Towards expertise by integrating r&d activities into educational processes

Jussi Horelli[1], Matti Väänänen[2]

[1,2]HAMK – University of Applied Sciences, Finland

jussi.horelli@hamk.fi[1],matti.vaananen@hamk.fi[2]

Abstract

A modern educational organization has to face many kinds of challenges these days. Even institutes focusing to degree-oriented education have to be more and more, not only aware of the needs of the industry, but also co-operating with them in several fields. Companies expect schools to 'produce' engineers who have customized skills and already have practical experience. On the other hand schools are also expected to have expertise to solve practical problems and to help companies to develop new products and solutions.

In HAMK – University of Applied Sciences - a very important toolbox for facing these challenges is offered by research centres. The mission of these centres is to act as a regional developer by offering training products and applied research services for companies. Research centres have also an important role in the area of degree oriented training. With research centres the university can educate students to become future experts having good practical skills and being familiar with latest technology.

AutoMaint is the biggest of HAMK's nine research centres. It is focusing to production efficiency, automation and maintenance as well as industrial business services. To practice its' educational mission, AutoMaint repeatedly recruits students for their work placement period. For each recruited student that is a starting point of a individual professional growth boosted by AutoMaint's projects and other activities, which usually lasts at least till the student's graduation, sometimes even further. During its' eight years of operation, AutoMaint has recruited nearly 150 students.

Working in AutoMaint is a mixture of working in industrial projects and taking part of educational activities. The students that work in AutoMaint often have a role of an assistant in courses related to AutoMaint's main substance areas. Also the orientation of new employees is mostly done by these senior students. There are great benefits in using advanced students as instructors; advanced students can recall easily the difficulties of beginners and on the other hand the beginners do not hesitate to ask guidance from their co-students. From learning perspective it is also good that the advanced students must repeat basic facts and understand whole context better and better when they advice novices. Learning by teaching is also one way to earn the respect of novices and improve the growth of professional identity.

By combining applied research activities into educational processes, AutoMaint – and HAMK in general - has a wide potential to offer practical experience and real life challenges to the students during their studies thus preparing them better to meet the expectations of their future employers.

Research unit AutoMaint as a part of a university of applied sciences

In Finland, naturally the main task of universities of applied sciences is teaching. However, research and development has also an important role in their organizations. This is based on several aspects; universities of applied sciences are expected to act as regional innovation motors and partners for companies, especially small and middle sized enterprises. On the other hand, several reports show that the students are keen to have more practical experience and industry related projects already during their studies. In year 2006 the national student union of universities of applied sciences announced a report, which pointed out that nearly 40 percent of students felt not to have enough practical experience during their studies and one third criticized the teaching to be too theoretical. In its' report year 2005 the national university evaluation council stated that engineering education has to be more adapted to the engineers' new working methods and environments. Traditional teaching methods are no longer sufficient.

As a response for these challenges, also HAMK University of applied sciences has developed tools for playing a key role in creating an innovative environment in the region and supporting the development of top-level know-how.

In universities of applied sciences, R&D projects and education need to be mutually supportive. At HAMK, these are united mainly by organizing the operations of the university into centres for education and research. Each of these centres include several degree programmes and a R&D centre. In practice, the R&D centres are responsible for most of the R&D activities at HAMK.

The R&D centres involve research-oriented personnel in particular. A R&D centre gathers researchers, teachers and students together for common research and product development projects, creates a framework for close cooperation with the working life and also facilitates the grooming of students as future professional experts in the field.

HAMK University of Applied Sciences consists of several research and training centres in seven different locations. In Valkeakoski there are three degree programs and one research unit forming Education and Research Centre for Industrial Service Business. The degree programs in Valkeakoski unit are Automation Engineering, Industrial Management and Engineering and International Business. The R&D centre in Valkeakoski is called AutoMaint.

Research activities

AutoMaint's main form of corporate cooperation is applied research. Company-related research projects are executed either as company group projects with AutoMaint as the actuator, or as a directly company initiated project, whereupon AutoMaint provides its knowledge in the project's scientific aspects. AutoMaint applies for funding from various sources case-specifically.

