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EMBRACING ENTREPRENEURIAL BEHAVIOUR IN A RESEARCH SCHOOL

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The Product Innovation Engineering program (PIEp) has recently established a Research School with the aim to increase innovation capabilities in Swedish industries and to promote entrepreneurial behaviour. By following a bottom-up approach PIEp has been able to both embrace and foster entrepreneurship. As a result, the research school has already been able to change preexisting mindsets and to encourage PhD students to be more proactive, risk-taking and innovative.
Through descriptions of their own experiences and of key cases along the way, the authors illustrate the transformation from the initial idea to the research school as it is today. This paper seeks to provide insight and draw comparisons with other research schools to further research and assist policy makers interested in founding new research schools.

Keywords: research school, product innovation engineering, entrepreneurial behaviour, case study

1 INTRODUCTION

Graduate research schools are becoming common phenomena to promote research in a specific field and to effectively handle national and international problems. Their popularity rose during the 1990s, but until now there has been little official consensus regarding the characteristics of a research school [1]. A research school usually involves several researchers collaborating across disciplines and university borders. These individual researchers are the heart of the research school and its success often largely depends on them. They can be PhD students, under-graduate students, or senior researches. This study focuses in particular on the PhD Students and how their behaviour is influenced by the management model of the research school.
Broadly speaking, two types of management models are recognized in application on research schools: the top-down approach and the bottom-up approach. ENDREA, the Swedish Engineering Design Research and Education Agenda, and ProViking are two recent Swedish research school programs whose management models refer to the traditional top-down approach, where the board members decide the projects and the role of PhD students [2]. The success of adapting a top-down approach does not seem to be clearly visible. Although the participants in ENDREA embody important roles in the Swedish society, their role in adding significant new value to Swedish industry has yet to be confirmed, e.g. by an above-average rate of new inventions or new company establishments.
The PIEp Research School was founded with 20 PhD candidates during two kick-off meetings in March/April 2008. PIEp follows a different management model, which can primarily be referred to as a bottom-up approach. In this sense the participating individual researchers are enabled to self-determine their contribution and their role in the school. The program promotes innovation driven research as well as the transformation of research results into commercially viable products and services. Thus the financial investment is returned to society in the shape of new values and newly created companies. As this is the target of the program, the following sections outline how – after just nine months since the school's formation – the behaviour of PIEp PhD students has been influenced towards a more innovative and entrepreneurial attitude.
The purpose of this study is to describe and emphasize the lessons learned since the introduction of PIEp to its status today as the largest research initiative in Product Innovation in Sweden. Taking on this aim the authors reflects on the participants' entrepreneurial behavior as facilitator in establishing and tracking recent and future activities. The paper follows a detailed approach with the aim to address parameters that might be useful to decision makers for other to-be-established research schools. The key role of common interest groups (CIGs) in this process is the basis for the innovative management model and for promoting new innovation and a more entrepreneurial attitude amongst the PhD

students. A limitation of this study is the context of investigating research schools, as it is relatively rare and new in the literature. We have struggled to find studies which have explained the interaction of management and PhD students' behaviour.

2 RESEARCH DESIGN

The study is founded on the experiences and descriptions of PIEp by research school participants and management. To enrich the knowledge and deepen the insight of the processes and initiatives that make up the chain of events in this kind of research community, both past and present research schools are reviewed. As active research school participants, the authors acknowledge an action-based research approach. Thus, self-experiences build a foundation together with semi structured interviews, focus group discussions and archival analysis.

Besides reflecting and drawing conclusions from their own experience, enrolled PhD students and members of the board of the research school have been interviewed. A total of 15 interviews took place, alongside a moderated focus group where individual perspectives on the research school were collected.

3 SWEDISH RESEARCH SCHOOLS

There is a long history of research schools in Sweden. A recent example is the ENDREA Graduate School (EGS), which was a part of the ProViking research program, financed by the Swedish Foundation for Strategic Research [1]. The EGS program, now closed, had the aim of educating licentiates and doctors with certain key capabilities that was perceived important by Swedish industry [2]. Graduates from the program were to become the industrial leaders of the future, well-prepared through courses, networks and practical work undertaken during the program.

