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PIEp EDU: EDUCATION FOR PRODUCT INNOVATION

Martin Grimheden
KTH Royal Institute of Technology

ABSTRACT
This paper presents results from the first two years of a large attempt at changing Swedish higher education – a system change toward synthesis, creativity, product innovation and entrepreneurship. The Product Innovation Engineering program is a ten-year governmentally funded research- and development program with a focus on educational change – PIEp Education. Activities are organized for three focus groups: students, doctoral students and teachers of higher education in Sweden.
Activities for students include an annual thesis competition, summer schools, thesis projects and international mobility programs. A research school gathers around 25 PhD students and offers a national complement to existing university research education programs. A teachers' network gathers around 50 university teachers in Sweden to workshops in creativity, course development and exchange of experiences. Among the results presented in this paper are examples of new courses, programs and local activities showing how the Product Innovation Engineering-thinking have been embraced among the members of PIEp and are beginning to show results in terms of new products, companies and businesses.

Keywords: Product Innovation Engineering, Engineering Education, Research Education

1. INTRODUCTION
In 2005, representatives from the Royal Institute of Technology (KTH) in Stockholm, Sweden, took the initiative to start a large, national long-term program to enhance product innovation capability in Sweden. This program was finally launched in late 2006, with governmental funding, as the Product Innovation Engineering Program, PIEp[1, 2]. The purpose of this article is to present the ambition of the PIEp program in terms of education for product innovation, together with results from the first two years.
The program is organized as a network of researchers, educators and students in innovation engineering with the ambition of creating a system change toward innovation and entrepreneurship in institutes of higher education and research. This paper presents work in progress, with limited results, but the intention is to introduce the activities focused on undergraduate education and postgraduate education[3, 4].

1.1 Engineering Design and Product Innovation
Before launching into describing the program – a brief note regarding national nuances in language and Swedish tradition: Engineering Design does not easily translate into Swedish. In German and Swedish, the term *Konstruktion* is typically used, in the absence of a better term. *Konstruktion* is more related to the English word *Construction*. This said, the focus on product innovation in this paper and in the PIEp program in general could be seen as taking a major step into the areas of Engineering Design rather than anything else. The PIEp program is an Engineering Design program[5].

1.2 The Product Innovation Engineering program
PIEp is a national research- and development program within and for product innovation. The program encompasses three areas of activities: research in product innovation, education for product innovation and industrial collaboration for product innovation. This article mainly focuses on the activities within education for product innovation.
PIEp addresses and facilitates increased Swedish ability in innovative product- and business development. The program ranges from theory to practice, from research in innovation to directed activities aimed at strengthening Swedish innovative product development. PIEp is implemented

through research efforts, educational efforts and development projects. The research efforts are necessary to develop a common platform, to gather existing, and generate new, knowledge about the innovator, the innovation process and the innovation system. Further, PIEp contributes to technical research efforts which are governed not only by the scientific questions but also more directly from a product and innovation oriented perspective. The innovation climate in participating companies is developed through research, development and directed activities such as creative sessions and the building of networks.

1.3 The national PIEp network

The PIEp program was launched in late 2006 by a network of five initial Swedish PIEp nodes with the ambition to add more. Among the initial financiers are VINNOVA (The Swedish Governmental Agency for Innovation Systems)[6], Innovationsbron AB (A Swedish business development agency)[7], industrial and individual sponsors. At this point in time, the number of nodes has been increased to six.

Figure 1. The six PIEp nodes represented by their respective universities' or organizations' logotype. The six nodes are distributed from the very south of Sweden (Lund) to the very north (Luleå).

PIEp is currently organized as a network of nodes and international partners. The six current nodes each represent a university or an organization within Sweden. Figure 1 illustrates the six nodes and their relative location in Sweden. The nodes are listed below, in order from south to north:

1. Faculty of Engineering at Lund University
2. Jönköping University
3. CTMH, Center for Technology, Medicine and Health
4. KTH, Royal Institute of Technology
5. Umeå Institute of Design at Umeå University
6. Luleå University of Technology

The current international partners are:

1. Center for Design Research, Stanford University
2. Sr Kenny Research Institute, Minneapolis

1.4 The need for PIEp and product innovation in Sweden

When measuring innovation in Europe, Sweden is in the top end concerning resources put into research; almost in the top concerning education, but behind concerning outcomes in terms of products and businesses[8].

