A Methodology facilitating Knowledge Transfer to both research experienced companies and to novice SMEs

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Abstract

In this paper, knowledge transfer is defined as a process of disseminating both technological and theoretical understanding as well as enhancing both industrial and academic knowledge through conducted research to project partners collaborating within a research project. To achieve this, a new methodology called 'user groups' is introduced. It facilitates knowledge transfer between project participants in collaborative research programmes engaging both experienced and unexperienced partners regardless of level of input.

The introduced methodology 'user groups' provides tools for collaborating with several research partner even though their levels of engagement in the project and prior research experience may vary without dividing them into separate groups. It enables all project partners to gain new knowledge and by so doing extending the Knowledge Society. The case study shows that the eight engaged companies are able to cooperate, achieve their own objectives and, both jointly and individually, contribute to the over-all project goals.

Keywords: methodology facilitating knowledge transfer; technology transfer; SME; Small and medium enterprises; knowledge society.

1 Introduction

Outcomes from research projects are often of interest not only for academics at universities. The projects results can impact society through engagement of project partners, typically companies were the results can be taken up and implemented. Many of the public research funding agencies demand involvement of non-academic project partners and also highly value the transfer of technology and knowledge into small and medium sized enterprises (SME, a company having up to 250 employees).

Setting up a research consortium can be a complex task involving building partnerships with a range of partners including SME's. Establishing a collaboration with the project participants both on an individual basis and on a company level is an important starting point and crucial for project implementation and delivery. Establishing a project scope and objectives with the project partners can lead to several questions asked by the companies, many of them related to "What can we gain from the project?" and "How do we participate and engage during the project?". The individual in a national or global company involved during project set up usually encounter similar kinds of questions concerning planning and development that stretch several years into the future. They are used to handling uncertainty inevitably involved in longer term projects. However the situation is often different for an SME, whose planning horizons are often relatively short term. Furthermore SME's are often less experienced in partnering with academic organisations and research. An SME has fewer resources to engage specifically in the planning and development of projects. One main challenge in research proposals accordingly is how to engage both larger companies and SMEs in a research agenda that meets both their expectations and aims and at the same time to perform leading edge research. In addition, technology and knowledge transfer to individuals covering a spectrum without prior experience to well-established and experienced in research cooperation is usually a key facet of the project agenda.

This paper introduces a methodology for enabling knowledge and technology transfer and exchange in collaborative research programmes aiming to increase the productivity in engaging both experienced and unexperienced research partners regardless of level of input. The methodology also facilitates knowledge exchange between project participants bringing the researchers and the implementers' and users of the research output closer together.

In the following Section a review of research on technology and knowledge transfer is presented. The methodology of 'user groups' is introduced and explained in Section 3. In Section 4 the development and achievements of an ongoing 'user group' are described. The paper concludes in Section 5.

2 Research on Technology/Knowledge Transfer

Exploring and generating new knowledge are the essence of research and together with knowledge transfer to students and to society it represents the main driving forces of an academic body. Knowledge obtained by research forms a foundation for future innovation for both students and companies. Innovations through research are key mechanisms for manufacturing companies striving to reach or keep a leading position in their markets. The integration of education together with research and innovation are seen as key to future international competitiveness for manufacturing industry by the European Commission (Manufuture, 2006). The European Commission emphasize research, innovation and education as the three central drivers of our knowledge-based society and the importance of developing strong links between them. These three drivers are together referred to as the Knowledge Triangle (European Commission, 2010) (Figure 1). It is essential that the knowledge gained through research projects are not held by the researchers alone but also reaches and are understood and possibly implemented by appropriate commercial project partners. The transfer of projects results are an important part of research programmes and vital for building towards the knowledge society.

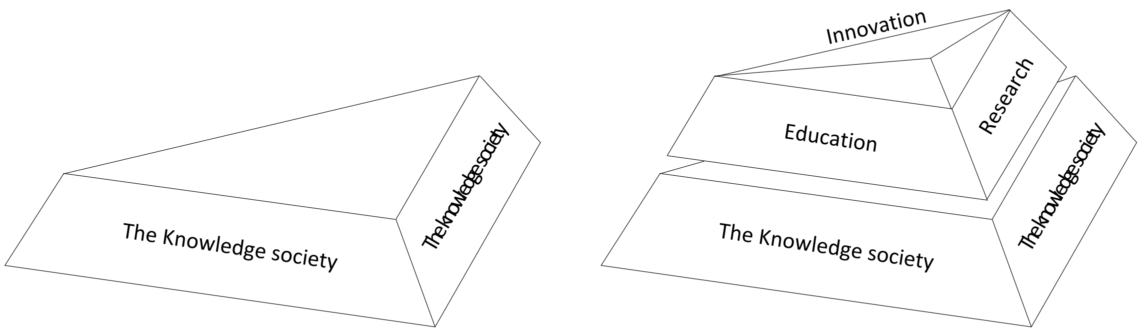

Figure 1. The Knowledge society and its drivers: Education, Research & Innovation.

In the literature there are in the main two expressions used for the transfer process, Technology transfer and Knowledge transfer. According to Mock, Kenkeremath, and Janis (1993) Technology Transfer is the transfer of research results and its applications to an industrial implementation. It occurs when knowledge gained by one individual or group is adopted by another individual or group. Mock et al. (1993) also include technical education and training as essential parts of Technology transfer. A definition of transfer of knowledge is “the process concerned with the effective exchange of research related findings” (Braun &

Hadwiger, 2011). The exchange takes place between the donors, having the knowledge and the receivers, receiving the knowledge. In an analysis of the knowledge transfer process Wei'e (2011) adds beside the three variables (1) the knowledge itself, (2) the knowledge sender and (3) the knowledge receiver, a fourth variable: the media and process used by which the knowledge flows when transferred.

There are several definitions of knowledge transfer and technology transfer, some mentioned by Wang (2006) and a synthesis of definitions are concluded by Hyppölä and Skournetou (2013): Knowledge and technology transfer "is often understood as explicit (e.g. intellectual property, IP, policies and patents) and tacit (e.g. experience and know-how) sharing of knowledge and technologies ….. between organizations". In this article knowledge transfer is defined as the process of disseminating both technological and theoretical understanding as well as enhancing both industrial and academic knowledge through conducted research to project partners collaborating within a research project. Our definition also includes the introduced methodology used for the process of knowledge transfer and exchange of knowledge as described in the following sections.

In the transfer process receivers in the companies are not just the engineers. An increasing complexity of the production systems demands an enhanced need of technical skills and knowledge for shop-floor operators (Holm, Adamson, Wang, & Moore, 2014; Karlsson, Mattsson, Fast-Berglund, & Stahre, 2013; Teknikföretagen, 2013). The future "knowledge worker" and the education needed to reach that level of understanding is discussed by Mavrikios, Papakostas, Mourtzis, and Chryssolouris (2013). They introduce a cognitive framework for industrial training and learning having four main steps to undergo for the "knowledge worker": Attitude (feel), Knowledge (think), Skills (do) and Competence (master). In combination with a technology framework based on an extended Teaching Factory framework they introduced a cognitive framework that enables industrial learning as a key to bridging the gap between research and industrial innovation supporting the company's growth and competitiveness.

As any project is about planning and project management being essential for success this equally applies for industry-academic joint research projects. Managing a research project is not only about setting up the research consortium it of course also includes implementation and delivery stages including knowledge transfer during the project period. Initial planning and a detailed description of the research goals reduce the risk of misunderstandings between the project partners later during the project. The importance of initial planning and both formal and informal interactions among project members are emphasised by Cummings and Teng (2003) and Morandi (2013). Initial conditions and management of university-industry partnerships are examined by Thune and Gulbrandsen (2014) where the relationship development within six different research projects were examined. They conclude that there is no definite link between initial conditions and how collaborative research projects evolve on a longer term. However initial mutual interests and strong interdependencies between the project partners help enforce the relationships within the project group. But, the formation of the group and good initial conditions are alone not enough for positive long-term group development. As in any human relationship the partners have to work continuously on the relationship. The importance of interrelation trust for successful knowledge transfer cannot be overstated. Interrelational trust and engagement can enable joint meetings hosted by partner companies for observation and discussion of project case studies implemented at hosts emphasizing exchange of ideas and knowledge overcoming impediments such as differences in status, aim and culture providing value to all participants. Partners that trust each other are also willing to facilitate both the project and each other in reaching and exceeding project goals (Battistella, De Toni, & Pillon, 2015; Bellefeuille & Rice, 2002; Braun & Hadwiger, 2011; Breznitz & Feldman, 2012; Hirose, 2012; Plewa et al., 2013; Santoro & Bierly, 2006; Santoro & Gopalakrishnan, 2000). A solution to keep up a long-term relationship within the project is to design support programs that enhance project partner efforts and interactions, which are considered beneficial for the learning process and needed for technology and knowledge transfer (Cummings & Teng, 2003; Muthusamy & White, 2005; Thune & Gulbrandsen, 2014).

The barriers faced for knowledge transfer within a research project are almost identical whether the transfer processes are between industry-industry or academia-industry. An obstacle for knowledge transfer can often be identified as either one out of these four barriers: a barrier of “not knowing”, a barrier of “not wanting”, a barrier of “not capable” or a barrier of “not allowed” (Albers, Bursac, Maul, & Mair, 2014). When facing a barrier, motivations are important counter measures. Four categories of rationale for engaging in academic – industry research cooperation are given by Broström (2012), these are:

- Cooperation for product and process development
- Access to academic networks
- Human capital management
- Direct business opportunities

Broström (2012) indicates that some companies see academic cooperation more as a way to generate knowledge and abilities for future innovations rather than reaching direct research outputs (normally seen as innovations). Depending on the knowledge to be transferred the importance of facilitators differs. For tacit knowledge (e.g. experience and know-how) trust is a significant facilitator together with social connectedness, technological capability and technological relatedness. When transferring explicit knowledge (e.g. intellectual property, IP, policies and patents) the same facilitators of course matter but also the organisations IP-policies play an important role in the interaction (Santoro & Bierly, 2006). To reach an effective stage of transfer, especially concerning SMEs some typical challenges have to be addressed (Braun & Hadwiger, 2011). On the donor side these are:

- An assumed benefit of exclusive possession of knowledge
- Lack of ability in transferring knowledge to a non-specialist
- To little direct contact with industry partners
- Barriers of culture and language (which of course is a concern for both sides of the transfer process)

For the receiving side during knowledge transfer the challenges to address include:

- Trust deficiency
- Absence of structures for knowledge processing
- A knowledge gap in how knowledge is transferred

With an aim to enhance the Technology Transfer performance some recommendations are given to the researchers: Create strategic partnerships using research networks; establish consortia and exploit intermediary institutions and assure that project members in both academic and industry have hierarchical power within each organization enabling decision making and integration of the research outputs (Heinzl, Kor, Orange, & Kaufmann, 2013; Morandi, 2013).