The main focuses in the research unit are automation and asset management. The research in the unit is mainly applied research and there are close relations to businesses. The task of the research unit is to act as a force in the region through research and education. Education is offered both to businesses and to the degree programs of the unit. Detailed areas of education and research are for example automation systems, automation control systems, automation of material handling, multimedia, information systems, industrial simulation etc. The research unit offers or is involved with several different courses for the degree programs. The research center employs 20-35 people. Most of them work in projects with temporary and sometimes part-time employment contracts. The staff contains people with higher academic degrees and bachelor's degree as well as people still studying. The research projects involve the same themes as the education that AutoMaint offers; the development of automation and asset management. The research unit has two clear purposes; education and research. A third task is to educate own students to professionally grow to face the needs of the unit itself and afterword the needs of the surrounding working life. The final goal is that the educated professionals can successfully transfer to the service of the industry and especially to the partner companies. Continuous development of one-self and encouraging entrepreneurship are seen important in the research unit.

In the regional influencing the research unit works with several interest groups: cities and municipalities, companies, other educational institutions, other units of the own school, business incubators, financiers etc.

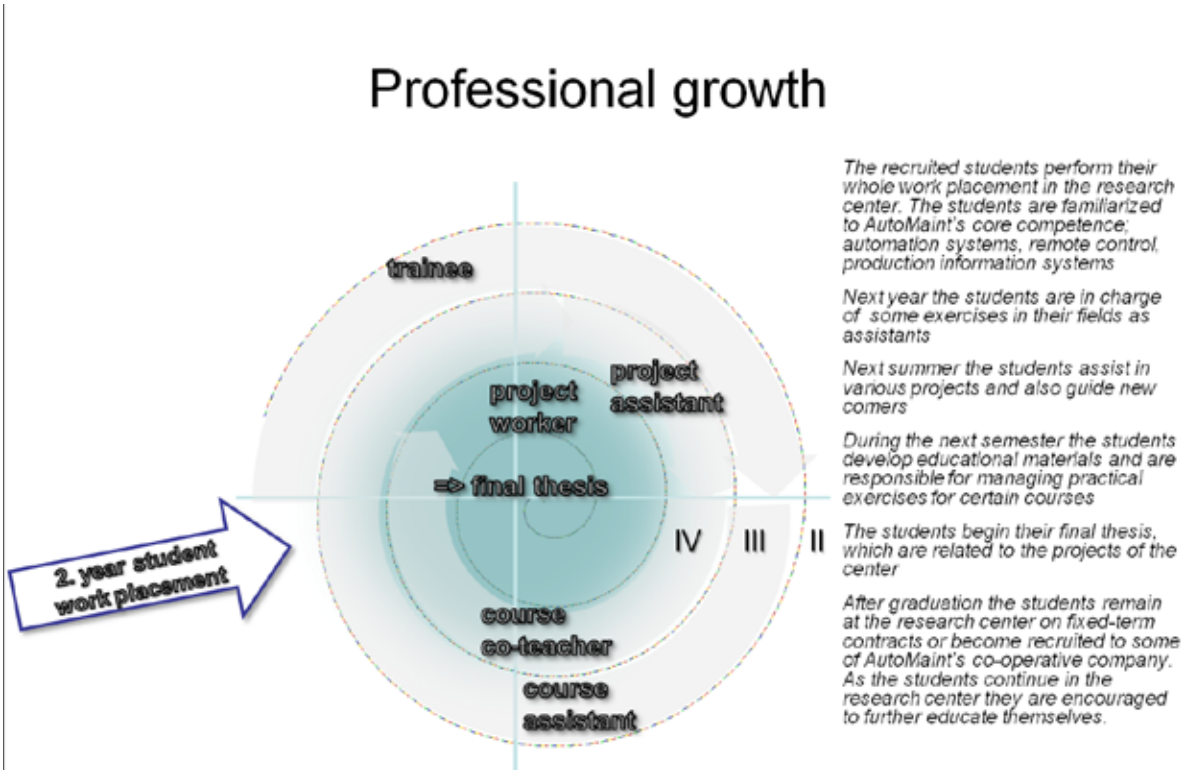
Development process of a recruited person in the research unit

The unit recruits approximately four students every year. In addition to this the unit commissions several final theses every year. The recruited students perform their work placement in the unit. The work placement period lasts for six months. During this time the student/ employee is familiarized with the central areas of know-how, software and tools of AutoMaint. First the students work under guidance of the more experienced workers and later more independently on a project. The projects usually include the planning and designing the control of an automation equipment, the implementation, data collection, remote diagnosis and control. In the end of the project the employees report on

the project and present their work. The learning environment of the unit is developed according to the work, equipment and materials. During the next year of studies the students that have worked for AutoMaint, work as assistants along with their studies. In this way they can immediately make the most of what they learned and they know the challenges of the beginners through their own experiences. The following summer the assistant work again as full time and can be used as help in research projects and in guiding the new comers. The assistant can be given more and more responsible and demanding tasks and they can deepen their knowledge on the field.