Innovation Engineering is here interpreted both as an ability to create conditions for innovation, and also as an innovative capacity in developing engineering products. The industrial history in Sweden can be characterized by a number of manufacturing companies that have grown to multinational corporations based mainly on technical innovations, with the examples of Volvo, SKF, Ericsson and Scania. The position is though challenged; several of the major companies have been acquired by international actors and the global competition forces decisions conveying that both activities and competencies move to other countries. In a situation where work and related competence within production technology is transferred a natural development would be that also activities related to research and development will take place in countries where the production now takes place.
Also, many of the larger Swedish corporations stem from innovations made many years ago[9]. According to the Swedish Patent and Registrations Office[10] the number of patent applications decreased in Sweden with 42% between 2000 and 2006. No clear explanation to the decrease is found, and the need to investigate further is apparent. The potential to develop new businesses is closely related to an increased ability in innovative product development, and to develop innovative organizations, processes and people with capacity in creating value through new products and services[11, 12]. There are many examples of good technical inventions that so far have not lead to a considerable commercial activity. There are also many examples where successful companies and economic growth appeared in other countries than where the invention originated.
Existing ideas, concepts, initial experiments and prototypes with the potential of becoming products that generates work, employment and growth should more frequently result in products or product concepts within companies, or as a result of undergraduate and graduate education, leading to sustainable business and growth. Engineering education could contribute to the satisfaction of known needs by way of new products and companies, and by that unexplored needs are identified and fulfilled by appropriate solutions, e.g. with new products for elderly and disabled. Innovation engineering is a generic and strategic competence. Knowledge, methods and instruments should be useable for both small and large companies, and the implementation should be adapted to the varying needs of the different companies. The activities presented in this paper are focused on innovation in the development of products and services with a physical carrier. Possible innovations could be found in technical development, in how to utilize academic research in product development, in service design and in business development. It is most necessary to address the entire product life cycle in an integrated perspective[13, 14].

2. PIEP EDUCATION

2.1 The resource system

The program is organized in five fields; two with a focus on process and organization oriented research (Innovation Knowledge and Innovation Management), two related to product- and business oriented development (Innovation Experience and Innovation Business) and one related to education (PIEp Education). All five fields will generate knowledge and feeds back knowledge and experiences to the other fields. Figure 2 illustrates the ‘resource system’ or ‘learning cycle’ of PIEp together with some keywords and key activities of the respective activity fields[15, 16].

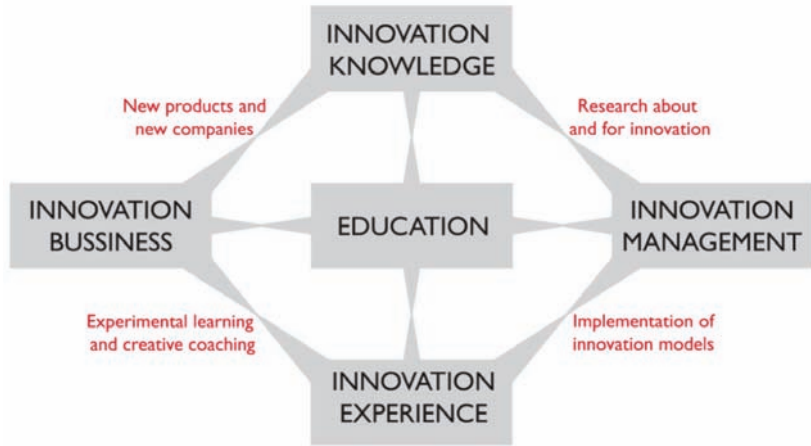

Figure 2. An illustration of the 'learning cycle' or 'resource system' of PIEp. The five boxes symbolizes activity fields and the text in red shows examples of activities organized in the fields with results from these. Results, experiences and competencies should 'feed into' the neighboring fields, as shown by the grey arrows.

2.2 Promoting a system change

PIEp Education is also nourished from activities in other PIEp activity fields, such as the fields of Innovation Experience and Innovation Knowledge where innovators and researchers in innovation collaborate and contribute. The main activities of PIEp Education involves new courses in innovation engineering, a graduate school for doctoral students, exchange programs for students, rotational programs for faculty and better utilization of all existing mechanisms for bringing ideas to market. To create a sustainable change of higher engineering education toward innovation, it is necessary to involve and include all teaching personnel in training activities. These activities are based on a number of training workshops where expertise from the entire PIEp is utilized.