4 PIEP

The Product Innovation Engineering program was conceived in 2006, and funded mainly by VINNOVA (the Swedish Governmental Agency for Innovation Systems) for a period of ten years with a budget of 1.2 million Euros. The program is hosted by the Royal Institute of Technology (KTH) in Stockholm,and there are an additional five nodes at universities or centers across Sweden, with specific strong competences in the national research landscape. The six nodes are KTH, Lund University, Jönköping University, Umeå Institute of Design, the KTH Center for Technology in Medicine and Health and the Luleå University of Technology.

PIEp's general aim is to improve the innovation environment and enhance new business opportunities in Sweden, and transforming future as well as existing ideas and patents into businesses is a major goal. Thereby the overall ambition covers an increase in new companies and eventually the creation of more jobs in Sweden. [3]

PIEp as a whole comprises not only the Research School but also further learning initiatives as well as the four fields: innovation knowledge, innovation business, innovation management and innovation experience *(see figure 1)*. The research school is a part of PIEp innovation learning and thereby combines, teaches and utilizes parts of the aforementioned other four focuses.

The fields of action for PIEp are shown in *figure 1*. The long-term effects of PIEp arise from the integration of these fields with its 3-fold strategy of Research, Education and Collaboration with innovation learning at the core., As an integral part of the field of Education, the PIEp Research School combines, teaches and utilizes parts these focuses.

Figure 1. PIEp Overview [3]

4.1 PIEp Research School

The PIEp Research School educates PhD students to become change agents, which means that they will be the ambassadors of a new mindset towards better innovation experience and management. In addition to a classic product development and engineering research education, the PhD students participate in special workshops and multidisciplinary projects which emphasis *Innovation learning*. A wide, competent and growing network especially for engineers eases entry into the innovation business. At the end of the day, each PhD student has to take their own steps towards making use of the things on offer to them, depending on what suits them as individuals, but PIEp's works to make this as easy as possible for everyone.

When the research school program was planned, medical technology was seen as a historically strong field in Swedish industry, but with the need for new inspiration [4]. In March/April 2008 the first 20 PhD students were invited to two kick-off workshops at Stanford University and Minneapolis, where the latter was tailored to the interests of the researchers in medical technology.

Four concepts form the cornerstones of the research school:

- A financial budget enables the PhD students in the program to travel to other universities and to meet national and international key players.
- The formation of networks that concentrate on specific problems and bundle competences to find solutions.
- By aiming to increase the utilization of research results for new products and businesses, synergies are created between innovators, innovation researchers and coaches.
- Last but not least, every PIEp PhD graduates with an additional certificate stating their successful participation in the program. This certificate stands as proof of excellence and successfully applied research.

The PIEp PhD students meet as a group at least twice a year, at a meeting in autumn and a workshop in spring. To date, the former has always been held at the Royal Institute for Technology in Stockholm, whereas the latter is held at a special place abroad. For this spring the event was postponed and to instead focus more seriously on the late-summer meeting and PIEp workshops on sight in Stanford and the ICED conference. These events serve as an opportunity for PhD students to communicate, reflect, plan and network. Important decisions are usually made during these meetings, when all the PIEp PhD students are present and able to contribute.

In between the two annual meetings, informal meetings are arranged in Stockholm, which (due to its size) is home to a greater portion of the involved PhD students. The location varies and chosen to

inspire communication so that the PhD students can stay updated on each others' research. Further opportunities to meet other enrolled PhD students are provided by workshops and events arranged by the common interest groups, so-called CIGs.

4.1.1 Bottom-up approach

The management model in the PIEp Research School differs from the traditional graduate research school structure. The participating PhD students are given a greater share of influence on the direction of the program but are also expected to take responsibilities for their actions and decisions. For example, the financial "backpack" serving the students in their travel ambitions has to be used carefully for journeys to conferences and meetings - when it's gone, it's gone.

Proactive students can find great support when they can convince and motivate others towards their vision. Each student is encouraged to make the difference. Every student may influence the next upcoming goal, workshop or any other event. The openness for new ideas and innovation is reflected in the dynamics of the Research School. The willingness to test prototypes is not restricted to product design. Driven by pro-activeness, the PIEp Research School Organization Workshop was basically the result of three dedicated PhD students. Loose reigns management allowed individual PhD students the responsibility to take charge of the entire scheduling and planning, which in previous research school cases has been less common.

