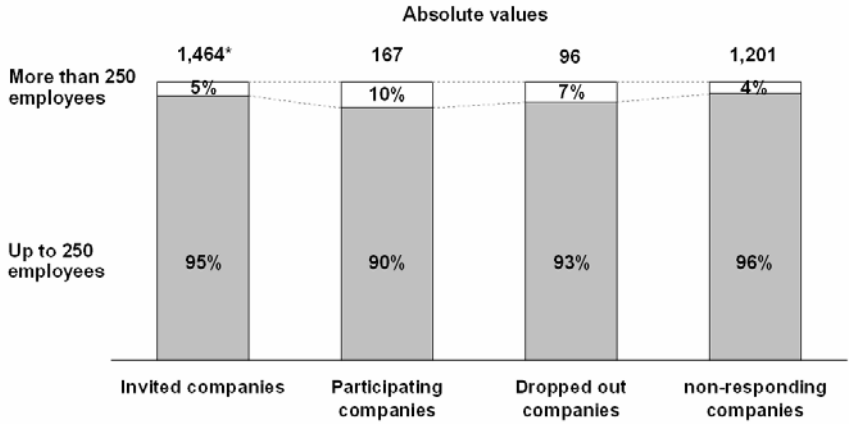

Figure 8: Distribution of companies of the respec ive groups according to their number of employees

Companies with lower sales have a lower than average response rate whereas companies with higher sales have a higher than average response rate. This is consistent with the table related to the number of employees where larger companies showed a higher than average response rate.

The productivity is calculated as sales divided by the number of employees. Companies with a productivity of up to 150,000 EUR had a lower than average response rate. Companies with a high productivity have a higher than average response rate.

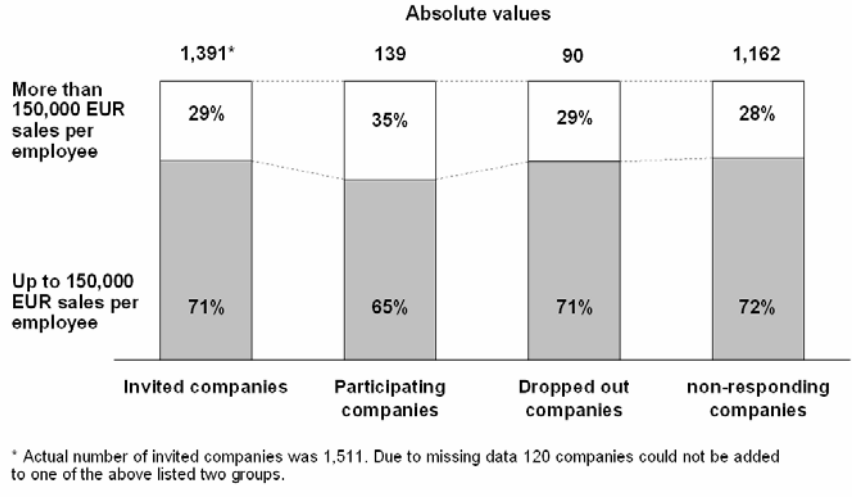

Figure 9: Distribution of companies of the respective groups according to their produc ivity (sales divided by number of employees)

Companies founded between 1965 and 1975 have a lower than average participation rate than expected due to their share in the invitation sample. For companies founded after 1995 and between 1945 and 1955 the response rate is higher than the average. The possible reasons remain unclear. For younger companies one explanation might be that these companies could have a higher than average share of knowledge in their products and services. This seems plaus ble because founding companies in highly industrialized countries like Austria seems only possible if companies operate in rather knowledge intensive business areas and such companies are supposed to be more open towards technology transfer with universities.

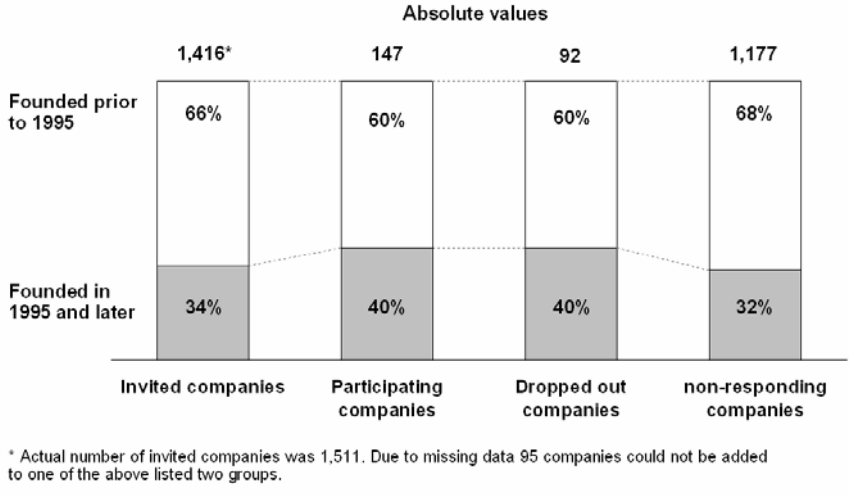

Figure 10: Distribution of companies of he respective groups according to their year of foundation

About 20 % of all invited companies have manual entries regarding their participation in R&D programs[25]. Their share regarding participation doubled, which is a strong sign for the increasing interest in technology transfer due to R&D activities.

[25] Remember that these entries were done manually by the technology transfer office at Graz University of Technology. They are not exhaustive. They were entered in case the technology transfer office noted a company taking part in R&D programs. The entries are not part of the Herold Marketing CD. Thus, the actual number of companies having taken part in national and international R&D programs is likely to be higher than the one in this survey.

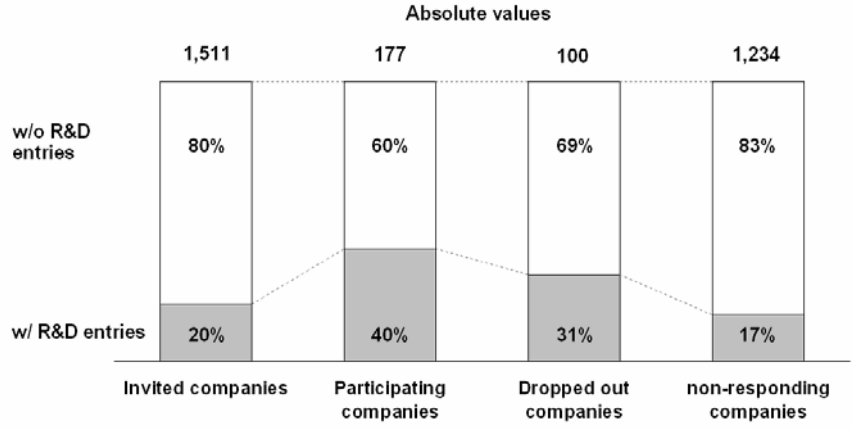

Figure 11: Distribution of companies with manual entries regarding participation in R&D programs according to their answering behavior

The following graph shows the distribution of invited and participating companies regarding their relations to the technology transfer office at Graz University of Technology. The group with existing contacts to the technology transfer office at Graz University of Technology has a higher than average response rate. The reason might be that for these companies the importance of technology transfer with universities is higher than for other companies. Also the existing personal relations of the author with some of the companies might have positively supported the answering behavior of these companies.

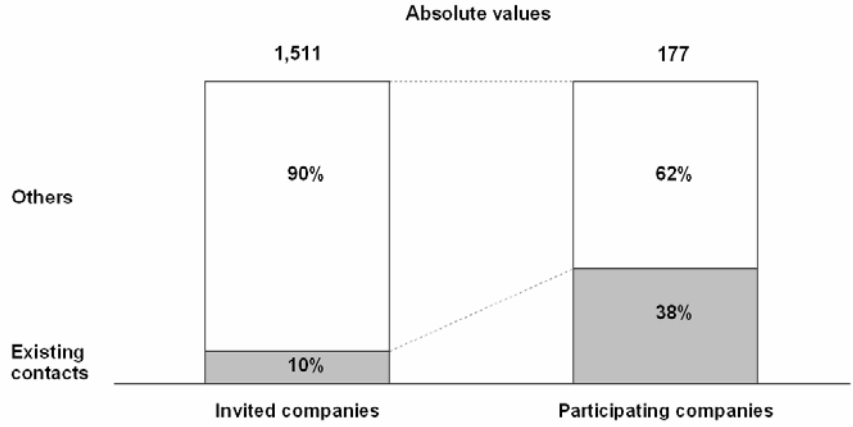

Figure 12: Distribu ion of companies w.r.t. their relation to the technology transfer office at Graz University of Technology according to their participation and answering behavior

5.2 Frequency analyses for companies and university researchers

In the following, the results of the two questionnaires processed with the help of frequency analyses are presented. Frequency analyses are one of the basic tools of SPSS and are especially well suited for a first look at a large amount of data (SPSS[26]). These analyses are a major step for getting a better feeling of the importance of specific characteristics in technology transfer.

5.2.1 Frequency analyses for companies

The majority of responding company representatives is aged between 31 and 50 years. Out of 177 replies more than one third does not have a degree from universities or universities of applied science. 51 respondents are graduates from Graz University of Technology, 24 from University of Graz, a classical university, seven from University of Leoben, three from Vienna University of Technology, and two from campus02, a university of applied science in Graz offering vocational courses. 14 respondents graduated from universities or universities of applied sciences located in other parts of Austria, Germany or USA.

113 respondents are CEOs, 17 R&D managers. Other respondents are department heads, management assistants, plant or business unit managers, innovation or liaison managers, marketing managers or CFOs.

The median value of their companies' yearly sales is 2.5 Mio EUR. The average is higher with around 30 Mio EUR. This shows the influence of several large companies. The following table shows the distribution of companies according to different sale's classes. The numbers are based on the average for the years 2003, 2004 and 2005e.

[26] SPSS (Ed.): SPSS Base 12.0 Benutzerhandbuch [SPSS Base 12 0 user manual], Munich 2003

Average sales in Mio EUR for 2003 to 2005e		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 0.5	29	16.4	17.6	17.6
	From 0.5 to 1	22	12.4	13.3	30.9
	From 1 to 5	51	28.8	30.9	61.8
	From 5 to 10	15	8.5	9.1	70.9
	From 10 to 50	30	16.9	18.2	89.1
	More than 50	18	10.2	10.9	100.0
	Total	165	93.2	100.0	
Missing	System	12	6.8		
Total		177	100.0		

Table 1: Average companies' sales for 2003 to 2005e

The majority of companies provide custom-made specialized services. The number of answers of the graph beneath is higher than the number of participating companies because companies had the possibility to choose more than one category.

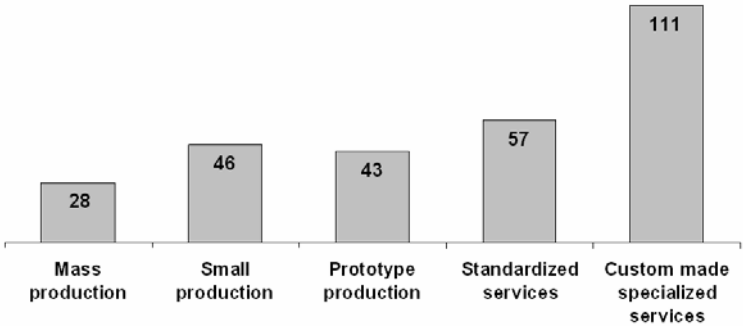

Figure 13: Product and service categories companies are active in

The companies employ on average almost 150 people, the median value is 25. The distribution according to different size categories of employees is similar to the one for sales figures. On average one company employes 24 university graduates, on median the value decreases to two. 18 out of 24 university graduates are on average graduates of universities of technology. The median value decreases again to two.

The majority of companies focus on quality leadership followed by niche strategy, technology leadership and finally cost leadership, which is mentioned rather seldom. The average percentage share of newly developed or markedly improved products and services on sales within the last three years is around 27 %, the median value

20 %. The average export quota is around 33 %, the median value with 12 % much lower. Germany is for more than 30 % of all companies the most important export country followed by Slovenia and Great Britain. More than 70 % of companies are at least partly process oriented and almost 80 % of the companies use innovation management methods at least rarely. 97 of all participating companies continuously carry out R&D, 29 companies rarely. In total, more than 70 % of all companies perform internally R&D.

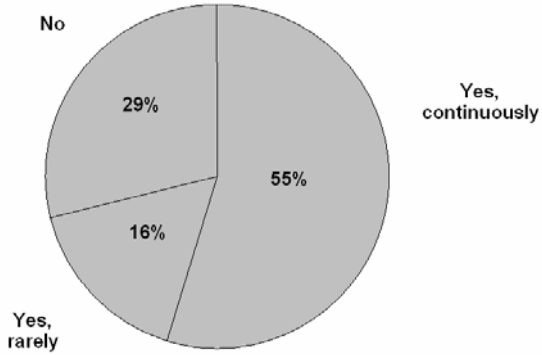

Figure 14: Companies' frequency in carrying out R&D

Of 51 companies not carrying out R&D, seven have at least expenditures for external R&D services. Two thirds of companies carrying out R&D also have expenditures for external R&D services. The median value for total R&D expenditures amounts to 5 % of sales, about 160,000 EUR per year. Average values are higher because of large companies' answers. The majority of companies spend from 5 to 20 % of their annual R&D expenditures for external R&D services. 113 companies already have contacts to or collaborations with universities. Thereof 60 companies, more than 50 %, have expenditures for universities. 12 of 53 companies without expenditures for universities have regular contacts to universities, the remaining part, 41 companies, rarely. 40 companies not yet doing technology transfer with universities are interested in doing technology transfer. This accounts for roughly one quarter of all responses. 24 companies not yet doing technology transfer with universities are not interested in doing so.

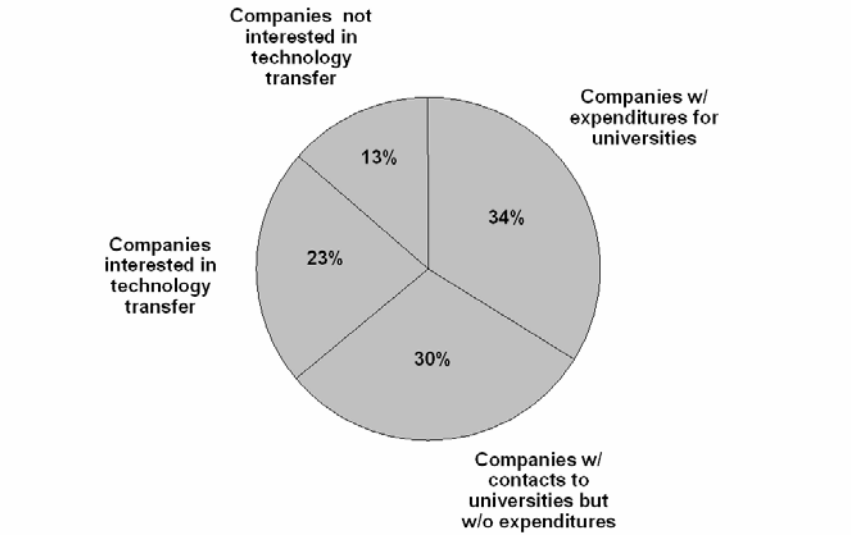

Figure 15: Distribution of companies regarding different relationship possibilities

Reasons for not being interested in technology transfer are lack of overlapping activities, i.e. not carrying out R&D, fear of losing internal knowledge, negative attitude of management towards collaborations with universities and lack of resources.

It is supposed that motivation of companies to get in contact with universities is multifaceted. The results show that this assumption is reasonable. The development of new products or services is stated most often with high importance, followed by access to potential new employees. On the other end of the scale contacts with universities are not perceived as appropriate to access new markets and balance capacity needs. Additionally motives are access to literature and realization of basic research within a reasonable period. According to company representatives, university researchers are motivated by establishing contacts for potential industrial careers, scientific interest in research proposals, and the possibility to finance theses and departments' employees. Collaborations as task of universities, using companies' infrastructure and additional personal income are not rated as that important. Existing personal contacts are the main reason for companies to contact specific university departments. Other important criteria are recommendations of others like suppliers, customers, or partners, excellence of research and geographic prosimity. Rather unimportant are publications in scientific journals, articles in press media and internet, Radio and TV broadcasts. Additionally mentioned factors are

industrial liaison or technology transfer offices looking for and establishing contacts to relevant university departments and projects with customers, which already have contacts to specific university departments. The most frequently stated modus to establish contacts with university departments is the active and direct approach of university researchers followed by university researchers and students approaching companies. One company mentioned that it uses conferences and events, which are attended by university researchers to establish contacts.

Expenditures for universities differ considerably from company to company. They range from 0.3 to 100 % of all R&D expenditures. The median value is 8.7 %. Of all companies, which assessed the future development of their expenditures for universities, more than 90 % stated that expenditures will either increase or stay stable. The two groups are distributed equally regarding the numbers of answers. On average companies spend the majority of expenditures measured in percentage for collaborative research projects. Additional mentioned technology transfer means are participation in projects with competence centers[27] and internships.

Of 108 companies in contact with or having expenditures for universities only two do not have contacts to or collaborations with Styrian universities, 61 often and 45 rarely. Of 90 responses, 16 have often contacts to or collaborations with Austrian universities outside Styria, 38 rarely and 36 never. The situation for German and Suisse universities is similar. 13 companies often have contacts to or collaborations with universities in these countries, 34 rarely and 43 never. Of 69 companies 11 often have contacts to or collaborations with universities in countries not yet mentioned, seven rarely and 51 never. Of the new EU countries especially contacts to or collaborations with universities in Slovenia are rather frequent. The reasons for contacts to or collaborations with universities outside Styria are specific research and knowledge, projects funded within EU framework programs with the need of different European partners and universities actively approaching Styrian companies. Occasionally other reasons like costs, previous bad experiences, and existing personal contacts are mentioned.

Contacts to or collaborations with universities of technology are far more important than to other types of universities, i.e. classical universities. Of 107 companies 57

[27] Competence centers are part of structural funding programs administrated by the Austrian funding agency FFG (www.ffg.at). They aim at translating scientific excellence in international market success. Competence centers are organizations, jointly established by partners from science and industry, doing high level research with immediate economic applications. Competence centers started in 2000 and are funded for seven years. International experts evaluating the competence centers emphasized „their effectiveness to establish closer links between science and companies. They have contributed considerably to creating a new culture of collaborations.“.

have exclusively and 31 primarily contacts to or expenditures for universities of technology. The majority of companies are in contact with only a handful of university departments. Considering that many of these companies have contacts to or expenditures for more than one university companies' contacts at universities seem to be rather focused. 64.1 % of companies do technology transfer since up to max. 10 years.

The majority of companies do not have systems in place to measure the impact of collaborations with universities on the economic success of the company. Reviewing projects with universities is done more frequently. More than half of the answering companies enter long-term relations with relevant university departments. In almost all companies, management supports collaborations with universities. In more than 70 % of all cases, more than one company employee has contacts to universities. This would mean that even in case individuals with contacts to universities leave the company contacts to universities remain.

Barriers most often assessed with high importance are: (1) Passive attitude of universities. (2) Fear of losing confidential data and (3) insecurity regarding exploitation and ability to secure research results. Negative attitudes of university researchers towards collaborations with companies are not seen as important barrier. Asked about the importance of barriers caused by companies a high workload is most often assessed as highly important barrier followed by not knowing the whole variety of technology transfer means and companies behaving too passive. Company representatives do not think that university researchers would assess the negative influence of technology transfer on research and teaching and potential conflicts caused by third party funding as highly important barriers. Additional barriers refer to a lack of understanding companies' problems. In addition, arrogant attitudes of individual university researchers, insufficient project management skills, problems in negotiating IPRs and lack of human capital at universities are mentioned as barriers.

Asked for their need for support company representatives wish for better presentations of universities' competencies, skills, research and poss bilities to realize projects. Additional entries refer to project management skills, i.e. focusing on deliverables, paying attention to deadlines, funding, i.e. leaner bureaucracy, and facilitating strategic collaborations.

5.2.2 Frequency analyses for university researchers

University researchers of the faculty for mechanical engineering and economics constituted the largest group of participants followed by colleagues of the faculty for chemistry, process engineering and biotechnology. The majority of participating university researchers work at departments with more than 20 employees followed by departments with 11 to 20 employees. The largest group of responding university researchers has up to 30 years. The second largest group consists of university researchers aged from 36 to 45 years. In accordance to the age distribution participating university researchers are mostly university assistants and scientific employees in formation followed by professors. The vast majority of participating university researchers is financed by the regular university budget followed by colleagues paid for by third party funds. On average participating university researchers entered the university in 1993. The median value is 2001. There are two major groups. One group comprises university researchers with up to four year experiences at Graz University of Technology. The second major group consists of university researchers, who are at the university since 10 years and longer. The average working experience in companies is 3.8 years, the median 1 year. More than one third of participating university researchers does not have any working experience in companies.

90.2 % of the 81 responding university researchers already have contacts to companies, thereof 77.8 % regularly and 12.3 % rarely. Of eight researchers not yet having contacts to companies three are interested in building up contacts to companies. Five are not interested in doing so. These university researchers emphasized their interest in basic research. In their opinion, companies are not able or willing to engage in this kind of research.

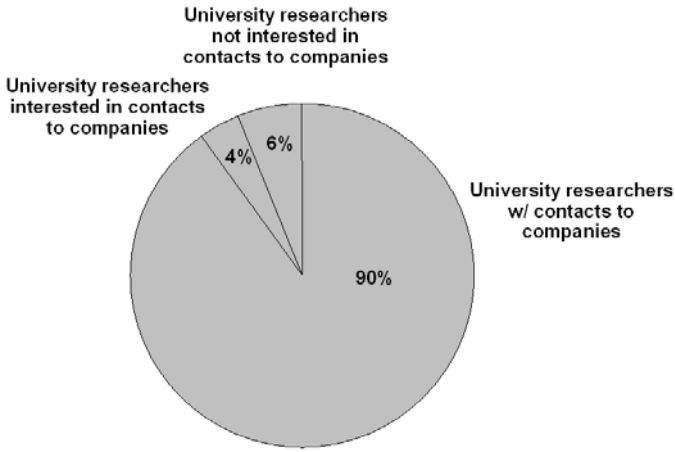

Figure 16: University researchers' categories in technology transfer

Two motives are mentioned especially often as highly important for university researchers to do technology transfer. One is scientific interest and the other the possibility to finance master and doctoral students and departments' employees. On the other end of the scale, mentioned especially often as unimportant, are *Financing your own job* and *Additional personal income*. Additional motives are technology transfer positively influencing the image of the university, additional finances as vital for the survival of the university, to keep own competencies up to date, to finance vocational trainings and doing technology transfer for the own personal (non-financial) satisfaction. University researchers were asked to assess the importance of companies' motives to do technology transfer. The motive mentioned most often with high importance is *Universities as cost efficient R&D service providers*. This is followed by improving existing products and services and building up competencies with the help of universities. On the other end of the scale, assessed as rather unimportant, are access to new customers and markets and universities to increase capacities temporarily.

The number of contacts to different companies per month varies strongly. The maximum are 50 contacts, the median value is four. The median time spent for teaching, doing basic research and technology transfer is split equally. These results confirm the remarks made by Etzkowitz[28], who stated that technology transfer is already one of the core missions of universities besides teaching and research.

[28] Etzkowitz, Henry: The European entrepreneurial university: An alternative to the US model, Industry & Higher Education, 2003, pp. 325-335

University researchers most often do consultancies for companies followed by organizations of guest lectures and the like and coaching master and bachelor theses commissioned by companies. Other technology transfer means are used less frequently.

The primary mechanisms to start collaborations with companies are university researchers directly approaching companies and companies directly approaching university researchers. Other forms play only a minor role. Additionally mentioned mechanisms are heads of working groups and departments and colleagues acquiring projects, known company partners opening up new contacts to other companies, public organizations approaching university researchers, collaborations within EU programs and competence centers[27] brokering collaborations. The project frequency with regular customers is mentioned most often as high, the one with occasional and first time customers is less frequently. The project size is mentioned most often high for regular customers and becomes gradually smaller for occasional and first time customers. This is in line with the assumption that companies start with rather small collaborations to learn to know university researchers and to establish trust before engaging in larger projects. University researchers collaborate most frequently with companies in Styria followed by Austria w/o Styria, Germany or Switzerland and other countries. This shows the importance of short geographic distances and equal cultural background, i.e. same language. The average size for projects with companies located in Styria is smaller than for companies of other geographic areas. This might be linked to the importance of regional collaborations for smaller companies and first time customers, which usually contract smaller projects. Larger, more experienced companies also collaborate with universities in other geographic areas and these companies usually contract larger projects.

The majority of university researchers perceive their collaborations with companies as supportive for their own teaching and research activities. Reasons are exchanging experiences, new points of views and companies providing data for setting up and analyzing theories. However, there are also negative responses, i.e. time efforts for collaborations. In some cases, collaborations are seen as interesting but also hindering the scientific career because of losing time for basic research.

The majority of university researchers do not yet have explicit obligatory standards for technology transfer. If they have standards in place, they refer to departments' quality management systems, model agreements for master theses and standardized offers for services comparable to engineering offices. University researchers most often actively seek feedback from companies and, if necessary, set up and realize

measures based on this feedback. Other activities like support until reaching market success or providing support in identifying and submitting funding proposals are not realized frequently.

67 % of responding university researchers would l ke to expand their collaborations with companies.

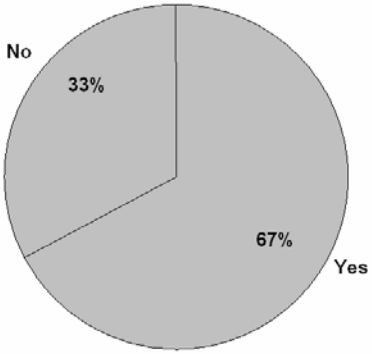

Figure 17: University researchers' attitude regarding an expansion of technology transfer

University researchers assessed passive companies most often as highly important barrier followed by high workload in companies. A negative influence of collaborations on teaching and research is not seen as important barrier. University researchers also assessed the importance of barriers out of the viewpoint of company representatives. The barrier *Difficulties in finding the right contact person at universities* is mentioned most often with high importance. This is followed by high workload at university departments and the fear of confidential data leaking to competitors. Skeptical attitude of university researchers and high costs of collaborations with universities are judged as rather unimportant. University researchers mentioned additional barriers: Competition via costs with other universities and universities of applied sciences, lack of resources, lack of understanding how companies work and what they need, lack of incentives to do technology transfer and lack of understanding benefits of basic research on side of companies.

The main assistance needs for technology transfer mentioned by university researchers are additional personnel resources, leaner administration within the university and in applying for external funding, opening up new contacts and increased marketing for the university.

5.3 Bi-variate analyses for companies and university researchers

The following results are based on bi-variate analyses. The primary methods used are cross tables, bi-variate correlations und T-tests, see the SPSS user manual 12.0[26] for guidelines and examples for the different methods.

5.3.1 Companies: What makes companies in- or outsiders?

The following examination analyzes differences of companies' characteristics with reference to their current technology transfer status[29]. It does not yet matter whether companies actually have expenditures for universities or not. The majority of participating companies already have contacts to or expenditures for universities, 63.8 %.

Insiders usually carry out R&D and have rather high absolute R&D expenditures. The higher the absolute R&D expenditures the higher the probability that these companies already have contacts to or expenditures for universities. The share for external R&D services does not play a statistically significant role regarding contacts to or expenditures for universities. It was supposed that companies follow a specific sequence for collaborations with external R&D service providers. This did not prove true in case of this survey.

Insiders are in general manufacturers. Service providers are less likely to have contacts to or expenditures for universities, independently if offering standardized or customized specialized services. Companies being part of a group of companies rather have contacts to or expenditures for universities. However, this result might be influenced by other variables like the number of employees. The correlation between the number of employees and being part of a group of companies is statistically significant. If a company is part of a group of companies, the company has in general more employees. A higher number of employees leads to a higher probability of being an insider. The same accounts for sales figures. Besides the total number of employees, also the qualification of employees plays a role. The higher the share of highly qualified employees the higher the probability of companies having contacts to or expenditures for universities. Companies with a higher share of in the last three years newly developed or markedly improved products and processes on sales rather have contacts to or expenditures for universities. Insiders have on average a

[29] Insiders are companies already doing technology transfer. Outsiders are the ones not yet doing technology transfer; see Beise, Marian; Spielkamp, Alfred (Eds.): Technologietransfer von Hochschulen: Ein Insider-Outsider Effekt [Technology Transfer from Universities: An Insider-Outsider effect], ZEW Discussion Paper 96-10, Mannheim 1996

share of 30.7 %; the median value is 25 %. For outsiders the values decrease to 21 % (average) and 10 % (median). The export quote shows the same tendency. Companies with higher export shares rather have contacts to or expenditures for universities. For outsiders the average export share is 18.3 % (average) and 1 % (median). For insiders values increase to 42.4 % (average) and 32.5 % (median).

Companies focusing on the following strategic options have a higher probability to have contacts to or expenditures for universities: Quality and technology leadership and niche strategy. The majority of companies following cost leadership strategies do not have contacts to or expenditures for universities. Companies being partly or totally process oriented as well as companies applying innovation management methodologies are more likely to be insiders. Again, this is likely to depend on i.e. the total number of employees. And in fact, with a higher number of employees companies are more likely to be process oriented and to apply innovation management methodologies. Companies with academics from universities being responsible for contacts to or expenditures for universities are more likely to be insiders. On the second place are companies with employees graduated from universities of applied sciences. Companies with employees being responsible for contacts to or expenditures for universities, who did not graduate from universities or universities of applied sciences, have the lowest probability to have contacts to or expenditures for universities.

The only sector with statistically significant influence on the classification of companies in in- or outsiders is the construction sector. More than 68 % of companies belonging to this sector do not have contacts to or expenditures for universities. This is rather different to companies of other sectors, where usually a rather large share has contacts to or expenditures for universities. The year of foundation provides a mixed picture. The median value of the year of foundation for all participating companies is 1992, the average value 1984. Companies founded 1992 upwards have a statistically significant higher probability of being insiders. Calculated with the mean value, 1984, a statistically significant relation does not exist anymore. However, it is likely that due to cultural changes like universities and companies becoming more open for technology transfer companies are more motivated to collaborate with universities and vice versa. Younger companies are more likely to embrace such changes faster than older, more traditional companies.

The companies' location and the age and function of employees being responsible for contacts to or expenditures for universities are not statistically significant related to the question of being an in- or outsider. However, the larger companies are the

more likely that the responding individuals within the companies chose the option *R&D manager*. This forebodes to a more differentiated organizational form of the company. Such companies show a higher likelihood of being insiders than companies where CEOs or individuals holding other functions than CEOs answered.

5.3.2 Companies: Differences between companies having expenditures for universities, companies not having expenditures for but contacts to universities and companies not having contacts to universities

The initial typology is now further detailed. While for the above analyses insiders were not divided in companies with expenditures for universities and companies not having expenditures for but contacts to universities the following analyses consider this fact. Thus, companies are now divided in three groups. This is necessary to identify differences between companies with expenditures for universities, companies not having expenditures for universities but contacts to and companies not having contacts to universities. The following graph displays the number of companies according to the different classes.

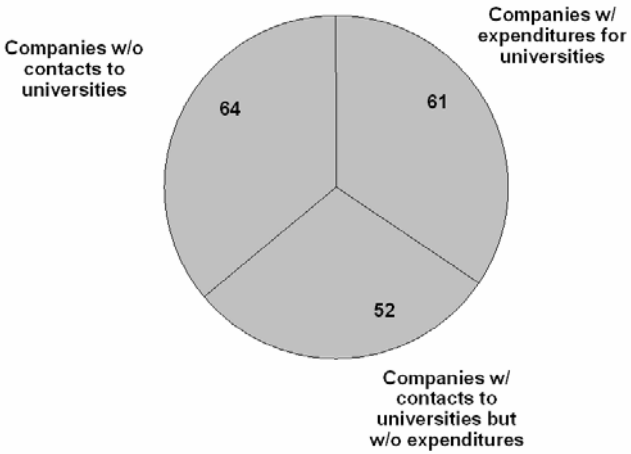

Figure 18: Number of companies according to the three different classes

Companies with expenditures for universities continuously carry out R&D. They have rather high R&D expenditures and are manufacturers. They are likely to be part of a group of companies, have rather high sales, high export quotes, and a high number of employees with a high share of highly qualified employees. These companies are likely to be technology leaders in their respective business areas. They are process

oriented and continuously use innovation management methods. In these companies the organization is differentiated enough to have a function *R&D manager*, which is in general hold by an academic, who is responsible for technology transfer issues.

Companies without expenditures for but with contacts to universities rarely carry out R&D. Thus, they also have smaller R&D expenditures. These companies are either manufacturers or service providers. They are likely to have smaller sales, medium export quotes and an overall smaller number of employees compared to companies with expenditures for universities. They are usually not technology leaders. The companies are only partly process oriented and rarely use innovation management methods. Individuals being responsible for technology transfer are graduates from university of applied sciences, who hold functions others than CEO or R&D manager within the company.

Companies not having contacts to universities usually do not carry out R&D. They either have none or only small expenditures for R&D. These companies are likely to be service providers and/or active in the construction sector. They have small sales, small export quotes, and small numbers of employees. They too are not technology leaders. These companies are not process oriented and usually do not use innovation management methods. These companies are managed by CEOs without academic education, who are also directly responsible for technology transfer with universities.

5.3.3 Companies: Differences in technology transfer features of companies with expenditures for universities and companies without expenditures for but contacts to universities

Companies with expenditures for universities are in the following compared to companies without expenditures for but contacts to universities regarding technology transfer features like i.e. extent or universities' location companies work with. The objective is to identify differences related to technology transfer between these two different groups.

Companies with expenditures for universities use all technology transfer means far more often than companies without expenditures. In addition, the geographic dimension of technology transfer is different. Companies with expenditures for universities also collaborate frequently with universities outside Styria and even Austria. These companies pay special attention to research excellence at university departments. Compared to companies without expenditures for universities

companies with expenditures for universities more often contact university researchers directly and are more often contacted by university researchers. They review more often projects with universities to find out what went good and what wrong. Finally yet importantly companies with expenditures for universities enter more often long-term relationships with relevant university departments, management supports technology transfer, and contacts to universities are usually distributed on several people within these companies. All these characteristics are weaker pronounced for companies without expenditures for universities.

5.3.4 Companies: Differences between companies interested in establishing contacts to universities and companies not being interested in establishing contacts to universities

The following analyses examine how companies, which are interested in doing technology transfer, differ in their characteristics from companies not being interested in doing technology transfer with universities. Both groups did not have contacts to universities at the time of the survey.

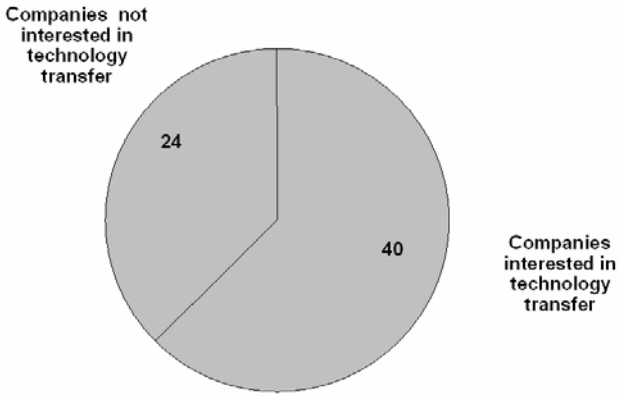

Figure 19: Number of companies at the time of the survey not doing technology transfer according to their interest in whether or not collaborating with universities

The figure above shows that more than 60 % of the companies not yet having contacts to universities are interested in establishing contacts to universities. Opening up these companies would be one possibility to increase technology transfer between universities and companies. In relation to the total number of surveyed companies, this share accounts for almost one quarter. Even though

companies stated to be interested in collaborating with universities, one has to consider that not all companies might have the capabilities and possibilities to collaborate. However, their motivation to do technology transfer can be regarded as a prerequisite.

Companies not yet doing technology transfer but being interested in collaborations with universities carry out R&D and already have expenditures for R&D services provided by other parties, i.e. other companies of their group, universities of applied sciences, public or private R&D labs and the like. The companies are likely to be active in mass production and to focus on technology leadership. Other characteristics do not play a statistically significant role. However, sales and number of employees seem to influence the decision at least slightly. Companies with higher sales and a higher number of employees are more likely to be interested in establishing contacts to universities.

5.3.5 Companies: Which companies' characteristics, technology features, barriers, and motives influence the amount of companies' expenditures for universities?

This part examines factors influencing the amount of companies' expenditures for R&D services provided by universities. The following table shows the average yearly expenditures for universities in absolute and percentage values.

		Average yearly expenditures in EUR	Average yearly expenditures in % of total R&D expenditures
N	Valid	45	48
	Missing	132	129
Mean		117,455.96	15.00
Median		40,000.00	8.71

Table 2: Companies' average yearly expenditures for universities

Companies' expenditures for universities are influenced by various factors. Besides suspected ones like the companies' size measured in sales and number of employees as well as the employees' qualification also other criteria play a role. Companies with rather high expenditures for universities are likely to be manufacturers and technology leaders with high overall R&D expenditures. They already spend a high share of their R&D budget for external R&D services. They are in contact with universities since many years. These companies focus on research excellence at university departments, use specific technology transfer means, focusing on collaborative research projects, and judge university researchers' attitude

towards technology transfer rather positive. All of these companies except one carried out R&D within the last three years. This confirms the view of i.e. Blume and Fromm[5] about the complementary nature of universities' and companies' research. Universities' research does not seem to substitute companies' research. Other factors l ke motives, barriers export quotes, or industrial sectors are not statistically significant.

5.3.6 *Companies: Which companies' characteristics, technology features, barriers, and motives influence companies' frequency in using technology transfer means?*

Only companies with expenditures for universities were examined for this question. Companies without expenditures but with contacts to universities use technology transfer means far less frequently. Therefore, they were not considered for this examination. The table beneath shows the frequency of use of technology transfer means for mean and median values for the last three years.

		Providing cases or giving guest lectures for seminars, lectures and construction exercises	Taking in consulting and expert opinions	Commissioning master and bachelor theses	Commissioning doctoral theses	Commissioning contract research projects (Companies not actively work with university researchers)	Commissioning joint research projects (Companies actively work with university researchers)	Using infrastructure (i.e. for tests)
N	Valid	33	33	43	31	21	47	29
	Missing	28	28	18	30	40	14	32
Mean		15.12	3.64	6 91	1.74	1.14	6.51	6.24
Median		3.00	2.00	2 00	1.00	.00	3.00	3.00

Table 3: Companies' use of technology transfer means

Some of the characteristics influence the frequency of use of all technology transfer means statistically significant. Technology transfer means are used more often if

- Companies have expenditures for universities
- Total R&D expenditures and absolute expenditures for external R&D services are high and
- Companies have high sales

In the following, characteristics influencing the frequency of use of single technology transfer means are displayed. The analyses showed that companies seem to use means specifically according to their needs and circumstances.

Providing cases or giving guest lectures for seminars, lectures and construction exercises as technology transfer means are used more frequently in case:

- Companies are in contact with universities since many years
- Companies are active in mass production, manufacture prototypes or offer standardized services
- Companies have a large number of employees with a rather high share of university graduates and graduates from universities of technology

Taking in consulting and expert opinions as technology transfer means are used more frequently in case:

- Companies assess the motives *Improving existing products and processes*, *Universities as economic R&D service providers (outsourcing)* and *Access to pot. new employees* rather important
- Companies enter long-term partnerships with relevant university departments
- Companies are not active in mass production
- Companies are service providers offering custom made specialized services
- Companies employ university graduates
- Companies are technology leaders

Companies using this technology transfer mean rather frequently often measure the impact of collaborations with universities on the economic success of the company with the help of indicators.

Commissioning master and bachelor theses as technology transfer means are used more frequently in case:

- Companies are in contact with universities since many years
- Companies are active in mass production, small production, manufacturing prototypes or service providers offering standardized services
- Companies have a large number of employees with a rather high share of university graduates and graduates from universities of technology

Commissioning doctoral theses as technology transfer means are used more frequently in case:

- Companies are in contact with universities located in other countries than Austria, Germany or Switzerland
- Companies are in contact with a high number of university departments
- Companies are in contact with universities since many years
- Companies are active in mass production or manufacture prototypes
- Companies have a large number of employees with a rather high share of university graduates and graduates from universities of technology
- Companies which do not follow niche strategies

Companies using this technology transfer mean often measure the impact of collaborations with universities on the economic success of the company with the help of indicators.

Commissioning contract research projects (Companies not actively work with university researchers) as technology transfer means are used more frequently in case:

- Companies assess the barrier *Internal knowledge of the company leaks to competitors with which university departments are in contact too* rather important
- Companies are not active in small production but service providers offering standardized services
- Companies follow the strategy technology leadership

Commissioning joint research projects (Companies actively work with university researchers) as technology transfer means are used more frequently in case:

- Companies are active in small production, manufacture prototypes or are service providers offering standardized services
- Companies have a rather high share of graduates from universities of technology

Using infrastructure (i.e. for tests) as technology transfer means are used more frequently in case:

- Companies assess the motive *Balancing capacity shortages* rather important
- Companies manufacturing prototypes
- Companies follow the strategy cost leadership

If companies follow the strategies quality or technology leadership they use this specific technology transfer mean less frequently.