The overall aim of PIEp Education is to lead and support a system shift of higher engineering education, toward innovation and entrepreneurship, and the mechanisms for this shift is applied on all levels in the engineering structure.

PIEp Education is organized with and for three focus groups: Teachers and coaches, doctoral students and students on B.Sc and M.Sc level. Figure 3 below illustrates the three focus groups and examples of activities. In the following sections, all activities offered to doctoral students is described in the section 'PIEp Research School'. Activities for teachers and coaches are described in section 'PIEp Teacher's Network' and activities for B.Sc. and M.Sc. students in section 'PIEp Undergraduate Education'.

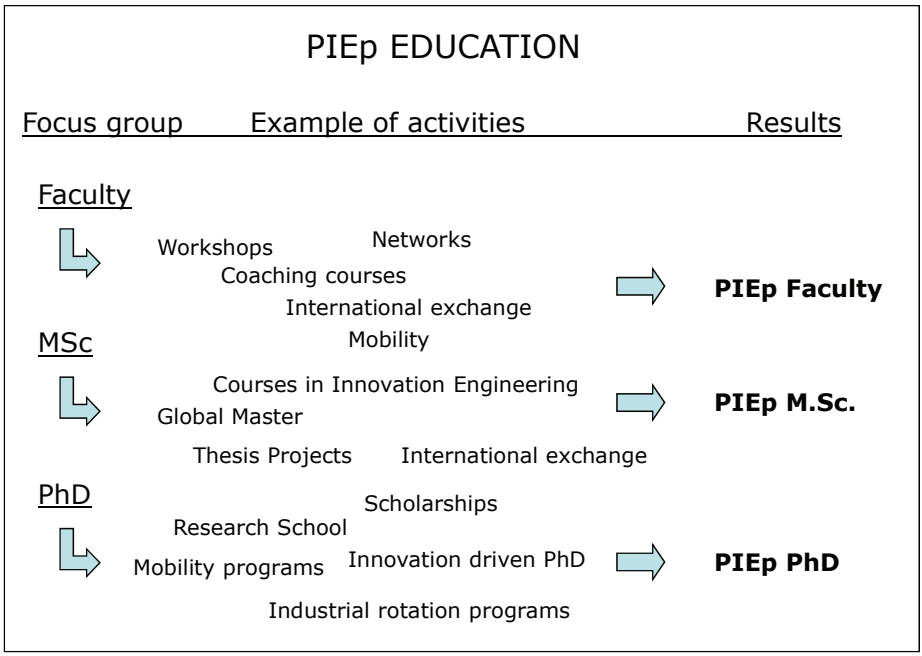

Figure 3. Illustration of the three focus groups with examples of activities. As seen in the figure, many activities and programs span two or all three focus groups.

3. PIEp RESEARCH SCHOOL

The PIEp Research School gathers PhD students in Sweden in one of three areas: students focused on research on product innovation, students focused on med-tech and product development in med-tech or thirdly students interested in utilizing their research results into new products, businesses and companies. All PhD students are enrolled at one of the six nodes (universities or organizations). Some PhD students are financed by PIEp with up to 50%, but the majority is financed elsewhere. The research school is defined as a complementary research school – meaning that all students are enrolled elsewhere, in some cases active in other research schools as well – but in all cases complementing the respective research education within the area of product innovation.

3.1 The PIEp Research School Fundamentals

The research school is based on four concepts, the four PIEp Research School Fundamentals:

Mobility of research students and supervisors

PIEp PhD students are offered a backpack of funding to support mobility, for participation in courses at other universities, for international/national/industrial rotation and to help the establishment of common interest groups (CIGs) among the PIEp network of PhD students. A number of international PIEp partners facilitate by providing exchange programs and infrastructure for mobility, such as Stanford University, Minneapolis University and the Boston region. National rotation is facilitated by exchange programs between PIEp node universities and related companies. Also mobility for supervisors: to support joint recruitment, supervision and the pooling of resources.

Networks and Common Interest Groups (CIGs) for students, supervisors, mentors and facilitators

PhD students collaborate nationally in CIGs, in product development teams, research projects and thesis work. Through the networks, resources such as business mentorship, industrial coaching and research supervision can be pooled among PhD students. Common Interest Groups are coordinated by

PhD students with financial support from the research school. The CIGs are also described further below.