During the next semester the assistants are involved more in developing the learning materials and projects. They can also be in charge of some practical cases in some courses. In addition they are in direct contact with the companies involved in for example some exhibition events. During the semester the assistants start their final theses which are somehow connected to one of the research projects of the unit. This way they have a chance to deepen their know-how and concentrate on a specific problem which arises from the needs of a partner company. Usually the students are directly in contact with the company and thus are also partly responsible of the result directly to the company. This gives the company an opportunity to follow the development of the student and at the same time search for a solution for the question at hand. After graduation the person can continue in the research unit or in some cases in the partner company. When continuing in the research unit, the person is given a chance to specialize and take responsibility of a specific area of education and training. However there are still responsible persons in the permanent staff for each area of expertise. In figure 1 you can see the idea of intensifying professional growth by working in research unit while studying. A significant addition to the learning process is the international atmosphere in the unit. Every year 10-15 foreign trainees work in the unit (making a thesis etc.). The unit works with multicultural teams by enforcing project work through the basis of problem-oriented learning (Väänänen 2005).

Figure 1: AutoMaint's model of the professional growth of a student



Benefits of the system

Benefits for a student

From the students point of view this system enables a more individual curriculum in a way that also concentrates to the main focus of the research unit. In this way the performance can be guided individually. This requires also independence and initiative from the student. This means that the student can complete courses so that they are tied to the research projects in which the students work for. Working with real problems allows the student to develop professional abilities. After graduation the student has already two years of work experience from the research unit. When the research is applied research, the work experience supports the students' settling to the service of the industry. During the work period the student improves also his/her team work skills and learns to work in a multicultural team as well. This arrangement also improves the motivation towards studying because the student is able to see the opportunities that he/she has after graduation and enables the student to reach his/her goals. Usually the students graduate in time or even earlier than others. The students will be encouraged to continue their studies in which case the student can continue as a part-time employee in the unit. The students are also encouraged to entrepreneurship which is supported by the close relation to the business incubation operations and to the Valkeakoski region development company. A significant advantage for the student is also the salary which the students get for their work.

Collaboration with AutoMaint is beneficial to the student in many ways. No matter what the form of cooperation, the student is dealing with competence and know-how tested with the strict requirements of the business world. AutoMaint's courses are conducted by professionals from their fields as the fresher apprentices act as assistants. Current and future business needs are emphasized in the education. AutoMaint's educational methods are based on problem based learning-by-doing methods creating an efficient and interesting learning environment for the student, where practical learning achieves a new level.

During its' existence AutoMaint has recruited nearly 150 students. Most of them have been from the degree programmes of Automation, Industrial Management and Engineering as well as International Business. Many of these students have continued on to work here after their graduation on research task on the various projects of the research centre. While working at AutoMaint the students have gained access to the research centre's extensive cooperation network, which is comprised of companies in the field in question as well as the research- and educational facilities. Through the various project activities the students have a unique possibility to create contacts too many companies; get the toe in the door as they say. The possibility for the student to employ him- or herself with one of these companies is very good, if the skills and attitude meet the demand.

Several final theses are done yearly in the projects of AutoMaint. The topics in the theses cover development targets crucial to the companies. The student has the chance to genuinely make an impact and prove one's professional competence.

Benefits for the university

Aims of this arrangement are quite same in small scale as in many large education programs, for example more collaboration with industry, more industry-oriented courseware etc. This arrangement provides also many benefits to the school. The personnel structure of a University of Applied Sciences is often very teacher centered. Thanks to this kind of arrangement the structure can be developed towards a team organization. This forms so called skill-teams in which include teachers, researchers and assistants. There are also some direct financial benefits. The know-how of the teachers can be utilized directly in the research projects, guiding and planning the education while the assistants concentrate in controlling the practical exercises. The system enables problem- based project learning. This can be implemented from the practical needs of the industry. Through the training of the assistant the learning environment of the school can be developed and take into use new programs and equipment as efficiently as possible. Along with the growth in know-how the unit ensures new project agreements and credibility in the eyes of financiers. Businesses can be offered more charged services. For international exchange the research center works as a central place. The incoming foreign trainees are usually placed in the research center, where they can do their work placement or do their

theses which are connected to the research projects of the unit. To the more experienced staff the research gives a chance to develop their own knowledge and bring their information up to date. This often leads also to post-graduate degrees and so the education level of the whole staff rises.

Benefits for partner companies and municipalities

The cooperation between education and working life should be seen as totality instead of just as a set of separate projects, meetings and events. Long term collaboration between companies and educational institutes requires mutual trust on each others will, skills and knowhow. For schools, the capability of using agile tools when working with company-related challenges is becoming more and more crucial for retaining fruitful relationships with working life (Lockett, 2008).

