Knowledge transfer
Industry - University
Viewpoints with respect to small and medium size enterprises

A. Brouwers

Distribution: Eindhoven University of Technology
Center for biomedical and health care technology
Postbox 513
5600 MB Eindhoven
The Netherlands
Fax: +31 40 443335
Tel: +31 40 472008
Eindhoven University of Technology

Knowledge transfer Industry-University

FEICRO-conference, Paris, 15th & 16th June '92
Improvement of the performances of European small and medium size enterprises (SME's) by co-operative research and technology diffusion.

Some contributing viewpoints
A. Brouwers; Center for biomedical and health care technology

Eindhoven University of Technology
Founded in 1956. 2400 staff members. Over 7000 undergraduate students. Approximately 400 Ph.D. students. Annual budget is about 250 million Dutch guilders i.e. 150 million US $.
It is part of the Eindhoven University policy to cooperate with industrial research and development (R&D) groups. The university aims at increasing cooperation with international institutions. Topical research areas are given in the addendum to this paper.

Address: Eindhoven University of Technology (in Dutch abbreviated to TUE),
PO Box 513, 5600 MB Eindhoven, The Netherlands.

Biomedical and Health Care Technology
Over 10% of the university research capacity is concentrated on the area, where scientific and technical knowledge and skills can be applied to problems in health care, medicine and biology.

The activities in this field are multidisciplinary. Interactions always enclose the three general domains: Health Care, Industry, University. Projects in this field require co-operation between a variety of medical and technical scientists, medical clinicians, and industrial specialists. Most projects are carried out in interuniversity frameworks. There is considerable amount of international co-operation on a number of topics.

Activities on this area include knowledge transfer between Industry and University. The following viewpoints are based on experiences in this field and chosen to picture aspects of a more general nature with respect to implications and validity.

The University as a knowledge center
A university can by nature be considered as a knowledge center. However the knowledge, and for a university of technology often also the skills, are not so assessible as one believes them to be in general. Especially between universities and small and medium size enterprises (SME's) knowledge transfer processes are often not very succesful due to remarkable cultural differences. For a better understanding of the problems involved, the folowing elucidation may be useful.
Research in closed systems
A university researcher is primarily concentrated on a limited area of the total reality, which is of course an obvious constraint. Such a researcher applies specific tools of his own discipline, mostly on self chosen problems, fitting well within the characteristics of such a scientific discipline. A scientific career needs a considerable lot of time and dedication within the framework of a specific discipline, so there is often little left for much orientation outside this domain.

In many aspects research groups at a university can be considered as closed systems. In such groups the knowledge and skills are very specific on certain fragments or aspects of a given object area, and assessible almost exclusively within a specific framework of concepts and scientific language.

Moreover there are all sorts of research groups, with a variety of disciplines, but also distributed over different forms of science, often with their own specific culture and standards. See figure 1.

![Figure 1](image.png)

Increasing distance: research \(\Leftrightarrow\) new product

Forms of sciences
Between a new product in the market and the scientific research upon which it is based there is a certain interval. This interval or distance can be described as time required, manpower and provisions needed, before research results can be translated into new industrial products.

It is the practical empirical science that is the most prone to a new product. Here one finds the realization of new products, -methods, -systems or processes. It is commonly described as
applied research. Theoretical empirical science stands further away from a new product. Here research is oriented to the acquisition of more fundamental insight in the form of a theory or a given model of reality. The distance to a new product mostly is even larger in the case of non-empirical science, the domain where analytical tools are developed.

In interpreting suggestions from researchers for new industrial products, it is important to consider the scientific starting point from which they must come to realization. From the standpoint of application-oriented research a new product can generally be developed in a shorter period of time than would be possible by the transfer of suggestions from more basic research. From successful basic research newly gained insight can lead to more thoroughly considered specifications for a new product, with greater promise for successful development, but then as a rule, a great deal more must be done before that can be realized.

The different standards, steering activities within the various groups distinguished above often cause serious obstructions in processes of communication and co-operation.

Life cycle of a technology

Another way of picturing characteristics of research and product development is presented in the figure above giving some phases in the life cycle of a technology. Each phase in this life cycle requires its own framework of experts, involved parties and intermediaries. Each phase has its own specific guiding standards and objectives and its specific necessities and constraints within the managerial care.
The conceptual phases are primarily allocated in the environment of research centres. Gradually the centre of gravity is transferred to industry.

In the continuum from fundamental research to a final product in the market many institutions and a variety of specialists are active. They each create and transform knowledge and information in a specific manner. In doing so they are not only separated by differences in domains of expertise and daily practise, but also by their finite time horizons regarding the total life cycle of the technology involved.

**Small and medium size enterprises (SME's)**
The figure of the life cycle already enters the industrial domain. Figures 3 and 4 are intended to be useful for communication on the industrial phases in research and development (R&D).