4.1.2 Common Interest Groups

In a way of cluster interests and research areas five distinctive domains were extracted also to the PIEp objectives. These areas were later formalized by the formation of the CIGs. The name relates to the definition of a special interest group (SIG) as defined in the Encyclopedia Britannica, which assigns the label to a group of individuals or organizations, which attempts to influence political decisions in its favor [5]. Unlike this definition, PIEp CIGs mainly intend to influence research by producing superior results. They can also initiate activities within PIEp and thereby impact on internal decisions within the program. To provide uniqueness, each CIG, formation is made in regards to a relevant PIEp research area where dissemination to new and existing members has a catalyzing effect.

Currently the CIGs are:

- The Medical Technology (MedTech CIG)
  comprising of researchers interested in any kind of medical engineering with the purpose of promoting synergies. The strong emphasis on medical engineering is reflected by the size of this group.
- The Open Innovation CIG (OICIG)
  comprising of researchers focusing on the study of product innovation development at the company level. These students are mainly from engineering and business backgrounds.
- The Innovation Capability CIG (ICAP)
  Focus of this grouping concerns internal and external factors that influence our innovative capability. The purpose is to enhance participants' interest and research areas, highlighting factors such as creativity, commitment, collaborative skills, team dynamics, user preferences, and business processes.
- The CIG for Cognitive Aspects of Innovation (CAICIG)
  The purpose of this CIG is to build a network of PhD students and researchers that are interested in learning more about the cognitive aspects of the innovation process.
- The International Relations CIG (IRCIG)
  People with extensive personal networks and those interested in cultivating new and existing contacts gather in this CIG. The group also has a strong interest in organizing events.

Through a CIG the students can gain access to additional funding resources, which can be used for interaction within the CIG, meeting well know researches and people from the world class and finally for arranging workshops/seminars. For ease of communication across CIGs, each group has an assigned CIG coordinator. This person is responsible for the information flow in and out of the CIG

towards the rest of the Research School. The coordinator and his/her assistant are also expected to play a greater role in inspiring other PhD students by conducting valuable and interesting activities.

4.1.3 Recent activities

- Within the first seven months, four workshops have been conducted, of either medium size (i.e. including 5 to 10 PhD students) or major size (including 10 PhD students or more). Coordinated by the CIG for International Relations, all PIEp PhD students were invited to a three-day workshop in Hamburg, Germany. Networking opportunities with related researchers from two German universities and two Japanese universities were organized. Two thirds of the time was invested in internal bonding and team building activities.
- In the middle of October 2008 a paper writing workshop was held at Luleå, the most northern node of PIEp. It initiated a great number of inter and cross-disciplinary studies and articles. Both, medical technology and innovation researchers were invited to brainstorm on paper ideas and paper-writing.
- At the end of October the MedTech CIG held a one-day workshop at one of the PIEp nodes. Joint research activities and the use of synergies were discussed while visiting the local laboratories.
- In November 2008, following an invitation from a senior researcher within biomedical engineering, the CIG for International Relations travelled to the University of Strathclyde in Glasgow, Scotland. Besides discussing the possibilities for joint research with the bioengineering unit, the PhD students arranged a meeting with entrepreneurial researchers from the Hunter Centre in Glasgow.
- The activity schedule of 2008 concluded with the PIEp's Annual Event, in November 2008. This is a large meeting attracts everyone within PIEp and also a number of company representatives, thus this provides a great opportunity for PIEp PhD students to reconvene and discuss during a 2-day workshop.
- Since the beginning of 2009 the CIGs have each organized an internal one-day workshop to reconvene and to plan ahead.
- In June 2009 the IRCIG arranged meetings with distinguished scholars and research groups relating to their individual CIGs while also disseminating knowledge on PIEp as a *'learning environment'* at the biannual international CDIO conference in Singapore.

4.1.4 Top-down characteristics

Having previously outlined the goal of pursuing a bottom-up management model within the PIEp Research School, a few issues do raise the question of the feasibility of adapting a completely bottom-up approach. For example, problems have been reported (probably due to unfamiliarity with the management model) when proactive PhD students organizing an event needed to communicate the necessity of a certain schedule for this project to other PhD students. Irritation arose when one small group of PhD students was required to inform the rest of the Research School of the inflexibility of a procedure. It can be assumed that due to heritage and education, a top-down component will always have to remain in the management model of a research school. To account for this characteristic, a slight change is being tested: from December 2008, the elected coordinator from every CIG takes on the responsibility of representing his CIG in a Management CIG that comprises only these coordinators plus the senior coordinator of the whole Research School. Although antagonizing to the general idea of a bottom-up approach, key skills are trained by this idea. Also the awareness of having a low level of hierarchy is given high priority.