Synergies

The third research school fundamental is the concept of activities aimed at creating synergies between innovators, innovation researchers and coaches. The main purpose is to increase utilization of research results into new products and businesses, which also should provide empirical bases for new knowledge about the innovative product development process. Researchers in med-tech related areas utilize, for example, competencies and experiences from experienced entrepreneurs and researchers in product innovation.

Certification

PIEp requires high standards and expect excellent research and results from students active in the research school. A set of requirements, or values, constitute the PIEp PhD criteria, such as international/industrial rotation, experience from start-ups, active participation in product development etc.

3.2 PIEp Research School Common Interest Groups, CIGs

PIEp Research School is organized in Common Interest Groups, CIGs. All PhD students are expected and required to actively participate in one or more CIGs. Each CIG is coordinated by a CIG chair/coordinator. All CIGs have direct access to funding for student initiated activities, meetings, travel etc. The CIG coordinators are financially responsible of the CIG budget and for reporting to the Research School management. All CIG chairs/coordinators together with the Research School coordinator constitute a management CIG with responsibility for overall Research School coordination and funding.

The CIGs can be divided into two types: subject CIGs and complementary CIGs. All CIGs are listed below:

Subject CIGs

- MedTech CIG - for all PhD students active in Medtech innovation
- Innovation Capability CIG - for all PhD students interested in innovation capability, teaching and evaluating innovation and creativity, methods etc
- Cognitive aspects of Innovation - for all PhD students interested in more psychological and cognitive aspects of innovation, creativity etc
- Open Innovation CIG - for PhD students interested in business aspects of innovation, in particular the open innovation concept

Complementary CIGs

- International Relations CIG - a CIG with the responsibility of developing, coordinating and utilizing international relations within the area of product innovation and med-tech
- IDRE CIG - a CIG for all PIEp PhD students enrolled in the IDRE program (Innovation Driven Research Education, see below)

3.3 Philosophies and strategies

In the following section, a number of underlying philosophies will be described to better understand the structure and ambition of the research school

Learn from the best – go places

All PhD students should have the ability to establish an international network within his/her field, to learn from the best and basically be given the individual responsibility to do this by him/herself. This includes access to sufficient resources in terms of travel funding but also an infrastructure provided by PIEp to handle contacts and organize an exchange of experiences. The keywords are ‘learn from the best’ and ‘if you want to meet somebody – go see him/her’.

One CIG, the International Relations Common Interest Group (IRCIG), is currently tasked with the responsibility of coordinating all international contacts, to give all international contacts one point of contact and to better utilize these contacts among the PIEp PhD students.

The bottom-up-approach

The organization of the research school was quickly characterized among the PhD students as having a 'bottom-up-approach'. While this was more an effect of insufficient resources put on research school management by the overall PIEp management than anything else, the approach was quickly adapted to and embraced by all actors. This leadership approach basically means that the PhD students should take a large responsibility of the research school, the content, infrastructure and leadership including financial responsibility, responsibility of creating courses and workshops and probably most importantly – taking charge of their own research education.

The Common Interest Groups are an effect of this approach. The program and the budget of the CIGs are decided upon by the CIG members. Each CIG is coordinated by a CIG chair, elected by the CIG members. A team of all CIG chairs and the formal research school director constitutes a research school management group which makes overall decisions regarding budget and general program for the research school. The overall budget, not including salaries or research stipends, is approximately US$150k per year, covering CIGs, workshops, travels and meetings.

The bottom-up-approach further implies that all decisions and overall planning should be grounded in a democratic process where all PhD students have the opportunity to speak their mind and be pro-active in the shaping of future events.

Students as agents of change

When returning to the original idea of all activities of PIEp Education, the overall aim is to create a system change of higher education toward synthesis, creativity and entrepreneurship. One method to accomplish this is to use students as 'agents of change', meaning that a new kind of PhDs should be educated and the system is changed from within through these actors.

The bottom-up-approach facilitates these 'new PhDs' by promoting entrepreneurs, by requiring all students to build networks and taking a larger responsibility of their education than what is currently the standard.