5.3.7 Companies: Which companies' characteristics, technology transfer features, barriers, and motives influence the expected future development of companies' expenditures for universities?

Companies with expenditures for universities had to estimate the development of these expenditures for the years 2006 and 2007. The answering options were *Increasing*, *Stable,* and *Decreasing*.

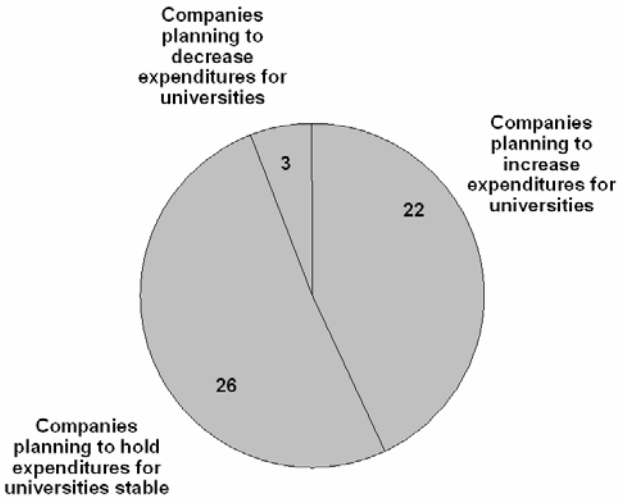

Figure 20: The future development of companies' expenditures for universities

More than 40 % of companies want to increase their current expenditures for universities. About half of the responding companies want to hold their expenditures for universities stable. Only a small part of companies wants to decrease their expenditures. It is supposed that the decision regarding the future development of R&D expenditures for universities depends on the current level. However, the results show the relation is not statistically significant but the trend confirms the assumption. Companies with currently small expenditures for universities are more likely to want to increase their expenditures for universities than companies with larger expenditures for universities. This accounts for percentage as well as absolute values.

Companies regularly carrying out R&D and wanting to build up competencies with the help of universities are statistically significant more likely to further increase their expenditures for universities. The examination shows also the trend that companies with an already high share of expenditures for external R&D services are more l kely to hold their expenditures for universities stable.

5.3.8 Companies: Which companies' characteristics and technology transfer features influence companies' assessment of the importance of barriers and motives?

The two variables being examined in the following are the importance of barriers and motives of companies related to technology transfer with universities. The variables were examined with the original, ungrouped ratings, high, medium and small importance and not important, and with two grouped ratings, high importance together with medium importance and small importance together with not important. Note that only companies already doing technology transfer with universities had to answer the importance of motives. Companies not yet doing technology transfer but being interested in establishing contacts to universities only had to answer the importance of barriers.

Barriers mentioned most often with high or medium importance are: (1) Universities are too passive regarding the information and presentation of their research results and collaboration possibilities. (2) The results of collaborations with university departments are rather insecure or difficult to realize in companies (i.e. exploitation, patenting). (3) Know-how of the company or confidential data leaks to competitors with which the university departments also have contacts. (4) It is hard to find the right people at universities. University researchers being skeptical regarding collaborations with companies do not seem to play a major role.

		Difficulties in finding the right contacts	Universities are passive in providing informa ion and presenting their research results and possibilities to collaborate	Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)	Internal knowledge of the company leaks to competitors with which university departments are in contact too	High work load at university departments hinder collaborations with companies	Collaborations with university departments are too expensive compared to benefits	University researchers are rather skeptical towards collaborations with companies
N	Valid	146	147	146	145	142	144	144
	Missing	31	30	31	32	35	33	33
Mean		2.48	2.16	2.27	2.40	2.68	2.51	2.85
Median		2.00	2.00	2.00	2.00	3.00	3.00	3.00

Table 4: Overall assessment of the importance of barriers (1 = High importance, 2 = Medium importance, 3 = Small importance, 4 = Not important)

The four major motives are (1) the development of new products and processes, (2) improving existing products and processes, (3) building up specific competencies with support from universities and (4) access to potential new employees. Motives like balancing resource bottlenecks or access to new customers and markets do not seem to play a major role.

		Developing new products and processes	Improving existing products and processes	Building up specific competencies with universities' support	Universities as economic R&D service providers (outsourcing)	Collaborations with universities increase the likelihood of success to acquire additional external funding	Access to new customers and markets	Balancing capacity shortages	Access to pot. new employees
N	Valid	104	103	104	101	99	99	99	102
	Missing	73	74	73	76	78	78	78	75
Mean		1.88	2.05	2.26	2.59	2.56	3.25	3.21	2.32
Median		2.00	2.00	2.00	3.00	3.00	3.00	3.00	2.00

Table 5: Overall assessment of the importance of motives (1 = High importance, 2 = Medium importance, 3 = Small importance, 4 = Not important)

Companies assessing the motive *Developing new products and processes* rather important have high absolute R&D expenditures and spend a relatively high share of R&D budget for external R&D services. They frequently commission doctoral theses and focus on collaborative R&D projects. They highly value publications in scientific journals and the excellence of research. Usually they actively approach university researchers and do not turn to industry near organizations to identify suited university researchers. These companies engage in long-standing relations with relevant university departments and the companies' management supports technology transfer. The companies' estimated future sales growth is at least + 10 % for the period 2006 to 2007.

Companies assessing the motive *Improving existing products and processes* rather important frequently take in consulting services and expert opinions of university researchers and commission frequently contract research projects. These companies judge the barrier *Difficulties in finding the right contacts* rather important. Also in this case publications in scientific journals and the excellence of research are important. The estimated future sales growth ranges from + 5 to + 10 % for the period 2006 to 2007.

Companies assessing the motive *Building up specific competencies with universities' support* rather important spend a rather high share of their total R&D expenditures for external R&D services. They frequently commission joint research projects and engage in collaborations with universities in other countries than Austria, Germany, and Switzerland. They are usually in contact with a relatively high number of university departments and assess the barrier *Internal knowledge of the company leaks to competitors with which university departments are in contact too* as rather important. They too engage in long-standing partnerships with universities and have a rather high export share.

Companies assessing the motive *Universities as economic R&D service providers (outsourcing)* as rather important pay attention to the excellence of research at university departments. They welcome short geographic distances to universities.

Companies assessing the motive *Collaborations with universities increase the likelihood of success to acquire additional external funding* as rather important realize projects with regional (in this case Styrian) universities and assess the importance of existing personal contacts rather high.

Companies assessing the motive *Access to new customers and markets* as rather important realize also projects with universities in other countries than Austria, Germany, and Switzerland.

Companies assessing the motive *Balancing capacity shortages* as rather important rarely carry out R&D and rarely use innovation management methods.

Companies assessing the motive *Access to pot. new employees* as rather important usually carry out R&D and have rather high R&D expenditures measured as percentage share of sales. They often use the technology transfer means *Providing cases or giving guest lectures for seminars, lectures and construction exercises*, *Commissioning master and bachelor theses* and *Commissioning doctoral theses*. These companies realize also projects with universities in Germany or Switzerland and pay attention to the excellence of research. Access to pot. new employees is rather important for service providers offering custom-made specialized services and rather unimportant for low volume manufacturers.

Companies assessing the barrier *Difficulties in finding the right contacts* as rather important often do not have expenditures for universities. Companies following technology leadership strategy, being process oriented and having R&D managers in charge for technology transfer assess this barrier as rather unimportant.

Companies assessing the barrier *Universities are passive in providing information and presenting their research results and possibilities to collaborate* as rather important judge publications in scientific journals and articles in magazines or internet about research rather unimportant. They usually turn to central university departments to find suited university researchers. These companies are often low volume manufacturers.

Companies assessing the barrier *Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spillovers)* as rather important usually are not yet differentiated enough to have functions like R&D managers.

Companies assessing the barrier *Internal knowledge of the company leaks to competitors with which university departments are in contact too* as rather important frequently commission contract research projects and engage in projects with Styrian universities. They pay attention to *Presentations of university researchers at meetings* and to the excellence of research. They often turn to central university

departments to identify university researchers and measure the impact of collaborations with universities on the company's performance with help of indicators. Often these companies are part of a group of companies.

Companies assessing the barrier *High workload at university departments hinder collaborations with companies* as rather important often have expenditures for universities. They frequently commission joint research projects, are approached by central university departments for potential projects, and measure the impact of collaborations with universities on the company's performance with help of indicators. Usually these companies are not cost leaders.

Companies assessing the barrier *Collaborations with university departments are too expensive compared to benefits* as rather important are often low volume manufacturers.

Companies assessing the barrier *University researchers are rather skeptical towards collaborations with companies* as rather important in general directly approach university researchers, turn to central university departments to identify university researchers, or are approached by students for potential projects. The companies are usually not part of a group of companies and do not follow strategies like cost leadership or focusing on niches.

With other characteristics like the number of years companies are already in contact with universities reasonable statistically significant relations do not exist.

5.3.9 University researchers: Which university researchers' characteristics influence whether or not university researchers are in contact with companies?

The following examination analyses which characteristics of university researchers play a role whether or not university researchers have contacts to companies. Remember that the study was realized with university researchers at Graz University of Technology. The results for similar studies at other universities might differ. In total about 90 % of the university researchers already have contacts to companies, almost 80 % regularly.

Researchers of the faculty for mechanical engineering and economics head the analysis. More than 96 % of university researchers of this faculty already have contacts to companies. The faculty for construction engineering with more than 93 % closely follows this faculty. The other faculties follow with a relatively small gap. The

different financial sources do not statistically significant influence the question whether or not university researchers have contacts to companies. However, the direction seems reasonable. University researchers financed by third party funds from companies are the ones having most likely contacts to companies followed by colleagues financed by the regular university budget. On the third and last place are university researchers paid for by third party funds from other sources than companies, i.e. national scientific funding programs. In case of examining answers regarding working experience in industry reduced to yes and no a statistically significant relation exists. Also the examination with metrical data shows the same direction even though the relation is not statistically significant anymore: The more working experience in industry the more likely university researchers have contacts to companies.

Answers to other questions like university researchers' age or function at university departments do not statistically influence if university researchers have contacts to companies or not.

5.3.10 University researchers: Which university researchers' characteristics, technology transfer features, barriers and motives influence the number of monthly personal contacts of university researchers with different companies?

University researchers were asked for their average number of personal contacts per month with different companies. This is one possible measure for the extent of technology transfer. In the following, the influence of other variables on this question is examined. On average university researchers have contacts to 6.9 companies per month. The median value is four.

University researchers with a high number of personal contacts to companies per month spend rather much time for collaborations with companies. They are often approached by industry near central organizations for projects with companies. Interestingly, central university departments like technology transfer offices seem to approach university researchers not yet having a high number of personal contacts to companies per month. The frequency of use of technology transfer means is rather high because of their high number of personal contacts to companies and the amount of time they spend for collaborations with companies. These university researchers have a stock of regular customers and realize projects with companies located in other countries than Austria, Germany, and Switzerland. They perceive collaborations with companies as supportive for own research and provide companies with information of suited funding poss bilities and support them in setting

up proposals for external funding. These university researchers in general already have working experience in companies.

5.3.11 University researchers: Which university researchers' characteristics, technology transfer features, barriers and motives influence the amount of time spend by university researchers for collaborations with companies?

Instead of the number of personal contacts with companies per month the amount of time spend for collaborations with companies is examined in the following. The average time spend for collaborations with companies amounts to 38.5 %, the median value is 30 %. Compared to the two other major tasks of university researchers, doing basic research and teaching students, time spend for collaborations with companies is on a similar level.

		Time spent for teaching	Time spent for basic research	Time spent for collabora ions with companies
N	Valid	72	72	72
	Missing	9	9	9
Mean		33.8	27.7	38.5
Median		32.5	30.0	30.0

Table 6: Time spent for teaching, basic research and collaborations with companies

University researchers spending rather much time for collaborations with companies are primarily aged between 31 and 35 years, have not yet finished their Ph.D. and are funded by third party funds from companies. They are usually not approached by other university departments for projects with companies and rather frequently do consulting for companies. They also realize larger projects with companies in Austria except Styria. One of the reasons for the high share of time spend for collaborations with companies of university researchers aged between 31 and 35 years might be a high share of employees funded by third party funds from companies.

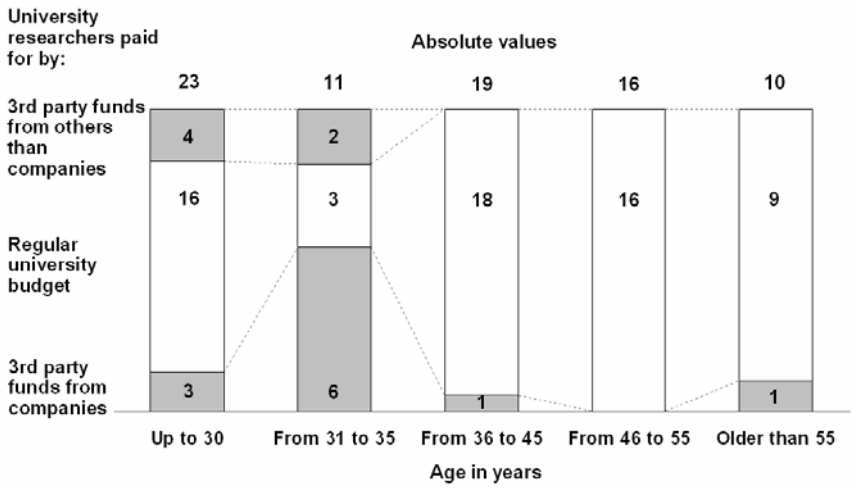

Figure 21: Relation between participants' age and the financial source they are paid for

As shown, the share of university researchers funded by third party funds from companies is highest in the group of 31 to 35 years. The relation between university researchers' age and financial sources they are paid for is statistically significant.

University researchers spending rather little time for collaborations with companies are either up to 30 years old or older than 35 years. The majority of these university researchers already have finished their Ph.D.; they are approached by other university departments brokering projects and realize projects with regular customers.

Answers to other questions do not statistically significant influence the amount of time spent for collaborations with companies.

5.3.12 University researchers: Which university researchers' characteristics and technology transfer features influence the frequency of use of technology transfer means?

University researchers were asked to indicate the frequency of use of technology transfer means. Besides the poss bility to enter additional means in a free text box university researchers had to respond for the following technology transfer means:

- Organization of guest lecturers, practical cases of companies for seminars and lectures, construction exercises and the like
- Doing consultancies and providing expert opinions
- Coaching master and bachelor theses commissioned by companies
- Coaching doctoral theses commissioned by companies
- Contract research projects for companies (Companies do not actively work with university researchers)
- Joint research projects with companies (Companies actively work with university researchers)
- Providing infrastructure (i.e. for tests)

The table shows the range of annual frequency of use for technology transfer means. Some university researchers use specific forms rather often. Responses for *not applicable* were added to missing data. For specific technology transfer means like *Coaching doctoral theses commissioned by companies* the number of these responses were rather high. Only two university researchers used the free text box. One entered doing tests for companies and the other construction exercises and doing tests relevant for companies. The small number of entries shows that the given table already included the major technology transfer means.

		Organization of guest lecturers, practical cases of companies for seminars and lectures, construction exercises and the like	Doing consultancies and providing expert opinions	Coaching master and bachelor theses commissioned by companies	Coaching doctoral theses commissioned by companies	Contract research projects for companies (Companies do not actively work with university researchers)	Joint research projects with companies (Companies actively work with university researchers)	Providing infrastructure (i.e. for tests)
N	Valid	59	60	66	39	59	63	52
	Missing	22	21	15	42	22	18	29
Mean		3.30	4.18	2.65	1.10	2.03	2.03	1.96
Median		2.00	2.50	2.00	1 00	1.00	1.50	1.00
Minimum		.00	.00	.00	00	.00	.00	.00
Maximum		25.00	50.00	15.00	5 00	15.00	10.00	15.00

Table 7: University researchers' annual frequency of use for technology transfer means

The technology transfer mean *Organization of guest lecturers, practical cases of companies for seminars and lectures, construction exercises and the like* is not statistically influenced by university researchers' characteristics and technology transfer features.

The technology transfer mean *Doing consultancies and providing expert opinions* is influenced by one of the modes to establish collaborations with companies. University researchers often being approached by central industry near organizations use this technology transfer mean more frequently.

University researchers frequently being approached directly by companies use the technology transfer mean *Coaching master and bachelor theses commissioned by companies* often. University researchers frequently using this technology transfer mean realize projects with occasional customers and often collaborate with Styrian companies. They in general use standards like master contracts, support companies in integrating and exploiting research results, and set up measures based on feedback from companies to improve collaborations with companies. The rather frequent use of master contracts is plausible because of the high absolute number of bachelor and master theses at Graz University of Technology. Per year around 800 students graduate, around the half realizes their theses in collaboration with companies. In this case, standards help to save time and secure the homogeneity of contracts. The university departments university researchers work at are in general small. These university researchers are either up to 30 years old or older than 35 years and have working experience in companies.

University researchers frequently approaching already known collaboration partners often use the technology transfer mean *Coaching doctoral theses commissioned by companies*. They realize projects with regular and occasional customers and frequently work with companies from Germany or Switzerland. They often support companies by providing information of suited funding programs and actually help them in setting up funding proposals.

The technology transfer mean *Contract research projects for companies (Companies not actively work with university researchers)* is frequently used by university researchers often being approached by companies. These university researchers usually have a Ph.D. and support companies by providing information of suited funding programs and actually help them in setting up funding proposals.

The technology transfer mean *Joint research projects with companies (Companies actively work with university researchers)* is frequently used by university researchers often approaching potentially new and already known customers. University researchers often doing joint projects with companies in general realize projects with companies in Austria except Styria. They often realize following activities: *Information for companies of suited funding programs, Supporting companies in setting up*

proposals for funding programs, Supporting companies in integrating and exploiting research results (i.e. accompanying companies until new products or processes are introduced in markets and the like) and *Setting up measures based on feedback from companies to improve collaborations with companies*.

The mean *Providing infrastructure (i.e. for tests)* is frequently used by professors. University researchers often using this technology transfer means in general already have working experience in companies. They rather frequently realize the following activities: *Information for companies of suited funding programs* and *Supporting companies in setting up proposals for funding programs*.

It was supposed that specific technology transfer means like i.e. doctoral theses or collaborative research projects are especially well suited to provide valuable input for university researchers and their own teaching and research activities. However, the supposed influence is not confirmed by these analyses.

5.3.13 University researchers: Which university researchers' characteristics, technology transfer features, barriers and motives influence benefits of technology transfer perceived by university researchers?

In the following benefits for teaching and research due to technology transfer are examined. This was measured by asking university researchers to assess benefits for their teaching and research. The analyses show that university researchers at Graz University of Technology assess their collaborations with companies rather supportive for their teaching and research.

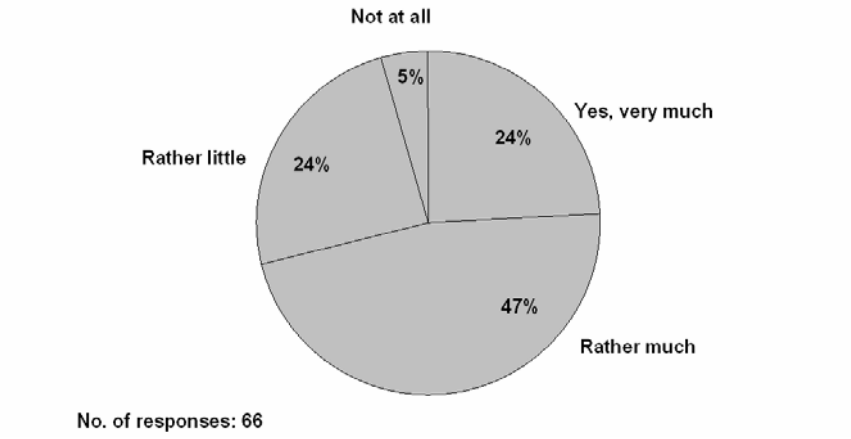

Figure 22: University researchers' assessment of technology transfer's impact on their teaching

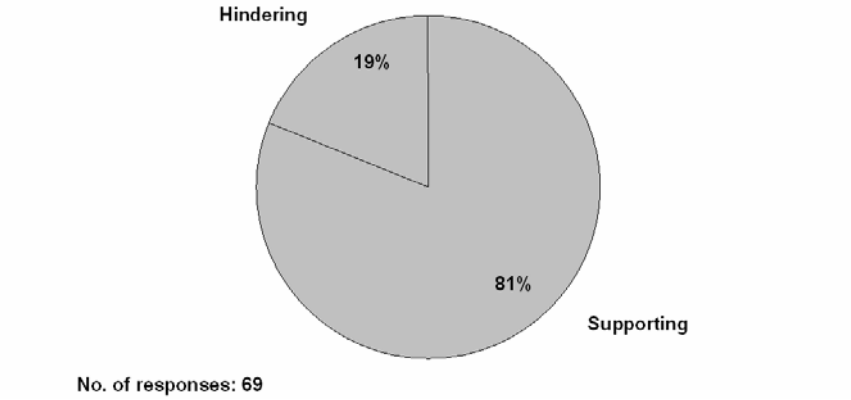

Figure 23: University researchers' assessment of technology transfer's impact on their research

Some university researchers stated that their collaborations with companies are both positive and negative. University researchers positively assessing technology transfer stated following reasons: New challenges and insights, different points of view, gaining experience, access to data and empirical knowledge, linking theory and practice, gaining financial means, learning to work in interdisciplinary projects, input for own research and ideas for new research areas and hypotheses. University researchers perceiving collaborations with companies as obstructive for their own research stated following reasons: Time exposure, enquiries outside the university

researchers' research area and low scientific content. It is interesting that the two questions are not statistically significant related with each other.

University researchers assessing collaborations with companies as positive for their teaching and research are more willing to extend their collaborations with companies. University researchers positively assessing collaborations with companies for their teaching frequently realize projects with Styrian companies. The closer collaboration partners are located the more likely university researchers get positive impulses for their teaching. These university researchers often realize the activity *Supporting companies in integrating and exploiting research results (i.e. accompanying companies until new products or processes are introduced in markets and the like).* Faculties and their research areas seem to influence the perception of benefits by university researchers. University researchers from the faculties civil engineering and mechanical engineering and economics assess collaborations with companies more often positively than their colleagues from other faculties. University researchers positively assessing collaborations with companies for their research establish their collaborations above average by *Other departments at my university broker projects for me* and *Companies approach me directly*. They frequently realize following activities: *Information for companies of suited funding programs*, *Seeking feedback from companies regarding collaborations (i.e. benefits for companies and the like),* and *Setting up measures based on feedback from companies to improve collaborations with companies*. These university researchers are usually paid for by regular university budget.

The answers to other questions do not statistically significant influence the perceived support provided by collaborations with companies for teaching and research.

5.3.14 University researchers: Which university researchers' characteristics and technology transfer features influence barriers and motives?

In the following the influence of university researchers' characteristics and technology transfer features on barriers and motives are examined. The following barriers were listed in the questionnaire:

- Companies are passive and do not ask for research projects and results
- Companies do not know the potential collaboration means with universities like consultancy, licensing commission seminar theses and the like
- Companies cannot name their needs and problems
- Companies have limited professional capabilities to collaborate with universities

- Companies' aggressive behavior regarding formal protection rights like IPRs hinder collaborations with universities
- High work load in companies hinder collaborations with universities
- Companies are rather skeptical towards collaborations with universities
- Collaborations with companies negatively influence teaching and research at the university department
- Too much third party funding negatively influences the university department (i.e. dependencies, limiting the possibilities to be unbiased, decreasing funding from public sources)

The following motives were listed in the questionnaire:

- It is one of the tasks of universities to collaborate with companies
- Scientific interest
- Building up contacts for a latter career in companies
- Using companies' infrastructure
- Financing investments in university department's infrastructure
- Financing master and doctoral students or university department's employees
- Financing your own job
- Additional personal income

University researchers also had the possibility to enter additional motives and barriers freely. The following graphs show the general assessment of the importance of barriers and motives.

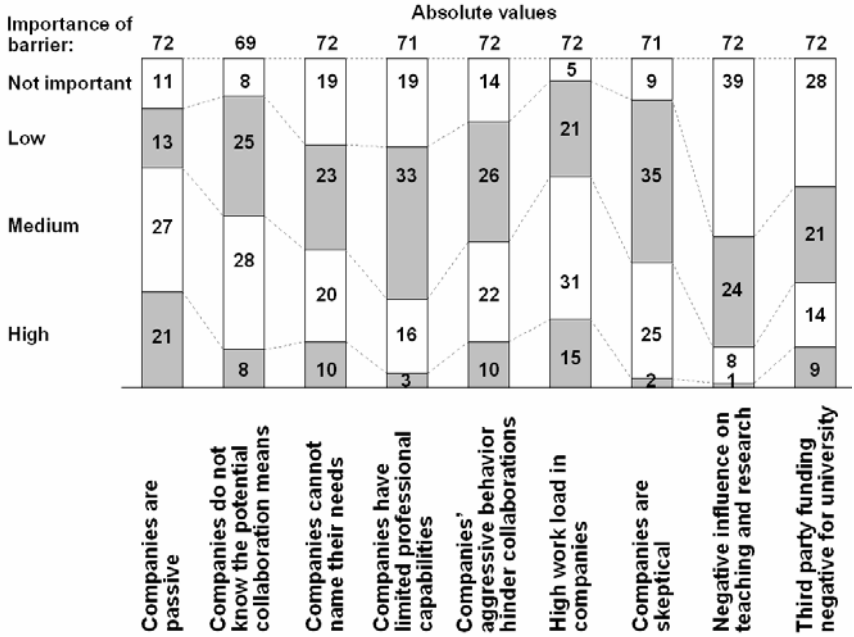

Figure 24: University researchers' assessment of barriers

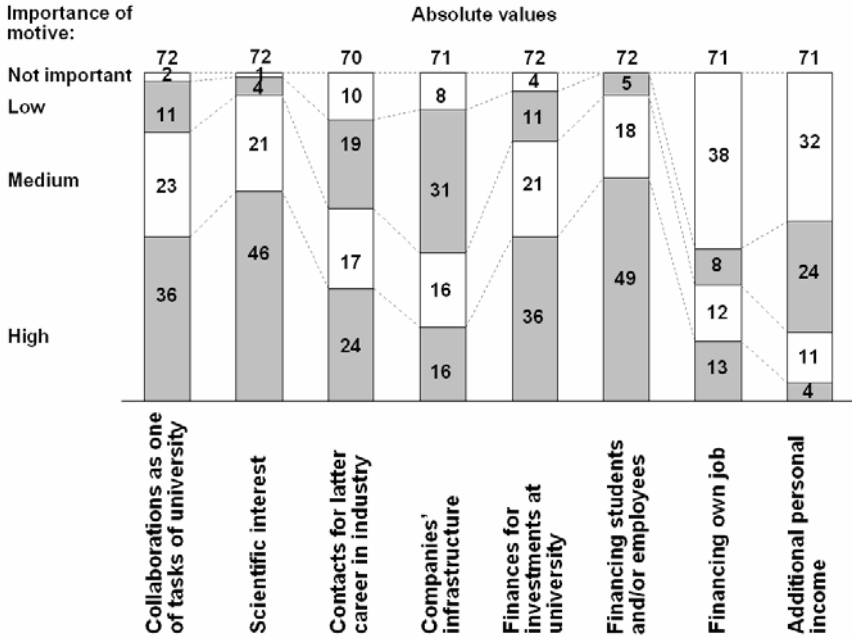

Figure 25: University researchers' assessment of motives

Barriers assessed most often with high importance are passive companies and the high workload in companies. Remember that also companies assessed the passiveness of university researchers as major barrier. Motives assessed most often with high importance are gaining financial means to finance master and doctoral students or employees at the university department and scientific

The barrier *Companies are passive and do not ask for research projects and results* is not statistically significant influenced by university researchers' characteristics, technology transfer features and motives.

The barrier *Companies do not know the potential collaboration means with universities like consultancy, licensing commission seminar theses and the like* is judged rather unimportant by university researchers realizing projects with occasional customers.

The barrier *Companies cannot name their needs and problems* is not statistically significant influenced by university researchers' characteristics, technology transfer features, and motives.

The barrier *Companies have limited professional capabilities to collaborate with universities* is judged rather unimportant by university researchers realizing projects with first time customers and by university researchers stating to get new inputs for their teaching activities due to their collaborations with companies. Professors assess this barrier in general as rather important, project employees and employees funded by third parties as rather unimportant.

The barrier *Companies' aggressive behavior regarding formal protection rights like IPRs hinder collaborations with universities* is judged rather unimportant by university researchers realizing frequently projects with companies in other countries than Austria, Germany and Switzerland.

The barrier *High workload in companies hinder collaborations with universities* is not statistically significant influenced by university researchers' characteristics, technology transfer features, and motives.

The barrier *Companies are rather skeptical towards collaborations with universities* is assessed rather important by university researchers realizing projects with Styrian companies and rather unimportant by university researchers realizing projects with companies outside of Styria. University researchers stating to get new inputs for teaching usually assess this barrier rather unimportant. In case the barrier is assessed important university researchers do not want to extend their collaborations with companies. University researchers with working experience in companies, independently from the duration, assess the barrier as less important than university researchers without working experience in companies.

The barrier *Collaborations with companies negatively influence teaching and research at the university department* is assessed rather unimportant by university researchers collaborating more frequently with regular customers and companies in Austria except Styria. If the barrier is assessed as important university researchers state to not get new inputs for teaching, perceive collaborations with companies negatively for their own research and as a result do not want to extend their collaborations with companies.

The barrier *Too much third party funding negatively influences the university department (i.e. dependencies, limiting the possibilities to be unbiased, decreasing funding from public sources)* is assessed rather unimportant in case university researchers realize projects with first time customers. Also university researchers stating to get new inputs for teaching usually judge this barrier rather unimportant.

The motive *It is one of the tasks of universities to collaborate with companies* is influenced by the barrier *Companies cannot name their needs and problems*. If university researchers assess this motive important also the barrier is rather important. The motive is judge important in case university researchers collaborate frequently with occasional and first time customers and have a higher project frequency with Styrian companies. In case university researchers assess their collaborations with companies positively for their own research, they assess the motive as rather important. If the activities *Supporting companies in integrating and exploiting research results (i.e. accompanying companies until new products or processes are introduced in markets and the like)*, *Seeking feedback from companies regarding collaborations (i.e. benefits for companies and the like)* and *Setting up measures based on feedback from companies to improve collaborations with companies* are realized rather frequently the motive is judged rather important. University researchers assessing this motive rather important are more likely to want to extend their collaborations with companies.

The motive *Scientific interest* is influenced by the barrier *Collaborations with companies negatively influence teaching and research at the university department*. In case the motive is judged important, the barrier is assessed unimportant. If university researchers assess this motive important they spend rather much time for collaborations with companies and realize frequently projects with regular and occasional customers. In case university researchers assess their collaborations with companies positively for their own research, they assess the motive as rather important.

The motive *Building up contacts for a latter career in companies* is assessed rather important in case university researchers realize frequently projects with companies located in other countries than Austria, Germany, and Switzerland. University researchers assessing this motive rather important spend much time for collaborations with companies. They usually neglect benefits for their own research. In case the motive is important, they usually realize the activity *Seeking feedback from companies regarding collaborations (i.e. benefits for companies and the like)* rather frequently. In general, third party funded university researchers, university researchers without a Ph.D. and university researchers being at the university only recently judge this motive more important than others.

The motive *Using companies' infrastructure* is assessed more important by university researchers funded by companies than by university researchers paid for by other sources.

The motive *Financing investments in university department's infrastructure* is influenced by the barrier *Companies' aggressive behavior regarding formal protection rights like IPRs hinder collaborations with universities*. In case university researchers assess this motive important, they also judge the barrier important. Usually these university researchers frequently realize projects with occasional customers.

The motive *Financing master and doctoral students or university department's employees* is influenced by the barrier *High workload in companies hinder collaborations with universities*. In case university researchers assess this motive important also the barrier is judged important.

The motive *Financing your own job* is influenced by the barrier *Companies do not know the potential collaboration means with universities like consultancy, licensing commission seminar theses and the like*. In case the motive is assessed important, the barrier is assessed unimportant. University researchers assessing this motive as important spend much time for collaborations with companies and realize frequently projects with companies in Germany or Switzerland and the activity *Seeking feedback from companies regarding collaborations (i.e. benefits for companies and the like)*. Third party funded university researchers have a higher interest in acquiring financial means to finance their own jobs. In addition, the age, the formal qualification, and the time university researchers are employed at the university play a role.

The motive *Additional personal income* is not statistically significant influenced by university researchers' characteristics, technology transfer features, and barriers.

With answers to other questions, statistically significant relations with barriers or motives do not exist.

5.3.15 Companies and university researchers: Assessing the importance of technology transfer barriers and motives from their own point of view and the view of potential partners

The following analyses show the assessment of motives and barriers from different points of view. Companies and university researchers were asked to assess not only the importance of their own motives and barriers but also the ones encountered generally by their technology transfer partners. The following analyses refer to the median values. The two major motives for university researchers to collaborate with companies are scientific interest and financing master and doctoral students or university department's employees. The assessment of the importance of the motives by university researchers is more differentiated than the one by companies. Companies assessed the importance of the motives in median with a medium importance.

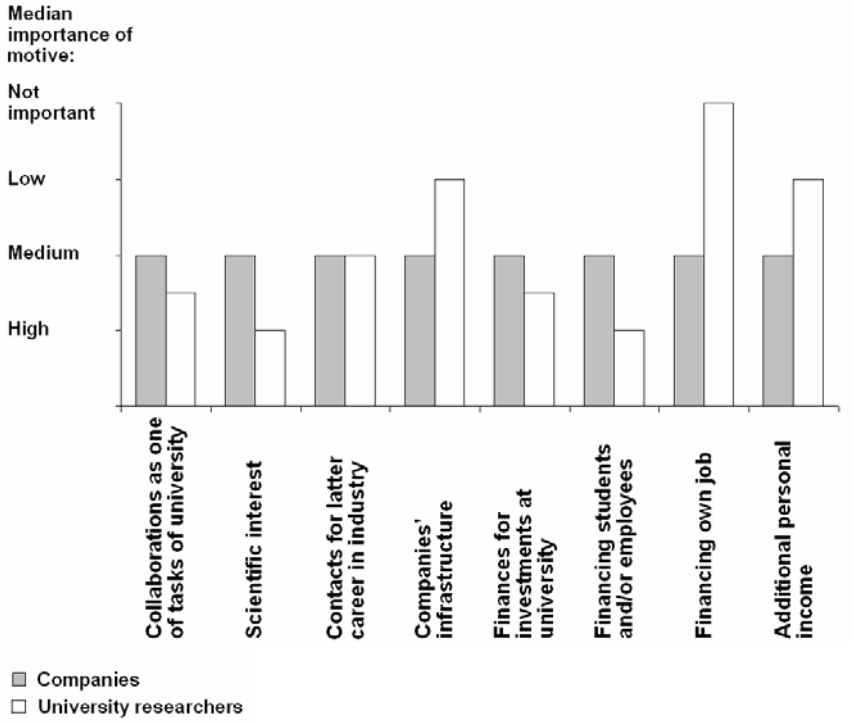

Figure 26: University researchers' motives assessed by university researchers and companies

Regarding companies' motivation to do technology transfer, especially the gap for the motive *Universities as economic R&D service providers (outsourcing)* is interesting. Companies do not assess this motive that important. The assessment of university researchers is different. University researchers think this motive is especially important for companies.

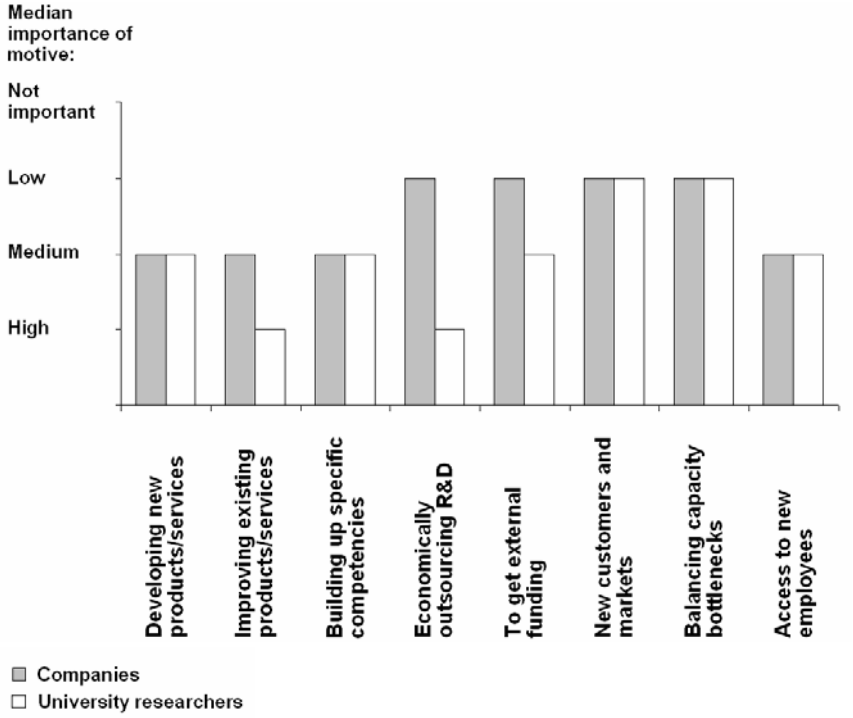

Figure 27: Companies' motives assessed by companies and university researchers

The assessments of the importance of barriers eventually encountered by university researchers are quite similar.

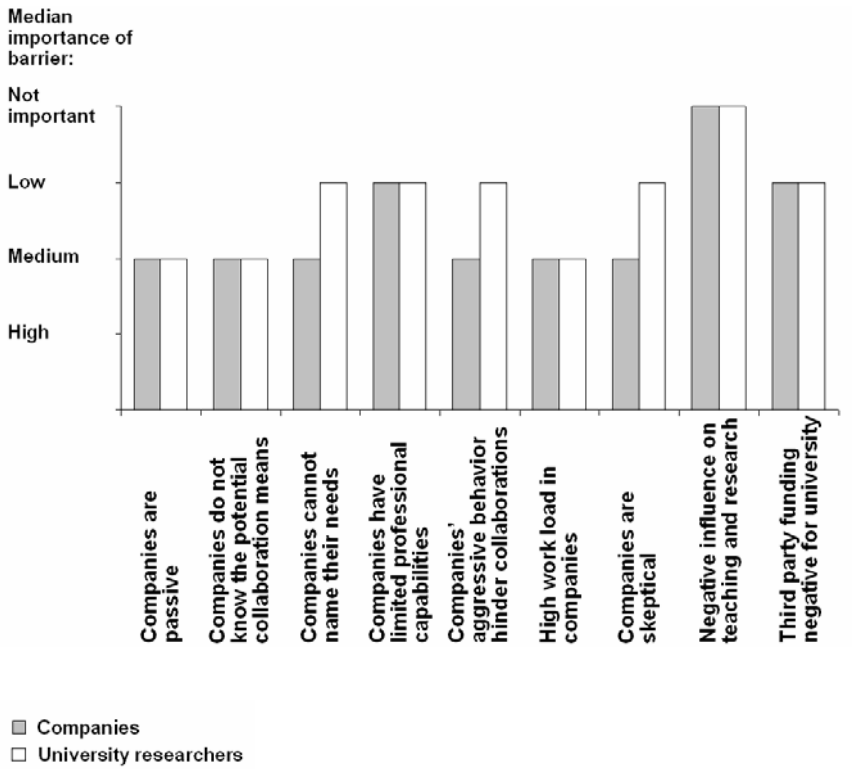

Figure 28: University researchers' barriers assessed by university researchers and companies

Except the different assessments of the barrier *Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)* the median values of the assessments of the importance of barriers eventually encountered by companies are equal.