5 CREATING CHANGE THROUGH ENTREPRENEURIAL BEHAVIOUR

Creating new knowledge in an organization is brought forward by individuals [6]. Following the bottom-up approach is a way of manifesting commitment and supporting learning ambitions in the PhD students. Analogous, an organization which relies on traditional control and authority relationships finds it difficult to disseminate knowledge. In addition, such management often restricts the opportunities to form social groups and prevents individuals from creating, sharing and disseminating knowledge.

As discussed in the introduction, the implication of adapting a bottom-up approach to the behaviour of PhD students is a topic of interest. In particular, we want to investigate if this management style enhances the PhD students' behaviour and motivates them to act entrepreneurially. Entrepreneurship and entrepreneurial activities are regarded as major factors important in-terms of economic growth and wealth creation [7][8]. However, the challenge is how to capture this entrepreneurial behaviour. Either the focus should be on the individuals or it should be on the organizational/institution-level. As discussed before the sum of individual actions are reflected in the organizational-level. Thus, for a complete picture, this study we focus on students' actions as they can be treated as a representation for the behaviour on of PIEp as a whole.
So what constitutes entrepreneurial behaviour or action? In the entrepreneurship literature five main dimensions have been highlighted, namely innovativeness, risk taking, proactiveness, autonomy, and competitive aggressiveness [9][10], however, most studies measure entrepreneurial behaviour by examining the first three dimensions. These three dimensions are explained below:

- The importance of newness has been considered a crucial part of entrepreneurship [11]. *Innovativeness* implies willingness of individuals to support new ideas, creativity and experimentation, which results in changing traditional practices. However, the degree of innovative initiatives can vary from radical to incremental.
- According to [12], entrepreneurship may be broadly defined as discovery and exploitation of profitable opportunities. Thus, the importance of acting *proactive* with a foresight for exploiting new opportunities is critical. Additionally, entrepreneurial individuals need to be better prepared for unexpected scenarios and to act at an early stage for transforming threats into opportunities.
- *Risk-taking* is associated with an individual's readiness to take daring actions that might lead to substantial losses. It also implies that they might invest in ventures were outcomes are unknown but promising [8]. This can be related to the early stage entrepreneurs' who chose a risky self-employment option instead of performing traditional professional employment.

In many ways the process of establishing a research school characterizes innovation, e.g. a process of creation and realization of an idea to an operational research unit. The actions involved in this process stem from the capability of individuals and organizations to practically manifest innovation and its functionality [13][14][15][16]. By embracing entrepreneurial behaviour, the establishment of a new research community is based on the self-motivation and ability to mobilize others. Participants act largely from inner directed aspects, where their distinctive assumptions and motivations determine the formation of the research school [17].

5.1 Chain of Events in Forming the PIEp Research School

The following section briefly explains the chain of events which lead to the current state of research school. Several of these events were based on the action intentionally take by the management to create a bottom up oriented research school.
In this process the initial workshops organized by PIEp at Stanford University and Minneapolis University were imperative. These locations were strategically selected not only for their reputation in the research community but also due to their attractiveness as learning and education facilities, and thus, as sources of inspiration. Invitations were sent to a large audience; however, only a few motivated students were selected. During the interviews, the students were asked to provide reflect on their initial feeling regarding the Research School and their first workshop experiences. The majority of these students reported that they were not clear about either one of them. The main idea behind this *'provoked uncertainty'* was relating to the PIEp Research School's nature and future, focusing on its establishment and flourishing opportunities, rather using a pre-decided outline. During the Stanford workshop students were given the opportunity to learn new tools, these tools were useful for planning ahead, forecasting trends, and *"thinking out of the box"*. This was reported as valuable for every individual, to be able to visualize and plan new ways to problem solving. So when the question regarding the Research School was discussed during the workshop, it was easy to notice that each PhD student came up with his/her well thought-out expectations and suggestions regarding the future. Some of these innovative ideas and thoughts were explored further, for example the focus on international presence, higher quality of research, networking, creations of different groups, certification, to name a

few. The outcome of the workshop was the identification of six ideas that were given high priority, and six students voluntarily took the responsibility to develop the action plan and present possible ways through which they could be realized. PIEp management promised each PhD student support in-terms of a budget to travel to the meeting, and the possibility to get a few of their ideas implemented in due course. During the following weeks these PhD students put in extra efforts and developed actions plans. This meant that in addition to spending time on the workshop they were willing to risk the loss of time with further development of their action plans. PIEp only supports 10% of each PhD student in terms of funding for their projects. Most students are funded by their own project that is not financially related to PIEp. Thus, justifying time invested in PIEp activities could sometime be difficult.