To reach and exceed an aim of successful knowledge transfer, which is the responsibility of all entities in the research process, the information to be transferred has to be processed and presented so that it is easily understandable by the receiving individuals. If the transfer process does not take off from the receivers' level of understanding and reality it will be undermined. But as important is also a common and consistent understanding of the scope and timing of a research project together with the challenge of including the "right" people (e.g. decision makers) in both the companies and the academic body (Bellefeuille & Rice, 2002; Braun & Hadwiger, 2011; Czarnitzki, Hussinger, & Schneider, 2012).

3 Engaging companies in research and knowledge exchange

A knowledge society needs education and research to have innovations. An ability and maturity to implement and master research output and innovations are vital to maintain competitiveness. The methodology introduced, namely 'user groups' facilitates cooperating companies to learn, apply, implement, share and master knowledge gained through research to strengthen their competitiveness (Figure 2). It is not a one-way methodology, it is bi-directional. It also eases feed-back from reception and implementation of research output back to the researchers reducing risk of misunderstanding and diversity of aims and by so strengthening research and facilitating new innovation.

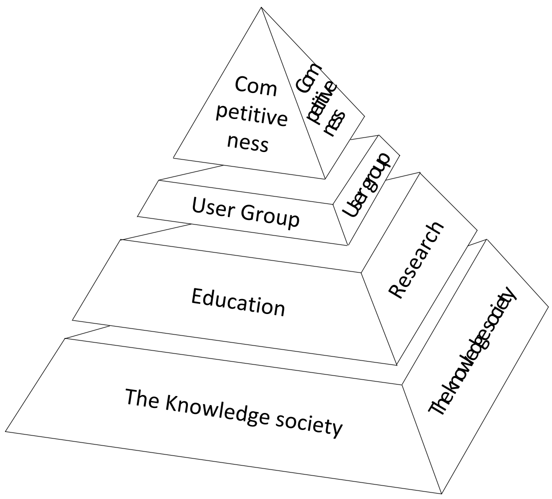

Figure 2. 'User groups' as methodology to facilitate competitiveness in building a knowledge society

3.1 Building the Knowledge society

The number of companies engaged in research and with ability to use and implement research results needs to increase. If only the “old” partners are invited to the new research projects the growth of the base of the knowledge society is limited. Academic institutions have a responsibility to engage with companies with low previous experience of research participation. The methodology introduced, ‘user groups’ enable researchers to include both mature and immature partners in the same project facilitating all of them to reach new levels of knowledge and at the same time give continuous feedback to the researchers during the project.

An initial question when we have met a company representative during set up of a research project has often been: *Will you work towards improving your productivity during the coming years?* If the answer is *no* then there are perhaps insufficient foundations for future cooperation and the management of the company in question does not recognize the demands from the market. Our experience however is that when asking this question the answer is always *yes*. This positive answer has been and will be a good foundation for further dialogue regarding research cooperation.

Long term relations with some companies are common in many research groups and these project partners have mostly no problem in understanding the aims and objectives of linked and subsequent research projects. The results of previous research is understood and sometimes already implemented in daily work. New research partners though do of course not have the long term experience of the established partners. This affects both their participation during the research project and their ability to absorb knowledge gained through the project and implement it.

Major Swedish research funding agencies like Vinnova and the Knowledge Foundation as well as the European Union Research and Innovation agencies emphasize the importance of industry related research and participation of SMEs. Larger companies acting in the international arena usually have their own research departments with experienced researchers while SMEs often do not have many research resources or experience. Though the size of the company does not itself define the probability of successful knowledge transfer (Santoro & Gopalakrishnan, 2000; Saunila & Ukko, 2014). In this paper however a research-inexperienced company is symbolized with “SME” and the research-mature company with “Large company”. Different datums are of course a challenge when leading a research project and it becomes even more challenging when facing knowledge transfer. Each company’s ability to understand and implement research outputs are often determined by its prior experience and level of maturity.