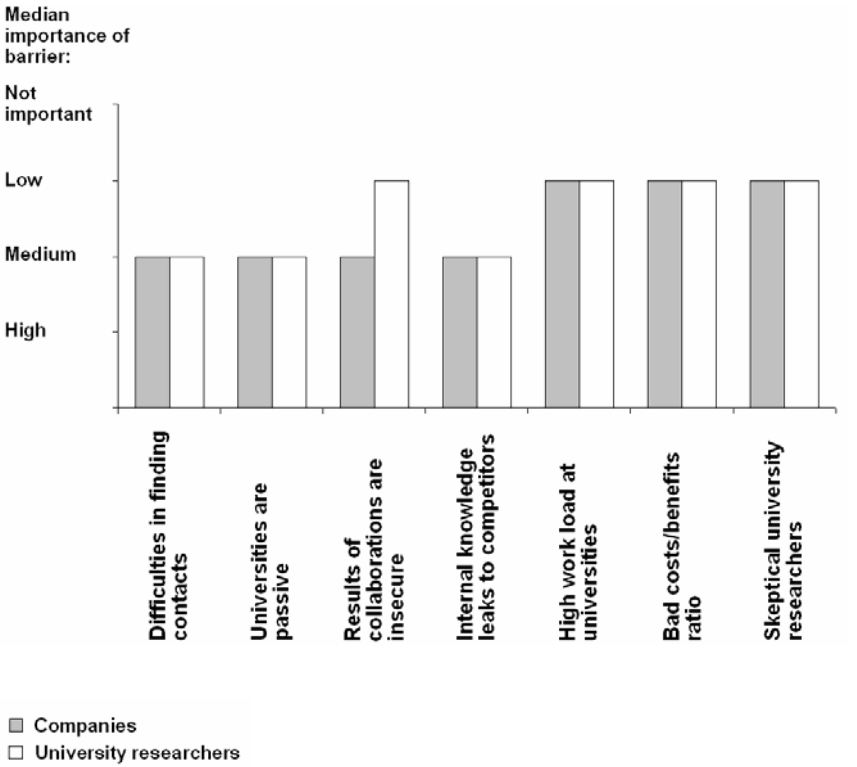

Figure 29: Companies' barriers assessed by companies and university researchers

6 Typology of companies and university researchers

This chapter presents the typology for companies and university researchers suited to provide custom-made recommendations for actions for the single classes. The first part describes the approach to identify a typology scheme. The second part presents the different classes resulting from the chosen approach.

6.1 Approach to identify a typology scheme

Even though technology transfer is already a mature research area, many typologies for companies and university researchers do not exist. If such schemes exist, they often refer exclusively to companies. Schemes for university researchers are not common. Three examples for existing typologies are presented in this thesis. They serve as input to identify a suited typology. The examples are provided by Etzkowitz[30], who does not only consider companies but also university researchers, Beise and Spielkamp[29], who shaped the terms insiders and outsiders and Hanel[31], who examined small and medium sized companies in detail and showed differences regarding their openness towards innovation activities and collaborations with external partners.

Etzkowitz set up a typology for companies and university researchers. The author drew his conclusion from about 150 interviews with company and university representatives in different waves starting as early as in the 1980s. He classified companies in four groups. The first one is made up of large multinational companies. They usually carry out R&D on their own but have a window of opportunity to collaborate with universities through i.e. participation in liaison programs and consultancies. The second group is made up of smaller companies usually based on low- and medium tech technologies. They engage with universities for trouble shooting like i.e. testing purposes and the like. These companies have little to no own R&D capabilities. The third group of companies is made of academic spin-offs. These companies spun out of academic research and still maintain their close relations with universities. The fourth and last group is made up of older, more traditional companies with the need to in-source technologies. They increasingly externalize

[30] Etzkowitz, Henry: The norms of entrepreneurial science: cognitive effects of the new university-industry linkages, in: Research Policy, Vol. 27, 1998, pp. 823-833

[31] Hanel, Gunter: Typen des Technologienachfrageverhaltens kleiner und mittlerer Unternehmen: ein Segmentierungsversuch als Grundlage für wirtschaftspolitische Maßnahmen [Types of Technology Demanding Behaviour of Small and Medium Sized Enterprises: A try to Classify for Policy Economics measures], doctoral thesis, Vienna University of Economics and Business Administration, 1996

R&D and engage in collaborations with universities. Etzkowitz also set up a typology for university researchers. Again, the author sketched four classes. The first group is made up of university researchers, who leave technology transfer entirely to technology transfer offices. They are interested in commercialization of their results but not willing to directly take part in this process. The second group is made up of university researchers aware of the potential impact of technology transfer and ready to play a significant role in market their results. The third group is made up of university researchers already heavily engaged in technology transfer. These university researchers are seamlessly networked with companies. University researchers not being interested in engaging in technology transfer make up the fourth group.

Beise and Spielkamp deal in their paper with technology transfer from universities to companies. Companies being in contact with university researchers and able to derive innovations from universities are so-called insiders. Companies not yet being part of such networks are named outsiders. Insiders are companies already in contact with university researchers and they usually use the whole range of technology transfer means available. They also realize larger projects with universities and in general do not use services provided by intermediaries. Outsiders are companies, which in general are aware of the potential positive impact of university research on their business but barriers are too high to actually get in contact with university researchers. In such cases, regional intermediaries and multiplicators are important to establish links and support companies in gaining trust in the capabilities of university researchers. According to the authors, the success of technology transfer is not a question of overcoming market failure but of socio-economic networks. The market approach handles universities' research results like goods being offered to companies for specific prices. Companies can take up these technologies by paying prices negotiated with universities. The network approach focuses on relationships between university researchers and companies as important issue for technology transfer. It is supposed that especially in case of university research implicit knowledge plays a major role. This component makes the market approach rather difficult by resulting in above average transaction costs.

Hanel introduced a typology for small and medium sized companies regarding their ways to in-source technologies. With the help of telephone interviews of around 1,000 small and medium sized companies in Austria the author set up three major groups: Conservatives, companies ready to innovate and change and the innovation elite. Conservatives are rather traditional companies not being aware of the positive impact of innovations. They are rather closed. Companies ready to innovate and

change are in general open for changes and communicate regularly with external groups. However, they need external help to start innovation projects. Companies belonging to the innovation elite have rather high innovation levels. They usually operate in high-tech areas and get information from a variety of different sources. The suited approach is to let them operate freely without putting obstacles in their ways.

The three presented typologies provide a rather good feeling for differences of companies and university researchers. However, the typologies are not yet suited to set up personalized recommendations for actions to improve technology transfer. One has to keep in mind that except Hanel, who focused on economic measures to improve innovation activities of companies, the others did not explicitly focus on providing recommendations for actions to improve technology transfer. The following approach to set up a suited typology for the aim of this thesis combines all three previously described approaches. Firstly, the original sample is subdivided according to the current extent of technology transfer. Already the previous analyses showed that differences exist due to different extent of technology transfer. The next step uses the importance of barriers of companies and university researchers to further split the groups. This is one important extension regarding existing typologies. Thus companies and university researchers can be approached in a personalized way by emphasizing issues of high importance to representatives of the different groups. Also answers regarding motives were considered to be used for this second step. However, the number of answers for motives is smaller than for barriers because companies and university researchers not yet doing technology transfer but being interested in doing so were only asked to assess the importance of barriers. It did not seem reasonable to ask them to assess the importance of motives. Anyway, motives and companies' and university researchers' characteristics were used to describe the different classes in detail. Thus, it is possible to classify companies and university researchers by knowing their characteristics and current extent of technology transfer and to approach them by emphasizing barriers and motives most likely being of high importance for them. Such an approach should increase the success rate of technology transfer. For i.e. regional development managers the scheme can serve as starting point to design suited support services for a group of companies of special interest to the region. In the same way, it could be used to specifically approach newly entering university researchers and to support them in building up collaborations with companies. The following figure shows the approach to define different classes of university researchers and companies according to their current technology transfer extent and their assessment of the importance of barriers for setting up recommendations of actions.

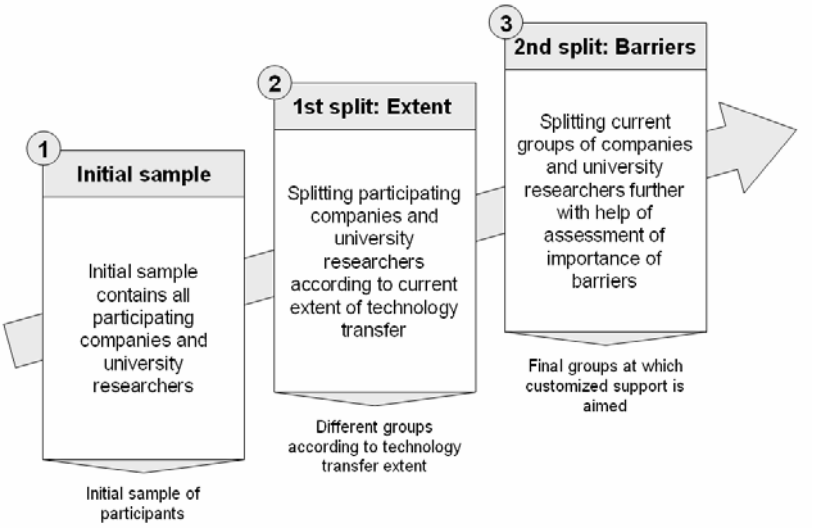

Figure 30: Approach to set up a technology transfer typology for companies and university researchers

6.2 Typology for companies

Companies in the initial step were classified in four groups related to their current technology transfer extent:

1. Companies with expenditures for universities
2. Companies without expenditures for but with contacts to universities
3. Companies not yet having contacts to universities but interested in building up relations
4. Companies not yet having contacts to universities and not being interested in building up relations

This is a suited scheme for measuring the extent of technology transfer. To further detail the scheme, the importance of barriers is used to subdivide the groups into smaller subgroups. This was done by cluster analyses provided by SPSS. This led to eight groups.

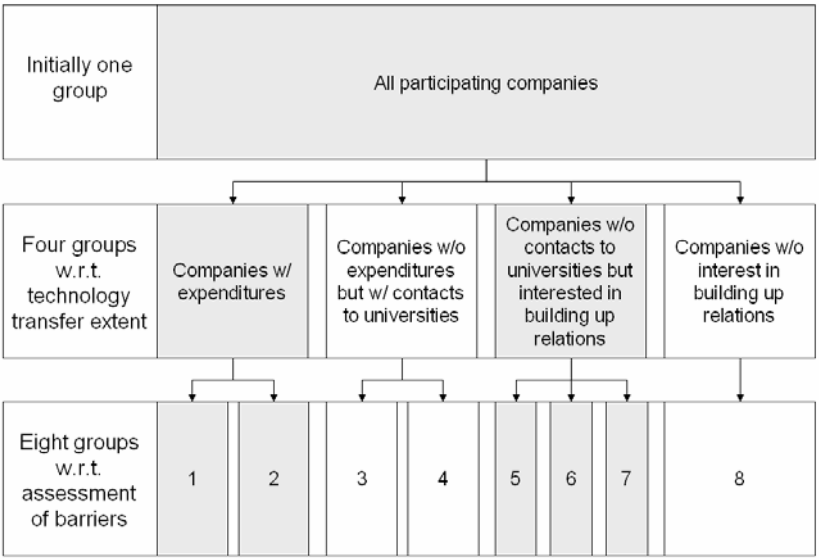

Figure 31: Typology for companies regarding technology transfer

Prior to describe the subgroups in detail the following two graphs provide an overview of the importance of barriers and motives assessed by the different groups. Note that not all groups had to answer questions regarding barriers and motives.

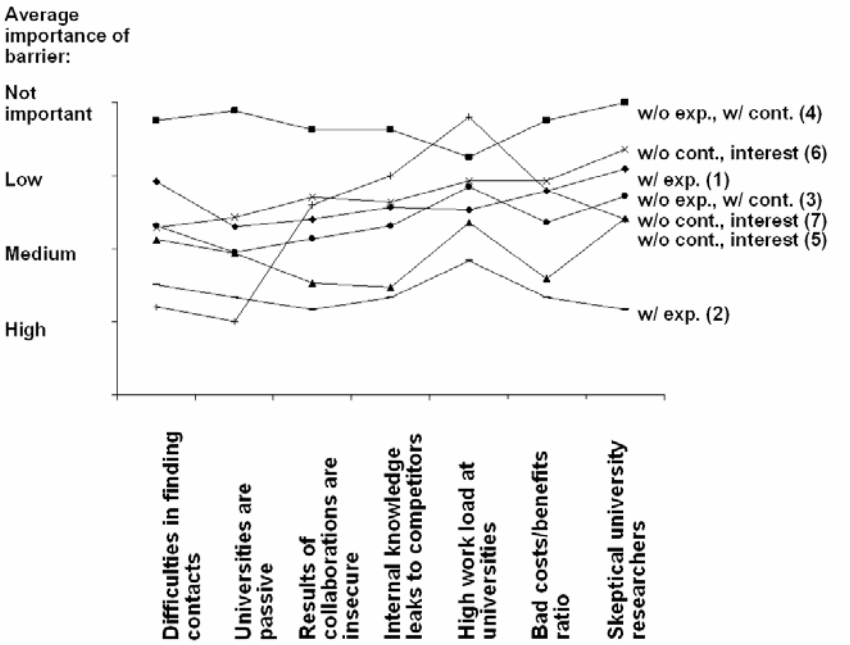

Figure 32: Companies' average assessment of the importance of barriers according to the different classes of the typology

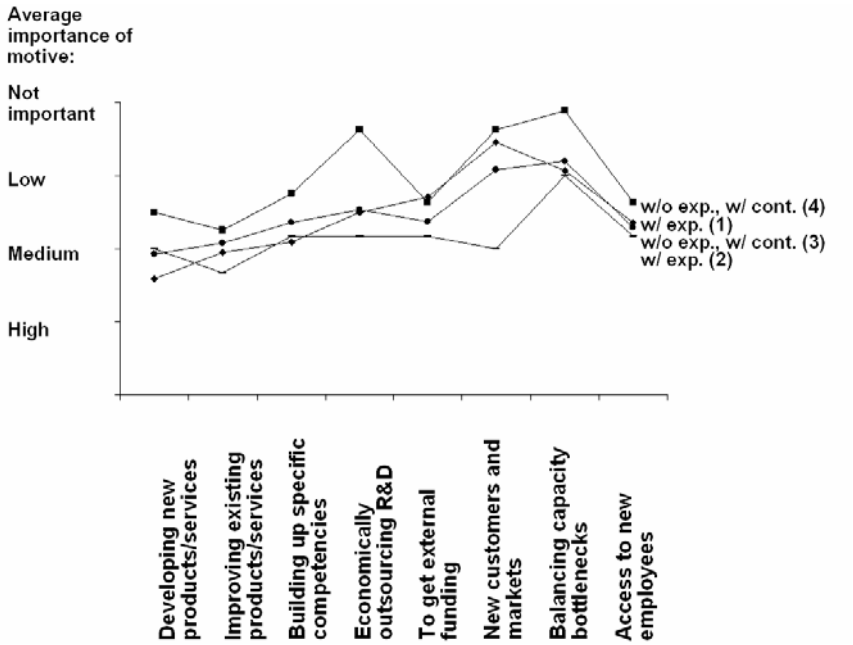

Figure 33: Companies' average assessment of the importance of motives according to the different classes of the typology

6.2.1 Companies with expenditures for universities

This group is divided in two subgroups, which are rather diverse in their assessment of the importance of barriers. Both groups have a similar trend but on two different levels. The first group assesses all barriers on average less important than the second group. The motives are rather similar except *Access to new customers and markets*. The first group assesses this motive rather unimportant. The second group rates it far more important.

Companies of the first group are the technology transfer elite. This group is a mix of large and small companies. The second group consists primarily of smaller companies, which are also R&D intensive. Companies of the first group use collaborative technology transfer means more frequently, companies of the second group rather contractual technology transfer means. However, group 1 and 2 belong to the most innovative companies of all examined ones. They are also used to international competition seeing their high export quotes. The major difference is the size of companies measured in number of employees and sales. This is also in line

with the assessment of the importance of barriers and motives. Smaller companies, even though they are rather R&D intensive, are more likely to be confronted with skeptical attitude of university researchers and to be motivated to use universities as door openers for new customers and markets than their larger counterparts.

	Group 1 (N=47)	Group 2 (N=6)
Carrying out R&D	Continuously	
R&D expenditures in % of sales (Median/Average)	4/12	2.75/16
Yearly R&D expenditures (Median/Average)	390,000 EUR/13,452,557 EUR	334,200 EUR/240,000 EUR
Expenditures for external R&D services in % of the total R&D expenditures (Median/Average)	20/31	12.5/28
Being part of a group of companies	Companies of group 1 are more likely to be part of a group of companies	
Sales in Mio EUR (Median/Average)	17/102	2.4/8.4
Number of employees (Median/Average)	100/377	42/87
Share of in the last three years newly developed or markedly improved products and processes on sales in % (Median/Average)	30/31	11/23
Export quote in % (Median/Average)	75/58	60/52
Number of all academics (Median/Average)	6/77	5/22
Number of graduates from universities of technology (Median/Average)	3/50	3.5/19
Use of innovation management methods	Companies of group 1 use such me hods more often. Companies of group 2 ra her rarely.	
Use of technology transfer means	Companies of group 1 use he following technology transfer means more often than companies of group 2: Guest lectures and input for seminars and workshops, bachelor, master and doctoral theses, collaborative research projects and using infrastructure. Companies of group 2 use experts' opinion and consultancies as well as contract research projects more frequently.	
Classical universities vs. universities of technology	Companies of group 1 exclusively have contacts to universities of technology. Companies of group 2 are more likely to have also contacts to classical universities.	
Number of university departments companies are in contact with (Median/Average)	4/16	6/6
Number of years companies are already in contact with universities (Median/Average)	10/16	12/16.8

Table 8: Comparing the two classes of companies with expenditures for universities

The following two graphs show the estimated future development of expenditures for universities.

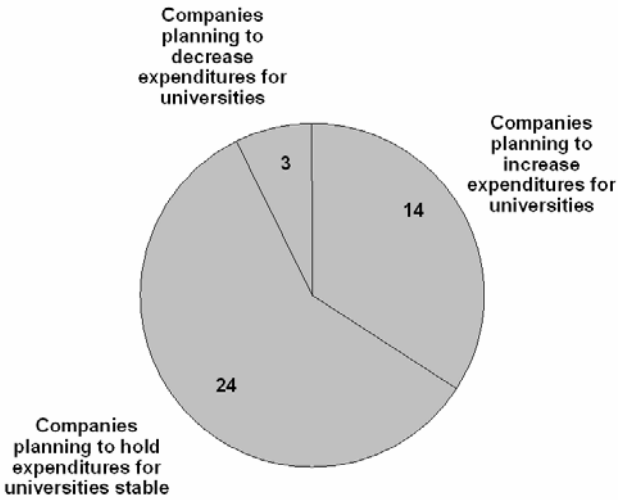

Figure 34: Companies of group 1 and their self-assessed development of expenditures for universities for 2006 and 2007

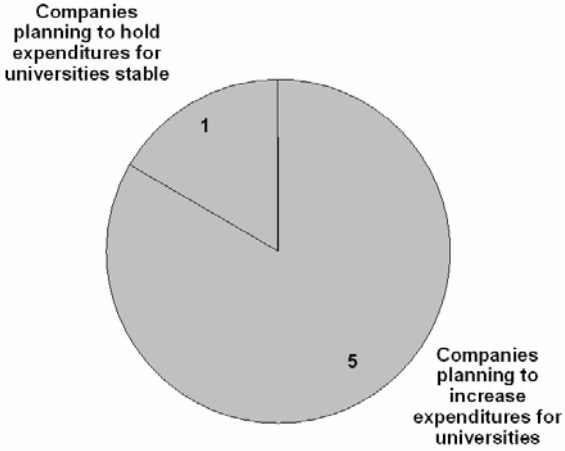

Figure 35: Companies of group 2 and their self-assessed development of expenditures for universities for 2006 and 2007

The graphs show that companies of group 2 are more likely to further increase expenditures for universities. However, also about a third of companies of group 1 want to further extent their expenditures.

Companies of both groups have contacts to or expenditures for universities outside of Styria. The trend is similar for both groups. The more distant universities are the less likely companies have contacts to or collaborations with universities.

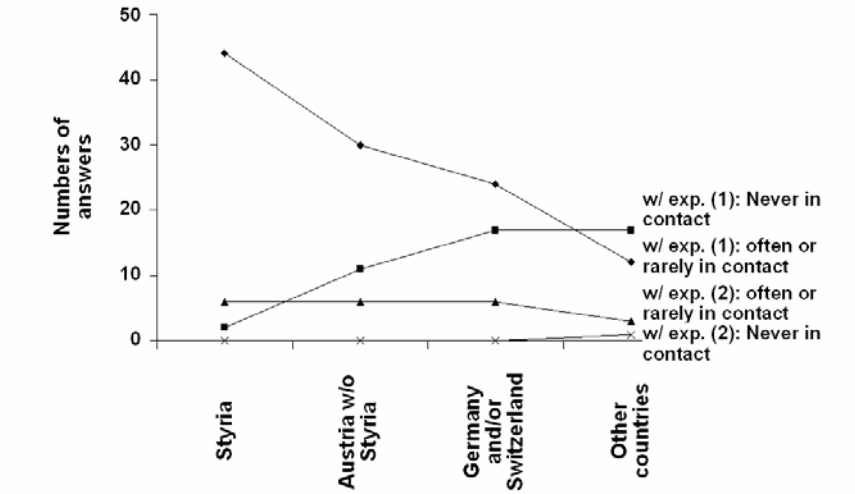

Figure 36: Companies of group 1 and 2 and their contacts to or expenditures for universities according to the geographic locations of the respective universities

Companies of group 1 state the following reasons for having contacts to or expenditures for universities outside of Styria:

Specific research (N=16)
Research projects with companies located outside of Styria (N=3)
International company with good access to other institutions (N=3)
Other universities actively approaching company (N=2)
Exchange of experience (N=2)
Alternative offers
EU projects
Personal vocational training
Availability of capacity

Table 9: Reasons of companies of group 1 for having contacts to or expenditures for universities outside Styria

Companies of group 2 state the following reasons for having contacts to or expenditures for universities outside of Styria:

Specific research (N=4)
Costs (N=2)
Local markets
Often easier access
EU projects
Personal contacts

Table 10: Reasons of companies of group 2 for having contacts to or expenditures for universities outside Styria

In both cases, companies primarily turn to universities outside their region because they need specific research competencies. Other reasons are not that frequently mentioned. In case of companies belonging to group 2 costs seem to be rather important. This might be due to their limited budget for universities compared to companies of group 1. It would be interesting to discuss more in detail the fact of lacking competencies. It might even be that the needed knowledge is available, but companies do not have the necessary contacts. Universities are located mainly in Western Europe, some in Slovenia, a neighbor of Styria and some overseas, i.e. in the USA and Canada.

Almost 50 % of companies belonging to group 1 have contacts to up to three university departments. 80 % have contacts to up to 10 university departments. Only seven companies of group 1 have contacts to more than 10 university departments. One company of group 2 has contacts to two university departments. Two companies have contacts to five university departments, two companies to seven university departments and one company has contacts to 10 university departments. Considering that many of the companies have contacts to more than one university, the number of university departments per university companies are in contact with is small.

Half of the companies belonging to group 1 are in contact with universities since at least 10 years. About 80 % are up to 17 years in contact with universities. Only a minor part of companies is in contact with universities since more time than 17 years. The median for companies belonging to group 2 is nine years. Only slightly less compared to companies of group 1.

The motive *Access to new customers and markets* is rather different for companies of the two groups. Companies of group 1 assess this specific motive as rather unimportant, companies of group 2 as rather important.

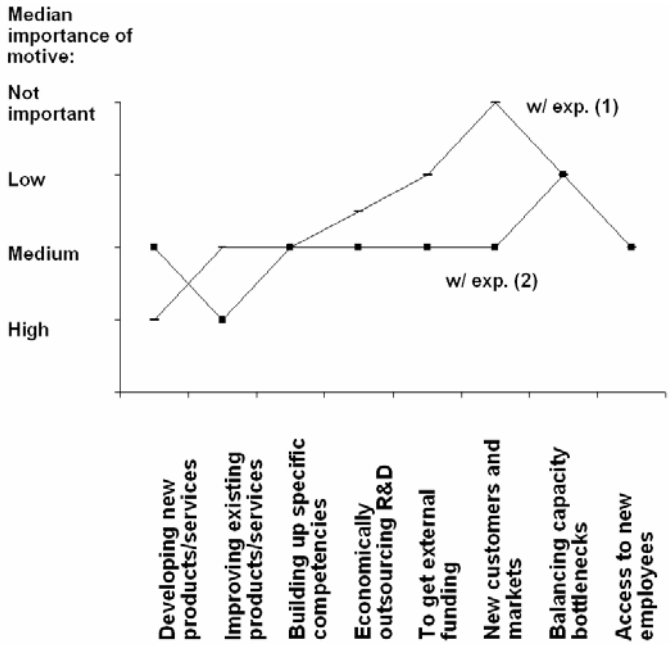

Figure 37: The importance of motives assessed by companies of group 1 and 2

One company of group 2 mentioned as additional important motive the possibility of doing basic research within a reasonable period. The company would not have the possibilities on its own because of the limited knowledge regarding basic sciences. Universities can build on already existing knowledge, thus being able to offer qualitative support within a rather small period.

Companies had to assess the importance of reasons for contacting specific university departments. Companies of both groups assessed existing personal contacts and the excellence of research as rather important. Differences exist in the importance of scientific publications and publications in magazines or internet. Companies of group 2 assess the importance of these reasons slightly higher than companies of group 1.

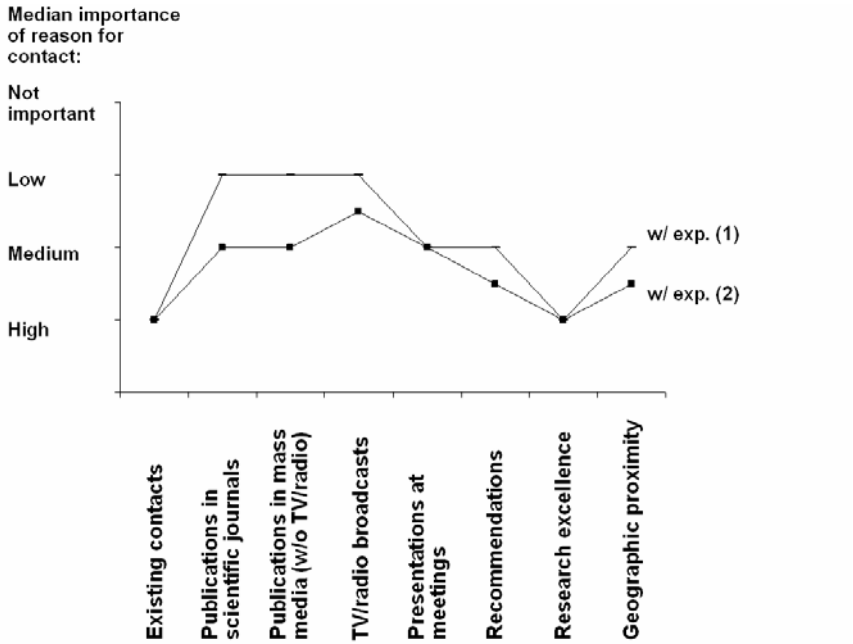

Figure 38: The importance of criteria decisive to contact specific university departments for potential collaborations assessed by companies of group 1 and 2

One company of group 1 stated that usually technology transfer offices establish the needed contacts. The company turns to technology transfer offices in order to find the right experts for their needs. This company is rather small. Therefore, this contact mode fits well in the overall picture.

Companies of both groups usually approach university researchers directly. Major differences are shown by students actively approaching companies. The relation is different than supposed. Companies of group 2, usually smaller ones, are often being approached by students. Students rarely approach companies of group 1. However, one possible explanation might be different absolute levels. For companies of group 1 the same number of students actively approaching the company might seem less frequently compared to other modes. Secondly, in case of companies of group 1 CEOs or R&D managers might not be informed of all enquiries made by students for potential projects. Usually companies of group 1 are larger, therefore such enquiries might be handled differently than in case of smaller companies, where such information is usually centralized.

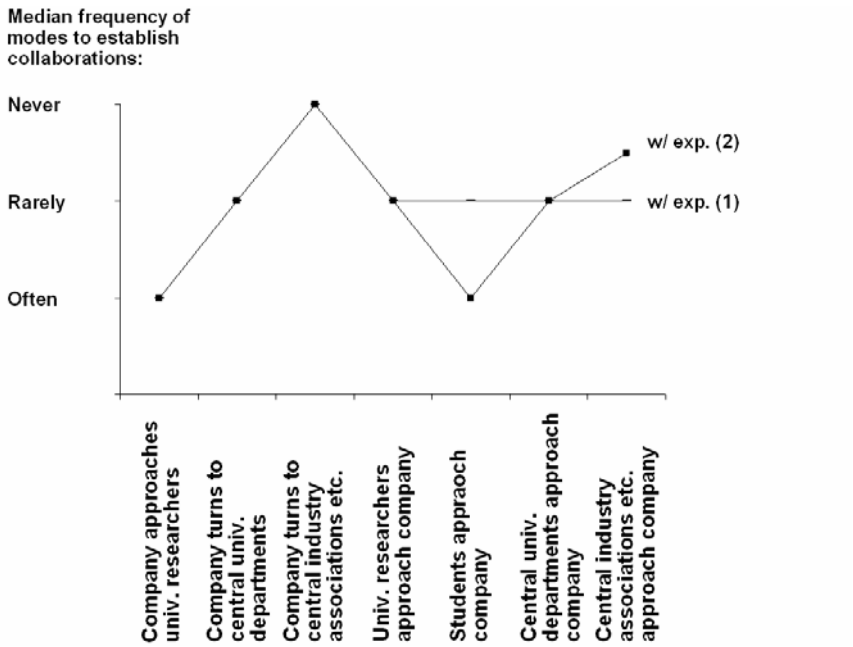

Figure 39: The frequency of modes how collaborations with universities are established assessed by companies of group 1 and 2

Regarding questions if companies enter long-term relations with relevant university departments and if contacts to universities are anchored within companies on various people companies of both groups answered similarly.

Barriers eventually encountered by university researchers are assessed rather differently. Usually they are assessed more important by companies belonging to group 2 than by companies of group 1.

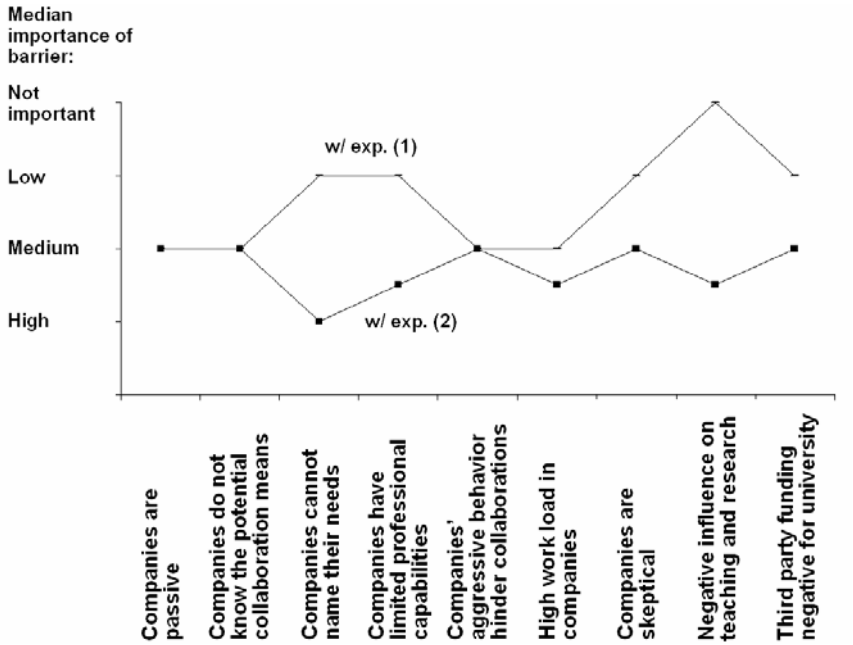

Figure 40: The importance of barriers out of the view of university researchers assessed by companies of group 1 and 2

Companies of group 1 stated following additional barriers:

Research is done almost exclusively on a basic level at universities. Applied research and thus collaborations with companies have little to no meaning. (N=7)
Lack of communicate skills (One talks first about costs, then about content of projects) (N=2)
Inflexibility, lack of project management skills (i.e. deadlines) (N=2)
Patent law, IPR rules at universities
Lack of resources (university researchers and students) in specific research areas at universities

Table 11: Additional barriers mentioned by companies of group 1

Companies of group 2 stated following additional barriers:

Fear of losing company internal knowledge to competitors and other companies
Lack of resources within company
Universities are too slow, too inflexible, and too pragmatic. They are not interested in collaborations.
High pressure to successfully finish research projects

Table 12: Additional barriers mentioned by companies of group 2

6.2.2 Companies without expenditures for but with contacts to universities

Companies without expenditures for but with contacts to universities were divided in two subgroups. Companies of group 3 assessed the importance of barriers slightly more important and the importance of motives rather similar to companies of group 1. Group 4 assessed the importance of barriers and motives on average least important compared to all other groups except the barrier *High workload at university departments hinder collaborations with companies*. Another group assessed this barrier even less important.

Group 3 consists of larger and smaller companies. Group 4 consists mainly of smaller companies. This is similar to the groups 1 and 2. According to the characteristics companies being part of the groups 3 and 4 are slightly less R&D intensive and use less frequently innovation management methods, have lower export quotes and a far lower number of university departments they are in contact with. In addition, the share of academics in the companies is already substantially below the values of the first two groups. Companies of group 4 have smaller absolute R&D expenditures than companies of group 3 and employ less academics than companies of group 3. Other characteristics are rather similar.

	Group 3 (N=39)	Group 4 (N=8)
Carrying out R&D	Rather continuously	Rather rarely
R&D expenditures in % of sales (Median/Average)	5/11	10/12.5
Yearly R&D expenditures (Median/Average)	102,700 EUR/ 682,303 EUR	10,000 EUR/ 279,200 EUR
Expenditures for external R&D services in % of he total R&D expenditures (Median/Average)	19/27	100 (N=1)
Being part of a group of companies	Rather not	
Sales in Mio EUR (Median/Average)	1.7/17.1	1.3/1.8
Number of employees (Median/Average)	15.5/80	33.5/30
Share of in the last three years newly developed or markedly improved products and processes on sales in % (Median/Average)	25/30.8	20/24
Export quote in % (Median/Average)	18.5/27	15/28
Number of all academics (Median/Average)	2.5/4.3	0 5/4.6

Number of graduates from universities of technology (Median/Average)	2/3	0/3.6
Use of innovation management methods	Rather rarely	
Use of technology transfer means	The use is ra her similar for all technology transfer means except using infrastructure. Companies of group 4 use this far more often.	
Classical universities vs. universities of technology	Both groups are similar and have primarily contacts to universities of technology han to classical universities.	
Number of university departments companies are in contact with (Median/Average)	3/3	2/2.5
Number of years companies are already in contact with universities (Median/Average)	7/9	7.5/8.2

Table 13: Comparing the two classes of companies without expenditures for but with contacts to universities

Companies of both groups have less frequently contacts to universities outside Styria than companies of groups 1 and 2. The trend is similar for both groups. The more distant universities are located the less frequently do relations exist.

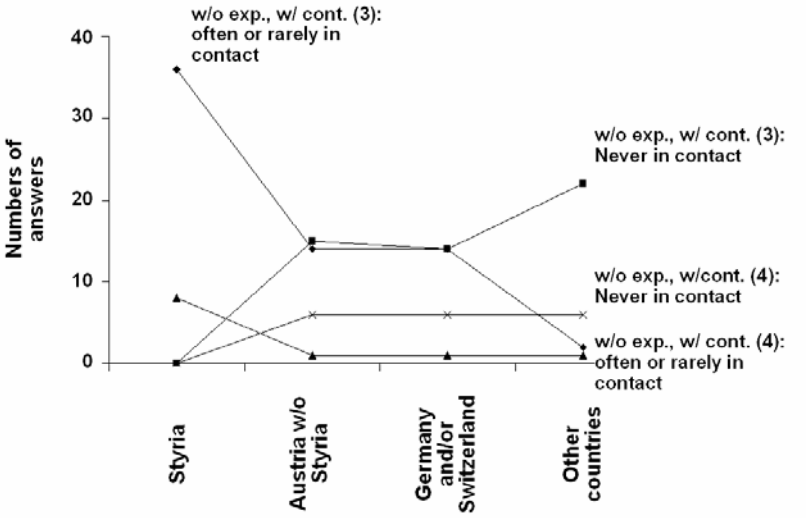

Figure 41: Companies of group 3 and 4 and their contacts to or collaborations with universities according to the geographic locations of he respective universities

Companies of both groups have contacts to universities from Great Britain to Russia. Compared to the two other groups, 1 and 2, these companies do not have contacts to universities from overseas.

Companies of group 3 mentioned following reasons for having contacts to universities outside of Styria:

Specific knowledge (N=11)
(Setting up) projects within EU FP, where partners of different EU countries are necessary (N=2)
Company is internationally active
Recommendations and existing contacts of company's customers
Ph.D. studies

Table 14: Reasons of companies of group 3 for having contacts to or collaborations with universities outside Styria

One company of group 4 mentioned EU projects as reason for having contacts to universities outside of Styria.

80 % of companies of group 3 are in contact with up to three university departments. The highest number of university departments companies of group 3 are in contact with is 10. The median for companies belonging to group 4 is two. The highest number of university departments companies of group 4 are in contact with is six.

The median number of years companies of group 3 are in contact with universities is seven, for companies of group 4 7.5.

Group 3 assessed motives similar to group 1. Group 4 assessed the majority of motives slightly less important except *Improving existing products and/or services* and *Collaborations with universities increase the likelihood of success to acquire additional external funding*. Compared to the first two groups an outstandingly important motive does not exist. In case of group 1 the outstanding motive was *Developing new products and processes*, for companies of group 2 the most important motive was *Improving existing products and processes*. Instead of single motives a bunch of motives are of medium importance for companies of group 3 and group 4.

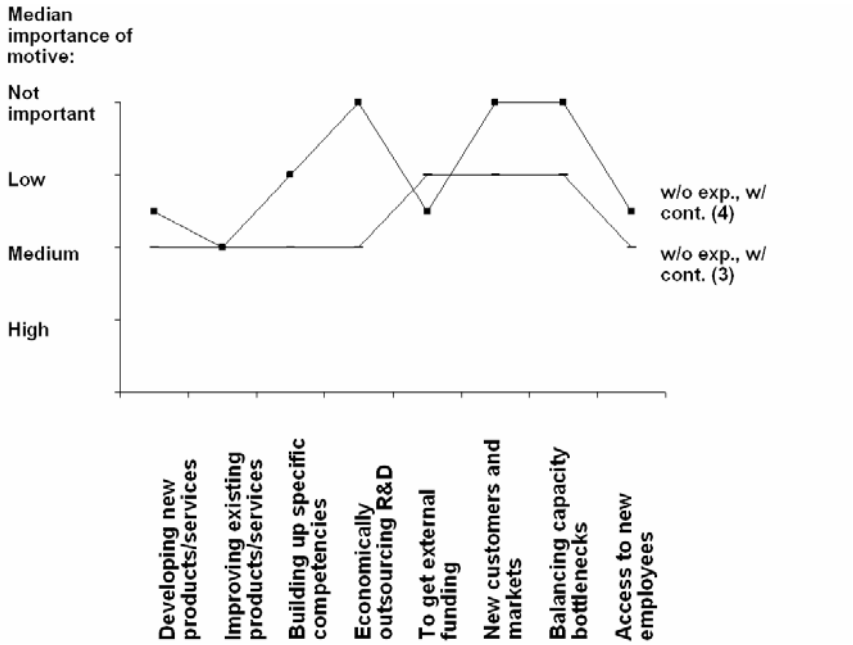

Figure 42: The importance of motives assessed by companies of group 3 and 4

Three companies of group 1 mentioned additional motives: Acquisition (universities as customers), consulting and expertise (this could have been counted to one of the listed motives) and access to literature.

Existing personal contacts are the most important reason for companies of group 3 and 4 to turn to specific university departments. For companies of group 3 the second most important reason is *recommendations from others*. Companies of group 4 value short geographic distances second most important followed by recommendations from others.

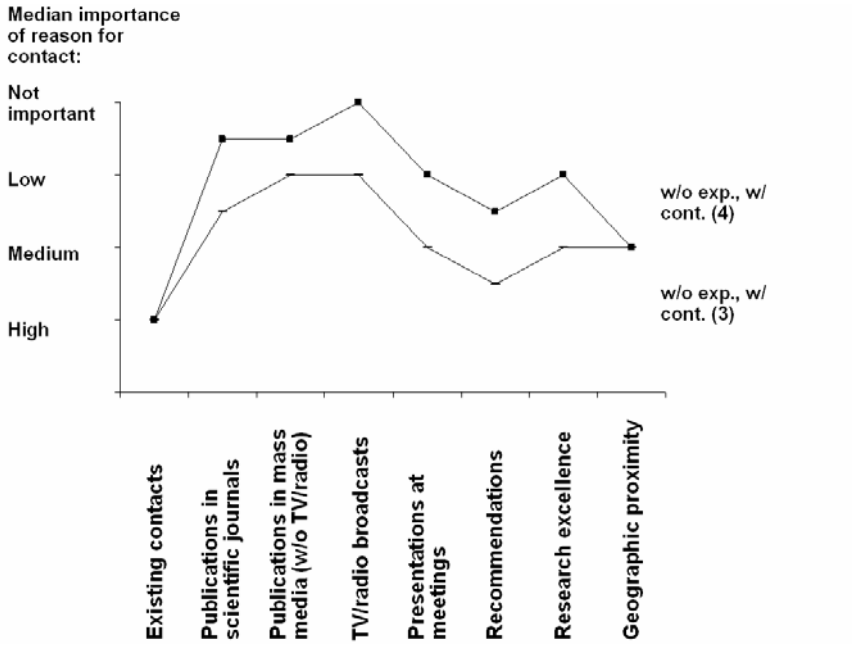

Figure 43: The importance of criteria decisive to contact specific university departments for potential collaborations assessed by companies of group 3 and 4

Two companies of group 3 additionally mentioned projects with customers and information events, where university departments present themselves in front of interested company representatives, as important possibilities to get in contact with relevant university departments.