In spite of the above low driving force, the students gave a short presentation and contributed with their ideas during the reception meeting. The initiative of preparing a video presentation due to physical absence at the meeting gave the impression of dedication and high motivation. The outcome from the meeting was not entirely promising for everyone, as only one idea (i.e. planning the next workshop) was given priority and remaining ideas were kept, but put on hold.

This was the start of the first CIG with the focus on building international relations and organizing international events. The group constituted three students who took the responsibility of creating a mini Stanford workshop experience. The initiative was welcomed and the CIG was given the task of entirely organizing and planning the workshop. These students took a very proactive approach in establishing contact with other universities, finding attractive locations for the workshop and activities which would interest everyone and focus on the development of the Research School. This process was not easy as the students had no previous experience and felt uncomfortable with deciding everything themselves. There were conflicts and confusion when information was communicated from the bottom upwards. In a lot of ways it took a longer time than top-down information flow and several times management members had to step-in and create additional pressure. For example, students were asked to provide short descriptions of their research projects and the response was initially low. Given the flexibility in budget, one could expect that the workshop would end up too expensive, unproductive and unplanned. Instead the overall cost was kept at a low level and students searched for cheap flights, accommodation and came up with exercises which promoted innovative thoughts. If the measure of success depends on the number of students joining in the workshop, the result has to be seen as below average. However, in terms of content and discussions, the workshop was a great success.

The workshop assisted in the identification of other Common Interest Groups with focus on students' research interests. For the first time, many students could clearly relate PIEp with benefits for their research. It was also decided during the workshop that the CIGs would be given funding to arrange activities (e.g. seminars, experimentations). The size of the funding was sufficient to enable the group to organize small scale activities and the decision of how the money should be spent was placed entirely at the responsibility of the group members. Each CIG decided itself on the nomination of a coordinator with the ambition of driving the group. The CIG coordinator can be seen as an entrepreneur encouraging his group to come up with innovative activities which not only support the group itself but also contribute to the knowledge base of the Research School. Additionally, the CIG leader is expected and required to behave with a proactive attitude and to plan ahead and communicate ideas for the future regarding the use of funds, attracting new participants and sharing knowledge with others. In many cases the responsibility to lead the group was shared between different students to prevent research pressures hindering the CIG activities. Within a few days after coming back from the workshop invitations were sent to invite PIEp PhD students to join each CIG and to initiate collaboration in the particular focus areas. The CIG founders created an agenda with goals, objectives, and activities planned for future. This development was obvious evidence that the Research School was in fact driven by PhD students - and that it was possible to get support, when needed, from the management. The dynamic idea flow coupled with the readiness to discuss every idea and to test the best ones has lead to continuous optimization of the management model of the research school. One example is the now-realized thought of establishing common interest groups to create environments for researchers with shared interests. These environments not only provide financial assistance but also support the PhD students by fostering communication amongst the researchers and by strengthening any activity with the opportunity provided by a team-based approach.

The primary challenge in the design of the PIEp Research School was finding the best way to promote synergies within and between different Common Interest Groups, as the optimized use of synergies has been the main idea from the beginning. The research aims bonded the teams internally but also separated them externally - in particular, the MedTech CIG and the CIGs dealing with innovation, which clearly had different research focuses.
When the idea of a joint-paper writing activity, the Tiger Team Writing Workshop (TTWW), was outlined and eventually conducted, students from the MedTech CIG were faced with a situation in which it was difficult for them to relate to their regular research situations. Still, surprisingly several students from the CIG attended the workshop and actively participated. This is worth noting as this meant them coming out of their comfort zone and took new risks. Behind the activity was a common objective, a conference at which the papers would aim.

5.2 Reflections on the PIEp Research School

Based on what has happened since the initiation of the PIEp Research School in April 2008 until today (December 2008) an increase in new thinking, processes and practice has occurred. From an individual's perspective, the chain of events have put emphasis on entrepreneurial behaviour and innovativeness where factors like communication, commitment, collaboration, coordination and creativity have played important roles. As such, these factors characterize the PhD students' variation in commitment, something that is also shown by the way CIG champions take initiatives to organize events and internal communication. