AC 2009-1134: THE PRODUCT INNOVATION ENGINEERING PROGRAM AND INTERNATIONAL COLLABORATION

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The Product Innovation Engineering Program and International Collaboration

Abstract

This article summarizes efforts undertaken within the Swedish Product Innovation Engineering program (PIEp), in the area of education for product innovation. A key aspect of the program is to create a systematic change in higher engineering education in product development, to move toward a focus on innovative product development, where entrepreneurship thrives and student ideas are brought to reality. Examples include the introduction of new undergraduate and graduate courses in innovation engineering, close integration between project courses offered at PIEp partner universities, joint research projects, and workshops that allow entrepreneurs and companies to better utilize student ideas and projects.

During the first years of PIEp, in the build-up phase, a large effort has been placed on creating an international network of 'innovation friends'. The founders strongly believe that the 'wheel should not be invented again – rather that there is an obligation to search for, find, and gather all relevant actors within this field, on a global arena. Within the rather limited network of partners and friends established this far, several common interest areas have been explored, including activities such as university-spanning workshops and collaborative projects.

Introduction – The Product Innovation Engineering Program, PIEp

The Product Innovation Engineering program (PIEp) is a Swedish national research and development program with the purpose of enhancing product innovation capability within Swedish universities and companies. PIEp was launched in late 2006, with governmental funding,[1] as the Product Innovation Engineering Program, PIEp.[2] 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.[3] The program encompasses three areas of activities: research in product innovation,[4] education for product innovation and industrial collaboration for product innovation.[5, 6] 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.

A key aspect of the program is to create a systematic change in higher engineering education in product development, to move toward a focus on innovative product development, where entrepreneurship thrives and student ideas are brought to reality. Examples include the

introduction of new undergraduate and graduate courses in innovation engineering, close integration between project courses offered at PIEp partner universities, joint research projects, and workshops that allow entrepreneurs and companies to better utilize student ideas and projects.

A particular focus of PIEp is the field of medical technology (Medtech). The medtech area is deemed as one of the most expansive in Sweden and with a history of several Swedish inventions turned into large international companies the intent is to explore this area in depth to realize its full potential when it comes to engaging students in medtech-focused product innovation activities. A major part of PIEp are the activities within 'PIEp Education', an organizational field with the responsibility of organizing activities and development within the higher engineering educational programs at the partner universities. Within this field, a network for educators has been established, which targets both teachers and coaches, and which includes a national research school for doctoral students in innovation and a number of activities offered to students at both PIEp partner universities and other universities in Sweden.

At this stage, the PIEp network includes two official international partners: the Center for Design Research (CDR) at Stanford University[7] and the Sr Kenny Research Institute in Minneapolis.[8] These partners have been chosen for their acknowledged recognition in creativity and design thinking applied to product innovation education and practice. These links were already established before the PIEp program and very strong links exists between Swedish researchers and the academic and industrial partners in both Minneapolis and Silicon Valley. During the fall of 2007 and spring of 2008, a total of four workshops were held at CDR and Sr Kenny for Swedish participants in the PIEp network, gathering more than 60 Swedish researchers and educators, with the purpose of exchanging experiences, creating networks and engaging in mutual learning.

PIEp Education

The PIEp program is organized in five activity 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 generate knowledge and feed knowledge and experiences to the other fields. Figure 1 below illustrates the 'resource system' or 'learning cycle' of PIEp together with some keywords and key activities of the respective activity fields.[9, 10, 11]

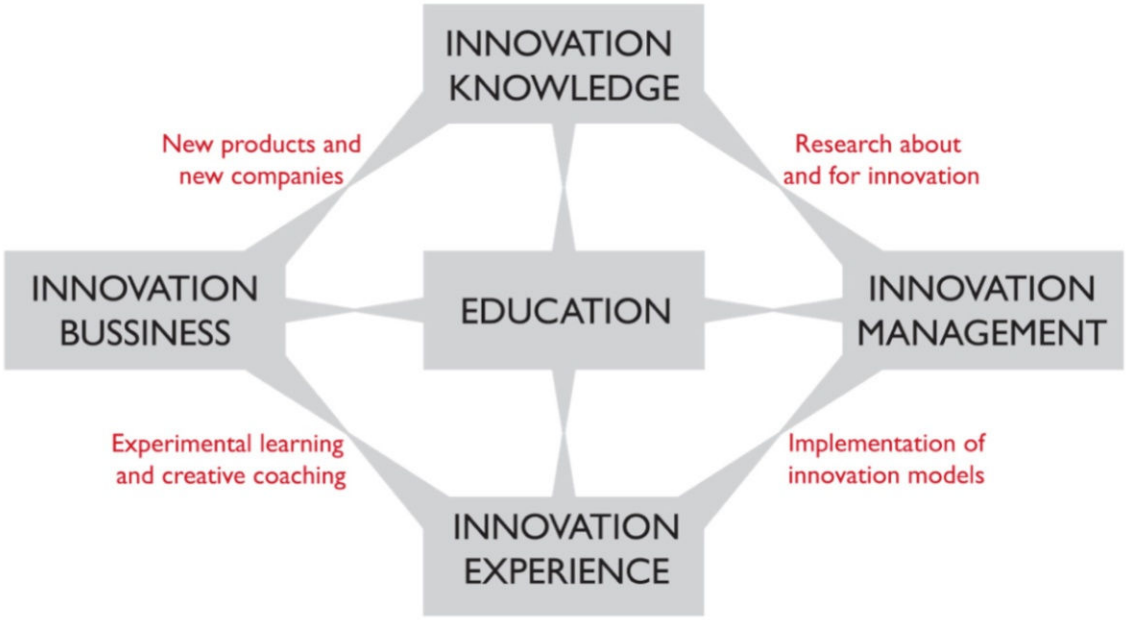

Figure 1. An illustration of the 'learning cycle' or 'resource system' of PIEp. The five boxes symbolize activity fields and the text in red shows examples of activities organized in the fields and some of the results from these. Results, experiences and competencies should 'feed into' the neighboring fields, as shown by the grey arrows.

The main activities of PIEp Education involve new courses in innovation engineering, a research 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 raising the innovative capability, it is necessary to involve and include all teaching personnel in training activities – a bottom-up approach that ensures alignment with PIEp objectives at an early stage of higher engineering education. These training activities are based on a number of training workshops where expertise from the entire PIEp network 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 Nodes and International Partners

PIEp currently consists of six Swedish universities and two international partners. Both international partners are in the US. A number of European and other universities are on the verge of signing up as additional international partners in the near future.

The list of PIEp Swedish nodes (node universities) is as follows:

- Faculty of Engineering, Lund University (LTH).
  LTH contributes in PIEp with research and education in the design sciences with need analysis, design methods and design principles. Also, ergonomics, industrial design and

innovation research. Ideon Science Park in Lund provides extensive experience from utilizing academic research with several success stories.

- Umeå Institute of Design, Umeå University (UmU)
  UmU contributes with extensive experiences from research and education in user-oriented design, interactive design and product design in general. The Institute of Design performs industrial collaborative research and educational projects with partners such as ABB, Ericsson, Telia and Volvo.

- International Business School and School of Engineering at Jönköping University (HiJ)
  HiJ provides the Jönköping Science Park, with extensive experience from SMEs, School of Engineering, Jönköping University with education directly to and for SMEs. Further, International Business School with research and education in entrepreneurship, business renewal and internationalization.

- Royal Institute of Technology, School of Industrial Technology and Management (KTH)
  KTH provides research and education in innovative and integrated product development, and industrial engineering and management. Also, research and education in complex, knowledge intensive products and systems development, in particular related to medical engineering, mechatronics and embedded systems.