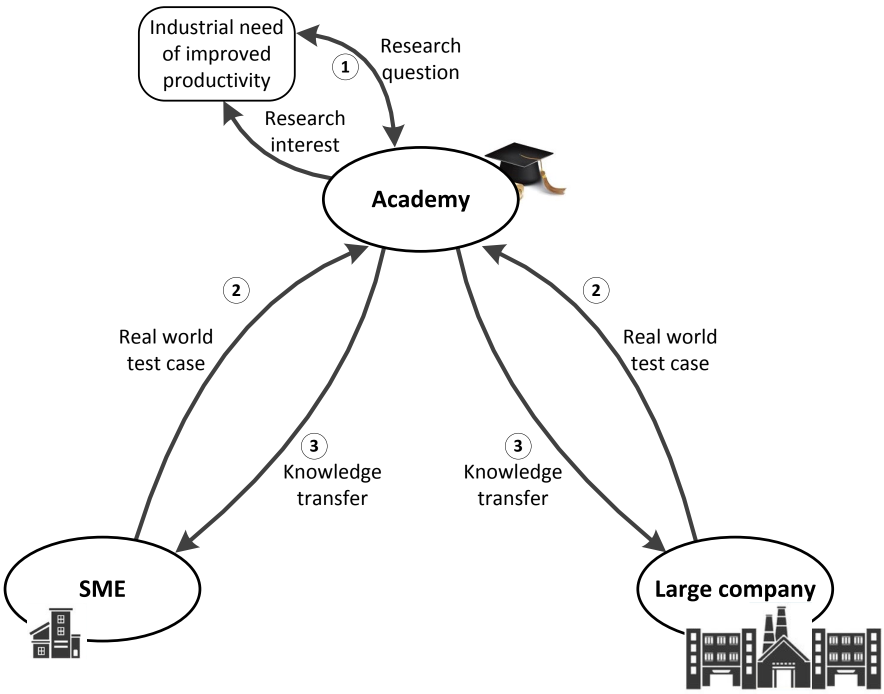

Figure 3. "One-way" knowledge transfer

3.2 “One-way” knowledge transfer

An obvious foundation for a research project is of course the researchers own in particular research interest and when aligned with an industrial need or productivity improvement, namely a research question ① (Figure 3) and at the same time a basis for an industry related research project is initiated. The research question and the problems it addresses are relevant for all the project partners. Previous experiences show however that the active project often is carried out as described in Figure 3. Each company participant contributes with test cases in their own production facilities ② for validation and verification but each test case is exclusive for the specific company and each company’s interest is focused on its own challenges and no real interaction between the project partners takes place besides seeing each other at the project meetings. The process of knowledge transfer is focused on each test case specific results and is in essence a one-way transfer between the researchers and the specific company ③. Besides joint project meetings the individuals from the separate companies do not interact much within the project.

3.3 A methodology for multi-directional knowledge exchange

To bridge the gap between the mature and immature project partners based on both research experience and ability to accept and implement new ideas and also achieving a multi-directional knowledge exchange a methodology called 'user groups' can be introduced. It is a methodology where leading-edge research and its innovative outputs together with knowledge transfer can be understood, adopted and implemented both by the research experienced "Large company" and the research immature SME meeting each project partner at their own level. The methodology facilitates multi-directional knowledge exchange between companies and also from the companies to the researchers. The set-up and initiation of the projects research questions and test cases applying the methodology are similar as previously described in Figure 3.

The 'user group' has two major aims: To transfer knowledge, methodology and innovations from both prior and ongoing research projects to the partners in the 'user group' through training, seminars, customized courses, field trips and showing good examples of applied research results but also to share knowledge from the companies to the researchers about the process of bringing research into real production and the issues occurring building the companies competitiveness and strengthening the researcher. A second aim is to build long-term relations, both between academia – industry and industry – industry, achieving interrelational trust and understanding and facilitating cooperation, knowledge exchange and future research in building our Knowledge society. The 'user groups' methodology is described in Figure 4.

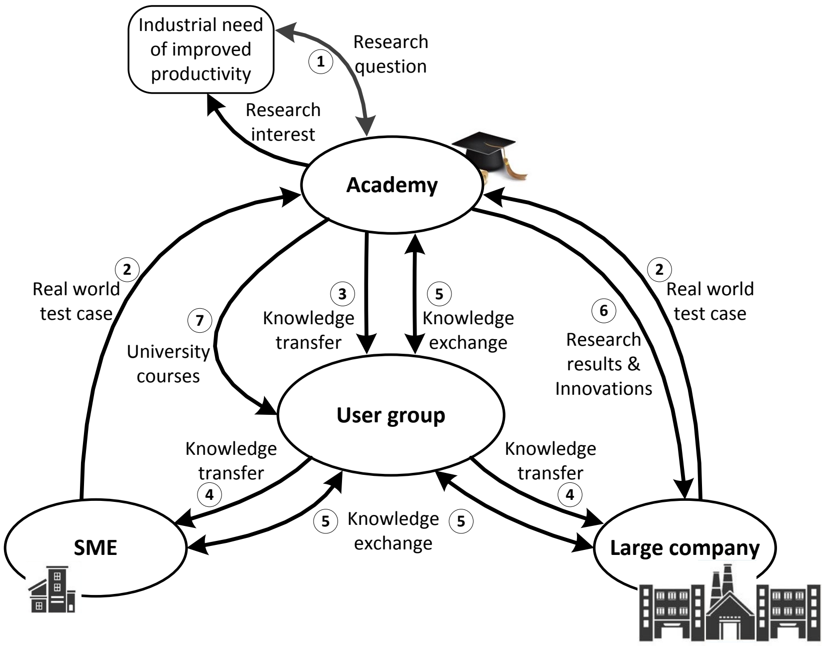

Figure 4. Methodology for a 'user group'

Initiation of a research project using the methodology 'user groups' is enabled when a research interest meets industrial needs ① and the participating companies contributes real world test cases into the project ② Figure 4.

Besides the usual project meetings (2-3 annual meetings) the 'user group' meets 4-6 times per year. The researchers' present both previously proven methods and innovations together with new knowledge to the participants of the 'user group' ③ who applies it according to each company's ability and aim in their own production facilities ④. Through the 'user group' the researchers get a direct link to the ones applying and using the research output which enables knowledge exchange and a fast feed-back loop facilitating discussions on research output usability, degree of satisfaction and level of project accomplishment ⑤. The larger company having prior research experience can directly understand, apply and implement the project outcome ⑥ while the in research inexperienced SME they have not yet reached that level of maturity. When the project is coming to an end and a successful project is built the initiating process ① is facilitated and the previously research inexperienced partner companies are ready to shoulder a greater responsibility.