![Simplified scheme of a product innovation process](image)

Within an industrial enterprise one can also distinguish subsystems having their own specific culture and standards. Differences between the departments for marketing and the R&D, for example, are considerable. These differences also can cause a certain "distance" between the co-workers involved. For an innovation process however the co-operation between these departments are of major importance. The quality of this co-operation has even been found to be one of the most important factors in the innovating capacity of an industry (Lian Krijger TUE 1991).

The power of integration and the pressure towards co-operation is considerably larger in an industrial enterprise when compared to a university. Nevertheless, in communication processes "university - industry" it is worthwhile to consider the specific disciplines of the researchers as well as the specific background of the industrial counterparts.

An SME in dialogue with a university research group has to consider the specific aspects of such a group as discussed above. Researchers in communication processes with SME's, also have to consider the background of the representatives. This can play a major role, marking not only the communication processes, but also setting certain constraints on achievable goals.

**SME needs for more knowledge**
The effective management of knowledge and information is increasingly important for the continuity of organisations. However, for many small organisation and SME's in particular,
this is already becoming too difficult to handle.

The need for more knowledge in SME's arises out of:
- Growing knowledge complexity of products
- Increasing product responsibility requiring maximum care for product quality
- Rising costs of product development, leaving little room for unsuccessful product innovations
- Faster aging of production systems
- Growing need for better adaptation to environmental constraints
- Increasing need for effective management in a strategic perspective i.e. over longer periods and a broader spectrum of product-market-technology combinations.

**Figure 4 Product innovation sub-processes. A communications scheme.**
The numerical notation indicates important points of attention in the managerial care for an innovation project.

**SME constraints for growth in knowledge**
In SME's situations occur that effect the ability to extend their knowledge and information system:
- Limited management capacity and the heavy workload on mostly one, or a few persons, responsible for continuity
- Dominating "short-term orientation" caused by the ever present need to fulfill short term goals
- Specific knowledge, concentrated in a few persons, with naturally a finite knowledge horizon leading to weaknesses within a broadening spectrum of relevant knowledge
- Limited financial resources.
Knowledge transfer Industry - University

A need for intermediaries

The needs and characteristics of SME's do not easily fit into the culture and structure of an university. The SME needs, as previously discussed, are very obvious. The university knowledge centres usually have a (knowledge) "product-out" orientation, and this is not easily changed in a more (SME) "market-in" approach. The university forms of output are not very assimilable for SME's in a direct way.

A variety of university institutions can contribute their specific knowledge and information to the continuum from fundamental research to a final product in the market, each having a specific function on certain aspects of this continuum. This body of scientific knowledge however is strongly fragmented, accessible only in bits and pieces from different experts, often too expressed in a variety of scientific "languages".

An innovation process on the other hand requires an effective integration of several packages of knowledge, with balanced attention for all aspects of an innovation process, such as (see figures 3 and 4):
- Product development, with proper care for all the technologies involved
- Development of the production process
- Preparing the market introduction
- Mostly ongoing R&D attention for improvements on the new product, preparing for a next generation of such an innovation
- Tuning to one goal of all the different co-workers on an innovation process
- Never lasting control on costs and progress.

In general a university has no capacity to offer for a proper selection and integration of knowledge and for suitable project management tuned on specific needs of SME's (a demand for a "market-in" approach). In general also SME's cannot easily supply for these wants themselves. This stresses the necessity of proper intermediaries (integrators, moderators), who make such knowledge transfer processes really effective.

Each university taking this SME market for knowledge seriously should have a specialized interface for this target group, a transfer center manned with persons experienced in industrial processes in general, knowing their way in the university, but knowing equally well the demands and problems within the reality of industries.

Of course this reality offers also a market for private advisers and bureaux. Although a growing amount of these are active, often presenting themselves as experts on almost everything, the present offer in this field for SME's turns out to be not very inviting. On this aspect much has to be changed, adapted also more to the reality of SME's.

Time horizons

Within the SME needs for knowledge transfer it is very functional to distinguish processes on their time horizon e.g. operational -, tactical -, and strategic processes. Each of this type of processes has specific characteristics, - requires often typical actors, - provides specific needs for extension.
Most requests on knowledge transfer from a university of technology are of an operational nature. In many occasions this concerns a problem in the production process requiring immediate attention. Usually a relationship with one expert turns out to be sufficient to solve such a problem.

Tactical processes require more attention. Here one finds needs for optimizing production processes, - idea-finding for new products, - product innovations, etc. In this category all the problems arise of the demand for good project management over a long period of time as discussed above. Here one finds the very successful examples of innovation as well as a great amount of failures in the process of co-operation between an university and an industry (Wim Biemans, TUE, 1989).

Knowledge transfer on strategic aspects turns out to be of increasing importance for SME's. However this field has been largely neglected in the overall picture. More than ever each enterprise must have a clear view on its future goals in the fast changing reality (in a SWOT context). Besides aspects on markets and products, commonly looked at, increasingly also technological aspects have to be considered as well in a company's strategy (Arie Nagel, TUE, 1992). Of course especially in this respect a university of technology has much to offer.