- Luleå University of Technology (LTU)
  LTU provides research in functional product development, product innovation and design for well-being. LTU also provides experiences from integration of entrepreneurship in engineering education, and their exceptionally strong partnership with both Swedish manufacturing industry (Sandvik Coromant, Volvo Aero, etc.) and European aerospace industry (Airbus, Rolls-Royce, etc.) offers a test-bed for new methods and processes for knowledge and technology transfer.

- Center for Technology, Medicine and Health (CTMH)
  CTMH performs multidisciplinary research and education in innovation and entrepreneurship in medical engineering.

See also Figure 2 below for the relative geographical location of the six node universities.

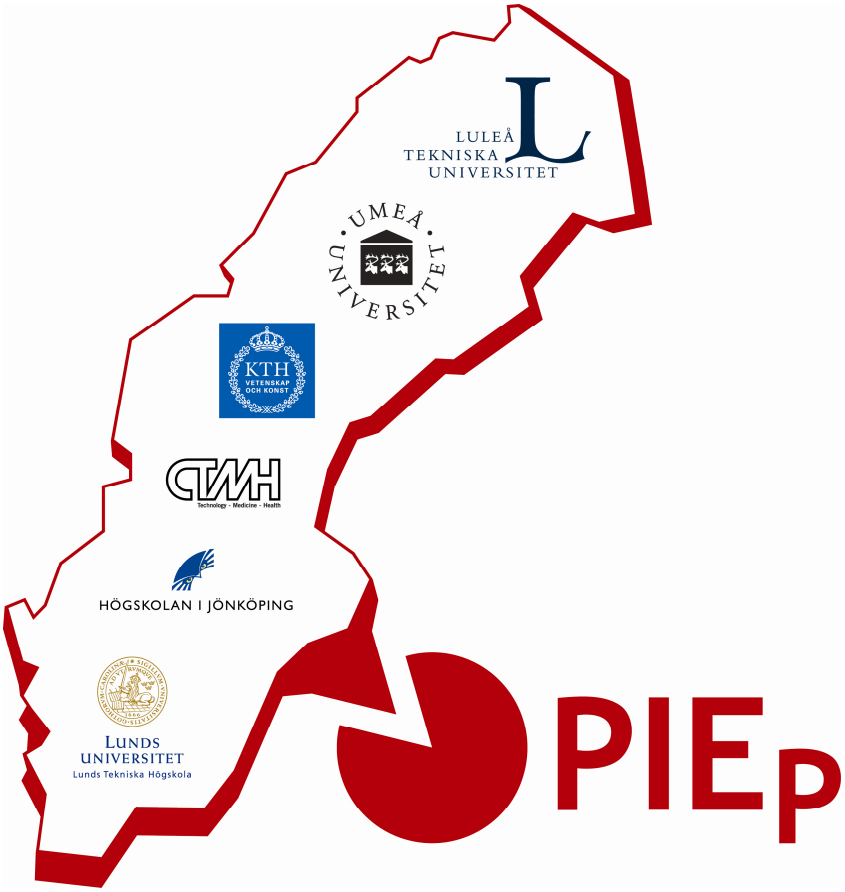

Figure 2. The six PIEp nodes represented by their respective universities' or organizations' logotype. The six nodes are distributed from the very south of Sweden (Lund) to the very north (Luleå).

The two international partners are chosen to complement the six Swedish node universities as follows:

- Center for Design Research at Stanford University (CDR)
  CDR performs research and education in design, design thinking and creative methods for product development, innovation and entrepreneurship. Situated in the midst of Silicon Valley, one of the most entrepreneurial regions in the world, CDR is a world-renowned research center that provides invaluable input and acts as a reference for the Swedish nodes.

- Sr Kenny Research Institute (SKRI)
  SKRI performs research and product development in the area of rehabilitation, well-being and medical technology in general. Integrating clinicians in the research institute, the SKRI bridges PIEp to both clinical research as well as one of the most active medtech centers in the US.

Through these international partners, a number of further contacts – called 'Innovation Friends' have been established as potential future collaborators. The Hasso Plattner Institute of Design (the d.school) at Stanford University, with its focus on interdisciplinarity, prototyping, social responsibility and the concept of 'design thinking', is a great role model for PIEp, as is the new Product Design and Business Development Program at the University of Minnesota with their focus on med-tech products, and their ability to attract local companies as sponsors and project owners.

Why International Collaboration? - Learn from the Best!

In this paper the activity field of education, PIEp Education, is primarily put forward. Activities of this field are organized in three target groups: teachers (faculty), doctoral students, and 'other' students.

Activities for doctoral students are organized in the form of a research school, the PIEp Research School. This is a complementary, national and virtual graduate school meaning that doctoral students are simultaneously enrolled at the respective node universities and, as is common in Sweden, also employed by their respective departments. PIEp Research School complements the respective universities education by providing the national and international networks, by offering national and international mobility programs, etc. PIEp doctoral students are offered a 'backpack' of funding to support mobility, for participation in courses at other universities, for international/national/industrial rotation and to aid the establishment of Common Interest Groups (CIGs) among the PIEp network of doctoral students. The international PIEp partners facilitate by providing exchange programs and infrastructure for mobility. Also, national rotation is facilitated by exchange programs between PIEp node universities and related companies.

All doctoral 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 guiding principles are 'learn from the best' and 'if you want to meet somebody – go see him/her'.

One group of doctoral students, the International Relations Common Interest Group (IRCIG), is currently tasked with the responsibility of coordinating all international contacts, which means that all international contacts are easily accessible through one point of contact and that the PIEp PhD students establish a feeling of 'ownership' of the international network. While these contacts and networks traditionally are organized by more senior researchers and faculty this setup provides for a more bottom-up, or entrepreneurial approach.

'Other' students are here defined as students other than doctoral students, mainly enrolled at the PIEp node universities. For this category, internationalization is primarily promoted two ways, by offering participation in summer schools and encouraging students to perform thesis work abroad.

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.

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 ME310 project (Project-Based Engineering Design, Innovation & Development) 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 diagnosis of balance disorders and one studying the innovation system in the context of the SKRI organization.

In a PIEp context the system change is not realized only through sending students abroad, but through utilizing the results and experiences from the pilot students. 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.

For teachers of the PIEp Teacher's Network, the infrastructure should also include easy access to funding for mobility as well as means to support course development. In October 2007, a workshop was held at Stanford University, with teachers from all PIEp nodes taking part. 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.

PIEp Innovation Friends

In the following, the international relations established so far will be presented, to set the stage for the inclusion of additional innovation friends.

1. Strathclyde University, the doctoral training center in medical devices
   The Doctoral Training Center at Strathclyde is a sister research school to the PIEp Research School. With a focus on medical device development, many similarities exist and a future collaboration seems very attractive from both perspectives. Representatives of the PIEp Research School visited the doctoral training center in 2008.

2. University of Lübeck, the medical imaging group
   This research team is a sister team to one of the research teams at CTMH, with interfaces to several of the doctoral students in PIEp Research School. Representatives of the PIEp

Research School visited the research group in 2008.

3. University of Hamburg, the entrepreneurship group
   This research group is active in the area of entrepreneurship, marketing and product innovation. Representatives of the PIEp Research School visited in 2008 and plans are being made for a joint workshop at Stanford Center for Design Research in 2009.

4. University of Minnesota
   A research- and teaching team at the University of Minnesota responsible for the Product Design and Business Development Program shows many interesting interfaces with PIEp Education, with their focus on med-tech products and ability to attract local companies as sponsors and project owners.

5. Swedish-American Chamber of Commerce
   The SACC have been extremely helpful with organizing visas for Swedish students and setting up internships and establishing contacts between PIEp and local US companies, mainly in the Minneapolis/St Paul region.