The two most frequent modes how companies of group 4 establish contacts to university departments are *The company approaches university researchers directly* and *University researchers approach the company directly*. Other modes are less frequently or not at all used. Companies of group 3 use all modes.

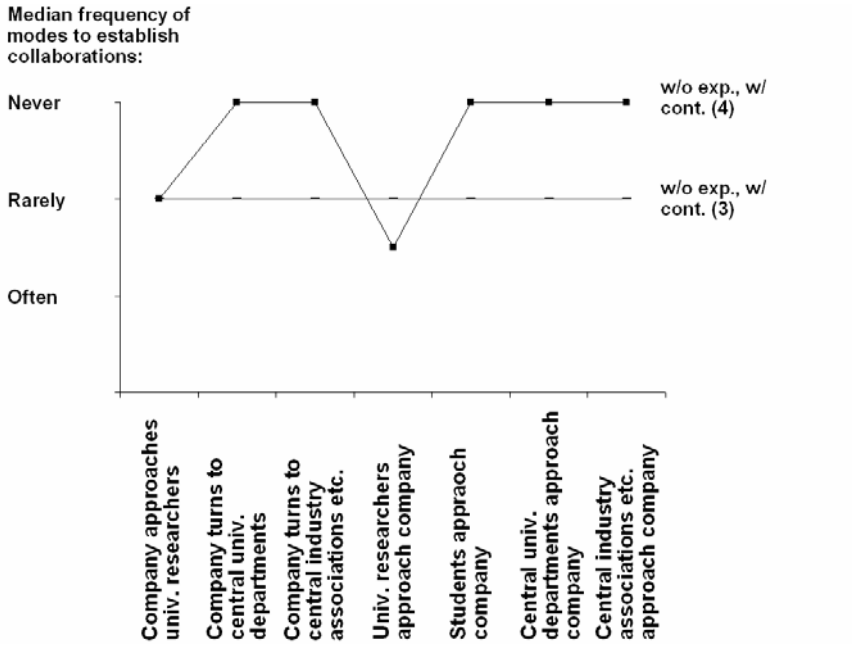

Figure 44: The frequency of modes how collaborations with university researchers are established assessed by companies of group 3 and 4

One company of group 3 mentioned public events as additional possibility to establish contacts.

Companies of group 3 are more likely to have anchored their contacts to universities on various people within the company than companies of group 4. On the other hand, companies of group 4 are more l kely to enter long-term relations with relevant university departments. However, the differences are rather small.

Major differences regarding the assessment of barriers eventually encountered by university researchers are the aggressive behavior of companies regarding IPRs and companies being skeptical towards technology transfer. Companies of group 4 assessed all barriers less important than companies of group 3. Compared to the two groups, 1 and 2, barriers are in general assessed less important by group 3 and 4.

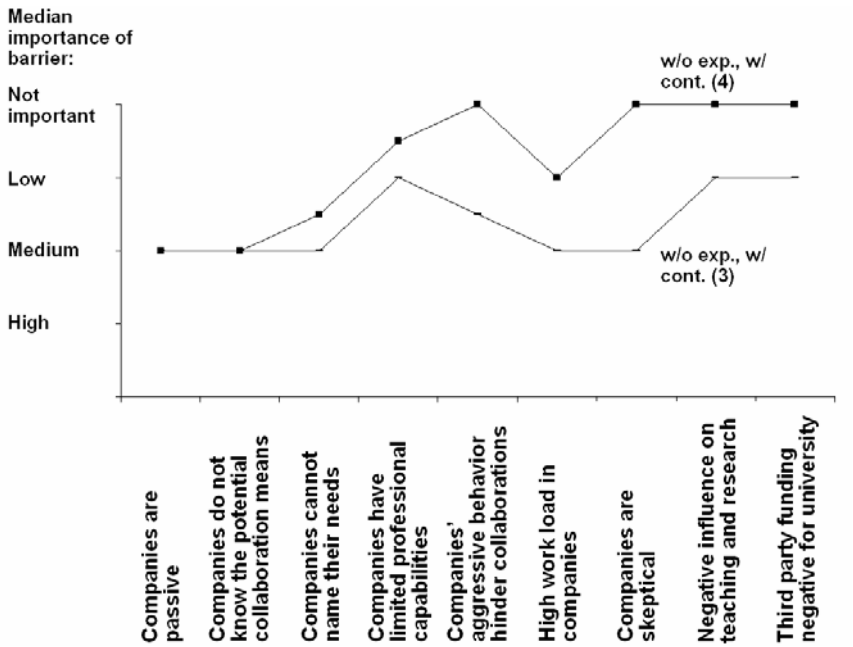

Figure 45: The importance of barriers out of the view of university researchers assessed by companies of group 3 and 4

Companies of group 3 mentioned additional barriers:

Time does not exist in companies. Deadlines for projects are often too short for collaborations. (N=3)
Lack of understanding companies' problems. Universities are too theoretically. (N=3)
Formalisms, high bureaucracy, lack of flexibility at universities (N=2)
University researchers being arrogant

Table 15: Additional barriers mentioned by companies of group 3

Companies of group 4 did not mention additional barriers.

6.2.3 Companies not yet having contacts to universities but interested in building up relations

This group is divided into three subgroups. Group 5 has a similar assessment of barriers like group 2 except the barrier *University researchers are rather skeptical towards collaborations with companies*, which is assessed less important by

companies of group 5. In overall companies of group 5 assessed all barriers as rather important. Group 6 is similar to group 1; barriers are assessed as rather unimportant. Group 7 shows a very different trend. Especially the barriers *Difficulties in finding the right contacts* and *Universities are passive in providing information and presenting their research results and possibilities to collaborate* are assessed rather important. Groups 5 to 7 did not have to assess the importance of motives to do technology transfer.

Group 5 is composed of rather small companies. Companies of group 6 are in general slightly larger than the ones belonging to group 5. Group 7 consists of larger but not R&D intensive companies. Companies of the groups 5 to 7 are likely to be service providers.

	Group 5 (N=17)	Group 6 (N=14)	Group 7 (N=5)
Carrying out R&D	Rather rarely		
R&D expenditures in % of sales (Median/Average)	5/6.4	7.5/14	2.25/5
Yearly R&D expenditures (Median/Average)	88,750 EUR/ 148,693 EUR	95,500 EUR/ 1,516,475 EUR	100,000 EUR/ 90,000 EUR
Expenditures for external R&D services in % of the total R&D expenditures (Median/Average)	75/75	30/30	15/15
Being part of a group of companies	Rather not		
Sales in Mio EUR (Median/Average)	1.5/6	2/8.4	7.5/11
Number of employees (Median/Average)	8/28	35/49	80/120
Share of in he last three years newly developed or markedly improved products and processes on sales in % (Median/Average)	12.5/20	15/25.5	3/6
Export quote in % (Median/Average)	5/14	0/24	10/23
Number of all academics (Median/Average)	0/1.3	2/4.8	3/5
Number of graduates from universities of technology (Median/Average)	0/0.6	1/1.3	2/4
Use of innovation management methods	Rather rarely		

Table 16: Comparing the three classes of companies not yet having contacts to universities but being interested in building up relations

Group 5 assesses the importance of the barrier *High workload in companies hinder collaborations with universities* highest. They are convinced that collaborations do not influence teaching and research at universities negatively. This is valid also for companies of group 6 and 7. Additionally companies of group 6 assessed the barriers *Companies are passive and do not ask for research projects and results* and *Companies do not know the potential collaboration means with universities like*

consultancy, licensing, seminar theses and the like as important. Companies of group 7 assessed the barriers *Companies are passive and do not ask for research projects and results* and *Companies are rather skeptical towards collaborations with universities* as important.

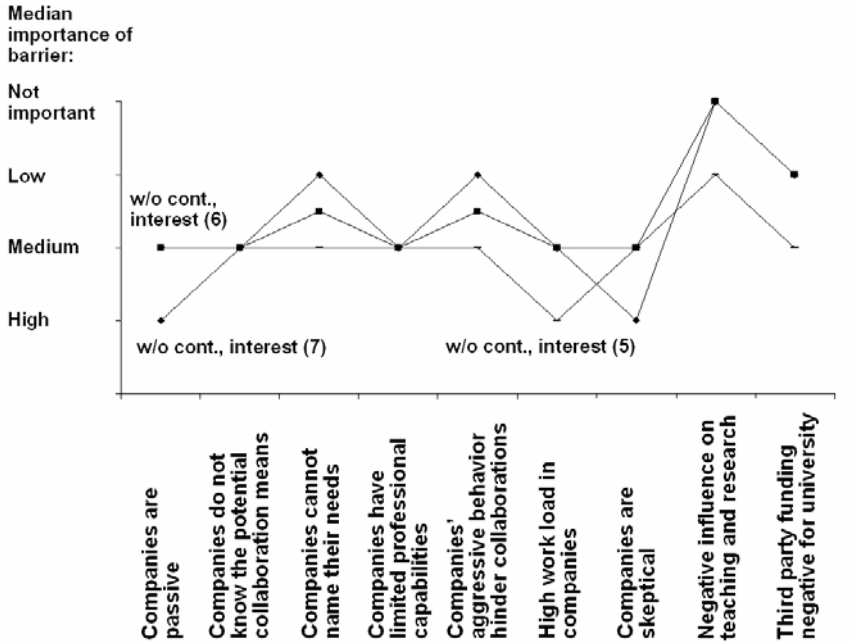

Figure 46: The importance of barriers out of the view of university researchers assessed by companies of group 5, 6 and 7

Companies of group 5 stated following additional barriers:

People should talk the same *language* and be willing to approach each other.
Arrogant attitude of university employees, especially professors. Often they do not have a realistic view of practical problems.
Lack of resources

Table 17: Additional barriers mentioned by companies of group 5

Companies of group 6 stated following additional barriers:

Lack of knowledge how to collaborate with universities to obtain exploitable solutions
University researchers lack a realis ic view of practical problems.
Output depends on individuals at universities
Company lacks internal awareness that projects with universities could be realized.
Supposed problems with confidentiality

Table 18: Additional barriers mentioned by companies of group 6

Companies of group 7 did not state additional barriers.

6.2.4 Companies not yet having contacts to universities and not being interested in building up relations

These companies did not have to assess the importance of barriers and motives. Therefore, this group could not further be divided in subgroups. The majority of companies are service providers, similar to companies of the groups 5 to 7. These companies are rather small and not R&D intensive. They have a small number of academics and rather small export quotes.

	Group 8 (N=24)
Carrying out R&D	Rarely to never
R&D expenditures in % of sales (Median/Average)	0.25/1.1
Yearly R&D expenditures (Median/Average)	10,000 EUR/ 19,333 EUR
Expenditures for external R&D services in % of the total R&D expenditures (Median/Average)	(N=0)
Being part of a group of companies	Rather not
Sales in Mio EUR (Median/Average)	1.2/2
Number of employees (Median/Average)	11 5/18
Share of in the last three years newly developed or markedly improved products and processes on sales in % (Median/Average)	15/23
Export quote in % (Median/Average)	0/14.6
Number of all academics (Median/Average)	0.5/0.9
Number of graduates from universities of technology (Median/Average)	0/0.5
Use of innovation management me hods	Rarely

Table 19: Companies not yet having contacts to universities and not being interested in building up relations

Companies belonging to group 8 mentioned the following reasons for not being interested in technology transfer:

No need (i.e. being service provider, not carrying out R&D, company is too small, universities are too far away from practical issues, lack of overlapping activi ies) (N=12)
Results of internal R&D shall remain within the company
Lack of time
Decision by the head quarter

Table 20: Reasons for not being interested in technology transfer stated by companies of group 8

6.2.5 Overview of specific characteristics of companies belonging to the different groups

The following figure, Figure 47: The eight groups of companies and their characteristics, offers the possibility to compare the different groups of companies with the help of specific characteristics. It presents the graphical result of a so-called correspondence analysis; see Moser, Reicher, Rosegger, De Frantz, and Havel[32] for a description of correspondence analysis. It shows the eight groups of companies and describes them with the help of R&D intensities, number of employees, sales, export quotes, and shares of within the last three years newly developed or markedly improved products and processes in percentage of sales. These characteristics form an n-dimensional room. The figure splits this n-dimensional room in two dimensions. The two axes display the dimensions, axis 1 and 2. These two axes explain most of the variations of the used characteristics. This is represented by the percentage values in brackets. The higher these values the better the variations of characteristics are described. The various characteristics were grouped according to the categories presented in the table beneath.

[32] Moser, W.; Reicher, D.; Rosegger, R.; De Frantz, M.; Havel, M.: Was ist so schön am Eigenheim – Ein Lebensstilkonzept des Wohnens [What is so beautiful with the own home – A life style concept of living], 2002, www.hausderzukunft.at/download/endbericht_eigenheim_1702.pdf as of 23rd of May 2006

	Small	Medium	Large
R&D intensity (R&D expenditures in % of sales)	Up to max. 5 %	> 5 to max. 10 %	More than 10 %
Number of employees	Up to 29	From 30 to 100	More than 100
Sales	Up to max. 2.5 Mio EUR	> 2.5 to max. 10 Mio EUR	More than 10 Mio EUR
Export quotes	Up to max. 15 %	> 15 to max. 30 %	More than 30 %
Share of within the last three years newly developed and markedly improved products and processes in % of sales	Up to max. 10 %	> 10 to max. 20 %	More than 20 %

Table 21: Categories of characteristics for the correspondence analysis

The graph offers two possibilities of use. Firstly, dependencies between characteristics can be identified graphically. The metrical distance between different characteristics and their values is a measure for their dependency from each other. If values of characteristics are near to each other, respondents usually give the same answers to these questions. In case of the graph beneath take the number of employees and sales figures. A large number of employees usually correlates with large sales, whereas a small number of employees relates to a small number of sales. Secondly, the graph also shows which characteristics describe the respective groups best. Therefore, one has to draw a line linking the group to be described with the intersection of the two axes. Characteristics nearest to the line measured in radian degrees are the ones describing the group best. The metrical distance to i.e. the coordination center or the group does not play a role. For example, companies of group 1 are described better by rather small R&D intensities than by large R&D intensities. This is because companies of group 1 are on average rather large with large sales figures. Therefore, even high absolute R&D expenditures result in rather small figures for R&D intensities.

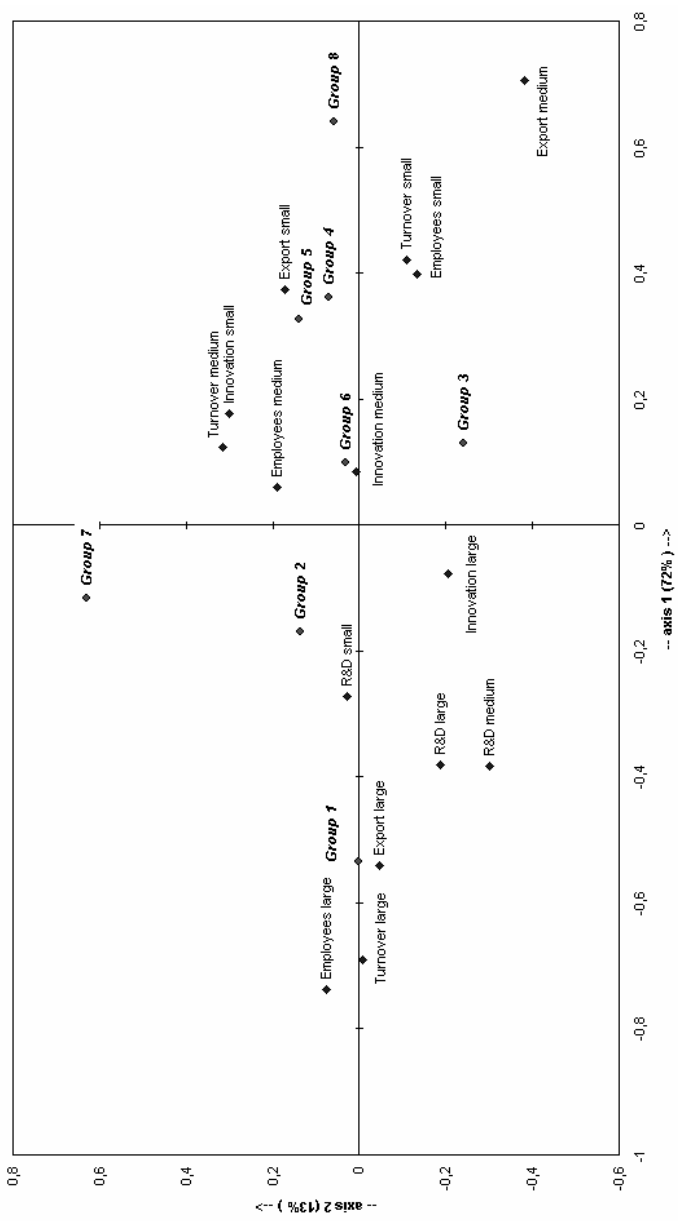

Figure 47: The eight groups of companies and their characteristics

An additional regression analysis did not reveal statistical significant relations between the different groups and characteristics used for the graph above.

6.3 Typology for university researchers

University researchers were classified in three groups related to their current technology transfer extent:

1. University researchers with contacts to companies
2. University researchers not yet having contacts to companies but interested in building up relations
3. University researchers not yet having contacts to companies and not being interested in building up relations

To further detail this classification answers to the importance of barriers were used to split the groups in smaller subgroups. This led to four groups of university researchers with differences regarding their current technology transfer extent and their assessment of the importance of barriers.

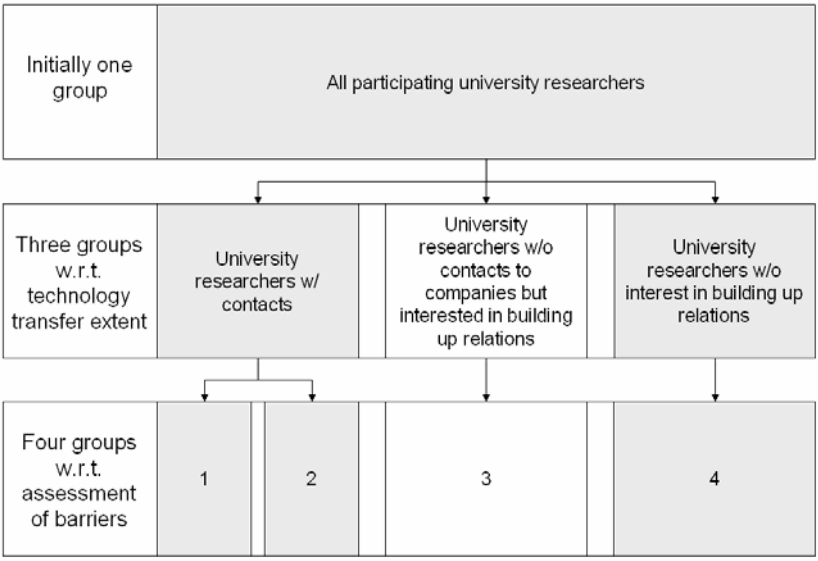

Figure 48: Typology for university researchers regarding technology transfer

Answers of the various groups regarding barriers and motives are displayed beneath. Note that not all groups had to assess the importance of barriers and motives.

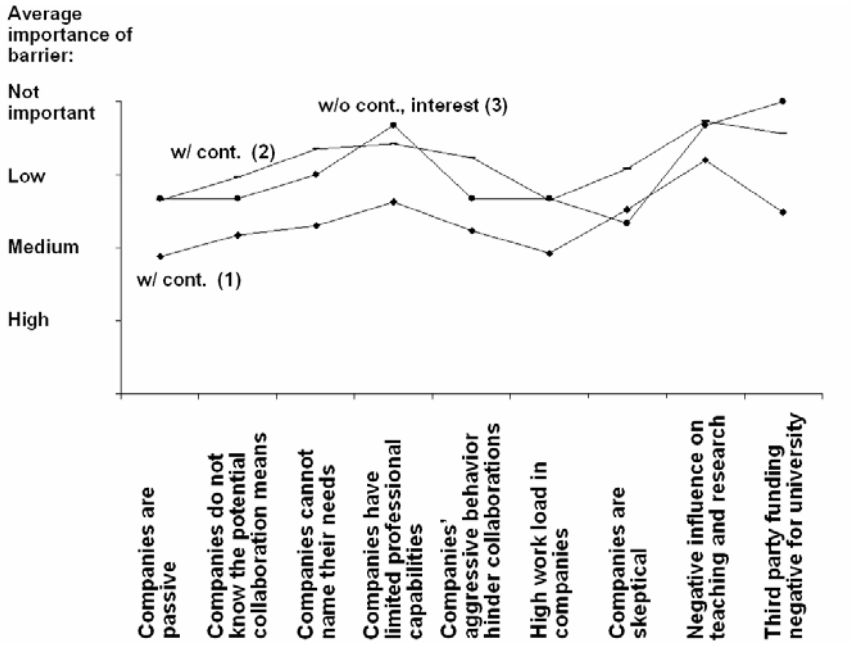

Figure 49: University researchers' average assessment of the importance of barriers according to he different classes of the typology

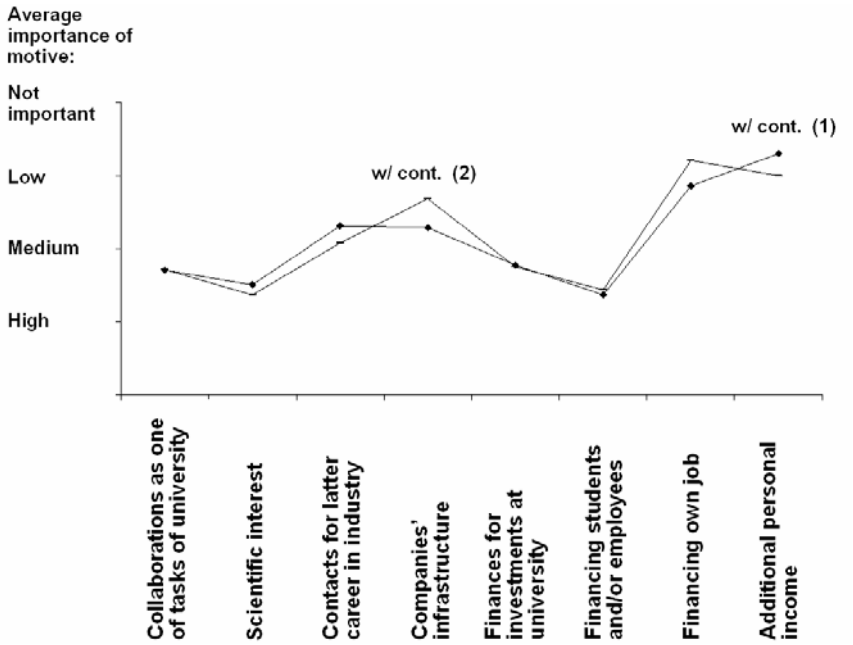

Figure 50: University researchers' average assessment of the importance of motives according to the different classes of the typology

6.3.1 University researchers with contacts to companies

University researchers already having contacts to companies are further split in two subgroups. The trend of barriers is similar for both groups. However, group 1 assessed all barriers on average more important than university researchers of group 2. Regarding motives group 1 and 2 are similar regarding the trend as well as the level of importance. The major difference of university researchers of group 1 and group 2 is their working experience in companies. University researchers of group 1 have far more working experience in companies than their colleagues belonging to group 2.

	Group 1 (N=44)	Group 2 (N=29)
Size of department	From 11 to 20 employees	
Age of university researchers	Between 36 and 45 years	
Function at department	Assistants	
Financed by	Regular university budget	
At university since (Median/Average)	2000/1993	2001/1995
Working experience in companies (Median/Average)	2 years/6 years	0.04 years/0.81 years
Number of personal contacts with different companies per month	4/7.6	3/5 9
Time spend for company collaborations (Median/Average)	30 %/39.5 %	30 %/37 %
Use of technology transfer means	Rather similar	

Table 22: Comparing the two classes of university researchers with contacts to companies

Regarding motives group 1 and group 2 are similar related to the trend as well as the level of importance. Looking at the median values differences exist with the motives *It is one of the tasks of universities to collaborate with companies*, *Using companies' infrastructure*, *Financing investments in university department's infrastructure* and *Financing your own job*. The motive *It is one of the tasks of universities to collaborate with companies* is assessed more important by university researchers belonging to group 2 than by colleagues of group 1.

University researchers of group 1 mentioned following additional motives:

Practical insight for research and teaching (N=6)
Personal sa isfaction if practically applying research results
Acquiring third party funds vital for the survival of the university

Table 23: Additional motives mentioned by university researchers of group 1

University researchers of group 2 mentioned following additional motives:

It is positive for the image of the university
To finance vocational trainings
Practical insights for research and teaching

Table 24: Additional motives mentioned by university researchers of group 2

The value of practical insight for research and teaching through collaborations with companies is mentioned rather often by university researchers of group 1. These university researchers have on average worked six years in companies. University researchers with little or even no working experience in companies do not mention

this motive often. It is only mentioned once compared to six entries by university researchers of group 1.

Modes how contacts to or collaborations with companies are established are rather similar. Central organizations, independently if at the university or by industry near intermediaries like i.e. cluster organizations or others, do not frequently broker projects. University researchers of group 1 frequently approach companies with which they are already in contact. Other forms to establish contacts do not differ widely.

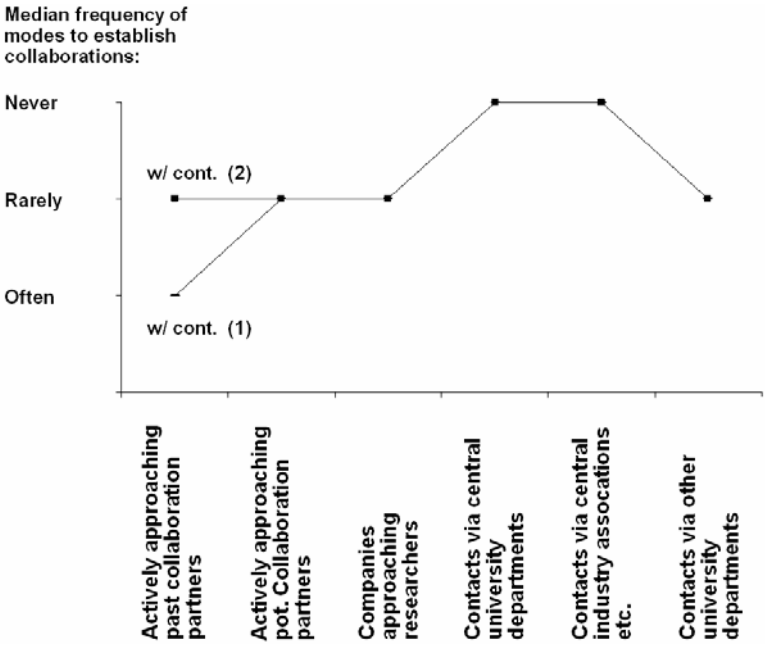

Figure 51: The frequency of modes how collaborations with companies are established assessed by university researchers of group 1 and 2

University researchers of group 1 mentioned following additional modes to establish contacts to companies:

Department head or project manager orders to take over projects (N=3)
EU projects (N=2)
Governmental organizations and the like
Competence centers[27]
Brokering by colleagues
Personal relations
Projects with partners introducing new previously unknown industrial partners

Table 25: Additional modes how collaborations with companies are established mentioned by university researchers of group 1

University researchers of group 2 mentioned following additional modes to establish contacts to companies:

Department head establishes contacts and projects (N=2)
New projects with already known companies (N=2)
Conferences, fairs, exhibitions

Table 26: Additional modes how collaborations with companies are established mentioned by university researchers of group 2

The following graph shows that both groups of university researchers are equal regarding the origins of the companies they collaborate with.

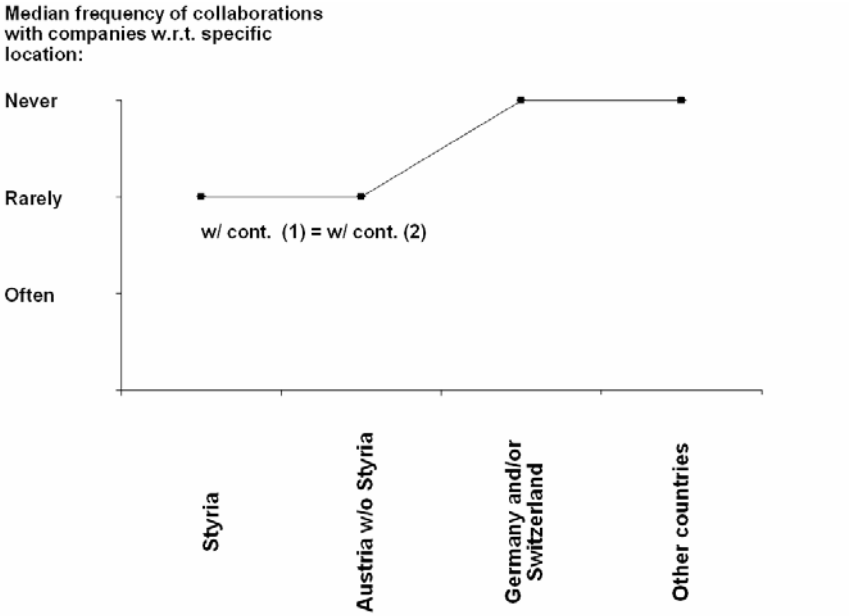

Figure 52: University researchers of group 1 and 2 and their contacts to or collaborations with companies according to the geographic locations of the respective companies

The distribution of answers regarding the question *Do you learn something from your collaborations with companies for your teaching activities* is rather similar for both groups.

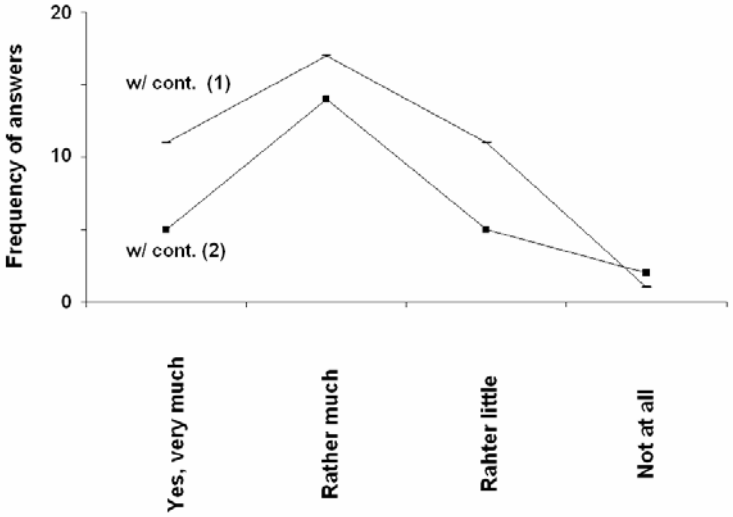

Figure 53: University researchers of group 1 and 2 assessing the benefits of technology transfer for their teaching activities

Differences in assessing the benefits of technology transfer for university researchers' own research do not exist.

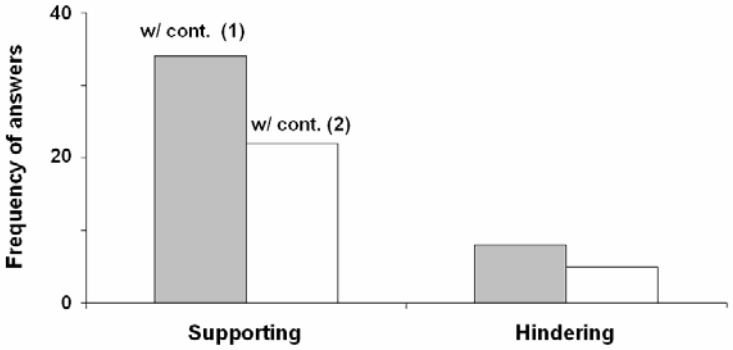

Figure 54: University researchers of group 1 and 2 assessing the benefits of technology transfer for their own research

University researchers of group 1 and group 2 do not show differences regarding the use of standards in technology transfer.

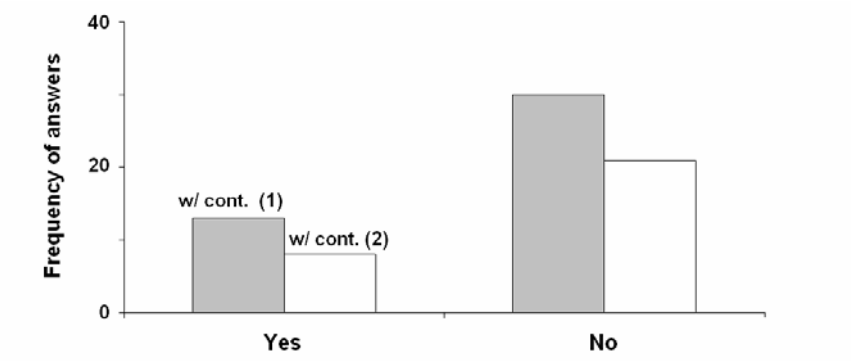

Figure 55: University researchers of group 1 and 2 answering to the question if standards for technology transfer are applied

University researchers of group 1 mentioned following standards regarding technology transfer:

Certified laboratory is part of the university department (i.e. quotation of prices etc.)
Reporting, project management
Collaborations like i.e. master theses are visualized as process including templates, check lists and forms
Standards according to quality management system
Contracts and information brochures for companies and students interested in doing their theses
Similar standards like consul ing engineers

Table 27: Standards used in technology transfer by university researchers of group 1

University researchers of group 2 mentioned following standards regarding technology transfer:

Rules of the university department and Graz University of Technology (N=2)
Information brochures regarding master theses for companies
Guideline for the realization of master theses
Contracts and project management
Answering enquiries within 5 working days
Standard contracts and offers
Quota ion of prices and project management

Table 28: Standards used in technology transfer by university researchers of group 2

The general trends for the realization of specific activities are similar except supporting companies in applying for external funding. University researchers of group 2 do this far less frequently than university researchers of group 1. There might

be different reasons for this difference. I.e. university researchers of group 1 with a higher working experience in companies might have more experiences in applying for funding. They might be more aware of the need of companies for support in setting up funding proposals. Alternatively, they might view such overlaps between universities and companies as more natural than university researchers of group 2 with little to no working experiences in companies.

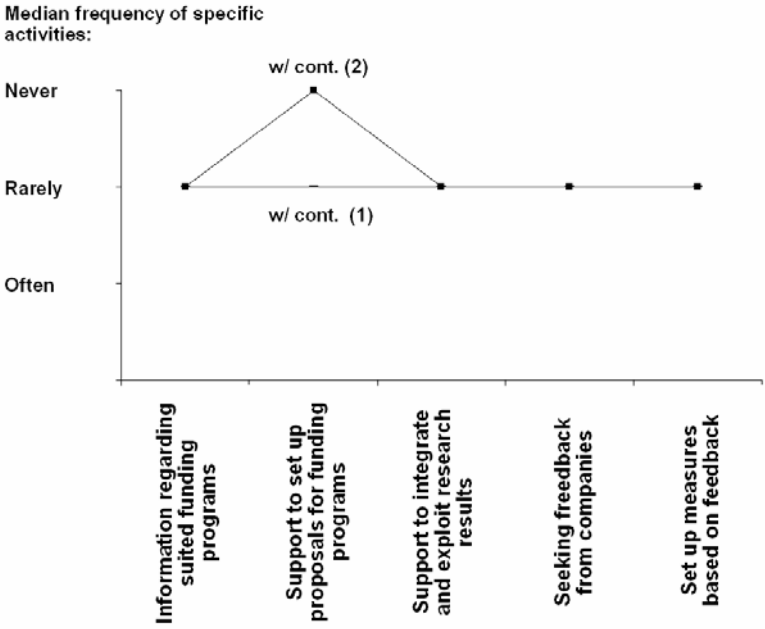

Figure 56: Frequency of realizing specific activities by university researchers of group 1 and 2

University researchers of group 1 mentioned following additional activities:

Maintaining existing relations and networks through visiting conferences, events etc.
The use of internet (open source software, www, accessibility), important to be contacted
Transfer of know how to companies
Free consultancies in case of enquiries
Regular contacts with project partners (project reviews) during projects

Table 29: Additional activities mentioned by university researchers of group 1

University researchers of group 2 mentioned following additional activities:

Analyzing and solving problems
Flexibility and customer orientation
Presentations and mee ings

Table 30: Additional activities mentioned by university researchers of group 2

University researchers of group 1 are more likely to be interested in extending technology transfer than university researchers of group 2.

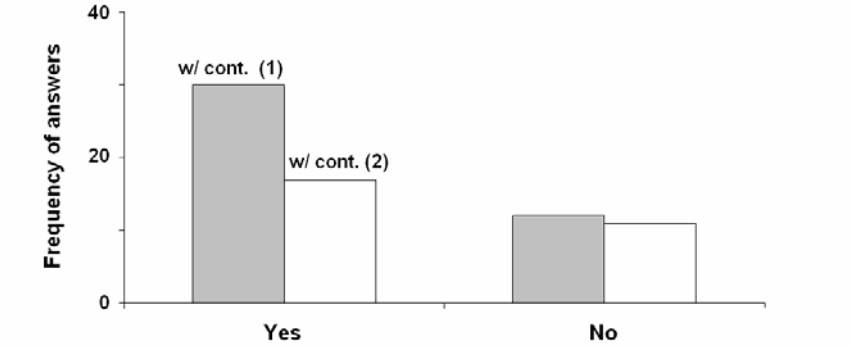

Figure 57: University researchers of group 1 and 2 answering to the question if they would like to extend technology transfer

University researchers of both groups assessed companies' barriers rather similar. Only the barrier *Universities are passive in providing information and presenting their research results and possibilities to collaborate* shows differences.

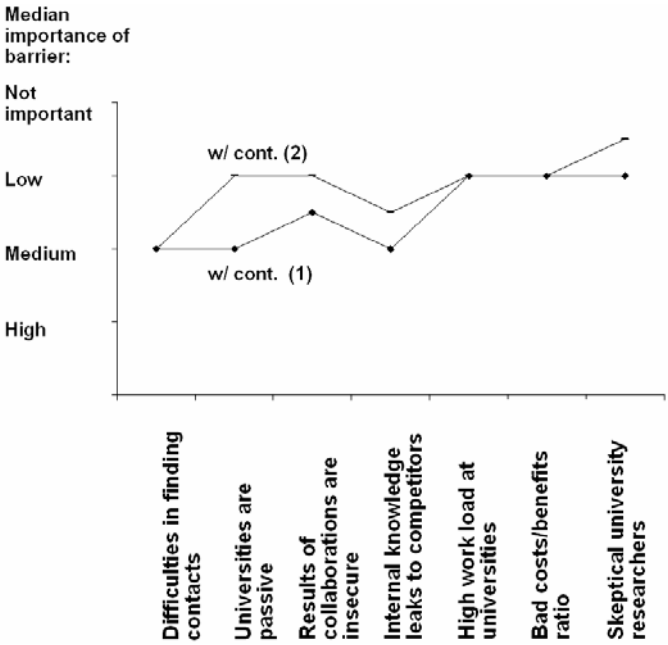

Figure 58: The importance of companies' barriers assessed by university researchers of group 1 and 2

University researchers of group 1 mentioned following additional barriers:

Industrial production and R&D centers are outsourced to foreign countries
Cost competition with other universi ies and universities of applied sciences
Lack of research budget
Companies are arrogant and do not believe in universities being able to provide support
Professors are often not participating in opera ive collaborations
Fluctuation of university researchers complicates long-term collaborations
Research at universities often takes too long (i.e. doctoral theses)
Companies do not want or are not able to take over full costs of one research post
Large number of currently running projects complicates further acquisition
University of applied sciences are better in marketing and offer comparable services
University departments cannot calculate sales taxes but have to pay them
Bad infrastructure at the university and the department, not suited for large research projects
Companies being afraid to contact universities
Bad marketing at the university
University departments only thinking on their own profits, which results in problems if trying interdisciplinary research
Lack of incentives to do more technology transfer
University researchers often do not understand the language and needs of companies

Table 31: Additional barriers mentioned by university researchers of group 1

University researchers of group 2 mentioned following additional barriers:

Cost competition with universities of applied sciences, especially in case of master theses
Lack of capacity is the only barrier
Freedom of basic research
Clear rules regarding competencies and resources
Lack of understanding of companies for basic research
Large geographic distances
Especially smaller companies do not even think of collaborating with universities, do not recognize the potential benefits or even are afraid of universities

Table 32: Additional barriers mentioned by university researchers of group 2

The following graph shows the importance of motives. Differences regarding median values are interesting, especially in the case of building up competencies. University researchers of group 1 assess this far more important than university researchers of group 2. Similarly important is the motive *Universities as economic R&D service providers (outsourcing)* and in case of group 2 the support of universities in *Improving existing products and processes*.