3.4 Innovation Driven Research Education, IDRE

One unique and more special case of the PIEp Research School is represented by the IDRE program, a subset of both PIEp and the research school. IDRE, for Innovation Driven Research Education, represents a system change of traditional PhD research education toward an integrated approach were research is combined with product- and business development in the specific research area.

IDRE is basically a complementary research funding program to the research school which makes it possible to recruit, hire and keep a number of PhD students more formally tied to the PIEp Research School and fully dedicated to the system change. Currently nine PhD students are partly funded by PIEp IDRE and the node universities, distributed across four nodes and one international partner. All nine PhD students are recruited for both research and product development, performing both research and product innovation within their research field, and expected to deliver both a thesis and a product at graduation. Currently, all research projects are within areas of medical technology.

IDRE doctoral students are required to participate in the PIEp Research School and its activities. All IDRE doctoral students are required to fulfill the mandatory demands of his/her university and department in terms of courses and other local prerequisites. IDRE workshops are organized twice annually, with the purpose of cross-supervision and experience networking. At these workshops, IDRE supervisors pool resources and co-supervise students at other nodes. Besides the above, IDRE doctoral students are required by PIEp to participate in a course in Innovation Driven Research, based on a textbook under preparation.

The IDRE aspect of the PIEp research school develops, implements and evaluates (longitudinal studies) a new kind of post graduate education. The evaluation part is very essential and made possible thanks to the long term nature of PIEp. The initiative, once running at full pace, contains five basic elements:

- product oriented postgraduate research (larger part)
- innovation process oriented research (smaller part, partly as action research)
- a new supporting course package and literature
- a new framework and mechanisms for research student supervision and coaching
- a continuous and creative activity towards finding additional funding schemes

Examples of IDRE research projects

The following is a list of current IDRE projects:

- Biomedical optics for human diagnosis – sinus infections
  This project deals with non-invasive measurement of free gas in body cavities, for example the sinuses, to be used to diagnose infections and blockages between sinuses in the human head.
- Biomedical optics for human diagnosis – skin cancer
  The project focuses on a spectroscopic detection technique for medical diagnosis of cancer were data is registered in a CCD detector. The method is believed to be able to diagnose chronic diseases such as diabetes, Alzheimer's disease and skin cancer.
- Simulation of surgical procedures with haptic feedback
  A simulator system for realistic simulation of surgical and similar procedures (e.g. for dentists) to be used both preoperative and in medical education. The simulator can handle stiff objects (bone, tooth etc) with 6 degrees of freedom haptic feedback and 2/3D visual feedback.
- Balance Prosthesis Device
  A balance prosthesis to facilitate human walk and posture in cases of no sensory feedback from the feet or loss of functionality in the inner ear balance system. The prosthesis is made possible based on current breakthroughs in a combination of sensor technology, signal conditioning algorithms and clinical experiments.
- Restoring vision disorders through infrared stimulation of the visual cortex
  This project is focused on a neural prosthesis for people suffering from visual disorders on the retina or optical nerve. The idea is a completely new concept - to use the 'light synapse'. In the most common synapses it is chemical substances, e.g. glutamine, serotonin, dopamine, GABA etc, that acts as the link between neural cells. In a light synapse it is instead transfer of photons that mediates the signal from source to cell.

3.5 Examples of activities and results of the PIEp Research School

The underlying philosophy of the research school is that doctoral students should meet, organize complementary activities such as workshops, courses and meetings and create a platform for enhancing mutual learning and exchange of experiences within product innovation. Students active in med-tech product development should be able to learn from students performing research on innovation processes, and all students should be able to learn from experienced innovators and entrepreneurs within the area.

Further, the research school should provide education in product innovation engineering, innovative product- and business development and entrepreneurship. This education should be integrated into all other activities and basically everything offered and organized by the research school should strive for the better utilization of ideas from research projects etc into new products and companies.