To have a high rate of investment in R&D, frequent patenting and frequent new to the market innovations in domestic firms might be important - especially if it reflects a strong capacity to absorb and use new ideas – and in certain fields such as pharmaceuticals it is the case. But in general small countries neither can nor should set the same ambitions for domestic innovation as the United States or China. Critical for small country performance is the capability to learn and this will reflect skilled labour, good labour relationships and good collaboration with customers and among experts with different backgrounds.

In official Finnish innovation discussions the role of universities of applied sciences is often described as regional innovation accelerators. Traditionally then most effective innovation processes have been assumed to "science as a source of innovation" (STI) -based. On the other hand, recent studies have shown that in many cases more efficient results can be achieved in experience-based "doing – using – interacting" (DUI) –kind of innovation processes. DUI-model fits very well to universities of applied sciences and to their role as regional innovators, since they work very close to local companies, their partner company networks are often quite wide and their r&d activities are mainly applied research. Also their role is often described as being the ones to dismount the results of fundamental research to small and medium enterprises. Especially for small countries most ideas based in scientific research come from abroad and the capacity to integrate them in the practice of domestic firms will reflect not only R&D-activities but also the competence and collaborative efforts of scientists, engineers, managers, workers and experts on marketing (Lundvall 2002).

From companies' point of view cooperation with AutoMaint increases services appointed towards them. The companis can quickly and flexibly get help for solving their minor problems. On the other hand, through the research unit's projects, companies can reach the most up-to-date information of the field, which they can apply quickly in their own activities. Especially important factor from the company point of view is the opening of a significant recruiting channel. Companies can get familiar with experts working in different projects and get the possibility to observe their progress. In some cases the needs of the company can be taken to account already when planning the courses.

From municipalities' point of view these activities can be considered highly significant. The attraction of the educational institution improves along with the development activities. Along with the projects and increased co-operation with companies, the educational institution will be able to acquire better equipment, which enables even more up-to-date education. This produces new experts who further the development of the companies. With the help of research activities the functions of companies are directly developed. On the other hand, during the projects fresh ideas are born, and these ideas can be used also on other fields. This enables the beginning of a new business operation, which will then be supported by, for example business incubation activities which lower the barrier of becoming an entrepreneur. A considerable fact is that these activities also tempt already existing companies. Thus, from the municipality's point of view these activities enable growth of personnel and tax income in its area.