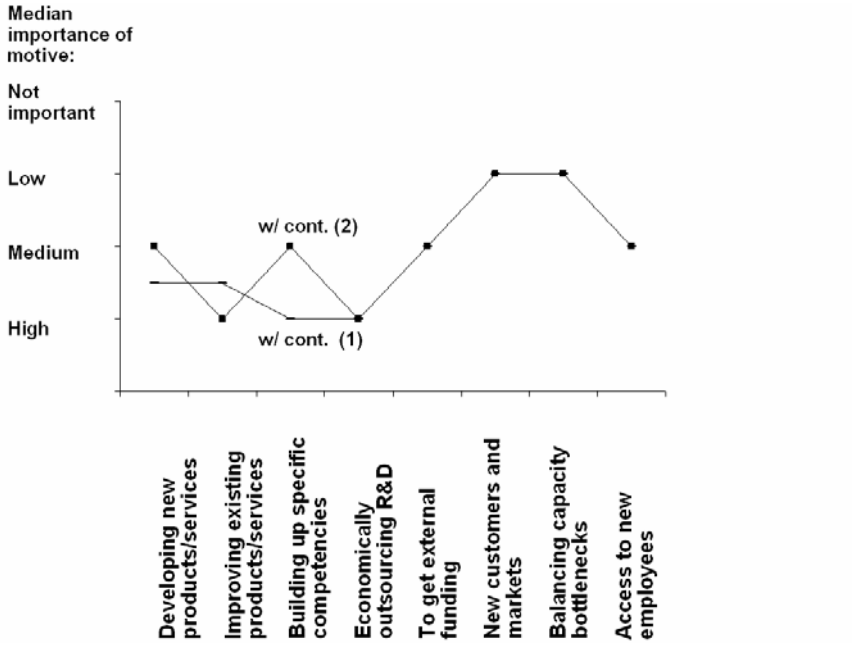

Figure 59: The importance of companies' motives assessed by university researchers of group 1 and 2

6.3.2 *University researchers not yet having contacts to companies but interested in building up relations and university researchers not yet having contacts to companies and not interested in building up relations*

The two groups are examined together for two reasons. Firstly, the number of answers is rather small in both groups. Secondly, a direct comparison of these two groups is interesting for further actions. University researchers of group 3 assessed the importance of barriers slightly different compared with their colleagues of group 1 and 2. However, the major trend is grosso modo similar. University researchers of group 4 did not have to answer the importance of barriers. The major difference between university researchers of group 3 compared to group 4 is their age. University researchers of group 3 are without exception younger. Group 4 consists of younger and older university researchers.

	Group 3 (N=3)	Group 4 (N=5)
Size of department	From 11 to 20 employees	
Age of university researchers	Up to 36 years	Between 36 and 45 years
Function at department	Between project, hird party funded employees, scientific employees in formation and assistants	Rather assistants
Financed by	Financed by regular university budget and third party funds	
At university since (Median/Average)	2004/2003	2001/1995
Working experience in companies (Median/Average)	0 years/0 years	0 years/1.7 years

Table 33: Comparing the two classes of university researchers interested and not interested in building up relations with companies

University researchers of group 4 were asked for their reasons not to do technology transfer. The following reasons were mentioned:

Basic research (provides little possibilities to do technology transfer) (N=3)
Contract ends soon and the post will be cancelled
For basic lectures the possibilities are limited.
No interest in working for industry. It is wrong to co-finance private industry by offering economic support by universities.

Table 34: Reasons for not being interested in technology transfer mentioned by university researchers of group 4

University researchers of group 3 judged the barrier *Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)* encountered by companies as most

important. The barrier *University researchers are rather skeptical towards collaborations with companies* is not assessed as important.

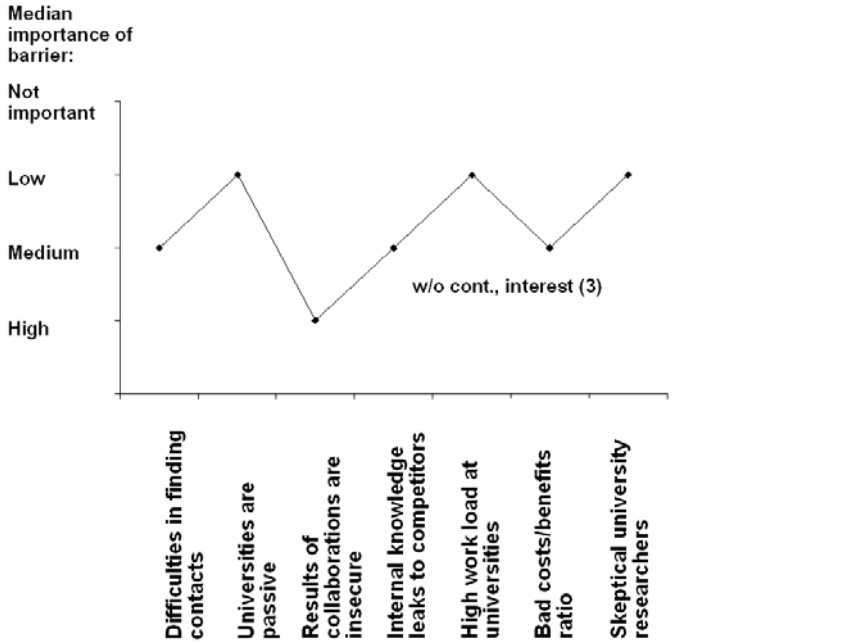

Figure 60: The importance of companies' barriers assessed by university researchers of group 3

University researchers of group 3 mentioned following additional barriers:

Industry unwilling to invest in research without promises that results can be useful
The existing bad equipment, infrastructure and lack of personnel risk future research and collabora ions
The main part of resources will be needed to keep teaching going

Table 35: Additional barriers mentioned by university researchers of group 3

The major motives for companies assessed by university researchers are *Universities as economic R&D service providers (outsourcing)* and *Collaborations with universities increase the likelihood of success to acquire additional external funding*. Building up specific competencies and access to new customers and markets are assessed as unimportant.

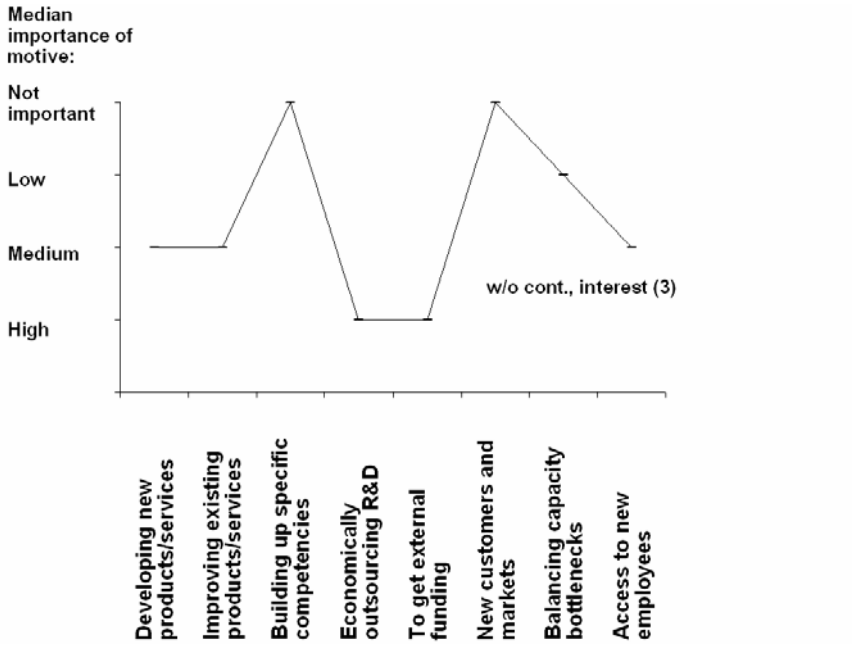

Figure 61: The importance of companies' motives assessed by university researchers of group 3

6.3.3 Overview of specific characteristics of university researchers belonging to the different groups

For the explanation of how to read the following graph see chapter 6.2.5. The four groups are described with the help of the following characteristics: Function at the university department, sources university by which university researchers are financed, age, and working experience at the university and in companies.

Function at he department	Professors	Assistants	Scientific employees in formation, project employees, third party funded employees
Source university researchers are financed by	Regular university budget	Third party funds from companies	Other third party funds
University researchers' age	Up to 35 years (young)	From 36 to 45 years (medium)	Older than 45 years (old)
At the university since	Since 2002	From 1995 to 2001	Before 1995
Working experience in companies	Up to max. 1 year	From 1 to max. 5 years	More than 5 years

Table 36: Categories of characteristics for the correspondence analysis

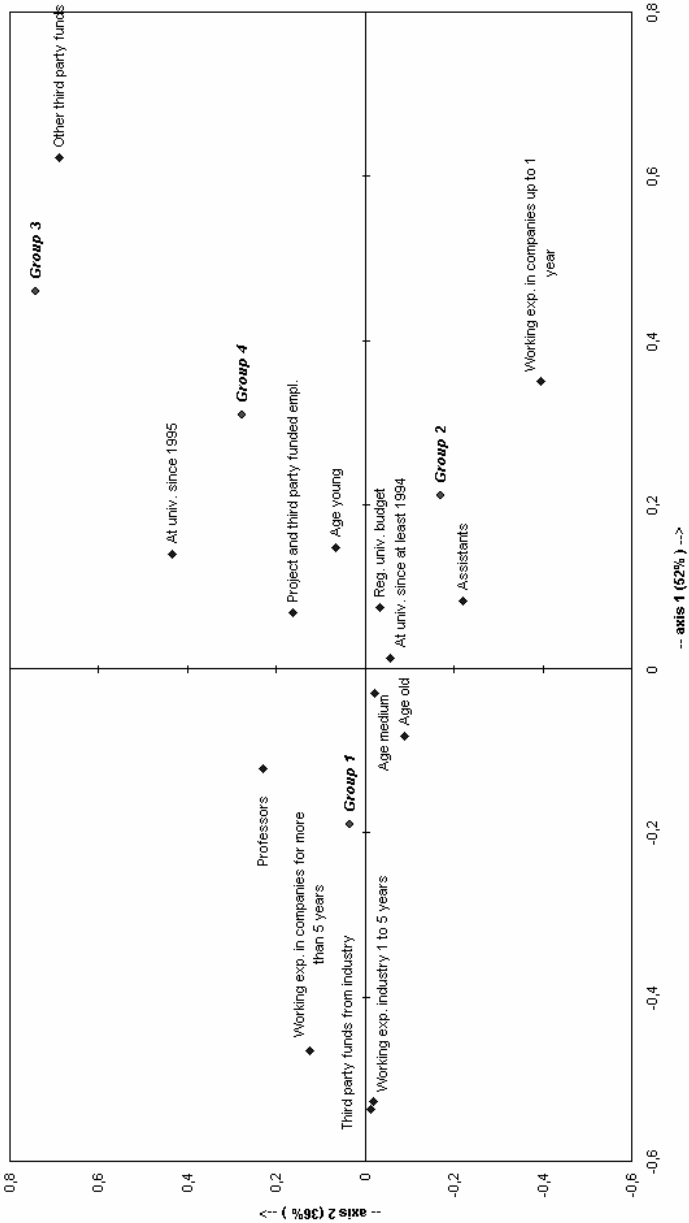

Figure 62: The four groups of university researchers and their relations to specific characteristics

The regression analysis shows statistically significant relations in case of the groups 1 and 2 and the characteristic *Working experience in companies*, thus confirming the descriptive results.

7 Interviews with company representatives and university researchers

The questionnaires' results are now enhanced with personal interviews with at least two representatives of each typology class where possible. Interviews were kept rather short, up to half an hour on average, and aimed at getting further information regarding potential recommendations for actions for the respective needs. This approach is suited to discuss technology transfer more in depth and draw conclusions for potential recommendations for actions.

7.1 Interviews with company representatives

All interviewees were asked to their current technology transfer, the history, i.e. how did it come to contacts to universities, and the future of technology transfer out of their point of view. Additionally they were asked to indicate relevant recommendations for actions to improve technology transfer. The interviews are comparable to case studies, from which the reader can draw additional insights.

7.1.1 Companies with expenditures for universities

Companies with expenditures for universities were divided in two groups. Two company representatives of each group were interviewed. Interviewees 1 and 2 belong to group 1, interviewees 3 and 4 to group 2.

	Group 1		Group 2	
	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4
Yearly R&D expenditures in % of sales	Roughly 25	Around 15	About 3	1
Development of yearly R&D expenditures for 2006 and 2007	From 0 to + 10 %	From + 11 to + 25 %	From + 11 to + 25 %	From 0 to + 10 %
Expenditures for external R&D services in % of all R&D expenditures	About 1	20	50	10
Expenditures for universities in % of all R&D expenditures	n/a	10	20	Less han 1
Development of expenditures for universities	Remaining stable	Increasing	Increasing	Increasing

% distribution for technology transfer means	Bachelor and master theses (10 %), doctoral theses (20 %), collaborative R&D projects (70 %)	Certifications and consultancy (20 %), contract research projects (20 %), collaborative R&D projects (30 %), using infrastructure (30 %)	Bachelor and master theses (10 %), collabora ive R&D projects (80 %), using infrastructure (10 %)	Cer ifications and consultancy (80 %), using infrastructure (20 %)
Origin of universities company collaborates with	Austria and central eastern Europe	Austria, Germany and Switzerland	Austria, Germany and Switzerland	Austria, Germany and Switzerland
Reasons for collaborating with universities outside Styria	The company has several sites in Austria, specific research activities	Specific research activities	Existing personal contacts	Specific research activities
Universities of technology vs. classical universities	Primarily universities of technology	Exclusively universi ies of technology	Primarily universities of technology	Exclusively classical universities
No. of departments companies are in contact with	25	3	5	2
Major motives to collaborate with universities	Developing new products and processes, building up specific competencies and access to potential new employees	Developing new products and processes and improving existing products and processes	Enables Basic research within a given manageable time span	Improving existing products and processes and universities as economic R&D providers
Major mechanisms to get in contact with universities	Existing personal contacts, recommendations from others (e.g. customers, suppliers, partners etc.) and excellence of research	Existing personal contacts	Existing personal contacts, excellence of research, short geographic distance to universi ies	Existing personal contacts, TV and radio broadcasts, short geographic distance to universities
Companies' categories	Mass and low volume produc ion, prototypes, customized and standardized services	Low volume production	Low volume production	Mass and low volume production, customized services
Part of a group of companies?	Yes	No	Yes	No
Sales in Mio EUR	More than 50	About 5	Around 38	Around 3
Development of sales for 2006 and 2007	More than + 10 %	More han + 10 %	From 0 to + 5 %	From 0 to + 5 %
Share of products and processes newly developed or markedly improved wi hin the last three years in % of sales	50	50	20	15
Export quote in %	48	60	70	3

Most important export countries in terms of sales	n/a	Germany, China and USA	Germany, France and Sou h Corea	Germany, Croatia and Hungary
No. of employees	More than 250	20	211	24
Share of university graduates in % of all employees	30	60	10	10
Share of graduates from universities of technology in % of all university graduates	70	75	More than 90	0
Strategies	Quality and technology leadership	Technology leadership and niche strategy	Quality and technology leadership, niche strategy	Niche strategy
Respondent's almer mater	Vienna University of Technology	None	University of Leoben	University of Graz
Current position at company	University liaison officer	CEO	CEO	CEO

Table 37: Characteristics of interviewees 1 to 4

7.1.1.1 Why and how did the company establish contacts to universities?

In case of interviewee 1, contacts to universities exist since the foundation of the company back in the 19th century. The foundation of the company coincides roughly with the establishment of universities of technology in Austria and as far as interviewee 1 knows technology transfer developed simultaneously. The company focused since the beginning on technologies. University graduates were and still are one of the major mechanisms for technology transfer. They take with them their contacts to former colleagues, university assistants, and professors. Since interviewee 1 is in charge for relations with universities technology transfer developed rather incrementally than radically because technology transfer already had a high importance in the past. Interviewee 1 has a coordinating role within the company. The person does not want to be the bottleneck. The tasks are i.e. providing a platform to exchange experiences and information like who is collaborating with which university, consulting company employees in case of entering collaborations with universities, designing suited standardized processes, and providing information about research interesting for employees. Such information is prior processed to experts in the specific field of research to assess the potential impact. In general, the network of the company is open for new universities. However, a core group of universities and research providers exist. Others are approached only if existing contacts do not have the necessary knowledge. Members of the existing core group usually provide such new contacts. The benefits of such a core group are that the

people know each other personally. In these cases master contracts exist which do not make it necessary to negotiate i.e. every single master thesis.

The company represented by interviewee 2 is a very good example of how individuals can lay the ground for technology transfer. A university liaison officer visited the company in the mid nineties two or three times. At that time, the company had four employees. For a restructuring process, the university liaison officer established a contact to an external expert not being a university researcher. And in fact, the company realized the project with this person, the results were very positive for the company. This first contact did not even involve universities. However, through to the good experience the company discovered collaborations and turned again to the same university liaison officer. Nowadays, collaborations are daily business for the company and with every collaboration experience increases. The first time contact with university researchers was a small contract with 1 or 2 hours efforts for one university researcher. This worked quite well. According to the company, it is l kely that the support provided by the university liaison officer ensured the realization of the contract by the university researcher. Gradually collaborations increased and the company started to use support by universities more frequently. At that time relations with other partners, mainly companies, existed already. However, such relations were mostly customer-supplier relations.

Contacts between the company represented by interviewee 3 and universities were not established out of specific reasons. Rather because university graduates from different institutions employed by the company took with them their contacts. Interviewee 3 for example built up contacts to the university the person graduated from. Contacts to this specific organization did not exist prior. The company's employees also share experiences with each other, i.e. with whom collaborations work rather well, who is doing research in specific areas and the like. Through the growing number of contacts, the current network with universities in Austria and beyond is still expanding.

The company represented by interviewee 4 contacts universities to solve specific problems. First it tries to solve the problem internally with the help of its own laboratory and by doing desk research. If this does not work, the company turns to external sources l ke universities. 15 years ago the company did not have a laboratory. Due to the increasing need the company established one. Thus, also the requirements for universities changed. In the beginning universities had to solve standard routine analytical tests for the company. Now tests are usually more specifically. The owner-manager graduated from University of Graz. The person

established contacts relevant to the business area. Now the contacts are widely distributed within the company and in case problems cannot be solved internally company employees jointly discuss whom best to contact externally. From the beginning the company had expenditures for universities. With the own laboratory relations changed and are now more often focused on the exchange of experiences. Thus, not all enquiries automatically lead to expenditures. Contacts to other R&D organizations, i.e. suppliers of raw material or equipment providers, exist and are used in case questions are related to these areas.

7.1.1.2 How satisfying are your contacts with universities?

Interviewee 1 is in general satisfied with current technology transfer. However, the person is convinced that potential for improvements exists. Challenges universities and companies are facing are rather different and it is necessary to overlap interests on both sides and to agree on joint objectives. The major motive to do technology transfer is to get access to unique and special knowledge and to try to build up this knowledge internally. In some cases, technology transfer also takes on a form of outsourcing, i.e. commissioning a master thesis for risk assessments of specific technologies.

Interviewee 2 assessed the professional part of technology transfer as very good. This is also a result of a thorough process regarding the identification of suited partners before actually starting collaborations and the good brokering by existing partners. Regarding project management, the company has more success with other companies, which are used to fulfill objectives. The major difference is that companies have a project manager responsible for keeping projects on track. At universities, dates often pass by without the delivery of results. It seems that university researchers are not aware what it means if results are not delivered on time. They do not focus on the interests of their customers. It would be helpful if there were someone responsible for such activities, someone who focuses on the delivery of results and keeps track of projects. According to the company in about 50 % of all projects with universities dates for i.e. deliverables have to be renegotiated.

Interviewee 3 also confirmed that professionally technology transfer works very well. The company does not have the knowledge to realize ideas universities can realize. Interviewee 3 is not personally involved in the project management of technology transfer. However, due to the already existing contacts the set up and management of projects runs rather smoothly. Important are short geographic distances to research organizations. It is not important to collaborate with world leading experts.

Average smart people with creativity nearby are even more important. Especially in case projects are about to finish and stress increases because projects seem to run wrong. If partners are located nearby, the team can meet easily. This is impossible if partners are located farther away. Usually the company delivers ideas to i.e. improve machinery or processes and external research organizations l ke universities realize these ideas within the necessary time. This would be impossible for the company because of the lack of basic research expertise.

Also for interviewee 4 technology transfer works rather well, both on the professional as well as management level; especially in case of existing contacts. However, there are sometimes topics the company wants to work on but university researchers do not seem to be interested. In some cases, simply knowledge is lacking, in other cases university researchers do not want to specialize in the specific kind of research. In addition, the lack of interest of university departments is surprising to the company. I.e., they seldom ask for new topics for i.e. doctoral or master theses. However, in any case the actual need for professional support provided by universities is rather low, because most of the analytical work is done internally.

7.1.1.3 Is technology transfer going to change?

The personal judgment of interviewee 1 is that technology transfer must change to even better use external resources and improve access to ideas. Resources internally are constraint but externally vastly available. The theoretical potential to further improve and expand business is huge. This attitude has to be promoted within the company. However, daily business and a strong marketing and sales orientation within the company make it difficult.

In case of the company represented by interviewee 2 technology transfer will not change significantly. The use will increase because more projects will be realized. However, this will be in line with the company's overall growth.

Interviewee 3 stated that currently the company focuses on increasing internal efficiency. The company is not yet so far to i.e. scan regularly external R&D organizations for interesting technologies. It is not likely that this will change in the near future. New contacts to R&D organizations currently happen rather by chance than through systematically screening external organizations.

Interviewee 4 stated that technology transfer is not going to change. Even though the company mentioned to have topics potentially interesting to realize with the support of universities these topics are not of immediate importance. If these topics would become important interviewee 4 would have the necessary contacts to either realize them with the help of existing partners or existing partners could name other researchers being able to provide support. The company tries to keep in contact with relevant departments and to have personal contacts to relevant university researchers, i.e. getting in contact with newly appointed department heads and successors of specific university researchers.

7.1.1.4 Which support services would help to improve technology transfer?

For the company represented by interviewee 1 funding as a stand-alone topic is not of major importance. It must leverage technology transfer. One support service would be support in realizing technology fairs. The company has experiences in realizing fairs to provide possibilities to establish collaborations with university researchers. In one case it needed about a year to motivate university researchers to take part in such a fair. Even though the set up was difficult, the feedback after the fair was very positive. Interviewee 1 emphasized the role of universities out of an economic point of view: Universities transform money into knowledge and companies re-transform knowledge into money. Some university researchers do not seem to be willing to justify their research by presenting results and to show potential applicability. This has to be improved. The company tries to stimulate technology transfer by internally providing necessary resources.

Reasons why the company represented by interviewee 2 is approached rarely by university researchers and students are that no one of the management graduated from universities in Styria and the small size of the company. However, the company now recruits university graduates from universities in Styria. These people will take with them their contacts and thus naturally expanding collaborations with regional universities. In case of projects with universities, it would be helpful having someone responsible for such projects at universities, someone who focuses on the delivery of results and keeps track of projects. Finally yet importantly also relevant information regarding research would be important. It would be necessary to personally meet university researchers to actually discuss research. This is also the major reason why finally collaborations are realized.

Interviewee 3 emphasized the complementary nature of universities and private R&D organizations like i.e. engineering offices. Universities do not have the economic pressure to i.e. finish projects with having set up a stable production process. University researchers are satisfied if it works once in the laboratory but making processes stable is not research anymore. Private companies are better in this perspective. They have the economic pressure to deliver results and are better suited to work out stable processes to make university research results fit for large-scale production or industrial applications. Interviewee 3 values informal meetings highly. I.e., lunches are a perfect possibility to exchange information usually not talked about during formal meetings. In the beginning of technology transfer with universities, funding for collaborative projects was rather important. Collaborations with universities were welcomed because of increasing the funding quote. Nowadays it is not that important anymore. Even if funding is not available, projects are still realized.

Interviewee 4 is rather satisfied with technology transfer. None of the current activities needs to be changed. Existing collaborations work fine and the company already has the necessary range of partners.

7.1.2 Companies without expenditures for but with contacts to universities

The following companies do not have expenditures for but contacts to universities. Interviewees 5 and 6 belong to group 3, interviewees 7 and 8 to group 4.

	Group 3		Group 4	
	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8
Yearly R&D expenditures in % of sales	5	None	None	5
Development of yearly R&D expenditures for 2006 and 2007	From 0 to + 10 %			From 0 to - 10 %
Expenditures for external R&D services in % of all R&D expenditures	20			0
Use of transfer means	No technology transfer means used; exchange of knowledge	No technology transfer means used; exchange of knowledge	Certifications and consultancy	Taking part or providing input for seminars or workshops, collaborative R&D projects
Origin of universities	Styria, Germany and Switzerland	Styria	Styria	Styria
Reasons for collaborating with universities outside Styria	EU project proposals			

Universities of technology vs. classical universities	Primarily universities of technology	Exclusively universities of technology	Exclusively universities of technology	Exclusively universities of technology
No. of departments companies are in contact with	2	3	2	1
Major motives to collaborate with universities	Developing new and improving existing products and processes, building up specific competencies, helpful for external funding, access to pot. new employees	Developing new and improving existing products and processes, building up specific competencies, access to pot. new employees	No major motives	No major mo ives
Major mechanisms to get in contact with universities	Presentations of researchers at events, short geographic distance to universities	Existing personal contacts, recommendations of others, short geographic distance to universities	No major mechanisms	Existing personal contacts
Companies' categories	Customized services	Customized and standardized services	Prototypes, customized services	Customized and standardized services
Part of a group of companies?	Yes	Yes	Yes	No
Sales in Mio. EUR	2,3	About 6	3,5	0,14
Development of sales for 2006 and 2007	More than + 10 %	From + 6 % to + 10 %	From + 6 % to + 10 %	From 0 to – 5 %
Share of products and processes newly developed or markedly improved within the last three years in % of sales	50	10	n/a	5
Export quote in %	17	0	3	30
Most important export countries in terms of sales	Germany		Bulgaria	Germany, Sweden and Netherlands
No. of employees	23	70	47	7
Share of university graduates in % of all employees	33	5	0	Roughly 50
Share of graduates from universities of technology in % of all university graduates	100	100		66
Strategies	Quality and technology leadership	Cost and quality leadership	Niche strategy	Niche strategy
Respondent's almer mater	None	BOKU Vienna	None	Graz University of Technology
Current position at company	CEO	Authorized signatory	CEO	CEO

Table 38: Characteristics of interviewees 5 to 8

7.1.2.1 Why and how did the company establish contacts to universities?

The company represented by interviewee 5 is an engineering office and works primarily for the automotive industry. Some of the customers act as role models regarding collaborations with universities. For a future project, the integration of universities is planned. This collaboration could be rather intensive. The company management usually establishes the contacts. Some of the contacts were established by chance through i.e. taking part in delegations, others because of short geographic distances to universities. Collaborations with private consultants and universities of applied sciences already exist. Some of the collaborations are driven by financial objectives because through outsourcing specific services the company can apply for funding from funding agencies, others are driven by the need for specific knowledge.

Interviewee 6 is the one who initially built up contacts between the company and universities. He was the first academic in the company. In the beginning he tried to establish collaborations with the university he graduated from, which is located about 1.5 hours by car from the company's location. This did not work, thus interviewee 6 turned to universities located nearby, which worked better. Now the company has more academics with different educational background. This implies that also contacts to universities are more broadly distributed. However, interviewee 6 still is the major contact point for universities. Contacts to public R&D labs without teaching activities do not exist because the company uses existing contacts also for recruiting purposes.

The company represented by interviewee 7 rarely has contacts to universities. These contacts are limited to employees of central university departments and were established because of university employees directly approaching the company. The business of the company is not R&D intensive. In case of necessary development activities the company realizes the work together with customers. However, the input of the company is usually relatively small. It does not have contacts to R&D organizations others than universities.

The company represented by interviewee 8 is a kind of academic spin-off. The professor coaching the master thesis and the beginning of the doctoral thesis, which remained unfinished, of interviewee 8 supported the foundation of the company. However, the development of the company ran differently than expected. The major reason to found the company in the first place was the lack of finances to keep on working on the doctoral thesis. After founding the company additional services

besides the originally planned ones had to be offered to make profits. Contacts and collaborations with university departments interviewee 8 was in contact with during his career as university researcher still exist. With the help of these contacts, relations to other R&D institutions active in this research area are established. The majority of contacts are mere customer-supplier relationships.

7.1.2.2 How satisfying are your contacts with universities?

Up to date interviewee 5 has made good experiences with universities. However, current contacts are not intensive. In the near future contacts will be intensified and then the company will get a better feeling how such collaborations could work. The major technology transfer means used by the company in the past were recruiting services and support for feas bility studies.

Interviewee 6 mentioned potential for improvements. This potential lies within the universities' organizations as well as the professional knowledge of university researchers. Interviewee 6 criticized that university researchers often are not available. They are simply not present at their university departments. This results in rather weak professional quality at university departments where engineers working in companies often know more than university researchers. In general, the company realizes the major part of the problem solving process on its own because university researchers do not want to engage in identifying solutions and setting up tests. In such cases, university researchers are contracted exclusively to actually realize necessary tests.

For interviewee 7 it was at the time of the interview not poss ble to comment on this question because the company only has loose contacts to central university departments but not to university researchers at departments. Currently the company thinks about the development of own products. In this case, support by universities would be needed.

Because of the existing personal contacts between interviewee 8 and university researchers current collaborations work rather well.

7.1.2.3 Is technology transfer going to change?

In case of interviewee 5 technology transfer will intensify. It is rather likely that for the next projects, where universities will be integrated, also expenditures for universities will occur.

Beginning with January 2006 the company of interviewee 6 got a new proprietor. In the past, an investment house without direct interest in the business area of the company was the proprietor. With the new proprietor, technology transfer is likely to intensify because the new proprietor already collaborates intensively with universities.

In case the company focuses on the development of own products it could become possible that technology transfer increases. Interviewee 7 mentioned another company heavily engaged in technology transfer as role model for the own company.

Interviewee 8 would be interested to work also with other university departments as service provider. However, it is difficult for the company to get in contact with the various university departments because immediate professional links as well as knowledge of their specific research are missing.

7.1.2.4 Which support services would help you to improve technology transfer?

Interviewee 5 could not name specific recommendations for actions to improve technology transfer. One service the company could use would be a pool of students with their competencies to be used in case of capacity constraints. A major barrier for the company is confidentiality. According to interviewee 5, it is impossible to collaborate with universities for radical innovations, i.e. new product development. Up to date the company has not made bad experiences. However, partners have complaint about universities regarding confidentiality and their inability to deliver project results on time. Also university researchers leaving projects because of teaching activities and their preference of larger companies are barriers mentioned by interviewee 5.

Interviewee 6 criticized the behavior of university researchers regarding the definition of projects. If companies contact universities, they usually want support to solve specific problems. If university researchers do not give feedback within a reasonable time, companies get nervous. Interviewee 6 knows this behavior and is used to it but

others are not. It is important to consider longer time frames if working with universities. Learning to collaborate is important to understand the modus operandus of universities and to develop such understanding. It would be helpful to realize regular events at university departments to establish contacts. These events should have a rather informal character where research is presented. Also suited information brochures should be provided to get an overview of specific services and knowledge. University researchers should also take care of not over committing their resources. It is not comprehensible if university researchers delay meetings and project dates because of teaching or attending conferences. Compared to universities like Oxford university researchers in Austria invest rather little time for students according to interviewee 6. This should change in order to provide highly qualified employees for companies.

Interviewee 7 did not have a clear picture of potential recommendations for actions. According to the previously provided input, the following services would be helpful: Focus on own products on side of the company, universities actively approaching the company with ideas for collaborations and support regarding funding.

Interviewee 8 did not name any specific needs either. It would be good if others like university researchers have ideas and ask the company to provide support in the realization process. In case ideas are developed and the company is chosen for realization it would be positive to have support regarding funding, i.e. identifying suited funding programs and setting up and formulating proposals.

7.1.3 Companies not yet having contacts to universities but interested in building up relations

The following interviews were led with company representatives whose companies did not have contacts to universities at the time of the survey but were interested in establishing contacts. Interviewees 9 and 10 belong to group 5, 11 and 12 to group 6 and 13 and 14 to group 7.

	Group 5		Group 6		Group 7	
	Interviewee 9	Interviewee 10	Interviewee 11	Interviewee 12	Interviewee 13	Interviewee 14
Yearly R&D expenditures in % of sales	None	5	Around 5	10	0.5	Around 3
Development of yearly R&D expenditures for 2006 and 2007		From 0 to + 10 %	From 0 to + 10 %	From + 11 % to 25 %	From 0 to + 10 %	From 0 to – 10 %

Expenditures for external R&D services in % of all R&D expenditures		50	0	0	10	0
Companies' categories	Mass production	Customized services	Customized services	Customized services	Mass production	Customized services
Part of a group of companies?	Yes	No	No	No	No	Yes
Sales in Mio EUR	Almost 20	n/a	Around 3	0.6	25	2.8
Development of sales for 2006 and 2007	From + 6 % to + 10 %	More than + 10 %	From 0 % to + 5 %	From 0 % to – 5 %	From 0 % to + 5 %	From + 6 % to + 10 %
Share of products and processes newly developed or markedly improved within the last hree years in % of sales	0	30	15	0	0	1
Export quote in %	97	20	15	0	10	10
Most important export countries in terms of sales	Germany, Italy and USA	Slovakia and Hungary	Germany		Germany, Italy and Slovenia	Poland, Croatia and Slovenia
No. of employees	105	1	30	3	325	35
Share of university graduates in % of all employees	0	0	3	66	0.3	Almost 50
Share of graduates from universi ies of technology in % of all university graduates			100	100	0	Around 95
Strategies	Cost and technology leadership	Niche strategy	Quality leadership	Niche strategy	Cost and quality leadership	Quality leadership and niche strategy
Respondent's almer mater	None	None	Graz University of Technology	Graz University of Technology	None	Graz University of Technology
Current position at company	Location manager	CEO	CEO	CEO	CEO	CEO

Table 39: Characteristics of interviewees 9 to 14

7.1.3.1 Why did you not yet establish contacts to universities?

Interviewee 9 already tried to establish contacts to university researchers. However, the problem solving capacity did not meet company's requirements. Years ago, the company location was rather strong in R&D. Many of the current products were developed internally in collaboration with the R&D department of the mother company located in another part of Austria. Also nowadays, the company faces regularly problems where universities could be of help. However, problems are rather specialized. Interestingly the company does not turn to universities outside Styria to

ask for support. If regional universities cannot help, the company tries it on its own by trial and error and asks the central R&D department of the mother company for help. This R&D department is also working on European and international standardization issues and the like.

Interviewee 10 represents a one-person-company. Like interviewee 9 also interviewee 10 already had contacts to universities. These contacts focused exclusively on the realization of standard tests for own customers. The contacts did not lead to increasing interest in technology transfer but hindered interviewee 10 from getting in contact with departments doing research potentially interesting to the company. According to interviewee 10 responsibilities at university departments are not clear and prices for the same service differ according to the person one asks. This experience throws a bad light on other university departments too.

Interviewee 11 mentioned that the company currently lacks a clear strategic orientation, experience, and resources for collaborations with universities. In the past, the company had students of universities of applied sciences. The delivered practical work was rather good but the students were not that independently as the company wished them to be. The company expects university students who are in general older than their colleagues of universities of applied sciences to be more independently and able to prepare and realize their work in a way that finally decisions can be taken. In addition, an interest for business activities of the company would be necessary for fruitful collaborations. Even though interviewee 11 graduated from one university of technology, he does not have a detailed overview of possibilities for collaborations between companies and universities. This might be because the person realized a master thesis without company participation.

Interviewee 12 is a university graduate and held lectures at universities. Still, interviewee 12 stated to lack information regarding research at university departments. Even though the company has contacts to university researchers collaborations are never realized as collaborations with universities because university researchers usually participate in such projects through their private companies. Interviewee 12 did not judge this negatively but thus collaborations with universities would not result. The person mentioned other R&D organizations like the German Fraunhofer Gesellschaft as positive example for their way to present research. Interviewee 12 gets regularly information regarding new studies and if needed pays online and downloads them. The company itself is not specialized. Therefore, it is difficult to establish long-term partnerships with specific departments.

However, questions arise regularly which could be solved together with universities because of their potential positive long-term impact.

Interviewee 13 named the lack of overlapping activities as reason for not having contacts to universities. The company is active within an area where regional universities do not realize specific research. If the company talks about R&D, it mainly means decreasing production failures. In case of problems, it is often sufficient to contact suppliers of machinery.

Interviewee 14, an academic, already knows many university researchers personally. However, the contacts are all outside the university researchers' activities at universities, i.e. university researchers as certified referees. He meets university researchers also regularly at events for university students and graduates of specific studies and is invited to give presentations on such occasions. Out of the point of view of interviewee 14 universities have to do the first step. The company represented by interviewee 14 mainly applies standards. Therefore, the need to collaborate with universities is not that strong.

7.1.3.2 How could technology transfer start?

Costs are not the major criteria for interviewee 9. The company would rather pay than to try to solve problems internally. The major barrier is to find someone willing or being professionally able to support the company in its specific areas.

Interviewee 10 would start with small and non-critical projects. If experiences with university researchers were positive, interviewee 10 would intensify contacts. In general, interviewee 10 could think of long-lasting relations with universities, i.e. regularly commissioning master theses. Such projects would also be a matter of costs and therefore subject to external funding. The company currently has contacts to one university of applied sciences and engineering offices. These relations are primarily for i.e. using infrastructure and commissioning tests for company's customers. Contacts are mainly established by other people with whom interviewee 10 is already in contact with.

Interviewee 11 thought already about potential topics for collaborations. The company would start with a pilot project and in case collaborations work well relations could be extended, i.e. building up competencies with help of universities. The

company highly values concrete deliverables. Currently the company does not have external R&D partnerships.

Interviewee 12 is interested specifically in publications interesting for the company's business area, i.e. specific calculations, current standards, and specific research potentially useful to the company. The company does not have external R&D partnerships.

Interviewee 13 mentioned during the interview one concrete topic, where the company would need support from universities. However, the company did not have a plan how contacts to universities could be established.

Interviewee 14 did not have concrete thoughts of how to start technology transfer. However, most likely would be small studies or master theses. Important are concrete measures and benefits resulting from such activities. All current developments are done internally. Partnerships with R&D providers do not yet exist.

7.1.3.3 Which support services would be useful in technology transfer?

Interview 9 misses university researchers and students actively approaching the company with interesting project proposals. However, since shortly this is getting better. The lack of expertise and interest especially in the area of the company is an important barrier for more intensive contacts.

Interviewee 10 stated that the company is principally interested in collaborations. Universities should provide more information about research and services offered by their departments including contacts and prices where suitable. In most of the cases, interviewee 10 does not know what university departments offer. It is likely that many services could be useful for either the company itself or other companies with which interviewee 10 is in contact with. Additionally university researchers should recommend funding instruments. University researchers would not have to prepare the proposals on their own but they should consult companies which funding instruments would be suitable for respective projects. Also other services l ke i.e. using library services should be more oriented towards business needs. Furthermore, universities and their departments should think about i.e. events l ke open doors and similar formats. Entry barriers for companies must be lowered, especially for the ones not employing academics and not being experienced in collaborations with universities.

Interviewee 11 mentioned that the company would not be ready to start collaborations. First of all the company would have to define objectives for collaborations with universities. This is a strategic decision. Currently the company focuses on realizing daily business without thinking much about the future. For technology transfer the company would have to build up one or two employees primarily responsible for contacts to universities. If the company is ready interviewee 11 expects universities to act by providing suited information about research and collaboration possibilities. Universities should start and initiate actions because otherwise it is likely that the company again focuses too much on daily business. Interviewee 11 mentioned the presentations of best practice examples of collaborations as one way to make technology transfer interesting for companies. The company is experienced regarding funding instruments. Anyway, interviewee 11 mentioned several times that the company would not like to realize projects only because of the available funding. The research topic and objectives are more important. The company would prefer if university researchers recommend funding instruments suited for specific projects. It does not make sense if funding agencies present instruments for collaborative research projects without a given occasion.