More examples of activities are:

- Kick-off workshops at Stanford University and in Minneapolis
  The Stanford Workshop was given by three Stanford professors and focused on Foresight and Strategy within a product innovation context. This workshop gathered 13 PhD students and three senior researchers. The Minneapolis workshop was organized around a Med-tech conference and gathered eight PIEp PhD students and five senior researchers.
- TTWW – The Tiger Team Writing Workshop Process
  This activity gathered 14 PhD students and three senior researchers at a kick-off meeting with the purpose of creating a number of national and multi-disciplinary Tiger Teams tasked with the purpose of writing scientific papers. The TTWW process at the time of writing have seen in total 25 paper ideas with 22 participants spread over all nodes.
- International workshops
  One workshop in Lübeck and Hamburg gathered nine participants and one in Glasgow had four participants. The purpose with both these were to establish an international network as well as finalize the research school organization with the CIGs

4. PIEp UNDERGRADUATE EDUCATION

A number of activities aimed at promoting innovative product development broadly among students at the PIEp nodes have been performed. The overall purpose is to create a movement among students where the students are acting as agents of change and thereby promoting the necessary system change of higher education toward creativity, synthesis and product innovation in general.

4.1 PIEp Engineering Creativity Contest

A thesis competition is organized annually and has so far been held twice: in 2007 and 2008. A call for abstract submission is distributed across all nodes and abstracts are submitted from students from all nodes. In both years a number of finalists were announced and an award was given to the winning contributions.

The main purpose of the thesis competition is to encourage students at the nodes to perform thesis projects in innovative product development: mainly to develop new products, to take the opportunity of trying new ideas and to start thinking about perhaps starting their own companies and choosing an entrepreneurial career. In 2007 two finalists were awarded a fully paid trip from Sweden to California, USA, including visits at universities and PIEp international partners. In 2008 one finalist was awarded a round-the-world trip to expand his network in the area of his product idea. All winners were also awarded exclusive sponsored watches, worth more than the travel stipends.

4.2 Summer Schools

The main purpose of the summer school activities is to promote student movement between the nodes and encourage students to broaden their knowledge base by taking complementary courses. For example, students of engineering programs at the technical university nodes are invited to participate in summer schools in entrepreneurship organized and offered by the Jönköping International Business School (the Jönköping University node).

Students at all nodes are also offered scholarships for participation in existing summer schools at the international partner nodes, for example the Stanford Graduate School of Business Summer Institute for Entrepreneurship. In the Stanford case, the students apply directly to Stanford University, and the fees are paid for by PIEp if the student fulfills all PIEp requirements.

4.3 Thesis projects and internationalization

PIEp supports thesis projects with a number of purposes. One example is to enable a student to actively participate in an international renowned setting, for example in the environment of an international partner. Secondly, thesis projects focused on the study of an innovative environment, context etc or, thirdly, more directly focused on product development.

International environments

During 2007-2008 the total of eleven M.Sc. students were supported by PIEp to perform a M.Sc. thesis project abroad, in collaboration with an international partner. Nine of those participated in Stanford University's "team-based innovation in a global setting"-project during the academic year of 2007/08. Two students performed thesis studies at the Sr Kenny Research Institute in Minneapolis, one developing a new product for the diagnosing of balance disorders and one studying the innovation system in the context of the organization.

In a PIEp context the system change is not realized by only sending students abroad, but when the results and experiences from the pilot students are utilized. These students are seen as agents of change, as role models that should be promoted by the universities so that the possibility of taking this path is clear to prospective students.

Master thesis projects

Master thesis projects are offered nationally by PIEp as a means of attracting students and promoting innovative product development projects. Also, studies of innovative environments and, for example, organizational factors for innovation are encouraged. Master thesis projects in Sweden have similarities with internships abroad, many thesis projects performed at a company, which creates an opportunity where PIEp can recruit students for industrial thesis projects and likewise supply companies with innovative students for an internship-like project.

Examples of master thesis projects supported by PIEp is the development of a new innovation educational program for a large international consultancy firm and a comparison study of similarities and differences between Swedish and US educational environments within this context.

4.4 Direct product development support

Even though the mechanisms are not fully developed yet, a number of projects have been financially supported by PIEp – mainly with the purpose of creating role models and examples of projects, innovations and new business opportunities. These projects have been supported with up to US$10k per project and in most cases with funding for prototypes, proof of concepts etc.
As with the international thesis projects, the main purpose is simply to create this opportunity and to be able to create the mechanisms necessary to be able to show students early how their ideas can be utilized by the students themselves, with the support of their universities and enabled by PIEp.