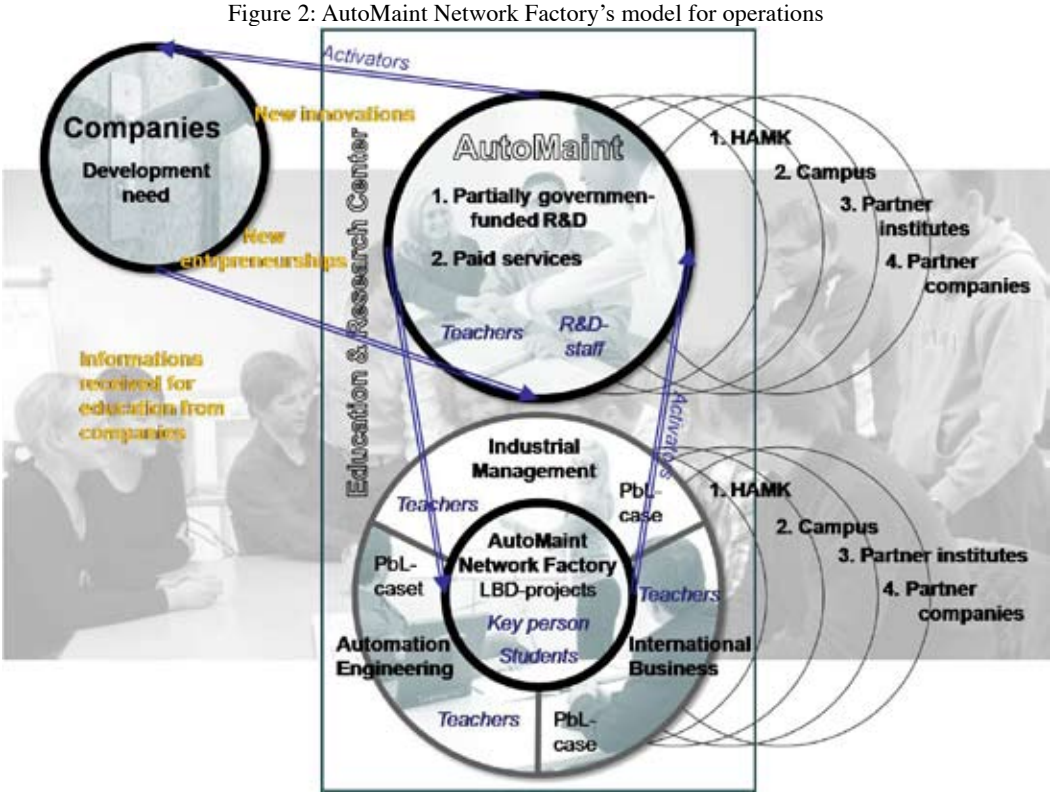
AutoMaint Network Factory

The operations of AutoMaint are mostly based on recruiting our own students to work alongside their studies. The systems has now worked for nearly ten years and it offers clear benefits to all participants. The need to enlarge this

kind of working and researching experience to cover more students has led to creating a new kind of learning environment, AutoMaint Network Factory (AMNF). This learning environment offers the possibility for students to exploit their skills in real working life cases.

From the students' perspective AMNF is a learning environment where to perform studies from technical and business fields by project learning. For the studies made in AMNF enough resources have been reserved for the students to be able to concentrate to the projects and advance in them. It is also vital that students reach learning objectives set for each course. A key person is coordinating projects and contacts between HAMK and companies in practice. This coordination includes the project management controlling all projects and organizing teaching whenever it is necessary. The teaching is held by the education staff from the unit. Some of the projects contain students from many culture and different fields of study. Also ways to exploit Valkeakoski Campus cooperation is under development. These aspects will have a bigger role in the future.

Figure 2: AutoMaint Network Factory's model for operations



Valkeakoski Campus

Valkeakoski Campus area forms quite unique centre of educational and research institutions. In the same area teaching is provided by HAMK's unit, professional school, adult education, secondary and industrial schools. In addition to this the campus area has two universities research centers (Tampere University and Tampere University of Technology) and the Development Agency of Valkeakoski region. All degree programmes of HAMK's Valkeakoski unit will be conducted in English next fall. This enables new ways to make cooperation between educational institutes. In total, there are over 2100 students from 30 different countries studying in the Valkeakoski Campus currently.

For this kind of new cooperation between different educational institutes Valkeakoski Campus is an excellent piloting environment for many reasons: the distance between educational institutes is quite minimal and cooperation between these parties already exists concerning education and projects. Examples for educational cooperation could be elementary courses in automation for upper secondary school or mutual language studying groups. At the mo-

ment, further developing of Valkeakoski Campus cooperation is executed under MOLAP –project, which is partially funded by European Regional Development

Conclusion - Every whole consists of parts

The AutoMaint research centre has been working for ten years with the above-described way. The research centre has successfully met the stated objectives and is a way for developing the functions of the university, in which the connection between research and education needed to be improved. At the same time the unit is a place where problem centered project learning can be genuinely used in multicultural teams.

To start AMNF by first pilot testing it with students from the degree programme of Industrial Management was a quite natural solution. A significant part of the work of an engineer in industrial management is related to project and production management. During AMNF's ramp up time the pedagogic models used in it were tested and polished. AMNF has become an important part of the r&d processes executed in HAMK's Valkeakoski Unit and it has been flexibly merged as a part of research centre AutoMaint's service palette. Together these kinds of actions form an adaptive toolbox for an educational institute to serve both the working life around it to have a local partner in development processes as well as its' own students to become more professionally skilled already during their studies.

References

01. Doggen, Jeroen; Goossens, Maggy; Pauwels, Sigrid; Schaeps, Tim; Van der Schueren, Filip; Vaningelgem, Leo. (2008). Thematic Weeks: a New Concept in Engineerign Education, ICEE 2008, Budapest, Hungary.
02. Heikkilä, Susan; Jokinen, Janne; Horelli, Jussi; Väänänen, Matti. (2008). Stimulating Innovation Activities in SME-companies by Co-operating with Networked Educational Institutes, ICEE 2008, Budapest, Hungary.
03. Väänänen, Matti; Horelli, Jussi (2005) Towards expertise by using research unit as an instrument for PBL, ICEER 2005, Tainan, Taiwan
04. Lockett, Nigel. (2008). Exploring the role of universities in communities of innovation: a systems approach, Promoting Entrepreneurship by Universities, FINPIN 2008, Hämeenlinna, Finland, pp. 158-159.
05. Lundvall, B.-A. (2002), 'The University in the Learning economy', DRUID Working Paper no. 6, Aalborg Universitet.