In parallel to the 'user group' meetings university courses ⑦ covering the aspects of the ongoing research projects are arranged for the staff working at the project partners. These courses cover topics such as: Lean Philosophy, Simulation and modelling, Methods engineering, Industrial robotics and Production systems development. Through the courses the partner companies are able to train their employees both in theories and to practice the knowledge gained at their own workplace. These courses enable the project partners to train their staff at both basic and intermediate levels and it facilitates the adoption of research output on both engineering and shop-floor levels.

3.4 Approaching the methodology 'user groups'

The 'user groups' methodology has been initiated by the Production and Automation research group at the University of Skövde together with initially eight cooperating companies engaged in four different research projects. Two of the larger companies are engaged in more than one of the research projects and the six SMEs are engaged in one project each. The introduced methodology is not limited to be used in a specific field of research but needs a compromising and including approach from the researchers. All research partners of our research group are invited to engage in the ongoing 'user group' when involved in a research project. The most important input to the methodology from both the researchers and the participating companies are an interest and willingness to share and gain knowledge both inside, outside and beyond the scope of the specific project.

4 Case studies and implementation

The ongoing 'user group' covers decision support for both managerial, engineering and shop-floor level supplemented with human machine interaction. The following case study describes an ongoing work where the introduced methodology 'user groups' has been implemented focusing decision support using simulation-based optimization, data mining and techniques for extracting knowledge.

4.1 Activities within a user group

A central and important aspect for the knowledge outcome to be realized is to establish an arena for collaboration and knowledge exchange between academia and research partners as well as between the research partners themselves. In order to facilitate this knowledge exchange between the project partners workshops are initiated with the aim of creating a fellowship between the project partners in order to learn from each other's experience and to share and exchange knowledge. The activities of a possible 'user group' during a twelve month period are illustrated in Figure 5.

Usual projects meetings are arranged within each research project once or twice a year. These meeting focus the project specific issues and if two projects have closely related issues to handle (for example shared demonstrators) jointly project meetings are arranged ①. In parallel to these meetings workshops are arranged. These workshops ② are not dedicated to a specific research project instead all project partners from the contributing research projects are invited. The scope of the workshops are knowledge transfer from both previous and ongoing research and are based on the aims and needs of the participating project partners. In parallel to the workshops university courses ③ specially addressing the needs of industry are arranged. When a need of knowledge further is recognized after a workshop the participants are invited to a course addressing these needs ④ preparing them for coming workshops and tasks within ongoing projects.

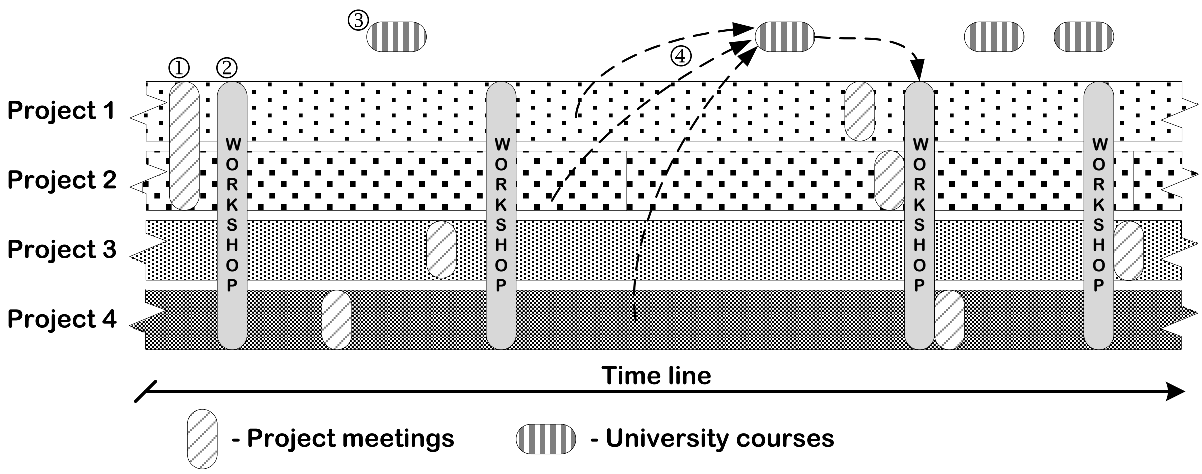

Figure 5. ‘User group’ activities during a 12 month period.

4.2 Expected outcome from a user group

When initiating a new ‘user group’ the participating companies all have their individual aims and starting points which of course affects the outcome when the research projects are concluded. Four of the participating companies in this example are identified by A, B, C & D (Figure 6). Companies A and B have previously been involved in several research projects with academics, and hence start off at different levels of comprehension due to their previous knowledge and maturity compared to companies C and D. Company A, which is an multi-national company with several thousand employees, is a long-term research partner and a type of company that is able to discuss research questions directly with academics. They are able to focus the core of a research project as well as directly utilize and implement the outcomes of the project as they already have an organization and approach to work with the methods and techniques investigated. Company B, which can also be considered a large company, has a similar organizational structure and approach to work with the investigated techniques. However in contrast to company A the personnel working with the investigated methods and techniques in company B are still limited to a few experts. Companies C and D on the other hand have not participated in any research collaboration before, and hence start to learn the scope of the project by introduction and tutoring the knowledge, technology and scope to their organizations. However, in contrast to the previous two companies C and D only aim to apply and test the latest research in the form of demonstrators, or test cases at their companies due to their low level of maturity regarding involvement in research projects as well as prior knowledge.