Interviewee 12 stated that even the company is not highly specialized in specific areas sometimes questions arise where universities could dock on. The company would have to give impulses for university researchers being able to provide solutions. Universities should take on comments and enquiries from companies, process them, and provide suited input for companies. Furthermore, research and results should be better displayed. Interviewee 12 mentioned one good example of collaborations between industry and science. It is collaboration in the area of wood where university researchers offer services and expertise for companies and companies use this network to exchange experiences. In addition, vocational training is offered according to the needs of companies. Such positive examples depend primarily on the commitment of companies and university researchers willing to push such networks.

Interviewee 13 mentioned the need to have entry gates at universities. Especially in case of not yet having contacts, it would be difficult to know whom to approach at universities.

Interviewee 14 emphasized the importance of management support in companies. Top and middle management posts of the company are held by academics. If they would stress the need and importance of collaborations with universities, the company would likely engage in collaborations. Management could establish

necessary contacts because of their own history and contacts. However, universities should initiate technology transfer by actively contacting companies. One way would be to strengthen links with their alumni in order to ensure ongoing contacts. Also events accompanied by marketing activities to attract companies are a good measure to establish contacts between university researchers and companies. Third parties like i.e. governments and funding agencies should stress benefits of collaborations and focus on collaborative projects. Despite increasing third party funding of universities, interviewee 14 emphasized the need for a stable level of basic funding for universities. Otherwise, danger exists that universities compete with companies in order to acquire additional finances. There must be a clear border between basic research and application. Many politicians think that such universities do not need that much basic funding because they have the potential and track record that through projects with companies and others they can acquire the needed financial means on their own.

7.1.4 Companies not yet having contacts to universities and not being interested in building up relations

The interview serial with company representatives concludes with two interviews with representatives of companies not yet having contacts to universities and not being interested in establishing such. Interviewees 15 and 16 belong to group 8.

	Group 8	
	Interviewee no. 15	Interviewee no. 16
Yearly R&D expenditures in % of sales	Less than 1	None
Development of yearly R&D expenditures for 2006 and 2007	From 0 % to + 10 %	
Expenditures for external R&D services in % of all R&D expenditures	0	
Companies' categories	Prototype manufacturer and customized service provider	Standardized and customized service provider
Part of a group of companies?	Yes	No
Sales in Mio EUR	4	8.6
Development of turnover for 2006 and 2007	From 0 % to + 5 %	From 0 % to + 5 %
Share of products and processes newly developed or markedly improved within the last three years in % of sales	10	0.5
Export quote in %	70	0
Most important export countries in terms of sales	Slovenia, Poland and Russia	
No. of employees	23	48
Share of university graduates in % of all employees	10	0

Share of graduates from universities of technology in % of all university graduates	100	
Strategies	Quality leadership and niche strategy	Quality leadership
Respondent's almer mater	Graz University of Technology	None
Current position at company	CEO	CEO

Table 40: Characteristics of interviewees 15 and 16

7.1.4.1 Why do you not want to do technology transfer?

Interviewee 15 stated as reason for the company not being interested in technology transfer that currently problems can be solved with internal capacities. Therefore, external R&D partnerships are not necessary. The industrial sector of the company does not face trends like knowledge based products and services as well as the necessity for collaborations with i.e. universities. It is mainly a competition via costs. In the past, other companies have tried to justify higher prices with new innovative products but they failed. The company is active in B2B where low investment costs and reliability of products are valued highly. Usually only the investment costs are important and not the life cycle costs because parties, which invest, and the ones running the machinery are not the same.

The company of interviewee 16 too is not engaged in external R&D partnerships. The company itself introduced business development measures around the year 2000 to ensure the future well being of the company. The respective measures already began to affect the business positively. I.e., the company decided to specialize on offering holistic solutions out of one hand to customers by subcontracting other companies. Marketing expenditures were drastically reduced because the company focuses on a small number of key customers who recommend the company by word of mouth. This approach seems to be successful. The family owned company has an above average equity ratio compared to similar companies. The organization itself is rather lean and the size is according to interviewee 16 just right to operate within this business. The company also has a rather good working atmosphere. The fluctuation of employees is low. Higher prices can be justified because of the offered quality and flexibility.

7.1.4.2 What would have to happen to do technology transfer?

Introducing new regulatory by governmental institutions could motivate the company represented by interviewee 15 to contact universities to work out solutions to meet requirements. However, in case of regional universities expertise in the company's business area is not that strong.

Interviewee 16 mentioned that if the company is asked to tender projects and encounters limits potential solutions are developed internally. The company does not actively offer new solutions to customers but responds strictly following customers' needs. The company already thought about screening externally for new developments and solutions in order to offer this actively to customers. However, this is not feasible because of the currently lean organizations. If the company would realize this activity, it would be necessary to recruit additional employees. This would increase overheads, thus decreasing profits.

7.1.5 Summary of the interviews with company representatives

Companies with expenditures for universities do technology transfer. The extent varies according to the absolute expenditures. The quantitative results and interviews show that these companies are well linked to universities. The other groups, even in case of companies with contacts to but without expenditures for universities, are not that heavily or not at all engaged in technology transfer. In case contacts exist, they are in general rather weak and centralized. These relations resemble rather supplier-customers relations than research collaborations. Thus, these companies do not really tap the knowledge available at universities. The interviews revealed the importance of technology transfer via heads by recruiting academics and enabling and facilitating personal meetings between company representatives and university researchers to discuss research possibilities and actually start projects.

7.2 Interviews with university researchers

All interviewees were asked to their current technology transfer, the history, i.e. how did it come to contacts to companies, and the future development of technology transfer out of their point of view. Additionally they were asked to indicate relevant recommendations for actions to increase and improve technology transfer.

7.2.1 University researchers with contacts to companies

This group consists of two subgroups. In total five interviews were realized, four with university researchers belonging to group 1, interviewees 1 to 4, and one interview with a university researcher belonging to the second group, interviewee 5. This university researcher was the only one being at the author's disposal for an interview.

	Group 1				Group 2
Interviewee	1	2	3	4	5
Faculty	Technical chemistry, process engineering and biotechnology	Construction engineering	Mechanical engineering and economics	Technical chemistry, process engineering and biotechnology	Construction engineering
Size of department in no. of employees	More than 20	More than 20	From 11 to 20	More than 20	From 11 to 20
Age	From 36 to 45 years	Up to 30 years	From 36 to 45 years	From 46 to 55 years	Up to 30 years
Employee category	Professor	Scientific employee in formation	Assistant	Professor	Scientific employee in formation
Academic degree		Dipl.-Ing.	Dipl.-Ing. Dr. techn.		Dipl.-Ing.
Posi ion financed by	Regular university budget	Regular university budget	Regular university budget	Regular university budget	Regular university budget
Since when do you work at the university?	2003	2002	2000	1980	2003
Working experience in companies	15 years	0 years	4 years	0 years	0.5 years
Number of different companies with which university researchers is personally in contact with per mon h	50	5	2	2	4
Time spend for teaching, basic research and collaborations with companies	60/5/35	20/10/70	50/5/45	25/45/30	50/30/20
Supportive for learning/teaching	Yes, very much/supporti ve	Yes, rather much/supporti ve	Yes, very much/supporti ve	Yes, rather much/supporti ve	Yes, very much/suppor i ve
Wanting to extent	Yes	No	Yes	Yes	No

Table 41: Characteristics of interviewees 1 to 5

7.2.1.1 Why and how did it come to contacts to companies?

Interviewee 1 is the head of the university department. The primary motivation to do technology transfer is to finance employees. The minimum financial objective is to hold currently employed third party funded university researchers and to ensure the quality of infrastructure. Contacts from the predecessor from which interviewee 1 took over the position some years ago are still used. Additionally interviewee 1 brought in new contacts from his own personal working experience. Interviewee 1 focuses strongly on technology transfer with companies from foreign countries. He is also the one usually establishing contacts to companies because the department lacks a middle management. Interviewee 1 motivates employees to publish at conferences, magazines, and scientific journals to market services and capabilities of the department and to acquire new company partners. He too is active in different associations at European level in order to open doors to participate in EU projects. New entries at the department are usually integrated quickly in projects with companies and learn from their more experienced colleagues.

Colleagues introduced interviewee 2 to technology transfer. Already two weeks after starting working at the department, the person had the first small project with a company. Collaborations with companies at the department are common. Now at the end of the four year contract the person has finally acquired an own company partner by actively approaching it to exchange experiences regarding the area of his doctoral thesis. The department has a large network of graduates and former colleagues. Additionally the department has unique infrastructure not commonly available in industry, which additionally motivates companies and other organizations to contact the department.

Interviewee 3 acquires most of the companies for technology transfer via an association closely related to the respective university department and students wanting to realize master theses for their family owned companies. The department has a mentoring system in place where an older colleague is being put together with a younger colleague. These two people share an office, work together on projects, and make joint company visits. The department systematically documents companies' data together with tasks like who calls next and the like. Additionally the department realizes a yearly event together with other departments where chosen master theses commissioned by companies are presented. This event serves to establish new contacts and cultivate established ones.

Interviewee 4 entered the university via a basic research project and was then afterwards recruited by the department on a full time job basis paid for by regular university budget. At the time of his entry, the former head of the department did not strongly focus on technology transfer with companies. Technology transfer started when interviewee 4 was contacted directly by companies because of published research results. Many collaborations result from existing personal relations with former employees of the department and students. A plan to systematically build up technology transfer did not exist.
Interviewee 5 is a rather young university research fellow. The person entered the university in 2003. The head of the department who is finally responsible for all projects establish the majority of technology transfer. The university researcher can acquire additional projects whereby the department head usually follows the recommendations of the university researcher about whether or not to realize joint activities. According to interviewee 5, technology transfer works well because of the individual efforts of the head of the department.

7.2.1.2 How satisfying is technology transfer currently?

Interviewee 1 is very satisfied with current technology transfer out of the professional as well as organizational point of view. However, currently all research at the department is realized jointly with companies. The university researcher mentioned that it is one of the objectives to realize also research projects without companies' participation to strengthen the basic research base. The department also uses project management tools like regular project meetings to control the development of projects, which ensures the success of technology transfer.

Interviewee 2 is also satisfied with technology transfer. Remember that the majority of current technology transfer is realized with one single partner, a company active in the same research area. Besides the professional overlap, also the personal relation has developed well. The university researcher provides the company also with the possibility to present itself in front of an academic auditorium to i.e. recruit new employees and to make the company known within the university.

Interviewee 3 assessed technology transfer also beneficially regarding teaching and research. The university researcher works primarily with companies already known. The only problem is the lack of students to realize master theses.

Interviewee 4 also rates technology transfer positive. Company representatives who know the person from conferences or due his scientific publications primarily contact the university researcher. The companies are in general rather large and mainly located in Germany. Regional companies interested in the specific research area do not exist. Because of the size and research intensity of the companies, they usually directly contact interviewee 4 and do not turn to central university departments to establish necessary contacts. The university researcher focuses mainly on research projects with potential for scientific publications. Sometimes interviewee 4 realizes contractual work like tests or coaching master theses because of the interest to get to know other industrial sectors, the potential of future collaborations or to finance laboratory equipment. However, usually the university researcher does not realize projects without the option to get more into detail and to publish scientific articles.

Also the representative of group 2, interviewee 5, assessed technology transfer positive for teaching and research. Current contacts to companies enable the university researcher to realize tests and access to necessary data for research.

7.2.1.3 Is technology transfer likely to change in the future and if yes how?

Interviewee 1 wants to strengthen the basic research at the department and increasingly join European projects as partner. Therefore, the university researcher engages in various European associations to establish necessary contacts. The quantitative objective regarding technology transfer is to hold the current level of third party funded employees and infrastructure. Missing infrastructure like room space hinders an absolute increase of technology transfer.

Interviewee 2 does not have free capacities until September 2006. After September 2006, the university researcher will focus on finishing the doctoral thesis. Therefore, technology transfer will run out with September 2006.

Interviewee 3 plans to establish a pool of students to act as consultants for projects with companies. This would be similar to so-called junior enterprises. This should help to overcome the shortage of students to realize more projects with companies.

Interviewee 4 does not expect technology transfer to change. The university researcher stressed the need to ensure a certain level of finances provided by the university. In case of laboratory material and equipment, many items nowadays have to be financed by other sources than regular university budget.

Interviewee 5 currently does technology transfer with Austrian partners. Half of them are from Styria. An internationalization of technology transfer might happen by joining international project consortia. However, the university researcher does not strongly work in this direction because of limited time resources.

7.2.1.4 How could respective parties support technology transfer?

Interviewee 1 stressed central university bureaucracy. I.e., the current controlling system is too complex and blown up for universities and on the other hand misses features like the controlling of personnel efforts, i.e. hours per person per project. The university researcher also stressed the need to focus on core competencies. This would be interesting for companies and out of the university researcher's point of view, a university of technology would be especially well suited to realize such an approach. The university researcher notes such a change in case of tests. Ordinary tests are increasingly outsourced to countries, which can realize such tests more economically because of cheaper labor costs. Also the shear amount of university researchers at other research organizations makes it necessary to specialize and focus. Following the core competence approach, it is necessary to establish a suited career model at universities, which allows university researchers to stay longer than the usual four years. In addition, the change from third party funded to university funded status should be easier. The payment must increase to remain competitive. A performance dependent model, where university researchers increase their personal income if acquiring and realizing projects with companies and other organizations, could be introduced. Besides the professional know how also requirements of companies regarding service orientation and speed have to be fulfilled. The university should try to motivate university researchers to engage in interdisciplinary projects. Interviewee 1 already made bad experiences with other university departments. They either calculate extraordinary high costs or are not interested in projects with companies because of focusing on basic research. On the other hand, it has to be said that with other university departments collaborations run smoothly. The university researcher criticized the personnel costs introduced by the university, which are rather high for companies the university department works for. Such costs cannot always be realized. Even if the university researcher would have the possibility to increase third party funding from companies infrastructure is lacking and administration would increase further, making additional projects more difficult.

Interviewee 2 is quite satisfied with current services and technology transfer. The university researcher would like to further extend technology transfer but time for own research is precious. This limits possibilities to acquire new customers.

Interviewee 3 would appreciate increased awareness activities of the university by i.e. publishing ads in magazines and regional or even sectoral media. The university researcher would focus on real cases demonstrating benefits of technology transfer. Also for central university departments like industrial liaison offices increased marketing should be done. Also interviewee 3 stressed the lack of interdisciplinary research. If the university wants to act as one research institution instead of an agglomeration of university departments management should enable and facilitate interdisciplinary research. Because of the necessity of financial support for smaller companies, funding agencies should provide suited information. They should provide such information actively also for university researchers and others working in the field of technology transfer. Additionally the university researcher mentions a high workload at companies and the lack of students at the university department as barriers for increased technology transfer.

Interviewee 4 emphasized high bureaucracy at the university and companies' lack of capabilities. One beneficial service for the university researcher would be professional support in acquiring external funding for projects. Only gathering information already available online would not be sufficient. The university researcher would need support if a company proposes projects, i.e. where to submit and how to phrase the proposal. The university researcher stressed that central university departments opening up new contacts may be suited for others but not for university researchers at the interviewee's faculty. In this specific research area, companies are highly specialized and company researchers know which university researchers work in relevant fields. The university researcher collaborates strongly with German companies because regional companies active in areas interesting for interviewee 4 do not exist. The university researcher also stressed the importance of students for the scientific output of the university department. Only thanks to them performing tests and doing analyses a high scientific output is possible. Also the efforts for coaching master theses is rather high compared to other faculties. Like interviewee 3 also interviewee 4 stressed the need for more students to realize more projects. The university researcher also mentioned the rather high bureaucracy regarding projects and the need to ensure a certain level of university funding to secure basic research. Besides the necessity of research intensive companies also a suited cultural attitude was mentioned by interviewee 4, i.e. companies in the USA are more active in research and more open towards exploiting research results from universities. The university researcher is also concerned about the current technology exploitation strategy, which might be too aggressive. One of the main reasons for German companies to collaborate with interviewee 4 is such aggressive strategies in Germany.

Interviewee 5 currently works alone within his research area. Usually there is another colleague but due to personal reasons, the colleague is temporarily off the job. This situation limits chances to exchange ideas and for fruitful discussions. Also this university researcher complains about high central university bureaucracy. In addition, the support provided by central university departments is rather weak. Even with other university departments, interviewee 5 made already bad experiences. Once a vocational training course offered by another university department was booked. Even though the course fees were cheaper than in case of private companies they still were quite high. The university researcher would appreciate a centrally available documentation of university's external links in the form of university department x is in contact with company y. Thus, already existing contacts could be used to enter collaborations with companies. It would be necessary to reach a common culture at the university, where all university departments work together towards the same objectives.

7.2.2 University researchers not yet having contacts to companies but interested in building up relations and university researchers not yet having contacts to companies and not being interested in building up relations

Interviews of university researchers of group 3 and 4 are presented jointly. Unfortunately, only one interview per group could be realized because other colleagues were not at the author's disposal. Remember that these two groups are rather small compared to the groups 1 and 2. This too restricted chances for interview partners. Both interviewees were asked what they would expect from technology transfer with companies and what services could be offered by other parties to support technology transfer. Interviewee 6, group 3, was asked why the university researcher did not yet do technology transfer and interviewee 7, group 4, was asked for the reasons not being interested in doing technology transfer.

	Group 3	Group 4
Interviewee	6	7
School	Informatics	Electronic and information technology
Size of department in no. of employees	From 11 to 20	From 11 to 20
Age	Up to 30 years	More than 55 years
Employee category	Scientific employee in formation	Professor
Academic degree	DDipl.-Ing.	
Position financed by	Regular university budget	Regular university budget
Since when do you work at the university?	2004	1969
Working experience in companies	0 years	0 years

Table 42: Characteristics of interviewees 6 and 7

7.2.2.1 What hinders the start of technology transfer?

The main reason for interviewee 6 not to engage yet in technology transfer is the current funding of the university researcher by regular university budget. Therefore, it was not yet necessary to build up contacts to companies. Even if the university researcher wanted to do technology transfer, he did not have the necessary time until now. The university researcher also stated that the knowledge of how do to it was lacking, i.e. how to approach companies and which companies to approach. The university researcher was not yet asked by colleagues to join company visits or meetings. Additionally the university researcher mentioned that the research topic of the doctoral thesis is rather theoretically without immediate applications in industry.

7.2.2.2 Why is the interest in technology transfer lacking?

Interviewee 7 is very well networked with other researchers of whom the majority works at universities. Only a minor part works in research centers others than universities. One of the colleagues even has founded a private company in the respective research area. At Graz University of Technology, the university researcher is unique regarding the research topic. The university researcher stated that earlier he could have focused on other topics which are nowadays more interesting for private companies. Now it would be too late to change. According to interviewee 7, companies active in the specific area do not realize R&D and this is the major reason for the university researcher for not doing technology transfer.

7.2.2.3 What would be objectives for technology transfer?

Interviewee 6's main motivation for technology transfer are career perspectives in companies following the formation at the university or acquiring funds to have the possibility to remain at the university even after the funding by regular university budget is finished.

Interviewee 7 stressed the importance of highly scientific questions. The university researcher emphasized not to be strictly against technology transfer with companies. The decision whether or not to engage in such collaborations depends on the scientific content measured in publications. This is also the reason why the university researcher is responsible for two thirds of all publications in highly ranked journals of the university department per year.

7.2.2.4 How could respective parties support technology transfer?

Interviewee 6 identified potential support within the university department, at the university as well as within companies. Support within the university department could be provided by colleagues acting as door-openers and invite interviewee 6 to join company visits and meetings with company representatives. Furthermore, it would be positive if companies interesting for the university researcher would be presented to know more about the company landscape within the specific research area. Additionally the university department could organize events like companies' presentations or open door days, inviting companies to the university department to present current research. Centrally the university researcher mentioned services like blackboards, where companies' enquiries could be published as well as companies' presentations and open door days. Activities like open door days and companies' presentations could also be organized by companies inviting university researchers to visit the company and discuss potential research collaborations.

Interviewee 7 emphasized the need for sufficient funding of basic research. It does not make sense to build up research areas based on third party funding where if necessary all enquiries have to be taken to guarantee sufficient money for research. On the other hand is it difficult to quickly recruit suited staff in case of collaborative research proposals. Basic funding should provide the poss bility to establish and run research and to have staff at hand in case collaborations are about to start. Such university researchers could also act as anchor for the research topic and keep developing the research area. The university researcher would also welcome efforts from others in establishing and developing contacts to companies, which do research

at a comparable level. The university researcher expects companies to be willing to engage in basic research. One of the major problems is the need for high competitive salaries. In case of graduates from universities of technology, starting salaries are already quite high and it is difficult to increase the number of i.e. doctoral students or female university researchers without paying competitive salaries. It also takes long until one knows whether a project proposal is approved or not. In the meantime, staff has to be paid for by other sources. Therefore, it is necessary to start very early to plan for such situations.

7.3 Summary of interviews with university researchers

The majority of university researchers already have contacts to companies. The extent varies widely. University researchers not yet having contacts to companies but being interested in building up such relations are usually younger. Doing technology transfer was not yet necessary for them. University researchers not yet having contacts to companies and not being interested in building up such relations argue that companies do not do basic research; technology transfer would not meet requirements of these university researchers. The interviews reveal that differences in potential support services not only depend on the age of university researchers but also their research area and their objectives. Many arguments touch central university bureaucracy, companies' R&D capabilities, and the facilitation of interdisciplinary research at the university.

8 Recommendations for actions

The following chapter summarizes recommendations for actions for the previously defined groups of companies and university researchers. These proposals also include suggestions, which organization should primarily drive these actions. The following chapters start with a summary of suggestions important for a major part or even all survey participants and then go deeper into detail for the different groups.

8.1 Companies

All companies wish for more and better information about research and possibilities of collaborations. However, different R&D strengths call for different approaches in communicating R&D competencies of universities. High export quotes have a similar influence on technology transfer l ke carrying out R&D. Companies with higher export quotes are more likely to have expenditures for universities. They usually also have contacts to or collaborations with universities outside their home region. This results in the high importance of research excellence at universities for these companies. Throughout all groups of companies, personal relations to university researchers are important. This shows the necessity to realize events where company representatives can meet university researchers personally and vice versa. There should also be room for informal meetings. Especially companies with expenditures for universities often approach university researchers actively. Nevertheless, university researchers also frequently approach them. In comparison with companies with expenditures for universities, university researchers rarely approach companies without expenditures for universities. Recruiting academics is one of the most important means to start technology transfer. In the interviews employment of university graduates was mentioned as important to establish contacts to universities. Companies also have to be aware that they must prepare themselves for technology transfer. Management support as well as a distribution of contacts to university researchers on various employees within the company are important issues in this regard.

8.1.1 Companies with expenditures for universities: Group 1

Companies of group 1 are supposed to be of major interest for university researchers because of their resources for universities and their R&D capabilities, which make them interesting out of a scientific point of view. In general, these companies do not seem to need support in establishing contacts to universities. They do not need to be

motivated to use external knowledge providers. They are well aware of possibilities and benefits provided by technology transfer. Intermediaries are only of importance for some of the smaller companies of this group, which are not yet that known at the campus. Research near intermediaries could play a role in designing new products and services and realize them with the support of university management. Especially the areas of interdisciplinary research and setting up poss bilities to meet each other would be suited for central technology transfer units at universities. Other intermediaries do not seem to be that important because of their loose links to universities. The area of master contracts and IPRs are also an issue of universities. Especially in cases where governments already set up laws how such issues at universities should be handled. Central university departments dealing with legal issues, technology exploitation and transfer should work out suited contracts and rules regarding these issues and ensure the use within the university. Companies of group 1 already have links to universities outside their home region. Universities should be aware that they have to offer high quality support and research in order to attract these companies. Otherwise, they are likely to turn to other universities and research centers, which can better satisfy their needs.

Companies of group 1 stated following need for support in the questionnaire:

Universities actively approaching companies (i.e. realizing events and presentations, projects for individual sectors), better presenting current research projects and possibilities to collaborate (i.e. standardized information exchange) and asking companies for current research questions (N=5)
Comparable contracts and standards for master and doctoral theses. Master contracts for collaborations. Clear rules regarding IPRs. (N=5)
Higher and less bureaucratic funding of R&D, which are contracted to universities (N=3)
Studies are often more welcomed than actually realizing research results. Not working on every question in form of doctoral theses because it prolongs the project duration. (N=3)
Interest of single university departments are too important (this leads to problems in doing interdisciplinary research). A more entrepreneurial hinking necessary. (N=2)
Personal contacts for small and medium sized companies at universities are necessary. Otherwise projects are unlikely to be realized (N=2)
Strategic collaborations (i.e. to build up employees) (N=2)
Focusing on research areas, which are realized continuously without the need for funding from companies
Setting up praxis semesters for students
University departments do not understand the way of working in small and medium sized companies.

Table 43: Need for support mentioned by companies of group 1

As is shown by the answers especially presenting research projects, results and possibilities to collaborate, standardized contracts and clear rules for IPRs are asked for by companies. Some also stated the need to build up professional areas at universities interesting to them.

The interviews with two company representatives of group 1 showed following needs for support: (1) Providing possibilities to establish personal relations and to present current research, i.e. events, fairs. (2) Increasing motivation of university researchers to show potential applications of their research. (3) Supporting employment of graduates from regional universities. (4) Project managers at universities for projects with companies. (5) Awareness that also companies have to take their turn in enabling and facilitating technology transfer.

The results show that even though these companies are R&D intensive and experienced in technology transfer potential for improvements exists. If university researchers approach these companies, the capabilities in developing new and improving existing products and processes should be emphasized. These two motives are of major importance for companies belonging to group 1. The most important barrier is *Universities are passive in providing information and presenting their research results and possibilities to collaborate*. Companies expect universities to become more active in providing information about current research projects and possibilities to collaborate. Communication does not only include suited brochures and web sites but also events where companies can directly establish contacts with university researchers and vice versa. Considering the strong R&D capabilities of these companies such events should be rather specific and provide detailed overviews of current research done at the university. It seems also important to consider suited follow up activities to ensure sustained results.

Equally important to the need for better information is the wish for master contracts and clear rules regarding IPRs. This is not surprisingly considering that the majority of companies of group 1 commission a rather high number of master and doctoral theses and realize a rather high number of R&D projects with university researchers. Master contracts are supposed to speed up negotiations and clear rules regarding IPRs give companies the safety about further steps regarding exploitations[33]. Companies also wish to play a role in defining research questions to be worked on at universities. This is reasonable because in general companies of group 1 are strong in R&D. Companies also stated the need for higher funding of projects with universities. This might be because such projects frequently deal with basic research issues where success in terms of new products or processes for companies is not necessarily guaranteed. In case of funding companies also emphasized the need for less bureaucracy. In some cases, companies also criticized the excessive use of doctoral theses to solve research questions. According to the companies, doctoral

[33] Note that Austrian universities are entitled to patent inventions made by their employees only since the beginning of 2004. At the time of the questionnaire the set up of agreements and rules regarding IPRs was still underway.

theses are too time consuming for companies' setting. Out of the view of universities, doctoral theses are a major instrument to ensure the university's research performance and such theses are appropriate to fund young university researchers for a given number of years.

Also the lack of interdisciplinary research was mentioned. Currently benefits of technology transfer are closely associated to single university departments. Technology transfer with more than one university departments seem rather the exception than the norm. University management should introduce measures to enable and facilitate interdisciplinary projects to ensure that universities can support companies in the best way.

Especially for smaller companies, even though R&D intensive, specific support seems necessary. Unlike their better-known and larger counterparts, smaller companies feel disadvantaged regarding technology transfer. These companies complain about university researchers not understanding the way how they have to operate and emphasized that without personal contacts projects would not be realized. Because of competition in technology transfer in case demand exceeds offers university researchers can choose with whom to collaborate. In such cases companies are selected which best suit the motivation of university researchers. In cases where offers exceed demand, it is unlikely that such situations arise. In the first case, where demand exceeds offers it might be the case that additional capacities at universities are not available or that university researchers are not in the need to do technology transfer. In such cases, it might be most likely that projects with better-known and larger companies are preferred to projects with small and medium sized companies. In such cases a university wide installed quality management system taking into account technology transfer issues could lead to improvements. Thus, university researchers would be forced to answer and document such enquiries independently from the size of companies. Such activities would bring forward more transparency.

In addition, strategic collaborations and praxis semesters for students to i.e. build up future employees were mentioned[34]. With the help of such activities, it is supposed that students would be even better prepared for their work after graduation. Out of the view of technology transfer, praxis semesters could also be used to acquire new technology transfer partners and to strengthen ties with existing ones. Strategic collaborations could be understood as the need to more closely determining common

[34] In case of praxis semesters the discussion already started at Graz University of Technology. The start date is not yet determined.

areas of interest between university departments and companies. The benefits of strategic collaborations for university departments are the usual longer durations, benefits for companies would be the long-term support by university researchers in basic research issues with potential impact for the companies' business. Such technology transfer means could be designed by central university departments like technology transfer offices, especially in the case where more than one university department is involved. University management should also think about ways to motivate university researchers to display their research results. Usually this is not seen as one of the tasks of university researchers. However, without their involvement efforts to increase technology transfer will fail. Interviews showed the importance of university graduates in establishing links between companies and universities[35].

Besides possibilities of universities to support companies of group 1 in doing technology transfer, also companies are aware that they have to do their share in technology transfer. Many of the large internationally active companies already have special departments dealing with technology transfer issues. Thus, they try to optimize their efforts. However, not only large companies are aware of such issues also smaller ones know that technology transfer depends on efforts of both sides.

Finally yet importantly also the issue of funding for university research areas was mentioned. It seems important that universities have the necessary public funds to do research in areas even where companies are not willing or able to pay for research. It should be secured that research is done even without companies paying for it. This is clearly addressed to governments but also to university management ultimately responsible for distributing the budget. This requires a transparent and objective system to assess the strengths and weaknesses of universities by considering threats and opportunities imposed by the environment.

8.1.2 Companies with expenditures for universities: Group 2

Companies of group 2 are usually smaller than companies of group 1 and even though they still are R&D intensive a gap between these two groups exists. Motives and barriers are different, thus resulting in different need for support services. The motivation of universities to collaborate with these companies might already be lower compared to companies of group 1. Because of their smaller size and their limited visibility, such references do not account for that much as their larger counterparts.

[35] Currently efforts at Austrian universities are underway to establish and keep in contact with alumni and to work with them for i e. life long learning and technology transfer.

Still, expenditures for external research organizations are substantial. Even though also these companies have contacts to universities outside their home region, regional universities are supposed to be of major importance to them. Therefore, universities acting professionally in favor of these companies are supposed to be in advantage compared to universities located farther away. Again, these companies do not seem to need special support in getting in contact with universities. However, technology transfer managed based on the principles of key account management should support companies' efforts to set up and realize projects with university researchers. This would counteract barriers like the perceived skeptical attitude of university researchers. They could also be invited to take part in lectures and seminars to gain better visibility, thus making students aware of these companies located right in their region. For these companies also support in identifying and applying for suited funding instruments should be provided. This can be done either directly by single university researchers or together with research near intermediaries or regional or national funding agencies. Even though companies of group 2 still have expenditures for universities and want to further increase these expenditures the competition by universities for these companies is supposed to be weaker than for companies of group 1, which are in general better known internationally and therefore interesting also for other universities.

Companies of group 2 stated following need for support in the questionnaire:

Competent personnel at universities
Funding and support in applying for funds
Focusing on deliverables
Easier access to university students for master theses

Table 44: Need for support mentioned by companies of group 2

Interviews with two representatives of companies from group 2 showed the following needs for support: (1) Emphasizing what universities can do and what they cannot, i.e. research vs. preparing production. (2) Providing possibilities for informal meetings. (3) Setting up and providing information about suited funding instruments.

Unlike group 1 group 2 consists mainly of smaller companies. Even though these companies still are R&D intensive and have expenditures for universities, they are rather different from companies of group 1 regarding technology transfer. The different size classes could explain some of the differences. If one supposes that smaller companies are in general less known than larger companies, regionally, nationally and internationally, the higher importance of the barrier *University*

researchers are rather skeptical towards collaborations with companies and motive *Access to new customers and markets* seems reasonable. As already mentioned in certain situations university researchers are likely to prefer larger companies to smaller ones. Gaining access to new customers and markets is in general seen as rather unimportant compared to other motives. However, companies of group 2 assess this motive as rather important. The smaller size and thus limited visibility are likely to make it necessary to use references like universities to acquire new customers and successfully enter new markets.

One area for improvement is related to funding. Companies wish an active participation of university researchers in identifying suited funding possibilities and in applying for these funds. Such support could be delivered directly by university researchers but also being supported by central university departments[36] or even private consultants.

Two other statements refer to the need for competent personnel at universities and the need to focus on deliverables. In case of the first statement, it is not clear what led to this statement. Research and the outcome of collaborations depend heavily on university researchers and companies. It might be that bad personal experiences or collaborations with i.e. university researchers at the time of collaboration not yet being expert in this field caused such statements. In case of the second statement regarding deliverables, the relation to statements made by companies of group 1 are obvious. Also these companies mentioned that university researchers are happier with doing studies than actually applying their research in practice. This discussion mirrors the differences between research and development and traditional tasks of universities and companies.

One company also mentioned the need of easier access to university students for master theses. Smaller companies are likely to be disadvantaged compared to their larger counterparts. In situations with a general shortage of students for master theses commissioned by companies, the bottleneck is more likely to painfully hit smaller companies than larger ones.

Interviews identified additional areas for improvements out of the sight of two companies belonging to group 2. The areas are related to communication, formal and informal, and funding. The two representatives of companies stressed the need for clear communication of universities' strengths and weaknesses as frame for

[36] Recently Graz University of Technology introduced such centrally provided consultation services for university researchers.

companies what could be realized and what should better be done with other partners than universities. Also the need for possibilities to meet each other on informal occasions was mentioned. During i.e. business meetings, people usually stick rather straight to the agenda. Such meetings leave little place for discussions besides the current professional topics. In case of informal meetings, other kind of information is exchanged. This might lead to new ideas for collaborations or at least to a better understanding of the needs of each other and thus to better relations.

Also the need for suited funding instruments was mentioned. This again is the task of governments and funding agencies dealing with such enquiries. Companies of group 2 should be supported in gaining better awareness at the campus. Even though they have expenditures for universities, they still have the handicap of being rather unknown. By providing possibilities for these companies to become known within universities and students these companies might overcome one of their most important barriers, *University researchers are rather skeptical towards collaborations with companies*. Suited communication measures emphasizing poss bilities and strengths of universities should further motivate these companies in choosing universities for the right tasks and thus increasing the success of technology transfer.

8.1.3 Companies without expenditures for but with contacts to universities: Group 3

In general, these companies perform R&D, not continuously like companies of group 1 or 2 but at least rarely. Their expenditures for R&D and for external R&D services are already rather small compared to companies of group 1 and 2. These companies have contacts to universities but these contacts do not lead to expenditures. The companies seem to be rather skeptical towards benefits due to technology transfer. The current situation for these companies seems to be satisfying. Therefore, the need to collaborate and use existing knowledge at universities is not yet necessary. In such cases, companies must define their objectives and areas of interest before actually establishing collaborations with universities. Regional universities are of major importance for these companies. Unlike the previous two groups, this group does not focus on research excellence but on short geographic distances. Out of the view of single university researchers, these companies are not of high interest because of their rather small R&D expenditures, their inexperience in collaborating with universities and thus the resulting high efforts to initiate technology transfer projects. Assuming that these companies would have the potential to collaborate and that technology transfer could be beneficial, regional governments could be interested in facilitating collaborations between companies of group 3 and universities. Governments could collaborate with intermediaries and funding

agencies to enable and facilitate meetings between companies and university researchers or technology transfer officers. These companies should be addressed personally to increase the awareness of benefits due to technology transfer. The companies are aware of possibilities but lack the last step towards technology transfer. Due to the importance of initial successful collaborations, companies should be supported during the first projects.

Companies of group 3 stated following needs for support in the questionnaire:

More transparency of qualification and content of studies (N=3)
Comparable contracts (with professional cost structure and standards to enable first steps, in case of success possibility of larger projects) (N=3)
Financial support for research (collaborations) (N=2)
Balancing different needs and processes (N=2)
Professional project and funding management (N=2)
Up to date information (i.e. current doctoral theses and potential research questions, innovation reports, contact addresses for more information) (N=2)
Establishing a pool where competencies of students are listed (similar to CVs)
Enabling and facilitating strategic collaborations
Ac ive company visits done by universities to check potential for collaborations together with companies' managers
Concrete projects
Enabling and facilitating interdisciplinary research

Table 45: Need for support mentioned by companies of group 3

During the interviews following additional support services were identified: (1) Ensuring confidentiality. (2) Ensuring that university researchers do not leave projects because of i.e. teaching. (3) Promoting projects with smaller companies. (4) Defining standards for i.e. giving feedback and introducing project management. (5) Realizing regular informal events at university departments to establish contacts. (6) Providing information material like i.e. brochures.

Like their counterparts belonging to group 1 companies of group 3 emphasized the barriers *Universities are passive in providing information and presenting their research results and possibilities to collaborate* and *Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)*. Also the most important motives are similar, namely the development of new products and processes and the improvement of existing products and processes. Approaching companies, which do not yet have expenditures for but contacts to universities, should be done by emphasizing ways to overcome these barriers and capabilities of universities regarding the development and improvement of products and processes. However, additional mentioned needs for support show differences between companies of

group 1 and 3. Companies of group 3 need an approach for technology transfer, which focuses rather on the set up and initial development of technology transfer.

Like other groups, also companies of group 3 wished for better communication. Examples are i.e. qualifications, contents of studies, current possibilities for collaborations and information about current master and doctoral theses. However, even though this group wants to better informed about current research it should be different than the one provided for companies of group 1 and 2. Companies of group 3 are supposed to need more general information than companies with expenditures for universities. This is also indicated by mentioned needs for support like universities actively approaching companies and information regarding explicit entry points and contact addresses at universities. Companies also ask for contracts with transparent cost structures and support in funding.

Companies without expenditures for but with contacts to universities seem to be skeptical towards engaging more in depth with universities. Clear and transparent projects, support in acquiring funding and professional project management is supposed to facilitate companies in upgrading technology transfer. These activities are primarily tasks of universities and partly funding agencies. Other suggestions are related to strategic collaborations, facilitating interdisciplinary research and establishing a pool of students with their competencies.

The two interviews revealed additional need for support like ensuring confidentiality, promoting projects with smaller companies, introducing standards and realizing events with the possibility to meet each other on a rather informal base. Again, this shows the possibilities for new means to establish contacts. Central university offices could support university departments in designing and realizing such events as well as work out standards for technology transfer.

8.1.4 Companies without expenditures for but with contacts to universities: Group 4

Because of the rather small size of companies of group 4 and their inexperience in technology transfer contacts to university researchers are rather centralized. In general, this group is comparable to group 3. The major difference is the on average smaller size of the company and the even smaller R&D expenditures. The recommendations for companies of group 4 are similar to the ones for companies of group 3, emphasizing even more direct company visits, and possibilities for additional external funding.

Companies of group 4 did not mention any possible need for support during the questionnaire. During the interviews, following support services were identified: (1) Universities actively approaching companies. (2) Support if applying for funding. (3) Transparently displaying needs and offers of universities. Companies belonging to group 4 wish for universities actively approaching companies to identify potential areas for collaborations. In case of overlapping areas also support in applying for funding would be helpful. Again suited communication measures would be helpful to transparently display universities strengths and services.

8.1.5 Companies not yet having contacts to universities but interested in building up relations: Group 5

Like companies of group 3 and 4, also companies of group 5 are supposed to be relatively uninteresting for individual actions of university researchers. These companies are not R&D intensive, they are not having many academics, little export shares and a small share of newly developed or markedly improved products and processes. Therefore, they operate in areas often uninteresting for university researchers. If these companies should be motivated to do technology transfer with universities one cannot hope that university researchers will do this out of their own interest. Therefore, other parties would have to take in the lead. In case of these companies, it seems important to support them in upgrading their internal knowledge base by i.e. recruiting academics prior to engage in technology transfer. In such cases, it is recommended that intermediaries closely work together with funding agencies to provide synthesized solutions. For these companies especially industry near intermediaries are supposed to play a major role. It is likely that industry near intermediaries have better links to these companies and could support technology transfer with universities by establishing contacts if needed. For companies of group 6 and 7 the same measures seem to be suited. Even though they differ from each other by i.e. the size measured in employees and their R&D intensity the groups have similar needs. Because of their general skepticism towards universities, they should be contacted by organizations with which they are used to be in contact like industrial chambers or chambers of commerce. In case of necessity, they could establish contacts to university researchers or technology transfer officers.

Companies of group 5 stated following need for support in the questionnaire:

Clearly defining financing of collaborations (smaller companies cannot carry these costs additionally to their own costs)
Long-term collaborations are hard to realize
Enabling and facilitating the establishment of contacts
Enabling interdisciplinary research projects
Regional collaboration days in collaboration with start up and technology centers
Enabling and facilitating technological developments

Table 46: Need of support mentioned by companies of group 5

Interviews revealed following support needs: (1) University researchers and students actively approaching universities. (2) Interest and competence in specific research areas. (3) Better information about research areas at universities and their services, i.e. open doors. (4) Information about suited funding instruments. (5) Professionalizing services, i.e. accessibility of libraries.