Electrical motor for sailboats

This is an example of a student project directly sponsored by PIEp through the KTH node. One engineering student in the fourth year of a five year M.Sc. program approached the PIEp KTH representative with an idea of replacing a traditional diesel engine in a sailboat with an electrical motor. The student specialized in Mechatronics and had an extensive competence in electrical motors, drives, batteries and microprocessor-based control systems. When the diesel engine in the sailboat owned by the student broke beyond repair, an idea evolved to replace with an electrical system. The uniqueness in this system consists of a combination of sensors and advanced control system that ensures that the batteries are always fully charged, using the motor as a generator driven by the propeller – always at optimal conditions not to cause drag (charging the batteries at times when the wind is at an optimal direction and speed only).
By a combination of courses and a thesis project, the student was able to spend the total of one year full time worth of studies developing the prototype, with funding from KTH to cover all prototype manufacturing costs. The prototype was installed in the sailboat and tested during one summer.
PIEp provided a network of supervisors, sponsors and coaches to support the product- and business development as well as provide a base for the next step – commercialization.

5. PIEp TEACHERS' NETWORK

Activities for teachers and coaches are organized within a network of teachers and coaches with mechanisms such as exchanges of experiences, mutual learning and sharing of resources. The ambition is to provide for a physical, national meeting every semester, rotating between nodes with the main purpose of cross-learning and networking. Beside these workshops, more directed activities such as a course-development workshop series are offered as well.

5.1 PIEp Teachers' Workshop Series

This workshop series alternate between the six PIEp nodes and provides a vehicle for meetings, exchange of experiences as well as the opportunity to visit the six node universities, labs etc. This is particularly useful when considering the opportunity for engineering educators to visit the international business school, to visit the institute of design and participate in the experimental learning ongoing there etc.

5.2 Coaching for Innovation

The coaching workshop is an example of more direct educational activities. In this example, a workshop was organized by PIEp, for 25 PIEp educators, where two professors from Stanford University were brought to Sweden for a four days training program. The 25 PIEp teachers came from all six PIEp nodes. The workshop provided extremely valuable insight into coaching for innovation and educational factors for creativity and innovation in general.

5.3 Workshop Series on Course Development

The workshop series on course development is another example, it's basically a workshop series where PIEp-related educators come together to share experiences and work together in the development of their courses and programs at the respective universities. So far two workshops have been organized, one at Stanford University for about 20 educators and one in Minneapolis for five

educators. At both workshops, steps were taken toward the establishment of new programs and courses in product innovation engineering at all nodes, based on input at the international partners as well as from the sharing of experiences between the nodes.

5.4 Mobility program and direct support to course development

Activities for PIEp teachers also include easy access to funding within the teachers' network for mobility as well as means to support course development. Teachers active in the network should be able to use PIEp funding to utilize and expand the network, meaning to visit the other nodes and international partners on an individual level. Means should also be available for activities that support the learning from each others' experiences.

5.5 New courses and programs in Product Innovation Engineering

The more measurable results of activities within this focus group would include the number of new programs and courses developed as well as the number of students who participate in these courses and programs. So far PIEp-resulted activities are visible at all nodes. This includes a complete new M.Sc progam in Luleå, a new M.Sc program under planning at KTH as well as changes to existing courses and programs in Lund, in Jönköping and in Umeå.

6. CONCLUSIONS

The aim of this paper was to presents results from the first two years of a large attempt at changing Swedish higher education – a system change toward synthesis, creativity, product innovation and entrepreneurship. The context is the Product Innovation Engineering program, a ten-year governmentally funded research- and development program with an educational change program – PIEp Education. Activities have been organized for three focus groups: students, doctoral students and teachers of higher education in Sweden.

Activities for students include an annual thesis competition, summer schools, thesis projects and international mobility programs. The research school gathers around 25 PhD students and offers a national complement to existing university research education programs. The teachers' network gathers around 50 university teachers in Sweden to workshops in creativity, course development and exchange of experiences. Among the results presented in this paper, besides the above, are examples of new courses, programs and local activities showing how the Product Innovation Engineering-thinking have been embraced among the members of PIEp and are beginning to show results in terms of new products, companies and businesses.

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Contact: Martin Grimheden
Royal Institute of Technology
School of Industrial Technology and Management, Machine Design
Brinellvägen 83
100 44 Stockholm
Sweden
+46 8 790 7797
marting@md.kth.se
http://www.md.kth.se

Martin Grimheden is an associate professor in Mechatronics at the Machine Design division at the Royal Institute of Technology in Stockholm, Sweden. Martin is managing PIEp Education and is the director of the PIEp Research School.