Decision support technologies used for this 'user group' are related to simulation-based optimization, data mining and techniques for extracting knowledge from the optimization results. One of the current research projects features the two latter subject areas and another project's focus is development of optimization algorithms. Knowledge on discrete-event simulation and simulation-based optimization is needed when engaging in the projects. However despite the pre-requisites for these two projects companies start at different level of understanding and maturity depending on previous collaboration within research projects and own experience. Typically, larger enterprises have more experience with research collaboration compared to SMEs.

The initial status of the companies A-D in the 'user group' regarding the scope is shown in Figure 6 (before-bar). Company A already master modelling and simulation and are skilled in optimization. They have tested data mining and knowledge extraction and are getting awareness of possible opportunities using such techniques. Company C & D on the other hand do not have any previous practical knowledge concerning simulation based optimization but have an awareness of the technology and what can be achieved by implementing it in their organization. The expected knowledge outcome when finalizing the ongoing research projects for company A-D is shown in Figure 6 (after-bar). Each project partner sets their own aims, which of course strongly affects the expected level of maturity reached after the three year project period has ended.

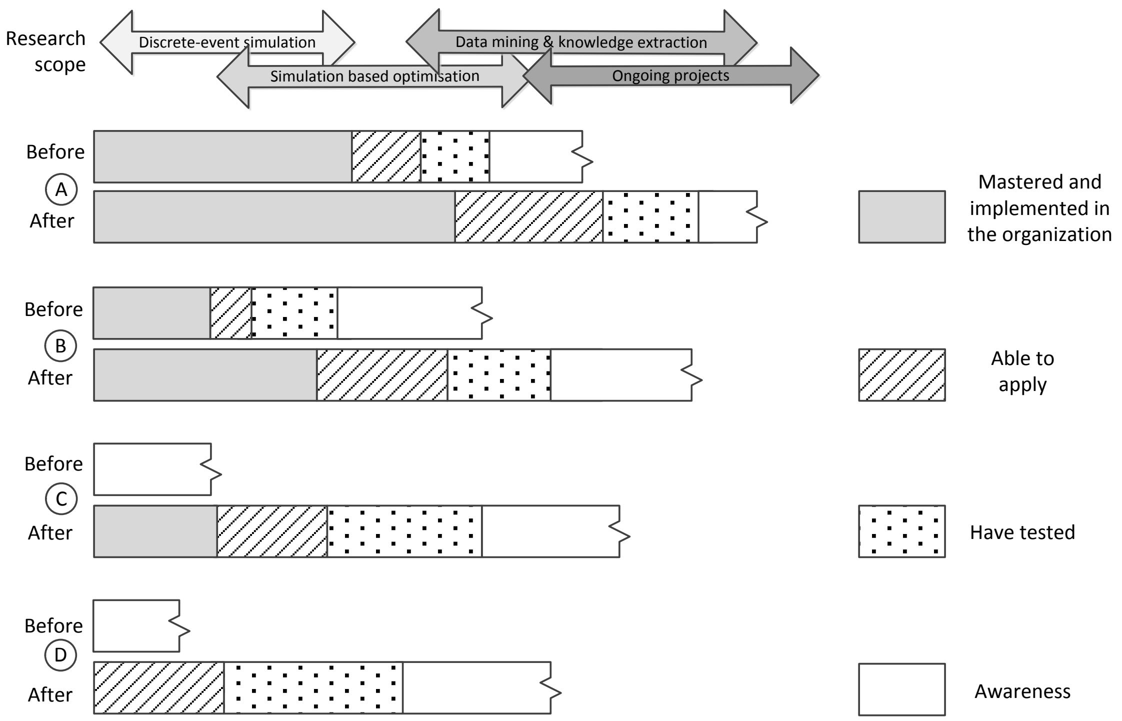

Figure 6. Starting points and expected knowledge outcomes for different companies in an ongoing user group.

4.3 Examples from an ongoing user group

This chapter describes an ongoing ‘user group’ at the University of Skövde. The initial workshop of the ‘user group’ is mainly for building the collaboration and understanding between academia and research partners, as well as discussing the aims of the research projects’ and the aims of each individual research partner in order to obtain a shared view on what is to be accomplished when the project ends as well as in future projects. Current as well as past research is presented and discussed in the workshops in order to obtain an understanding for the ongoing research at the university. These presentations do not only include research conducted within specific projects but also research from other ongoing projects is also presented in order to disseminate project outcomes as well as finding synergic effects between various projects and project partners. In addition to these presentations various demonstrators created in the research projects resulted achieved are also been demonstrated in order to display the practical usage of the research. Furthermore, one of the more experienced company partners have also held workshops and shared their experience and view on participating in research projects and how to utilize and take advantage of the research outcomes. Presentations and examples from the more experienced company partners in the workshops has been shown to generate a powerful impact, since they can share their way of working with research and academia as well as sharing their experience regarding their journey to get here, i.e. in terms of research maturity. For instance, in a workshop held at company A they explained that in the beginning they also had only a few experts, within the field of simulation based optimization, until they were able to demonstrate possible savings in a few key research projects. However despite successful research projects and acknowledgement from management they weren't able to integrate this school of thought, i.e. participating and fully utilizing research outcomes, in the organization and in their way of working until the company decided to send about 70 engineers to attend university courses in order to obtain basic discrete-event simulation and simulation-based optimization knowledge. This was extremely powerful in order to attain an understanding for the possibilities and limitations of these techniques. Thus, one of the things addressed in the workshops is providing exercises and tutoring for the company partners in order to enhance their understanding and knowledge regarding the various subject areas that concerns the research project. This action proved to be very fruitful and contributed so that almost all company partners focusing on simulation based optimization decided to send personnel to attend university courses within discrete-event simulation and simulation-based optimization.