Companies not yet having contacts to universities but being interested in establishing such relations are concerned about giving away their knowledge to companies also collaborating with universities. Universities have to react to these concerns and apply industry standards like material transfer agreements. The second most important barrier, *Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)*, is reasonable. Companies with little R&D capabilities are unlikely to have necessary competencies to fully exploit universities' knowledge. Such companies have to be supported to fully exploit technology transfer benefits. University researchers have to consider this in case of projects. Such companies should be supported in upgrading their internal R&D competencies by i.e. recruiting academics.

The companies are also afraid of the costs they would face in case of collaborations. Especially for smaller companies it is hard to finance additional costs for universities. Additionally companies wish for presentations of technological developments, facilitation of interdisciplinary projects, long-term collaborations, and possibilities to make contacts with university researchers. Especially the need for interdisciplinary and long-term projects is somewhat surprisingly. Remember that these companies do not yet have contacts to universities. Thus, these companies can only have heard by word of mouth that other companies had difficulties regarding these issues. Possibilities to make contacts with university researchers can be realized by i.e. active company visits, regional collaborations days, open door events and targeted marketing measures.

Overlapping areas of interest and competencies are necessary to increase motivation of companies to make use of universities' knowledge. Like other companies, also companies of group 5 would like to be better informed about suited funding instruments. One of the interviewed company representatives criticized the bad accessibility of libraries. This shows the need to professionalize all areas of interest for companies to fully exploit technology transfer.

8.1.6 Companies not yet having contacts to universities but interested in building up relations: Group 6

Companies of group 6 are the first ones assessing the barrier *Difficulties in finding the right contacts* on average most important followed by the passive attitude of universities. This is emphasized by the wish for better and more information regarding research and collaboration possibilities. Companies of group 6 are also self-critical. They are aware that they have to define objectives for collaborations for universities and to provide stimuli for universities, which can then be taken in by university researchers for further developments.

Companies of group 6 stated following needs for support in the questionnaire:

Better and more information about activities at universities, i.e. establishing a platform with transparent offers at universities. (N=4)
Specific research support like market research and produc ion site analysis

Table 47: Need for support mentioned by companies of group 6

The interviews revealed the following additional support needs: (1) Companies working out objectives for collaborations with universities. (2) Impulses from companies for university researchers and university researchers reacting to impulses from companies. (3) Funding recommendations provided by university researchers. (4) Transparency of offers.

8.1.7 Companies not yet having contacts to universities but interested in building up relations: Group 7

Companies of group 7 are similar to companies of group 6. These companies again have difficulties with finding the right contacts at universities and wish for better presentations of research at universities and possibilities to collaborate. As a result, companies would l ke university researchers actively approaching them to present relevant research and possibilities for technology transfer. However, companies are

aware that they too have to contr bute to technology transfer by i.e. providing management support. These companies are also open to actions introduced by governments and funding agencies emphasizing collaborative research projects. The likelihood of technology transfer increases with existing personal relations, which stresses amongst others the need to establish and keep in contact with alumni. Even though technology transfer is assessed as important, universities should still get sufficient funding for basic research. Companies of group 7 did not emphasize this because of their need for basic research knowledge but the fear that university departments might enter competition with private companies to acquire third party funds. The lack of practical knowledge of assistants was mentioned as barrier too.

The two most important barriers for companies of group 7 are similar to the ones of group 6. Only the order has changed. The barrier *Universities are passive in providing information and presenting their research results and possibilities to collaborate* is assessed as most important followed by *Difficulties in finding the right contacts*.

Companies of group 7 stated following needs for support in the questionnaire:

Offers and research in specific sectors (N=2)
Universities actively approaching companies, not waiting until companies come to universities
Lack of practical knowledge of university assistants
Support in realizing strategic projects

Table 48: Need for support mentioned by companies of group 7

The interviews revealed following additional support needs: (1) Central entry gates. (2) Commitment of company management. (3) Strengthening contacts to alumni. (4) Governments and funding agencies emphasizing the need to collaborate. (5) Ensuring basic research funding for universities. (6) Building up personal relations.

8.1.8 Companies not yet having contacts to universities and not being interested in building up relations: Group 8

Also these companies are not a priori interesting for university researchers. These companies do litte to none R&D and have little to no experiences in doing R&D with external organizations. It does not seem to make sense to approach these companies actively to motivate them to do technology transfer. It would cost rather many efforts to bring them together with university researchers and the likelihood of success would be rather small. These companies primarily have to change their

attitude towards technology transfer and their internal knowledge base before actions should be taken.

The interviews revealed following support needs: (1) Governmental actions, i.e. by introducing limits, which lead to necessary innovations. (2) Specific research areas and competencies. (3) Customers' attitudes and industrial sector. (4) Resources to establish and realize collaborations with universities.

The interviews suggested that companies of group 8 are not strictly against technology transfer. However, they do not feel the need to get in contact with universities. Regulatory actions introduced by governments or research done at universities within their specific business areas could lead to establish contacts to relevant universities. Reasons why these companies are not interested in technology transfer are i.e. the innovation and risk adverse nature of their industrial sectors and customers and the lack of resources to establish contacts to universities.

8.2 University researchers

The results of the questionnaire show that faculty and working experience in companies influence whether university researchers have contacts to companies or not. The importance of barriers and motives for the four different groups do not differ that much as in the case of companies. Also the stated needs for support are grosso modo similar, even though differences between the different groups exist. The examination shows the potential to optimize existing and to introduce new services.

The major need for support relates to opening up contacts, marketing of the university as reliable partner for companies, consulting in funding related issues and taking over administrative tasks. University researchers not yet having contacts to companies also wish to be introduced to technology transfer, i.e. which companies to approach and how to actually approach companies. The following sub chapters present the results in detail.

8.2.1 University researchers with contacts to companies: Group 1

This group of university researchers is the best lever for increasing technology transfer. They are interested in increasing technology transfer and have good knowledge of companies' working routines. Possibilities to support them are manifold and could be realized by heads of their departments, central university departments like technology transfer offices, other intermediaries, companies and governments. Intermediaries could support this group by opening up new contacts to potentially interested companies. Again, intermediaries like technology transfer offices or associations focusing on specific industrial sectors could set up and realize measures to increase possibilities for direct personal contacts between university researchers and companies. Universities should support these researchers successfully doing technology transfer by diminishing their administrative duties, thus freeing some of their resources. Additionally, they could introduce payment models, where some of the acquired finances are used to increase the income of university researchers responsible for the respective acquisition. Heads of departments with researchers successfully doing technology transfer should promote and enable projects for companies together with other departments of their university by using their established contacts. Thus, they would also act as role models for other university departments. However, it is supposed that only due to a systematic approach by universities in collaboration with other external groups full benefits could be exploited.

University researchers of group 1 stated following needs for support in the questionnaire:

Additional personal resources, i e. pool to finance personnel for shorter contracts, additional resources at university departments. (N=8)
Opening up new contacts (N=8)
Marketing, i.e. realizing events, symposiums, marketing for the university and not for individual university departments. (N=7)
Better (leaner and easier) administra ion. Current system is rather inflexible. (N=3)
Better and more infrastructure, i.e. buildings, available space, equipment (N=2)
Incentives, i.e. considering technology transfer performance for career at the university or for internal benchmarks between university departments, additional personal income for university researchers acquiring and successfully realizing projects. (N=2)
Organizational and administrative support in case of large projects (N=2)
Higher budget
An industrial liaison office offering suited support.
Possibilities to finance technology transfer
Time for basic research
Vocational trainings for professional and soft skills
Support for IPRs, i.e. trademarks
Quality management
Facilitating projects wi h industrial partners and more than one university department

Table 49: Need for support mentioned by university researchers of group 1

One participant mentioned that possibilities would be limited because of existing agreements with companies regarding confidentiality. This shows the importance of negotiating agreements, which respect needs of companies by simultaneously considering the needs of university researchers. During interviews with representatives of group 1 following additional needs for support were mentioned: (1) Leaner university bureaucracy and offering support, i.e. project controlling and support in case technology transfer is extended. (2) Focusing on core competencies. (3) Incentives to do technology transfer. (4) Introducing a suited career model for university researchers. (5) Offering competitive salaries for university researchers. (6) Fulfilling industry standards regarding service orientation and speed. (7) Facilitating interdisciplinary projects. (8) Introducing realistic personnel costs per hour per university researcher. (9) Providing sufficient basic resources, i.e. infrastructure, personnel. (10) Ensuring more public awareness for universities, their services, and possibilities to collaborate. (11) Suited information of funding instruments for technology transfer and support in applying for funding. (12) Decreasing the high workload at companies. (13) More students for i.e. master theses. (14) Initiating and realizing a cultural change, which values universities and collaborations.

Similar to companies, which criticized frequently the passive attitude of university researchers, also university researchers critized the passive attitude of companies.

This is followed by the supposed high workload in companies. University researchers of group 1 did not assess technology transfer as negatively for teaching and research. They are more likely to rate too much third party funding as negatively for the university department by i.e. decreasing funding from public sources or limiting the freedom of academic research. Doing technology transfer to acquire additional financial means is of major importance. It is used to finance master and doctoral theses, employees at university departments and investments in the university department's infrastructure. Additional motives are scientific interest and technology transfer as a task of universities. This already shows the broad range why university researchers of group 1 do technology transfer.

University researchers of group 1 mentioned three recommendations for actions most often: (1) Additional resources like i.e. a pool to finance university researchers for shorter contracts. (2) Support in opening up new contacts and (3) marketing for the university, not necessarily for single university departments. Especially opening up new contacts and university wide marketing measures could be realized with the support of central university departments. Additional personnel resources for university departments are not easy to realize, especially in times of stable public funding.
Another group of support services deals with organizational and administrative issues. It is related to support in case of large projects, project controlling like i.e. documentation of personnel hours and up to date infrastructure and equipment. This includes also consultancy to apply for funding. Also incentives for technology transfer were mentioned. This could be done by distributing a share of acquired third party sums within the group of university researchers who acquired these funds and considering the performance of university researchers in acquiring third party funds for the career at the university.

Last but not least, also vocational training for professional and soft skills, support in IPRs related issues, sufficient time for basic research, a technology transfer oriented quality management system and facilitating interdisciplinary projects were mentioned. A technology transfer quality management system should consider standards common within companies regarding speed and service orientation.

One important point made by one university researchers during an interview is the core competence approach. Like companies, also universities should focus increasingly on their core competencies. This seems especially important if university departments would like to do technology transfer with companies of group 1, the ones with strong internal R&D capabilities. In order to offer these companies added

value universities have to be rather strong in their specific research areas. Closely linked to research excellence is also the need to be able to pay competitive salaries for university researchers. Otherwise, the brightest are lost to other universities or companies.

Especially in some cases, a lack of students to work on master theses exists. In such cases, more master theses could be realized for companies if a sufficient number of students were available. This calls for efforts to increase the number of students at universities of technology. This is related to a general wish for a cultural change, where issues related to sciences and technology get more awareness and are regarded within companies and society as important.

8.2.2 University researchers with contacts to companies: Group 2

Characteristics of this group of university researchers are rather similar to the ones of group 1. However, the share of researchers wanting to extend technology transfer is smaller than in group 1 even though the frequency of use of technology transfer means is on a similar level. Overall recommendations and the proposal to integrate different parties to improve technology transfer are similar to the ones of group 1 and would increase technology transfer. Nonetheless, the overall potential impact is l kely to be smaller.

University researchers of group 2 stated following needs for support in the questionnaire:

Additional personnel resources; i.e. extending technology transfer depends on adjusting the structure of the university department. An additional management level would be necessary. (N=6)
Opening up contacts, i.e. by realizing CRM. (N=4)
Funding for collaborative projects, i.e. leaner bureaucracy in case of funded projects, support by central university departments, support in applying for funding, possibilities to apply for funding. (N=4)
Marketing, i.e. specific for university department but also for university as a whole. (N=4)
Additional financial resources (i.e. capital to start with, financial support in general, better infrastructure) (N=3)
More students being interested in topics covered by the university department (N=2)
Additional personnel resources to outsource standard tasks which cost substantial amount of time
Information of similar problems in different industrial sectors

Table 50: Need for support mentioned by university researchers of group 2

The interviewed university researcher of group 2 mentioned the following needs for support: (1) Colleagues in the same research area to exchange ideas. (2) Leaner bureaucracy. (3) Introducing a more collaborative culture within the university.

(4) Centrally available documentation of existing contacts of all university departments with companies.

Barriers and motives are similar to the ones of university researchers of group 1. The order is almost the same, only the level is at least in the case of barriers different. Also university researchers of group 2 mentioned the need of support for i.e. applying for funding. Examples are leaner bureaucracy and support by central university departments. Additional resources were mentioned too. This accounts for personnel resources but also for i.e. competitive equipment and capital to start with technology transfer.

University researchers of group 2 would also appreciate if i.e. central university departments and other university departments would provide support in opening up new contacts. One way would be a central CRM system where all contacts are centrally documented and accessible. Thus, other university departments could eventually use existing contacts between university departments and companies too. University researchers of group 2 would also like to have additional resources for taking over standard administrative tasks. Central university departments could also provide such support. Again marketing for the university as a whole would be welcome. This should increase the motivation of companies to contact university researchers and it is supposed that it would increase the number of students.

Technology transfer in some cases depends also on the current structure at university departments. In some cases, it would be necessary to install a sort of middle management. This depends also on the support provided by public funding because of the need of i.e. additional personnel, additional offices, equipment, and the like. University researchers would also like to get information of potential applications of their research in industrial sectors they do not yet think of. One example is the area of computer vision. This is a cross section technology. Without good knowledge of industrial sectors, it is difficult to sort out potentially interesting applications. One university researcher mentioned also the wish to have colleagues working in the same area of research. This is important to exchange ideas and to share knowledge. This is related to the previously mentioned core competence approach. If university departments focus on their core, competencies it is more likely to have a sufficient number of university researchers working in related areas, which facilitates the sharing of ideas and experiences. Finally, the need for a more homogeneous culture at the university was mentioned. Thus, interdisciplinary projects would become easier and companies could be served more professionally.

8.2.3 University researchers not yet having contacts to companies but interested in building up relations: Group 3

Universities could support their researchers to start with technology transfer. University researchers of group 3 are mainly younger colleagues with little to no working experience in industry. They seem to have starting problems. Usually they do not yet have the need to do technology transfer to i.e. acquire additional finances. However, supporting them to start technology transfer would likely lead to positive results. One example would be presentations of examples how younger university researchers could be supported by their more experienced colleagues. Some of the university departments have a kind of mentoring system in place, which seems to work rather well. Other university departments could take over such practices and implement them for their departments. Universities should gather such examples and set up a systematic approach to be used by university departments recruiting young research fellows to support them in getting started with technology transfer.

University researchers of group 3 stated following needs for support in the questionnaire:

Systematic marketing
Opening up contacts to companies
Stimula ing interest of industry in basic research
Additional personnel
New equipment
Efficient and functioning structures at he university

Table 51: Need for support mentioned by university researchers of group 3

Only one university researcher of group 3 was interviewed because the number of university researchers of group 3 is rather small and others were not willing to act as interview partners. The interviewed university researcher of group 3 mentioned the following needs: (1) Support within the university department by colleagues, who act as door-openers and invite the interviewee to join company visits and meetings with company representatives to learn how technology transfer works. (2) Information about companies interesting to the university researcher to know more about the company landscape within the specific research area. (3) Events like companies' presentations or open door days inviting companies to present current research activities, i.e. at the university department, the university or companies. (4) Blackboards, where companies' enquiries are published.

Unlike the previously examined group of university researchers, the ones of group 3 have a rather balanced assessment of the importance of barriers. The most important one is *Companies are rather skeptical towards collaborations with universities*. Other barriers are similar to the ones already mentioned previously.

The major need of support relates to central university services, equipment, additional resources, stimulating the interest of companies in basic research, marketing, and opening up new contacts. The needs are not different from the ones already mentioned by university researchers of group 1 and 2. The interviewed university researcher of group 3 would like to have a sort of mentoring system at the university department. In some cases, such a system is already in place. Enabling and facilitating university departments to share their experiences with each other would thus be helpful to eventually realize similar activities at other university departments.

The university researcher would also appreciate an overview of the landscape of companies potentially being interested in services being provided by the university researcher. Central documentation of companies' enquiries l ke black boards and accompanying events like open doors at companies but also the university department would further facilitate technology transfer.

8.2.4 University researchers not yet having contacts to companies and not being interested in building up relations: Group 4

The group of university researchers not being interested in doing technology transfer is rather small. The interviewee stated to be open towards collaborations as long as they fulfill criteria like i.e. the necessary scientific content. The interviewee does not want to engage in projects, which are not scientifically interesting. In such cases, the interviewee together with the university and central departments could systematically search for and open up contacts to companies operating in such areas and being active in basic science issues. However, the motivation is rather small because usually these university researchers are already rather good placed within their research area and do not need to acquire additional financial means for their research area or other colleagues.

During the interview following needs for support were identified: (1) Sufficient public funding for basic research. This is necessary to keep on with research areas without the need to take on all enquiries from companies or to have university researchers at hand in case interesting enquires come in. (2) Support in establishing and developing

contacts to companies doing research at a comparable level. (3) Companies being interested in doing basic research. (4) Career model and respect for university researchers.

It is important to note that the interviewed university researcher is not a priori against technology transfer. Technology transfer has to meet specific requirements like the necessary scientific content. In such cases, it is necessary to support university researchers in establishing contacts to companies being interested in the basic research areas and not trying to push the research area versus more applied areas. Here again the need for sufficient public funding is mentioned as necessary to have university researchers working in research areas even without funding from companies. Also the career model of university researchers has to be updated to keep talented university researchers at the university. Last but not least, the performance of the university should be better communicated to society and companies to increase the awareness of achievements of university researchers.

8.3 Proposal for a technology transfer design model

The prior comments showed that actions to improve and increase technology transfer are manifold and depend on the respective target group. The potential support provided by parties others than university researchers and companies differ according to their respective objectives. Assuming that universities do technology transfer to acquire additional financial means to strengthen their scientific output they are likely to focus on the first two groups of companies. Both groups are R&D intensive, used to technology transfer and have the necessary financial means. However, especially in case of companies belonging to group 1 universities have to be aware that they are competing with other universities aiming at the same target group. Companies of the groups 3 to 7 depend more on regional universities. This is one advantage for regional universities in case they offer knowledge in the respective business areas. These Companies do not yet have expenditures for universities. In some cases, only a tiny step might be missing to turn these companies into insiders, in other cases companies might still be far away from being able to successfully exploit universities' knowledge. In these cases, regional universities are of major importance. Due to the short distances, they can act as starting points for technology transfer. However, the interest of universities is likely to be rather weak, especially in case of universities already experienced in technology transfer. Therefore, in case parties are interested to link such companies with universities they have to work out programs and support measures to realize suited activities. Choosing the right

partners and ensuring the necessary financial means and coordination is vital for such endeavors.

Companies on the other hand should ensure that they are internally capable to exploit universities' knowledge before starting technology transfer. Also the process of choosing the right university researcher should be thoroughly planned. Even though the majority of university researchers already do technology transfer differences exist. Services of intermediaries located at universities as well as recommendations by others can be helpful. Companies can also access central services for i.e. funding, master contracts and other services provided by many universities. Results show that motivation of university researchers can be rather different from individual to individual. It is necessary for companies to ensure that they consider the right mix of incentives, thus increasing chances for successful projects.

The following control loop model for technology transfer shows a possibility how to structure technology transfer independently of the organization and its objectives.

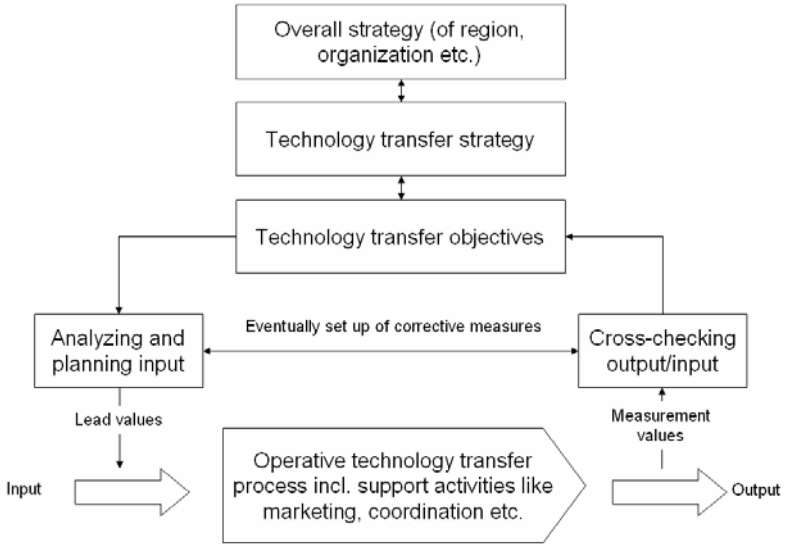

Figure 63: Control loop model for technology transfer

The control loop model shows different steps in managing technology transfer. Technology transfer comprising realizing projects, marketing activities, documentation etc. constitutes the control area. Input like knowledge and money is transformed by the operative technology transfer process in i.e. new or improved products or new competencies within companies and universities. Comparing output with the original objectives shows the need to eventually change the framework or input variables' characteristics. The overall strategy determines the strategy for technology transfer and this lays the ground for objectives. The model is suitable for single organizations but also for regions or other units of examinations. In case of examining technology transfer for a whole region it is likely that different control loops for technology transfer exist, depending on the objectives for technology transfer.

Results of the thesis provide input for the connection between organizations' or regions' overall strategy and the strategy and objectives for technology transfer, for the realization of technology transfer processes and eventual corrective measures. It is well suited to serve as starting point to set up technology transfer, to coordinate different technology transfer processes for different target groups and to manage technology transfer.

9 Technology transfer in Styria: Qualitative similarities and differences compared to other studies

The following chapter compares qualitative results obtained by questioning university researchers at Graz University of Technology and Styrian companies with the ones of the literature review, which examined technology transfer in other regions of Europe, the USA and other parts of the world. To provide the reader with a better understanding of the context, this section starts with a short overview of the general situation in Styria.

Styria, the second largest Austrian state, has a population of about 1.2 million. The main industries are automotive, mining and metallurgy, pulp and paper, environmental engineering and electronics and information and communication technology related industries. The mining and metallurgy industry is located mainly in the northern part of Styria, whereas the automotive sector is located around the city of Graz, the state capital. Styria become in the last decade one of the most R&D intensive states of Austria. In 2002, about 3.67 % of the regional GDP in Styria was spent on R&D activities – well above the Austrian average. Industry contributed the major part of the R&D expenditure. Styria has five universities and two universities of applied science. This high concentration of higher education institutions provides regional companies with a highly educated workforce. Ploder, Schleich, and Adametz[37] noted an above average number of highly qualified employees within Styrian companies. To summarize, Styria is an economically well-developed region with an average high number of small and medium sized companies and large internationally active companies. Companies are rather strong in R&D and active in traditional industries like mining but also in sectors like electronics and IT. The qualification of employees is rather good, thanks to the education system. Based on these indicators Styria is comparable to other well-developed regions in Western Europe and the USA.

The overall results do not display large differences in technology transfer in Styria compared to results of publications based on studies in other, similar industrialized countries. Most of the individually available results from studies of companies and university researchers in other parts of the world are confirmed by the results obtained by questioning Styrian companies and university researchers at Graz University of Technology. This strengthens the assumption that economically

[37] Ploder, Michael; Schleich, Michaela; Adametz, Christoph: Innovationsmonitor 2005: Endbericht [Innova ion Monitor: Final Report], September 2005

comparable regions seem to face the same challenges and have similar technology transfer patterns. In the following, the major results are exemplary summarized.

The importance of personal contacts is confirmed by the empirical results, i.e. interviews' results and the importance of working experience of university researchers and the role of academics within companies. This refers not only to possibilities for discussions regarding eventual collaborations but also to formal and informal meetings. The influence of companies' industrial sectors as measure for their knowledge intensity and therefore their need to collaborate with external partners like universities is controversial. There are statistical significant relations with single sectors like construction and regarding the categories of companies, manufacturers vs. service providers. However, the overall influence seems to be rather weak. Other characteristics like realizing R&D, export share or the qualification of employees are far more important.

Organizations as role models for technology transfer are important. Several interviewees mentioned this. They can act as motivation to actually start technology transfer. In addition, the importance of cultural issues is confirmed. Results show that especially companies inexperienced in technology transfer often have exclusively contacts to regional universities whereas experienced companies often have contacts to universities in other countries too. Technologies and their completeness influence technology transfer. This can be seen by the importance of internal R&D of companies. Remember that most of the companies engaged in technology transfer do R&D. This shows the importance of having necessary absorptive capabilities.

Companies' and universities' external factors play a role. This starts with the need for overlapping activities at universities and the need for financial support provided by funding agencies and governments and ends with legal issues regarding IPRs and the employment of researchers at universities. It seems to be important to use the right technology transfer mean. The current range of instruments seems to be satisfying for companies and university researchers except for strategic collaborations and interdisciplinary research, which was criticized by university researchers and company representatives as well. The need for specific support services for smaller companies is justified. However, results show that it is not sufficient to divide companies solely by their numbers of employees. The typology presented in this thesis is one possibility how to consider the different technology transfer stages independently of companies' numbers of employees.

Results show the different motives for university researchers and companies. It is important to consider such differences to approach partners accordingly. Especially for university researchers motivational differences should be considered because of their relative autonomy in choosing with whom to collaborate. For technology transfer to be successful one should consider different types of currencies for partners. It depends amongst others on factors like age, position at the department and sources of current payment. At universities in the USA researchers are paid for nine months, the gap has to be filled with projects financed by third parties l ke companies. In Austria, university researchers paid for by the regular university budget are similar to public servants. The need to make up part of the salary with third party projects does not exist. Still, as results show, they are heavily committed to technology transfer. In cases of university researchers paid for by third party projects the motivation exists to engage in such projects. Companies too are motivated by a variety of different motives. I.e., technology transfer experienced R&D intensive companies value the excellence of research highly whereby for companies inexperienced in technology transfer short distances to universities are important. Contacts to companies for a latter career in industry are more often important for younger university researchers than for older ones. Gaining additional financial means to finance the own job is rated rather unimportant by university researchers except the ones aged from 31 to 35 years. This group contains the majority of third party funded university researchers participating in this study.

To learn how to exploit ideas from universities seems to be important. This is supported by a high qualification of companies' employees. Being an academic helps in getting in contact with university researchers and to discuss potential areas of interest because of the knowledge how universities work. Interviews confirmed the importance of knowing strengths and weaknesses of universities. Many of the companies, especially the more experienced ones, know these strengths and weaknesses and choose partners accordingly. Inexperienced companies approach universities, initiate projects, and are disappointed afterwards because outcomes are different than expected.

Especially the pressure provided by the daily business seems to be a major barrier on side of companies. This was valued highly important by university researchers. Engineering and consulting companies mentioned potential conflicts of interest at universities. They fear that universities by being forced to turn even more to companies for additional finances could become competitors. Due to the availability of students, universities can offer cheap but qualitative services, thus competing with unfair means. Both groups, university researchers and company representatives,

stated the need to enable and facilitate interdisciplinary projects. This concerns not only collaborations between departments of different universities but also within one university. Management support, clear objectives, and measurement systems were initially supposed to positively influence technology transfer. Results show that management support is usually provided and it is perceived as critical. I.e., one interviewee mentioned that if the management would support technology transfer it would take place. Measurement systems are not frequently used in practice. Companies seem to rely more on their guts feeling than on objective measurable criteria.

Results of the study show that the size of university departments does not greatly influence technology transfer. Some dependencies exist in case of i.e. frequency of use of specific technology transfer means. However, the overall influence of the departments' size does not seem to play a major role. Blume and Fromm[5] showed in their technology transfer study that 30 % of companies not having contacts to the university were interested in establishing such. The results for Styria show that more than 60 % of the companies not yet having contacts to universities are interested in establishing such. Reasons can be manifold, i.e. different dates studies were realized and changing attitude of companies over time, different examined company landscape, or different development situation of technology transfer in the two regions. University researchers' working experience in industry seems to be of major influence. University researchers with working experience in companies are more likely to do technology transfer. It is supposed that due to their working experience they have a better understanding of companies' working routines and are better in offering companies suited support.

Especially important are companies' internal R&D capabilities. Results show that companies without own R&D capabilities usually do not do technology transfer. Reasons might be the necessary adsorptive capabilities and the knowledge to understand potential impact of universities' research on the own business. This is underlined by the need of highly qualified employees, academics, who know how universities work and take with them their contacts from their universities. This clearly points out the limits of outsourcing R&D to universities. Universities' research can be used complementary to companies' research, but it will not substitute companies' research. This is also being expressed in the high share of newly or markedly improved products and services on sales of companies doing technology transfer. The resulting high export share is a result of continuous R&D activities and the innovativeness of these companies.

Manufacturers still have more frequently contacts to or expenditures for universities than service providers. However, the gap is closing. Service providers are often interested in building up contacts to universities. Especially companies active in the construction sector are reluctant to do technology transfer. The study revealed that more than two thirds do not do technology transfer. Interestingly, even though not strongly marked, companies founded after 1992 are more likely to do technology transfer than their counterparts founded earlier. Reasons might be that management of younger companies is more open towards collaborations because of changing circumstances. Winning a company as regular customer is not an easy task for university researchers. Results show that two thirds of companies have contacts to up to four different university departments. Taking into consideration that in general companies have contacts to more than one university contacts per university are rather limited. Especially in case of R&D intensive companies, research excellence is the most important reason to establish contacts to specific university departments, independently of the location of the university.

The longer companies already are in contact with universities the higher are absolute R&D expenditures for universities. The study also shows that only three of 51 companies want to decrease expenditures for universities. The rest will increase this share or hold it stable. Companies with currently high expenditures for universities want to hold them rather on the current level; the ones with currently small expenditures rather want to increase them. The amount of expenditures depends also on the motives, i.e. wanting to build up competencies likely leads to higher expenditures. The majority of expenditures for universities companies invest in collaborative R&D projects followed by bachelor and master theses and contract research projects. This again shows the rather strong R&D capabilities of companies doing technology transfer. The frequency of use of the respective technology transfer means relates logically to i.e. the location of the university companies collaborate with or companies' strategies.

For university researchers technology transfer is rather standard than exception. Even though the belonging to specific faculties slightly influences the rate of technology transfer differences are rather small. Interestingly the source of finances university researchers are paid for is not decisive whether or not university researchers do technology transfer. There are differences but they are not big. One reason might be that usually department heads paid for by the regular university budget are responsible for collaborations with third parties at the university departments. Thus, they are often actively involved in technology transfer due to their

existing contacts. The extent and intensity of technology transfer is therefore comparable to university researchers paid for by industry.

One of the major reasons to do technology transfer and to increase such activities are the perceived benefits provided for university researchers' teaching and research activities. University researchers learning from collaborations with companies for their teaching and research activities are more l kely to want to extend their collaborations. In total about 75 % of university researchers assess technology transfer as beneficial for their teaching and research activities. University researchers judging technology transfer as positive for their own research have twice as many contacts to companies per month than colleagues assessing collaborations as hindering their own research activities. Interesting differences can be noted by comparing the answers regarding benefits for teaching and learning with the three different personnel categories professors, assistants and project employees and scientific employees in formation. The group of professors in general state that they do not learn from their collaborations with companies for their teaching. The two other groups indicated far more often to learn from their collaborations with companies for their teaching. Regarding research the picture changes. Now professors answered most often to perceive collaborations with companies as supportive for their own research followed by assistants and the group of scientific employees in formation, project, and third party funded employees. Also the location of companies university researchers collaborate with seems to have an influence. University researchers learning from their collaborations with companies for their teaching activities collaborate above average often with Styrian companies. Thus, there seems to be a link between learning for teaching and the geographic origin of collaboration partners. The closer the companies' location the higher the chances those university researchers get new input for their teaching. The decision whether or not to extend technology transfer does not depend on the current number of contacts to companies per month and not on the amount of time spend for technology transfer.

The average time spend for collaborations with companies amounts to 38.5 %, the median value is 30 %. Compared to the two other major tasks of university researchers, doing basic research and teaching students, time spend for collaborations with companies is on a similar level. The examination for the three time categories teaching, basic research, and collaborations with companies shows that university researchers paid for by regular university budget almost exclusively perform teaching. The two other groups have a rather limited time budget for teaching. The examination supports the suspicion that the geographic origin of companies university researchers collaborate with influences their preference of

specific technology transfer means. University researchers having more frequently projects with companies in Germany or Switzerland use coaching doctoral theses commissioned by companies more frequently. The same accounts for collaborative research projects and companies in Austria except Styria. University researchers having more frequently projects with Styrian companies more frequently coach bachelor or master theses commissioned by companies. This is in line with the results that especially smaller inexperienced companies often have their first-time contacts with regional universities and depend on financially smaller projects like bachelor and master theses.

10 Discussion and further need for research

The results regarding recommendations for actions for the different groups of companies and university researchers can help companies, university researchers and others working in the area of technology transfer to further increase and improve technology transfer. Setting up recommendations of actions was the main objective of this thesis. The present results can also be used to i.e. single out specific target groups interesting for universities or organizations working on behalf of the development of regional development. Still, the recommendations are not as detailed as needed to be realized without major efforts. Further research is necessary to detail suited support services. Such an examination regarding operational details was beyond the scope of this thesis. In case specific target groups are singled out, it is recommended to specify support services based on the herein presented recommendations with the help of interviews, workshops, or pilot projects.

Further research could also be done in technology transfer in regions with other economic circumstances and professional areas. For this thesis a wide variety of industrial sectors were considered, on side of university researchers only the ones working at Graz University of Technology. A study for other types of universities and geographic regions with other economic framework would shed additional light on the influence of regions and research areas on technology transfer. However, the results of this thesis show that Styria is qualitatively comparable with other, similar developed regions.

The results also show that out of the view of single companies and individual university researcher technology transfer is dynamic. Companies and university researchers build up knowledge and experience in technology transfer. Such developments have to be accounted for by i.e. providing continuous suited support. In such cases, it is necessary that companies and university researchers are accompanied continuously and support services take into account the accumulated knowledge and experiences.

References

ABRAMSON, N. H.; ENCARNACAO, J.; REID, P. P.; SCHMOCH, Ulrich (Eds.): Technology Transfer Systems in the United States and Germany: Lessons and Perspectives, Washington DC 1997

ADAMETZ, Christoph; GRUBER, Markus; PLODER, Michael: Innovationsmonitor Steiermark 2004 Endbericht [Innovation Monitor Styria 2004, final report], www.innoregio-styria.at/Projekte/Innovationsmonitor/Bericht%20Kurzfassung.pdf as of 11th of May 2006

ARTLEY, R. J.; DOBRAUZ, G.; PLASONIG, G. E.; STRASSER, R. R. (Eds.): Making Money out of Technology: Best Practice in Technology Exploitation from Academic Sources, Zurich 2003

ASHEIM, Björn T.: Learning regions as development coalitions: partnerships as governance in European welfare states?, in: Concepts and Transformation, Vol 6, No 1, 2001, pp 73-101

ASHEIM, Björn; ISAKSEN, Arne: Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge, in: Journal of Technology Transfer, Vol. 27, 2002, pp. 77-86

AURIL: Continuing Professional Development Framework for Knowledge Transfer Practitioners, 2003, www.auril.org.uk/publications/cpdframework.pdf as of 11th of May 2006

AURIL: Continuing Professional Development Survey results, 2005, www.auril-cpd.org/downloads/download-docs/CPDSurvey.pdf/download as of 11th of May 2006

AUTIO, Erkko; BIANCHI-STREIT, Marilena; HAMERI, Ari-Pekka (Eds.): Technology Transfer and Technological Learning Through CERN's Procurement Activity, Geneva 2003

BEISE, Marian; LICHT, Georg; SPIELKAMP, Alfred (Eds.): Technologietransfer an kleine und mittlere Unternehmen: Analysen und Perspektiven für Baden-Würtemberg [Technology transfer to small and medium sized companies: Analyses and perspectives for Baden-Würtemberg], Baden-Baden 1995

BEISE, Marian; SPIELKAMP, Alfred (Eds.): Technologietransfer von Hochschulen: Ein Insider-Outsider Effekt [Technology Transfer from Universities: An Insider-Outsider effect], ZEW Discussion Paper 96-10, Mannheim 1996

BESSETTE, Russell W.: Measuring the Economic Impact of University-Based Research, in: Journal of Technology Transfer, Vol. 28, 2003, pp. 355-361

BLUME, Lorenz; FROMM, Oliver: Wissenstransfer zwischen Universitäten und regionaler Wirtschaft: Eine empirische Untersuchung am Beispiel der Universität Gesamthochschule Kassel [Knowledge Transfer Between Universities and regional economy: An empirical study at the University of Kassel], in: Vierteljahreshefte zur Wirtschaftsforschung [Quarterly economy research journal], 69. Jahrgang, Heft 1/2000, pp. 109-123

BOURGEOIS, François.: Basic Science and Technology Transfer: Means and Methods in the CERN Environment, workshop records, 28th and 29th of November 1997 in Geneva

BOZEMAN, Barry: Technology transfer and public policy: A review of research and theory, in: Research Policy, Vol. 29, 2000, pp. 627-655

BUSINESS-HIGHER EDUCATION FORUM (Ed.): Working Together, Creating Knowledge: The University Industry Collaboration Initiative, Washington DC 2001

CARAYANNIS, Elias G.; ALEXANDER, Jeffrey: Winning by Co-Opeting in Strategic Government-University-Industry R&D Partnerships: The Power of Complex, Dynamic Knowledge Networks, in: Journal of Technology Transfer, Vol. 24, 1999, pp. 197-210

CZARNITZKI, D.; LICHT, G.; RAMMER, C.; SPIELKAMP, A.: Rolle und Bedeutung von Intermediären im Wissens- und Technologietransfer [Role and importance of Intermediaries in knowledge and technology transfer], in: ifo Schnelldienst, 54. Jahrgang, Vol. 4, 2001, pp. 40-49

CZARNITZKI, Dirk; RAMMER, Christian: Technology Transfer via the Internet: A Way to Link Pubic Science and Enterprises?, in: Journal of Technology Transfer, Vol. 28, 2003, pp. 131-147

DACHS, Bernhard; EBERSBERGER, Bernd; PYKA, Andreas: Why do Firms Co-operate for Innovation? A comparison of Austrian and Finnish CIS 3 results, in:

Volkswirtschaftliche Diskussionsreihe des Institut für Volkswirtschaftslehre der Universität Augsburg [Economic Discussion Series of the Department for Economics at the University of Augsburg], 2004, No. 255

DAVENPORT, Thomas H.; PRUSAK, Laurence (Eds.): Working Knowledge: How Organizations Manage What They Know, Boston Massachusetts 1998

DE JUAN, Veronica: Comparative study of technology transfer practices in Europe and the USA, in: Industry & Higher Education, October 2003, pp. 337-349

EDLER, Jakob; SCHMOCH, Ulrich: Wissens- und Technologietransfer in öffentlichen Forschungseinrichtungen [Knowledge and technology transfer at public research organizations], in: ifo Schnelldienst, 4/2001, 54. Jahrgang, pp. 18-27

ETZKOWITZ, Henry: The European entrepreneurial university: An alternative to the US model, Industry & Higher Education, 2003, pp. 325-335

ETZKOWITZ, Henry: The norms of entrepreneurial science: cognitive effects of the new university-industry linkages, in: Research Policy, Vol. 27, 1998, pp. 823-833

EUROPEAN COMMISSION (Ed.): SMEs and co-operation, Observatory of European SMEs, No. 5, Luxembourg 2003

FREY, Bruno S.; OSTERLOH, Margit (Eds.): Managing Motivation: Wie Sie die neue Motivationsforschung für Ihr Unternehmen nutzen können [Managing Motivation: How to use modern research in motivation for your company], Wiesbaden 2000

FROMHOLD-EISEBITH, Martina; SCHARTINGER, Doris: Universities as agents in regional innovation systems. Evaluating patterns of knowledge-intensive collaboration in Austria, in: ACS, Zoltan J.; DE GROOT, Henri; NIJKAMP, Peter (Eds.), The Emergence of the Knowledge Economy: A Regional Perspective, Heidelberg 2002, pp. 173-194

GOMEZ DA CRUZ, Emanuel; HERZOG, Robert; SIRAGE, Emir: From purchasing goods & services to pro-active Technology Transfer & Partnerships, final report for the Master program Master of Technology at EPFL Lausanne based on an internship at CERN, 2004

HÄHNLE, Michael: R&D Collaborations between CERN and Industrial Companies: Organizational and Spatial Aspects, doctoral thesis, University of Economics Vienna, 1997

HAMBLIN, David; WILLCOCK, John: Assessing the l kely effectiveness of intervention programmes in small manufacturing companies, in: Industry & Higher Education, October 1999, pp. 349-355