It may be clear without further discussion that each of these categories of transfer processes indeed have different characteristics, - will need specific actors, - requires special adapted actions of extension.

<table>
<thead>
<tr>
<th>Target Groups</th>
<th>Operational</th>
<th>Tactical</th>
<th>Strategic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediaries</td>
<td>Production problems requiring ad hoc solutions</td>
<td>Optimization of production processes</td>
<td>New technologies</td>
</tr>
<tr>
<td>Research Groups</td>
<td>Product innovation</td>
<td>New production processes</td>
<td>Marketing</td>
</tr>
</tbody>
</table>

Figure 5: For communication on knowledge and information transfer this scheme can be of practical use

Figure 6: A communication scheme: Industry - University, for the field of biomedical and health care technology
In figure 6 this approach has been worked out and is being used regularly as a communication scheme for interactions between the Eindhoven University of Technology and the industries active in the field of medical technology, a very dynamic and promising area.

SME's a market for universities?

Summing up viewpoints in relation to this question as discussed before:
- SME’s do have a clear need for increasing knowledge
- SME’s perceive constraints in extending their knowledge
- Universities can offer packages of knowledge useful for SME’s
- Universities also have their constraints in transferring knowledge to SME’s
- Between universities and SME’s differences do exist in culture and structure of knowledge
- Proper intermediaries will be needed for transfer processes between universities and SME’s

There are many examples of SME’s having fruitful relations with universities, often orginated from universities, mostly very innovative, usually with a staff covering certain fields of emerging technologies in an outstanding way. But in general the interactions between SME’s and universities are scarce and of a poor quality.

Large companies are usually not hindered by the constraints for knowledge acquisition as indicated here for SME’s because they have the right staff to select and manage needed knowledge transfer from universities in a proper way.
Furthermore they are able to finance knowledge transfer processes and are able to pay for knowledge befitting their needs.

Considering the industries as a market for the universities as centres of knowledge, clearly the segment of large companies is more interesting than the one formed by SME’s!

However, as has been made clear so often already, from a macro-economic point of view SME’s are also an important segment. In total this segment provides more jobs and larger contributions to the gross national products of our western countries. This segment turns out to be more flexible in following changes in society, science and technology. For our national economies SME’s are considered just as important as large corporations.

For regional, national and super-national authorities it is of major importance to promote and facilitate knowledge transfer to SME’s!

A few more points of view

Without much discussion for short a few more viewpoints:
- Knowledge transfer to SME’s should be kept in small scale frameworks, giving preference to person to person communication processes
- Such transfer processes have to be taken care of for long periods of time
- In general increasing the diffusion of already existing knowledge is more effective than development of new knowledge
- For SME’s most attention has to be given to a proper transformation of knowledge and to a functional integration of packages of knowledge in concrete innovation processes
In conclusion

- Knowledge transfer to SME’s is important from a regional-, national-, and supernational point of view.

- For universities this is not a natural and easy thing to do;
  * in addition to their primary concerns in education and research
  * not having the proper culture and forms of knowledge applicable for direct transfer to SME’s
  * SME’s not being an interesting segment in the market for the knowledge of universities.

- Since the universities must play a role in knowledge transfer to SME’s this has to be stimulated and supported financially by regional-, national-, and supernational authorities.

- In this process the existence of effective intermediary bureaux / institutions / university centers is a necessity.

- Intermediaries should interact effectively in both directions;
  * from university scientific knowledge to SME’s
  * and from SME’s reality and practical knowledge to university research and education.

- It follows as a matter of course that such centers / institutions should be manned with proper personnel;
  * not primarily, and certainly not only, by persons conditioned in a university setting alone
  * experienced in industrial innovating processes in the first place,
  * having a great capacity for interactions within a broad spectrum of sciences and technologies,
  * and last but not least having qualities and experiences in managing innovation - and knowledge transfer processes of a complex and multidisciplinary nature, partly within the culture and structure of a university, not always fit to the needs of such projects.

- For continuity SME’s must increase their attention considerably to long term goals and strategies, including a focus on relevant emerging technologies.

- On the development of SME policies in strategic perspectives universities especially can be good partners.
Eindhoven University of Technology

Topical research areas

- Instrumental analysis
- Discrete mathematics
- Information technology
- Catalysis
- Process technology
- Fundamental programming
- Solid state physics
- Nuclear physics
- Materials
- Physical aspects of the built-up environment
- Biomedical and health care technology
- Perception, communication and knowledge transfer
- Production automation and computer aided design
- Production and logistical management
- Transmission and tribotechnology
- Fundamental mechanical engineering
- Plasma research and technology
- Electrical power technology

Biomedical and health care technology

This multidisciplinary research at the Eindhoven University of Technology includes and combines if needed the following domains:

- Human perception
- Internal climate
- Biomechanics
- Biophysics
- Electrical engineering in medicine
- Organisation and management in health care institutions
- Physiological chemistry
- Thematic multidisciplinary research:
  Cardiac-valve prostheses
  Atherosclerosis
  Technology for body fluids
  Information ergonomics
  Gerontechnology