The persons attending the course focusing discrete event simulation were mainly production engineers, but there were also technicians and managers attending the course. This was also reflected in the categories selected to compare the studies as well as objectives of the studies. The nine simulation studies done by the 'user group' participants are presented in Table 1. The studies have been categorized in the following way:

- Type of problem:
    - *Application area*: Assembly (A), machining (M) or other (O). The application area describes the main area modelled by the students.
    - *Level of detail*: High (H), medium (M) and low (L), where L means very detailed.

    - *Number lines or stages*: A number specifies the number of lines (L) or production stages (S) of the problem studied. In the cases serial production stages (one resource/machine per stage) have been studied it use the notation SS.
    - *Simulation-based optimization*: Whether simulation-based optimization have been used in the simulation study or not.
- *Types of experiments and optimizations* categorize the different experiments carried out in the simulation studies. If there are few studies (less than three) in one type of experiment they are added in the category "Other What-If".
- *Results* present the main result of each study even though many studies have several results.

There were four participants from company B, three from company C and two from company D. During the course, company A had students attending that weren't part of the 'user group' and they are therefore not part of Table 1. However, it is possible to see that all the companies having different starting points are able to successfully perform a complete simulation study. Furthermore, most of the simulation studies even use simulation-based optimization, including some knowledge extraction, which is a proof of research maturity. The most common type of problems modelled is machining lines and where the numbers of production stages are quite many. The main result of each study is presented and four of the studies have analyzed the impact of something, e.g. impact of increased buffer capacities. Five of the studies have even proposed what is required to be changed in order to improve the result (productivity), and is atypical result achieved from using simulation-based optimization. In those cases where there are several interconnected investments needed to achieve a better result the *Results* column in Table 1 are marked as "Investments required".

Table 1. University course for 'user group' participants and their results.

Type of problem					Types of experiments and optimizations											Results
Company	Application area	Level of detail	Number lines or stages	Simulation-based optimization	Number operators or skill of operators	Shift forms and breaks	Production volume and variant mix	Abstraction and modelling	Availability and MTTR	Processing time	Bottleneck analysis	Pallets/carriers	Buffers	Machine alternatives	Other What-If	Main result achieved
B	M	M	37S	Yes						x	x		x	x		Machine investments
B	A	M	19SS	Yes			x				x				x	Impact of buffers
C	M	M	5S	Yes					x	x	x	x	x			Investments required
D	O	M	3L	No				x				x	x		x	Impact of prod. volumes
B	O	H	4L	No		x							x			Impact of buffers
C	A	L	12S	Yes						x	x	x	x			Processing time required
D	M	M	9S	No		x			x		x					Bottleneck analysis
B	M	M	18S	Yes		x			x		x		x			Buffer capacities required
C	M	L	12S	Yes				x	x	x	x		x			Investments required

5 Conclusions

It is essential to engage new companies to participate in research so knowledge gained is not only held by few but instead is spread to, understood and implemented by many. To be one of the workers building and extending our knowledge society is an important task for the Academy. Many research funding agencies require industry related projects having leading edge research and at the same time emphasize the importance of engaging SMEs in research projects. Though size does not define a company's ability to adopt research outputs a national or international company usually have available staff with research experience that can engage in the project in contrast to a SME. Meeting requirements of leading edge research, SME engagement and knowledge transfer in one project is not easily done due to diversity in research matureness, prior experience of the participating companies and a lack of a suitable methodology. Previous experience shows that interaction within a research project is usually limited to company – researcher and not many relationships between the active companies. Researchers engaging companies without prior research experience often face a situation where the partners within a project have different starting points regarding ability to adopt the research output.

The methodology of 'user groups' introduced provides tools for cooperating with both the experienced research partner and the novice having different levels of engagement in the same project without dividing them into separate groups. The 'user group' case study described has shown that companies with a big diversity in both prior experience and levels of engagement are able to cooperate, reach their objectives and at the same time, both jointly and individually, contribute to the over-all project goals. Knowledge transfer to companies and facilitating exchange of knowledge both between company – researcher but also between companies within the 'user group' are essential when building and maintaining the companies' market competitiveness. The 'user groups' methodology facilitates both the inexperienced and the research mature companies to gain new knowledge and by so doing extends the Knowledge Society.