6. The Indian Institute of Science
   Students of the PIEP Research School have established contacts with representatives in the area of creativity research, with the hope of organizing a future workshop together.

Examples of PIEp International Activities

Most activities were mentioned previously, but to give the full picture a list is compiled below:

- Research School workshops at PIEp international partners
  Two workshops have been held: one at Stanford for about 15 doctoral students and one in Minneapolis for 10 doctoral students. Both workshops were organized as kick-off workshops for the research school and most doctoral students had not met before. The Stanford workshop was organized together with professors and seniors at CDR and aimed at introducing the PIEp doctoral students to the research undertaken at CDR, and to create possibilities for future collaboration on doctoral student level. Visits to four Silicon Valley design firms and the Hasso Plattner Institute of Design at Stanford were also included in the program. The workshop in Minneapolis was organized in parallel with a med-tech conference and the doctoral students, mainly med-tech oriented, were offered visits at local companies and research institutes – all with the purpose of creating opportunities for future collaboration. Both workshops lasted one week each.

- Workshops for the teacher's network
  Two workshops have been organized for the teacher's network together with the international partners. The first was held at Stanford University for about 20 Swedish

faculty members and the second in Minneapolis for five teachers. Both of these workshops aimed at promoting course- and program development at the various nodes, by offering input from activities at the international partners and by sharing of experiences between nodes. At both workshops, a special focus was held on how to utilize the international partners for collaboration. The Stanford workshop lasted one week and the Minneapolis workshop three days.

- Workshops in collaboration with 'innovation friends'
  Two workshops have been organized, both for members of the research school, with the purpose of finding and establishing international collaboration. In the first case, a team of ten doctoral students organized a workshop together with researchers at Lübeck University and Hamburg University, as described above. In the second workshop a smaller team visited Strathclyde University. In both these cases, the workshops have been setup and organized by the doctoral students under the mottos 'learn from the best' and 'if you want to meet somebody, just go there'. Funding for this purpose is covered by the doctoral student mobility funds, as described above.

- International master thesis projects
  About 15 individual M.Sc. students have so far been funded through the PIEp Mobility program for an international master thesis project. In all cases, these master thesis projects have been undertaken with one of the two international partners. For PIEp, this exchange is important and the experiences gained by the students are important to feed back to PIEp – as learning for other students and members of PIEp.

The Need for More Innovation Friends

When looking at the list of international partners, innovation friends and the list of activities performed during 2008 the author want to put forward the need to invite more international innovation friends, and that is also the main purpose of this article. So far preliminary contacts are established with a number of universities and organizations, for example a research team at Zhejiang, China, researchers at the Indian Institute of Technology, a university in Johannesburg, South Africa as well as with research teams in Europe.

The ambition is both to formally invite international partners to the PIEp network and also to find innovation friends either in the area of med-tech product development or in the areas of innovative product development, creativity, engineering design, etc. In the search for these partners, of primary focus is mutual interest, learning and appreciation – PIEp wants to learn from the best.

Conclusion and Discussion

The main purpose of this article is to summarize the efforts undertaken within the PIEp program, mainly in the area of education for product innovation. A major aspect of the program has been to create a systematic change of higher engineering education in product development, to move

toward a focus on innovative product development, toward entrepreneurship and better utilization of student ideas. Examples are the introduction of new courses in innovation engineering, integration between project courses, research projects, entrepreneurs and companies to better utilize student ideas and projects.

During the first years of PIEp, in the build-up phase, a large effort has been placed on creating an international network of 'innovation friends'. PIEp strongly believes that the wheel shouldn't be invented again, rather that there is an obligation to search, find and gather all relevant actors within this field, in a global arena.

This effort has only begun, but between the limited number of partners and friends established so far, several very interesting common activities such as workshops and areas of future collaborative projects have been identified and performed with very good results.

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