HANEL, Gunter: Typen des Technologienachfrageverhaltens kleiner und mittlerer Unternehmen: ein Segmentierungsversuch als Grundlage für wirtschaftspolitische Maßnahmen [Types of Technology Demanding Behavior of Small and Medium Sized Enterprises: A try to Classify for Policy Economics measures], doctoral thesis, Vienna University of Economics and Business Administration, 1996

HARMON, B.; ARDISHVILI, A.; CARDOZO, R.; ELDER, T.; LEUTHOLD, J.; PARSHALL, J.; RAGHIAN, M.; SMITH, D.: Mapping the University Technology Transfer Process, in: Journal of Business Venturing, Vol. 12, 1997, pp. 423-434

HARPER, Jeffrey S.; RAINER, R. Kelly Jr.: Analysis and Classification of Problem Statements in Technology Transfer, in: Journal of Technology Transfer, Vol. 25, 2000, pp. 135-156

HARTLIEB, Erich: Zur Rolle der Wissenslogistik im betrieblichen Wissens-management [The Role of Knowledge Logistics for the Knowledge Management of companies], doctoral Thesis, Graz University of Technology, 2000

HERSEY, Karen: MIT as catalyst for high-technology start-up companies, in: Industry & Higher Education, December 1999, pp. 409-501

HOFER, Franz: Knowledge Transfer Between Academia and Industry, in: Schwartz, David (Ed.), Encyclopedia of Knowledge Management, New York 2005

HOFER, Franz; ADAMETZ, Christoph; HOLZER, Franz: Technology and knowledge transfer in the Graz region: Ten years of experience, in: Industry & Higher Education, June 2004, pp. 177-186

HOLZER, Franz; ADAMETZ, Christoph: TUG-AbsolventInnenbefragung 2003 Endbericht [Graz University of Technology Alumni survey 2003 final report], 2003,

www.fth.tugraz.at/tt/projekte/pdf/TUG_AbsolventInnenbefragung-2003.pdf as of 12th of May 2006

HOWELLS, Jeremy: The Knowledge Boundaries of the Firm and Sourcing for Innovation, in: Hosni, Yasser; Smith, Richard; Khalil, Tarek (Eds.), 13th International Conference on Management of Technology, Washington DC 2004, Paper ID 1296

INNO-REGIO STYRIA: F&E Kooperationen von forschungsintensiven Unternehmen der Steiermark [R&D collaborations of research intensive companies in Styria], presented at a workshop for members of the platform for R&D managers of Styrian companies organized by inno-regio styria on the 7th of February 2005 in Graz

JANKOWSKI, John E.: Trends in Academic Research Spending, Alliances, and Commercialization, in: Journal of Technology Transfer, Vol. 24, 1999, pp. 55-68

JASSAWALLA, Avan R.; SASHITTAL, Hemant C.: Accelerating technology transfer: Thinking about organizational pronoia, in: Journal of Engineering and Technology Management, Vol. 15, 1998, pp. 153-177

KREMIC, Tibor: Technology Transfer: A Contextual Approach, in: Journal of Technology Transfer, Vol. 28, 2003, pp. 149-158

LAIGAARD, Karen: Establishing a TTO: A Thrilling Experience, presented at the ASTP Workshop, 14th and 15th of October 2004 in Lisbon

LAMBE, C. Jay; SPEKMAN, Robert E.: Alliances, External Technology Acquisition, and Discontinuous Technological Change, in: Journal of Product Innovation Management, Vol. 14, 1997, pp. 102-116

LAMBERT, Richard: Lambert Review of Business-University Collaboration: Final Report, 2003, www.lambertreview.org.uk as of 10th of April 2006

LANGMANN, Philipp: Motivation zum Wissenstransfer [Motivation to transfer knowledge], master thesis, University of Graz, 2002

LARGE, David; BELINKO, Keith; KALLIGATSI, Katerina: Building Successful Technology Commercialization Teams: Pilot Empirical Support for the Theory of Cascading Commitment, in: Journal of Technology Transfer, Vol. 25, 2000, pp. 169-180

LI-HUA, Richard: From Technology Transfer to Knowledge Transfer - A Study of International Joint Venture Projects in China, presented at the 2003 International Association for Management of Technology (IAMOT) Conference in Nancy, www.knowledgemanagement.uk.net/resources/Richard%20Lihua%20paper.pdf as of 11th of May 2006

LIPSCOMB, Marguerite; MCEWAN, Anne Marie: Technology Transfer in SMEs: The TCS Model at Kingston University, in: Proceedings of the Fourth SMESME International Conference, Aalborg, 2001

LUNA, Matilde; VELASCO, José L.: Bridging the gap between firms and academic institutions: The role of 'translators', in: Industry & Higher Education, October 2003, pp. 313-323

LUNDVALL, B. A.; JOHNSON, B.; ANDERSEN, E. S.; DALUM, B.: National systems of production, innovation and competence building, in: Research Policy, 31, 2002, pp. 213-231

MACPHERSON, Alan D.: The role of external technical support in innovation performance of scientific instruments firms: Empirical evidence from New York State, in: Technovation, Vol. 17, No. 3, 1997, pp. 141-151

MANIMALA, Mathew J.: Managing R&D in SMEs: Taking advantage of the giants' shoulders, in: Industry & Higher Education, June 2002, pp. 177-190

MARTINSON, Brian C.; ANDERSON, Melissa S.; DE VRIES, Raymond: Scientists behaving badly, in: nature, Vol. 435/9, June 2005, pp. 737-738

MCCULLOUGH, John M.: Technology transfer: creating the right environment, in: Industry & Higher Education, April 2003, pp. 111-117

MESERI, Ofer; MAITAL, Shlomo: A Survey Analysis of University-Technology Transfer in Israel: Evaluation of Projects and Determinants of Success, in: Journal of Technology Transfer, Vol. 26, 2001, pp. 115-126

NICOLAY, Rainer; WIMMERS, Stephan (Eds.): Kundenzufriedenheit der Unternehmen mit Forschungseinrichtungen: Ergebnisse einer Unternehmensbefragung zur Zusammenarbeit zwischen Unternehmen und Forschungseinrichtungen [Customer Satisfaction of companies with R&D organizations: Results of an company survey

regarding collaborations between companies and R&D organizations], Berlin Bonn, 2000

NORDBERG, Markus; VERBEKE, Alain: The Strategic Management of High Technology Contracts: The Case of CERN, in: McGee, John; Thomas, Howard (Eds.): Technology, Innovation, Entrepreneurship and Competitive Strategy Series, Oxford 1999

OUGHTON, Christine; LANDABASO, Mikel; MORGAN, Kevin: The Regional Innovation Paradox: Innovation Policy and Industrial Policy, in: Journal of Technology Transfer, Vol. 27, 2002, pp. 97-110

PEACOCK, Nicola; LADKIN, Adele: Exploring relationships between higher education and industry, in: Industry & Higher Education, December 2002, pp. 393-402

PLODER, Michael; SCHLEICH, Michaela; ADAMETZ, Christoph: Innovationsmonitor 2005: Endbericht [Innovation Monitor: Final Report], September 2005

POLYANI, Michael (Ed.): The Tacit Dimension, Gloucester-Massachusetts 1966

REINHARD, Michael: Wissens- und Technologietransfer in Deutschland: Ein langer Weg zu mehr Effizienz [Knowledge and Technology Transfer in Germany: A long way to increased Efficiency], in: ifo Schnelldienst, 54. Jahrgang, Vol. 4, 2001, pp. 14-17

RIIS, Jens O.: University-Industry Interaction: A Means for Stimulating Manufacturing Excellence, in: Proceedings of the Fourth SMESME International Conference, Aalborg, 2001

MOSER, W.; REICHER, D.; ROSEGGER, R.; DE FRANTZ, M.; HAVEL, M.: Was ist so schön am Eigenheim – Ein Lebensstilkonzept des Wohnens [What is so beautiful with the own home – A life style concept of living], 2002, www.hausderzukunft.at/download/endbericht_eigenheim_1702.pdf as of 23rd of May 2006

SACKETT, Peter J.: Towards concurrent processes technology transfer, in: Industry & Higher Education, October 2000, pp. 288-296

SAMMER, Martin: Vernetzung von Wissen in Organisationen: Gestaltung von Rahmenbedingungen [Linking Knowledge in Organizations: Designing the frame], in: Bauer, Ulrich; Biedermann, Hubert; Wohinz, Josef W. (Eds.), Techno-ökonomische Forschung und Praxis [Techno-economic research and practice], Wiesbaden 2000

SANTORO, Michael D., GOPALAKRISHNAN, Shanthi: Relationship Dynamics between University Research Centers and Industrial Firms: Their Impact on Technology Transfer Activities, in: Journal of Technology Transfer, Vol. 26, 2001, pp. 163-171

SCHARTINGER, Doris; SCHIBANY, Andreas; GASSLER, Helmut: Interactive Relations Between Universities and Firms: Empirical Evidence for Austria, in: Journal of Technology Transfer, Vol. 26, 2001, pp. 255-268

SCHIBANY, Andreas; SCHARTINGER, Doris: Benchmarking Industry-Science Relationships: Main Results and the Austrian Positioning, presented at the TIP workshop Benchmarking Science and Technology Policy, 11th and 12th of April 2002 in Vienna

SCHMOCH, Ulrich; LICHT, Georg; REINHARD, Michael (Eds.): Wissens- und Technologietransfer in Deutschland [Knowledge and technology transfer in Germany], Stuttgart 2000

SCHNEEBERGER, Arthur; PETANOVITSCH, Alexander (Eds.): Innovation und Hochschu bildung: Chancen und Herausforderungen einer technisch-naturwissenschaftlichen Qualifizierungsoffensive für Österreich [Innovation and academic education: Chances and challenges of science and technology oriented qualification offensive for Austria], Vienna 2003

SCHNEIDER, Ursula: Management in der wissensbasierten Unternehmung, in: Schneider, Ursula (Ed.): Wissensmanagement, Frankfurt/Main 1996

SCHREINER, Melanie; FAHRNI, Fritz (Eds.): Partnering for Success: Creating Win-Win Constellations for long-term Industry-Academia Collaboration, Zurich 2001

SCHULZE, Anja: Wissensmanagement: Räume fördern Austausch [Knowledge Management: Space supports exchange], in: TECHNOVATION 3/02, 2002, pp. 35-37

SHERMAN, J. Daniel; OLSEN, Eugene A.: Stages in the project life cycle in R&D organizations and the differing relationships between organizational climate and performance, in: Journal of High Technology Management Research, 1996, pp. 79-90

SIEGEL, D. S.; WALDMAN, D. A.; ATWATER, L. E.; LINK, A. N.: Commercial knowledge transfer from universities to firms: improving the effectiveness of university-industry collaboration, in: Journal of High Technology Management Research, Vol. 14, 2003, pp. 111-133

SIEGEL, Donald S.; WALDMAN, David A.; LINK, Albert N.: Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study, 2000, www.nhh.no/sam/stabssem/siegel.pdf as of 11th of May 2006, a previous version of this paper appeared as NBER Working Paper #7256 in July 1999

SPSS (Ed.): SPSS Base 12.0 Benutzerhandbuch [SPSS Base 12.0 user manual], Munich 2003

STARBUCK, Elizabeth: Optimizing University Research Collaborations, in: Research Technology Management, January/February 2001, pp. 40-44

THOMAS, Brychan; PACKHAM, Gary; MILLER, Chris: A temporal model of technology diffusion into small firms in Wales, in: Industry & Higher Education, August 2001, pp. 279-288

TICHY, Gunther; WULZ, Heribert: Notwendigkeiten, Möglichkeiten und Kosten eines Technologietransfers an österreichische Klein- und Mittelbetriebe nach dem Steinbeis-Modell: Gutachten für die Kammer für Arbeiter und Angestellte Wien [Necessities, possibilities and costs by realizing technology transfer according to the Steinbeis model to Austrian small and medium sized companies: Study for the Vienna chamber of labor], in: Kammer für Arbeiter und Angestellte für Wien [Vienna chamber of labor] (Ed.), Beiträge zur Wirtschaftspolitik [Contributions to economic policy], Vol. 1, Vienna 1996

TÖDTLING, Franz; KAUFMANN, Alexander: SMEs in Regional Innovation Systems and The Role of Innovation Support: The Case of Upper Austria, in: Journal of Technology Transfer, Vol. 27, 2002, pp. 15-26

TORNATZKY, Louis G. (Ed.): Building State Economies by Promoting University Industry Technology Transfer, Washington DC 2000

VAN EGMONG-DE WILDE DE LIGNY, Emilia L. C.; KUMARASWAMY, Mohan M.: Determining the success or failure of international technology transfer, in: Industry & Higher Education, February 2003, pp. 51-57

VOCK, Patrick: University Technology Transfer in Switzerland: Organization, Legal Framework, Policy and Framework, in: OECD (Ed.), Turning Science into Business: Patenting and Licensing at Public Research Organisations, Paris 2003, pp. 189-201

WASHBURN, Jennifer: Why Universities Need to Recommit Themselves to Serving the Public Good, in: InnovationMatters, June 5, 2005, Vol. 3, Issue 11

WILLFORT, Reinhard: Innovationsdienstleistungen im wissensorientierten Management von Innovationsprozessen [Innovation Services in Knowledge Oriented Management of Innovation Processes], doctoral thesis, Graz University of Technology, 2000

Appendix: Definition of terms

To provide a common understanding the thesis's key terms are specified in the following.

Knowledge, data, documentation, information and communication processes

The following definitions of knowledge, data, documentation, information, and communication processes are based on the ones used by Willfort[38]. In this case, knowledge is exclusively bound to individuals. It does not exist without them. A written paper does not contain knowledge but simply data. The distinction of knowledge in explicit and implicit forms introduced by Polyani[39] is not that relevant for this thesis even though it is important to consider in case of realizing single technology transfer projects. Data comprise signs, chains of signs, graphs, and pictures. Data usually can be stored and processed with the help of information and communication technologies. The processes information, documentation, and communication link data with knowledge and vice versa. Examples for the processes are reading a paper for an information process, writing a paper for a documentation process, a telephone conversation for a communication process. The information process is one possibility for individuals to generate knowledge. The documentation process generates data based on the knowledge of individuals, which again can serve as starting point for the generation of knowledge through the information process. Communication processes describe interactions between at least two individuals. It comprises verbal and non-verbal forms. Communication can take place either personally, i.e. face-to-face conversations, or being supported by information and communication technologies like phones, online-chat, or videoconferences to name just a few. By using up to date technologies communication can take place virtually independent from time and location.

[38] Willfort, Reinhard: Innovationsdienstleistungen im wissensorientierten Management von Innovationsprozessen [Innovation Services in Knowledge Oriented Management of Innovation Processes], doctoral thesis, Graz University of Technology, 2000

[39] Polyani, Michael (Ed.): The Tacit Dimension, Gloucester-Massachusetts 1966

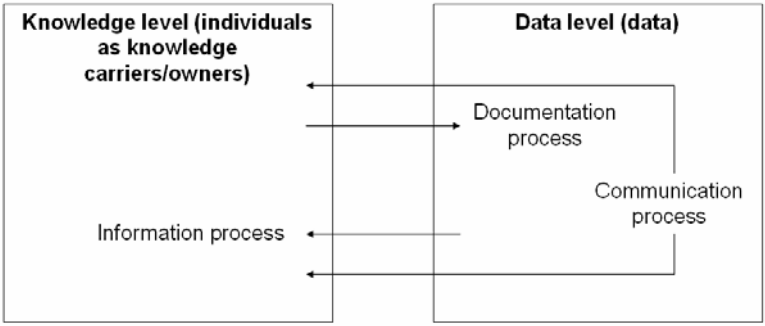

Figure 64: Relations between knowledge, data, and documentation, information, and communication processes

Technology transfer related terms: Knowledge transfer, knowledge induction

Knowledge transfer is often being used synonymous for technology transfer because in many cases technology transfer does not refer exclusively to the transfer of technologies in the sense of artifacts. Abramson, Encarnacao, Reid, and Schmoch[40] define technology transfer as the movement of technological and technology-related knowledge amongst partners. Also for this thesis, the term technology transfer refers to such a broader view. Sammer[41] introduced the term knowledge induction. The author refers to the misleading image provoked by using terms like knowledge and technology transfer. Knowledge cannot be transferred, only signals and stimuli. Knowledge can only be generated by absorbing stimuli. Two models introduced by Schneider[42] describe the differences between transfer and induction. The two presented models show the principal views regarding knowledge: The package model and the interaction model. The mechanism of the package model with knowledge as a picture of the reality and being ready to be transferred like a package from sender to receiver corresponds with the term transfer. The second model, the interaction model, views knowledge as something being created by interaction and being an interpretation of the reality and not the reality itself. This is in line with

[40] Abramson, N. H.; Encarnacao, J.; Reid, P. P.; Schmoch, U. (Eds.): Technology Transfer Systems in the United States and Germany: Lessons and Perspectives, Washington DC 1997

[41] Sammer, Martin: Vernetzung von Wissen in Organisa ionen: Gestaltung von Rahmenbedingungen [Linking Knowledge in Organizations: Designing he frame], in: Bauer, Ulrich; Biedermann, Hubert; Wohinz, Josef W. (Eds.), Techno-ökonomische Forschung und Praxis [Techno-economic research and practice], Wiesbaden 2000

[42] Schneider, Ursula: Management in der wissensbasierten Unternehmung [Management in knowledge based organizations], in: Schneider, Ursula (Ed.): Wissensmanagement [Knowledge Management], Frankfurt/Main 1996

Sammer's view of knowledge induction. The fundament of this thesis corresponds with Sammer's view about the impossibility to transfer knowledge. However, for this thesis the term technology transfer is preferred because of the widely use in science and practice, independently all the potential misunderstandings.

Technology transfer

In general, technology transfer between universities and companies stands for universities and companies interacting with each other for reasons like i.e. joint developments, improving existing products or sharing knowledge. Not necessarily, both sides interact directly and personally. In addition, publications available online for download or theses accessible at libraries are potential sources for knowledge. Technology transfer can happen either intentionally or unintentionally. Examples for intentional technology transfer are industrial liaison programs. In such cases, companies pay for specific services provided by universities. MIT for examples offers for companies paying to take part in their industrial liaison program services like university researchers visiting companies and discussing potential new developments, access to new research results, reduced fees for conferences and support in issues related to business development based on research at the university. Technology transfer is often perceived as one way where universities make and companies take. This might be true in some cases. However, companies with excellent research capabilities are likely to be equivalent research partners for universities. Companies' input, i.e. practical problems and need for further research can be important for universities. Technology transfer does not have to take place exclusively between universities and companies within a certain geographic region but also at the national as well as international level. Technology transfer can include exclusively university researchers and companies but also others like i.e. university technology transfer officers. The creation of spin-offs based on universities' inventions or licensing universities' IPRs to companies can be part of technology transfer. Technology transfer can vary in intensity. It spans from university researchers and companies having occasionally contacts with each other to companies having expenditures for collaborations with universities and university researchers realizing collaborative research projects with companies.

Appendix: Questionnaire for companies

1. Did the company carry out R&D within the last three years?

Yes, continuously ☐ ▼ **Go to question 3**
Yes, rarely ☐ ▼ **Go to question 3**
No ☐ ▸ **Go to question 2**

2. Did the company have expenditures for <u>external</u> R&D services within the last three years?
I.e. for other companies of the group, universities, public research centers, other companies and the like.

Yes, continuously ☐ ▼
Yes, rarely ☐ ▼
No ☐ ▸ **Go to question 8**

3. Please indicate R&D expenditures for the following years.

	2003	2004	2005e
R&D expenditures as share of turnover in %			
OR in EUR			

4. Please indicate the expected development of R&D expenditures for the years 2006 and 2007.

More than +25%	From +11% to +25%	From 0 to +10%	From 0 to -10%	From -11% to -25%	More than -25%
☐	☐	☐	☐	☐	☐

If you have answered question 1 with no please go to question 7. Otherwise proceed with question 5.

5. Did the company have expenditures for <u>external</u> R&D services within the last three years?
I.e. for other companies of the group, universities, public research centers, other companies and the like.

Yes ☐
No ☐ ▸ **Go to question 8**

6. How large is the share of current expenditures for external R&D services of the total R&D expenditures? %

7. Did the company have expenditures for collaborations with universities within the last three years?

Yes ☐ ▼ **Go to question 11**
No ☐ ▸ **Go to question 8**

8. Did the company have contacts to universities in the area of R&D within the last three years?

Yes, continuously ☐ ▼
Yes, rarely ☐ ▼
No ☐ ▸ **Go to question 9**

Go to question 13

9. Would you principally be interested in collaborating with universities?

Yes ☐ No ☐ ▸ **Go to question 10**

▾

Go to question 24

10. Please name the reason(s) why you are not interested in collaborating with universities.

▾

After answering question 10 please go to question 29

11. Estimate the yearly expenditures for universities for the last three years and the expected development of these expenditures for the years 2006 and 2007.

		Expected development for 2006 and 2007		
	Yearly expenditures for universi ies	Increasing	Stable	Decreasing
Yearly expenditures in EUR OR		☐	☐	☐
In % of all R&D expenditures (question 3)				

12. Please indicate how the current expenditures for universities are split between the following means.

	Sum = 100 %
Taking in consulting and expert opinions	
Commissioning master and bachelor theses	
Commissioning doctoral theses	
Commissioning contract research projects (Companies not ac ively work with university researchers)	
Commissioning joint research projects (Companies actively work with university researchers)	
Using infrastructure (i.e. for tests)	
Others:	

13. Estimate how often the company used the following means within the last three years.
Enter the respective numbers in the corresponding fields. I.e. if the company commissioned four master theses wi hin the last three years enter the number four in the respective field.

	Number
Providing cases or giving guest lectures for seminars, lectures and construction exercises	
Taking in consulting and expert opinions	
Commissioning master and bachelor theses	
Commissioning doctoral theses	
Commissioning contract research projects (Companies not ac ively work with university researchers)	
Commissioning joint research projects (Companies actively work with university researchers)	
Using infrastructure (i.e. for tests)	
Others:	

14. Please indicate how often the company had contacts to or collaborated with universities located in the following geographic areas within the last three years.

	Often	Rarely	Never
Styria	☐	☐	☐
Austria w/o Styria	☐	☐	☐
Germany and Switzerland	☐	☐	☐
Other countries:	☐	☐	☐

15. If necessary please name the reason(s) why the company had contacts to or collaborated with universities located outside Styria. I.e. need for specific research, capacities, costs, bad experiences with regional universities.

16. Estimate how contacts to or collaborations with universities are split between universities of technology and other universities. Universities of technology are i.e. Graz University of Technology or University of Leoben. Other universities are i.e. University of Graz or Vienna University of Economics, medical universities and the like.

Exclusively universities of technology		Contacts and collaborations are equally distributed		Exclusively other universities
☐	☐	☐	☐	☐

17. Estimate with how many university departments the company is in contact with.

18. Since how many years the company is already in contact with universities?

19. How important are the following reasons for the company to establish contacts to and initiated collaborations with universities?

	Importance			
	High	Medium	Small	Not important
Developing new products and processes	☐	☐	☐	☐
Improving existing products and processes	☐	☐	☐	☐
Building up specific competencies with universities' support	☐	☐	☐	☐
Universities as economic R&D service providers (outsourcing)	☐	☐	☐	☐
Collaborations with universities increase the likelihood of success to acquire additional external funding	☐	☐	☐	☐
Access to new customers and markets	☐	☐	☐	☐
Balancing capacity shortages	☐	☐	☐	☐
Access to pot. new employees	☐	☐	☐	☐
Others:	☐	☐	☐	☐

20. How important are the following factors for choosing university departments the company finally contacts?

	Importance			
	High	Medium	Small	Not important
Existing personal contacts	☐	☐	☐	☐
Publications in scientific journals	☐	☐	☐	☐
Publications about research in newspapers, magazines and the internet	☐	☐	☐	☐
TV and radio broadcasts about research	☐	☐	☐	☐
Presenta ions of university researchers at meetings	☐	☐	☐	☐
Recommendations from others (i e. customers, suppliers, partners etc.)	☐	☐	☐	☐
Research excellence	☐	☐	☐	☐

Geographic nearness of university	☐	☐	☐	☐
Others:	☐	☐	☐	☐

21. Please indicated how usually your contacts to or collaborations with universities are established.

	Often	Rarely	Never
The company approaches university researchers directly	☐	☐	☐
The company turns to central university departments, which find the right university researchers.	☐	☐	☐
The company turns to central industry near organizations like chamber of commerce, industry associations or clusters, which find the right university researchers.	☐	☐	☐
University researchers approach the company directly	☐	☐	☐
Students approach the company directly	☐	☐	☐
Central university departments approach the company directly	☐	☐	☐
Central industry near organizations like chamber of commerce, industry associations or clusters approach the company directly	☐	☐	☐
Others:	☐	☐	☐

22. Please indicate how often you carry out the following activities.

	Often	Rarely	Never
Measuring the impact of collaborations with universities on the economic success of the company wi h the help of indicators	☐	☐	☐
Review of collaborations with universities to find out potential for improvement	☐	☐	☐

23. Please indicate if the following characteristics apply to the company.

	Yes	No
The company enters long-term partnerships with relevant university departments	☐	☐
The management supports collaborations wi h universities	☐	☐
Contacts with universities are anchored on several people within the company	☐	☐

24. Which support would help the company to improve and increase collaborations with universities? I.e. facilitating strategic collaborations, master contracts, equal standards at university departments and the like.

25. How important are the following barriers for (pot.) collaborations between your company and universities? Please judge the actual importance for your company.

	Importance			
	High	Medium	Small	Not important
Difficulties in finding the right contacts	☐	☐	☐	☐
Universities are passive in providing information and presenting their research results and possibilities to collaborate	☐	☐	☐	☐
Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)	☐	☐	☐	☐
Internal knowledge of the company leaks to competitors with which university departments are in contact too	☐	☐	☐	☐
High work load at university departments hinder collaborations with companies	☐	☐	☐	☐
Collaborations with university departments are too expensive compared to benefits	☐	☐	☐	☐
University researchers are rather skeptical towards collaborations with companies	☐	☐	☐	☐

26. Try to take in the viewpoint of university researchers and to judge the following barriers for collaborations with companies.

	Importance			
	High	Medium	Small	Not important
Companies are passive and do not ask for research projects and results	☐	☐	☐	☐
Companies do not know the potential collaboration means with universities like consultancy, licensing, seminar theses and the like	☐	☐	☐	☐
Companies cannot name their needs and problems	☐	☐	☐	☐
Companies have limited professional capabilities to collaborate with universities	☐	☐	☐	☐
Companies' aggressive behavior regarding formal protection rights like IPRs hinder collaborations with universities	☐	☐	☐	☐
High work load in companies hinder collaborations with universities	☐	☐	☐	☐
Companies are rather skeptical towards collaborations with universities	☐	☐	☐	☐
Collaborations with companies negatively influence teaching and research at the university department	☐	☐	☐	☐
Too much third party funding negatively influences the university department (i e. dependencies, limiting the possibilities to be unbiased, decreasing funding from public sources)	☐	☐	☐	☐

27. If necessary name additional barriers being important for your collaborations with universities.

28. Judge the importance of following motives for university researchers to collaborate with companies.

	Importance			
	High	Medium	Small	Not important
It is one of the tasks of universities to collaborate with companies	☐	☐	☐	☐
Scientific interest	☐	☐	☐	☐
Building up contacts for a latter career in companies	☐	☐	☐	☐
Using companies' infrastructure	☐	☐	☐	☐
Financing investments in university department's infrastructure	☐	☐	☐	☐
Financing master and doctoral students or university department's employees	☐	☐	☐	☐
Financing your own job	☐	☐	☐	☐
Additional personal income	☐	☐	☐	☐

Finally please answer some questions regarding the company and your person.

29. Please indicate which product and service categories apply to the company. Multiple answers possible. „Standardized services" are services without major customer specific changes. "Custom made specialized services" are designed and sold individually, i.e. R&D services and the like.

Mass production	Small production	Prototype production	Standardized services	Custom made specialized services
☐	☐	☐	☐	☐

30. Is the company part of a group of companies?

Yes	No
☐	☐

31. Please indicate company's sales for the given years. In case the company does not have sales because it exclusively realizes R&D for others, please indicate an equivalent, i.e. the amount of R&D expenditures contracted by others.

	2003	2004	2005e
In Million EUR			

32. Estimate the expected development of company's sales for the years 2006 and 2007.

More than +10%	From +6% to +10%	From 0 to +5%	From 0 to -5%	From -6% to -10%	More han -10%
☐	☐	☐	☐	☐	☐

33. Please indicate the share of in the last three years newly developed or markedly improved products and processes on sales. %

34. Please indicate the company's export quota. %

35. Please indicate the three most important export countries. Important in the sense of sales.

Export country with the highest share on sales	
Export country with the second highest share on sales	
Export country with the third highest share on sales	

36. How many employees are employed at the company?

37. How many thereof are university graduates?

In number of people OR	
In % of all employees	

38. How many of all university graduates are graduates from universities of technology?

In number of people OR	
In % of all university graduates (Question 37)	

39. Please indicate which strategy the company follows. Multiple answers possible.

Cost leadership	Quality leadership	Technology leadership	Niche strategy
☐	☐	☐	☐

40. Please indicate if the company is process oriented. I.e. applying standards like VDA or ISO. It is not necessary hat the company is granted he respective certificates.

Yes, continuously	Yes, rarely	No
☐	☐	☐

41. Please indicate if the company applies innovation management methods. I.e. CIP (continuous improvement processes), creativity techniques like brainstorming, 635 and he like.

Yes, continuously	Yes, rarely	No
☐	☐	☐

42. How old are you?

Up to 30 years	From 31 to 40 years	From 41 to 50 years	From 51 to 60 years	Older than 60 years
☐	☐	☐	☐	☐

43. Please indicate if and if yes from which universities or universities of applied sciences you graduated. Multiple answers possible.

I do not have an academic degree from universities or universities of applied sciences	☐
Graz University of Technology	☐
University of Leoben	☐
University of Graz	☐
FH JOANNEUM (university of applied science)	☐
campus02 (university of applied science)	☐
Vienna University of Technology	☐
Others:	

44. Please indicate your current position in the company.

CEO	☐
R&D manager	☐
Others:	

Thank you very much for your support. Please send the questionnaire per e-mail or fax to:

Franz Hofer, franz.hofer@tugraz.at, (Fax) 0316/873-8397

In case you send back the questionnaire per fax, please indicate the name of your company to ensure the assignment of your answers to centrally available data for the following analysis:

Appendix: Questionnaire for university researchers

1. Do you have contacts with companies during your work at Graz University of Technology?
I.e. master theses, presentations, lectures, collaborative projects, consultancies and the like.

Yes, regularly ☐ ▼ **Go to question 4**
Yes, rarely ☐ ▼ **Go to question 4**
No ☐ ▸ **Go to question 2**

2. Would you be interested in entering collaborations with companies?

Yes ☐ ▼ **Go to question 16**
No ☐ ▸ **Go to question 3**

3. Please state why you are not interested in collaborations with companies?

▼ **Go to question 21.**

4. Assess your personal motivation why you collaborate with companies.

	Importance			
	High	Medium	Small	Not important
It is one of the tasks of universities to collaborate with companies	☐	☐	☐	☐

Scientific interest	☐	☐	☐	☐
Building up contacts for a latter career in companies	☐	☐	☐	☐
Using companies' infrastructure	☐	☐	☐	☐
Financing investments in university department's infrastructure	☐	☐	☐	☐
Financing master and doctoral students or university department's employees	☐	☐	☐	☐
Financing your own job	☐	☐	☐	☐
Additional personal income	☐	☐	☐	☐
Other reasons:	☐	☐	☐	☐

5. **Estimate with how many different companies you are in contact with during an average month.** „Being in contact with" stands for personal communication independen ly if face-to-face, via e-mail or phone.

6. **Estimate how much of your time you spend on average for teaching, basic research and collaborations with companies.** It is only a rough estimation. Basic research stands for not applied research without involvement of companies and without concrete exploitation objectives. Collaborations with companies comprise research ac ivities with companies and also presentations for companies and the like. Activities not belonging exclusively to one of the three categories should be divided in three similar shares.

	Teaching	Basic research	Collaborations with companies
Sum = 100 %			

7. **How are your collaborations with companies usually be established?**

	Often	Rarely	Never
I approach companies, which I already know from previous collaborations directly	☐	☐	☐
I approach companies, which might be interested in my research and which I do not yet know personally directly	☐	☐	☐
Companies approach me directly	☐	☐	☐
Central university departments broker projects for me	☐	☐	☐
Central industry near organizations like chamber of commerce, clusters or industry associations broker projects for me	☐	☐	☐
Other departments at my university broker projects for me	☐	☐	☐
Others:	☐	☐	☐

8. **Estimate how often you personally use the following means in collaborations with companies per year.** If i.e. you do not coach doctoral students because you do not have the formal authority please check the box „n/a" for not applicable. The same accounts for if you are employed at the university since shortly and cannot yet provide information for the means.

	Number per year	n/a
Organization of guest lecturers, practical cases of companies for seminars and lectures, construction exercises and he like		☐
Doing consultancies and providing expert opinions		☐
Coaching master and bachelor theses commissioned by companies		☐
Coaching doctoral theses commissioned by companies		☐
Contract research projects for companies (Companies do not actively work with university researchers)		☐
Joint research projects with companies (Companies actively work with university researchers)		☐
Providing infrastructure (i.e. for tests)		☐
Others:		☐

9. How many of your collaborations with companies do you do with companies according to the following categories and how do <u>average</u> project sums differ? Regular customers are companies regularly collaborating with you or your department. First time customers are companies for the first time collaborating with you or your department. Occasional customers are companies occasionally collaborating with you or your departments but less frequently than regular customers.

	Number of projects				Project sums		
	High	Middle	Small	None	High	Middle	Small
Regular customers	☐	☐	☐	☐	☐	☐	☐
Occasional customers	☐	☐	☐	☐	☐	☐	☐
First time customers	☐	☐	☐	☐	☐	☐	☐

10. How many of your collaborations with companies do you do with companies according to the following geographic areas and how do <u>average</u> project sums differ?

	Number of projects				Project sums		
	High	Middle	Small	None	High	Middle	Small
Styria	☐	☐	☐	☐	☐	☐	☐
Austria w/o Styria	☐	☐	☐	☐	☐	☐	☐
Germany or Switzerland	☐	☐	☐	☐	☐	☐	☐
Other countries:	☐	☐	☐	☐	☐	☐	☐

11. Do you learn something from your collaborations with companies for your teaching activities? Examples are ideas for new input for seminars and lectures, new points of view or possibilities to solve problems and the like. If you do not teach please check the box "n/a" for not applicable.

Yes, very much ☐ Rather much ☐ Rather little ☐ Not at all ☐ N/A ☐

12. How do you judge your current collaborations with companies for fulfilling your scientific research objectives?

Supporting ☐ ▾ Hindering ☐ ▾

Please state your reason(s) for your judgment:

13. Do you have explicit obligatory standards for collaborations with companies like xx days to respond to external enquiries or standardized contracts and the like?

Yes ☐ ▾ No ☐ ▸ **Go to question 14**

Please describe the standards shortly:

14. How often do you realize the following activities in case of your collaborations with companies?

	Often	Rarely	Never
Information for companies of suited funding programs	☐	☐	☐
Supporting companies in setting up proposals for funding programs	☐	☐	☐
Supporting companies in integrating and exploiting research results (i.e. accompanying companies until new products or processes are introduced in markets and the like)	☐	☐	☐
Seeking feedback from companies regarding collaborations (i e. benefits for companies and the like)	☐	☐	☐
Setting up measures based on feedback from companies to improve collaborations with companies	☐	☐	☐

Other activities important for collaborations with companies:	☐	☐	☐

15. Would you like to increase your collaborations with companies?

Yes ☐ ▼ **Go to question 16**

No ☐ ▸ **Go to question 17**

16. Which support would help you in increasing your collaborations with companies? I.e. additional personnel resources, systematic marke ing, opening up contacts to companies and the like.

17. Do following barriers hinder your (potential) collaborations with companies? Please judge the actual importance of barriers for <u>your</u> collaborations with companies.

	Importance			
	High	Medium	Small	Not important
Companies are passive and do not ask for research projects and results	☐	☐	☐	☐
Companies do not know the potential collaboration means with universities like consultancy, licensing commission seminar theses and the like	☐	☐	☐	☐
Companies cannot name their needs and problems	☐	☐	☐	☐
Companies have limited professional capabilities to collaborate with universities	☐	☐	☐	☐
Companies' aggressive behavior regarding formal protection rights like IPRs hinder collaborations with universities	☐	☐	☐	☐
High work load in companies hinder collaborations with universities	☐	☐	☐	☐
Companies are rather skeptical towards collaborations with universities	☐	☐	☐	☐
Collaborations with companies negatively influence teaching and research at the university department	☐	☐	☐	☐
Too much hird party funding nega ively influences the university department (i.e. dependencies, limiting the possibilities to be unbiased, decreasing funding from public sources)	☐	☐	☐	☐

18. Try to take in the view point of company managers (CEOs or R&D managers) and judge the importance of following barriers.

	Importance			
	High	Medium	Small	Not important
Difficulties in finding he right contacts	☐	☐	☐	☐
Universities are passive in providing information and presenting their research results and possibilities to collaborate	☐	☐	☐	☐
Results of collaborations with university departments are rather insecure or difficult to exploit for and integrate in the company (i.e. protection against spill-overs)	☐	☐	☐	☐
Internal knowledge of the company leaks to competitors with which university departments are in contact too	☐	☐	☐	☐
High work load at university departments hinder collaborations with companies	☐	☐	☐	☐
Collaborations with university departments are too expensive compared to benefits	☐	☐	☐	☐
University researchers are rather skeptical towards	☐	☐	☐	☐

collaborations with companies				

19. If necessary name additional barriers being important for your collaborations with companies.

20. Judge the importance of following motives for companies to collaborate with universities.

	Importance			
	High	Medium	Small	Not important
Developing new products and processes	☐	☐	☐	☐
Improving existing products and processes	☐	☐	☐	☐
Building up specific competencies with universities' support	☐	☐	☐	☐
Universities as economic R&D service providers (outsourcing)	☐	☐	☐	☐
Collaborations with universities increase the likelihood of success to acquire additional external funding	☐	☐	☐	☐
Access to new customers and markets	☐	☐	☐	☐
Balancing capacity shortages	☐	☐	☐	☐
Access to pot. new employees	☐	☐	☐	☐

Finally please answer some questions regarding your person.

21. At which faculty are you employed? In case you are employed at more than one faculty please indicate the one where you work for most of your time. Please chose faculty

22. How many employees in total are employed at the department you work for?

Up to 5 employees ☐ From 6 to 10 employees ☐ From 11 to 20 employees ☐ More than 20 employees ☐

23. How old are you?

Up to 30 years ☐ From 31 to 35 years ☐ From 36 to 45 years ☐ From 46 to 55 years ☐ Older than 55 years ☐

24. Please indicate the personnel category you belong to. Multiple answers possible. In case of different options regarding the following questions (Go to question 25 or 26) please take the lower one. In case you are not sure which category you belong to consult TUGonline.

Category	Abbreviation in TUGonline		
Professor	UP, VP	☐	
University assistant professor (title „Ao.Univ.-Prof.“)	UD	☐	
Contract assistant professor (title „Ao.Univ.-Prof.“)	VD	☐	▸ **Go to question 26**
University assistants (title “Assistant professor“	UA	☐	
University assistants – temporary	UA	☐	▸ **Go to question 25**
Contract assistants	VA	☐	
Staff Scientist – unlimited	ST	☐	▸ **Go to question 26**
Assistants according to § 49 VBG	AS	☐	▸ **Go to question 25**
Scientific employees (in formation) and scientific assistants	WM, WA	☐	
University assistants – new	UA	☐	▸ **Go to question 26**
Civil servants, employees for scientific use	WB, VW, AN	☐	
Project employees	PM	☐	▸ **Go to question 25**
Third party funded employees	DP	☐	

25. Please indicate your current academic title, i.e. Dipl.-Ing. or Dr. In case you do not have an academic degree please tick the box “No academic degree”.

Current academic degree	No academic degree
	☐

26. Please indicate how your position is financed. Multiple answers possible. In case your position is financed by third party funds please distinguish in third party funds from companies (i.e. competence centers, CD labs, EU projects with companies and the like) and from other sources without companies’ involvement.

Regular university budget	Third party funds from companies	Third party funds from other sources without companies’ involvement
☐	☐	☐

27. Since which year are you employed at Graz University of Technology? (yyyy)

28. Please indicate your working experience in companies: (yyyy)

The questionnaire is the first empirical part of my doctoral thesis. In autumn this year the results will be complemented with personal interviews. Please write down your e-mail address if you want to be at my disposal for an interview. Your answers will be treated confidential like all the others.

e-mail address:

Please keep a copy of the questionnaire to compare your answers with the results of all questionnaires. These will be published probably in the middle of September this year.

Thank you very much for your support. Please send the questionnaire with the internal post to:

Franz Hofer
Department no.: 9303