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References

Albers, A., Bursac, N., Maul, L., & Mair, M. (2014). The Role of In-house Intermediaries in Innovation Management – Optimization of Technology Transfer Processes from Cross-industry. *Procedia CIRP, 21*(0), 485-490. doi: http://dx.doi.org/10.1016/j.procir.2014.03.151

Battistella, C., De Toni, A. F., & Pillon, R. (2015). Inter-organisational technology/knowledge transfer: a framework from critical literature review. *The Journal of Technology Transfer*, 1-40.

Bellefeuille, J. H., & Rice, J. B., Jr. (2002). *A job fit for Evel Knievel: jumping the canyon of academia-to-industry knowledge transfer.* Paper presented at the Engineering Management Conference, 2002. IEMC '02. 2002 IEEE International.

Braun, S., & Hadwiger, K. (2011). Knowledge transfer from research to industry (SMEs) – An example from the food sector. *Trends in Food Science & Technology, 22, Supplement 1*(0), S90-S96. doi: http://dx.doi.org/10.1016/j.tifs.2011.03.005

Breznitz, S. M., & Feldman, M. P. (2012). The engaged university. *The Journal of Technology Transfer, 37*(2), 139-157.

Broström, A. (2012). Firms' rationales for interaction with research universities and the principles for public co-funding. *The Journal of Technology Transfer, 37*(3), 313-329.

Cummings, J. L., & Teng, B.-S. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and Technology Management, 20*(1), 39-68.

Czarnitzki, D., Hussinger, K., & Schneider, C. (2012). The nexus between science and industry: evidence from faculty inventions. *The Journal of Technology Transfer, 37*(5), 755-776.

European Commission. (2010). European research area, ERA in the knowledge triangle. .

Heinzl, J., Kor, A.-L., Orange, G., & Kaufmann, H. (2013). Technology transfer model for Austrian higher education institutions. *The Journal of Technology Transfer, 38*(5), 607-640. doi: 10.1007/s10961-012-9258-7

Hirose, Y. (2012). *Knowledge transfer from researchers to society: How to offset the cultural gap?* Paper presented at the Technology Management for Emerging Technologies (PICMET), 2012 Proceedings of PICMET '12:.

Holm, M., Adamson, G., Wang, L., & Moore, P. (2014). *The Future Swedish Shop-floor operator - Interviews with production managers.* Paper presented at the Proceedings of the sixth Swedish Production Symposium, 2014, Gothenburg.

Hyppölä, J., & Skournetou, D. (2013). *Knowledge and technology transfer as a form of industry-academia cooperation in a joint training and research project*. Paper presented at the 6th International Conference of Education, Research and Innovation, Seville, Spain.

Karlsson, M., Mattsson, S., Fast-Berglund, A., & Stahre, J. (2013). *Could the use of ICT tools be the way to increase competitiveness in Swedish industry?* Paper presented at the Analysis, Design, and Evaluation of Human-Machine Systems.

Manufuture. (2006). Manufuture - Strategic research agenda, Report of the High-Level Group, Assuring the future of manufacturing in Europe. 11.

Mavrikios, D., Papakostas, N., Mourtzis, D., & Chryssolouris, G. (2013). On industrial learning and training for the factories of the future: a conceptual, cognitive and technology framework. *Journal of Intelligent Manufacturing, 24*(3), 473-485.

Mock, J. E., Kenkeremath, D. C., & Janis, F. T. (1993). Moving R&D to the Marketplace, A Guidebook for Technology Transfer Managers (pp. Medium: ED).

Morandi, V. (2013). The management of industry–university joint research projects: how do partners coordinate and control R&D activities? *The Journal of Technology Transfer, 38*(2), 69-92. doi: 10.1007/s10961-011-9228-5

Muthusamy, S. K., & White, M. A. (2005). Learning and knowledge transfer in strategic alliances: a social exchange view. *Organization Studies, 26*(3), 415-441.

Plewa, C., Korff, N., Johnson, C., Macpherson, G., Baaken, T., & Rampersad, G. C. (2013). The evolution of university–industry linkages—A framework. *Journal of Engineering and Technology Management, 30*(1), 21-44.

Santoro, M. D., & Bierly, P. E. (2006). Facilitators of Knowledge Transfer in University-Industry Collaborations: A Knowledge-Based Perspective. *Engineering Management, IEEE Transactions on, 53*(4), 495-507. doi: 10.1109/TEM.2006.883707

Santoro, M. D., & Gopalakrishnan, S. (2000). The institutionalization of knowledge transfer activities within industry–university collaborative ventures. *Journal of Engineering and Technology Management, 17*(3), 299-319.

Saunila, M., & Ukko, J. (2014). Intangible aspects of innovation capability in SMEs: Impacts of size and industry. *Journal of Engineering and Technology Management, 33*, 32-46. doi: http://dx.doi.org/10.1016/j.jengtecman.2014.02.0020923-4748/

Teknikföretagen. (2013). Made in Sweden 2030, Strategic Agenda for Innovation in Production.

Thune, T., & Gulbrandsen, M. (2014). Dynamics of collaboration in university–industry partnerships: do initial conditions explain development patterns? *The Journal of Technology Transfer, 39*(6), 977-993. doi: 10.1007/s10961-014-9331-5

Wang, L.-p. (2006). *The Process of University-to-Industry Knowledge Transfer And Influential Factors.* Paper presented at the Service Systems and Service Management, 2006 International Conference on.

Wei'e, W. (2011). *Analysis of knowledge transfer process and model building.* Paper presented at the E -Business and E -Government (ICEE), 2011 International Conference on.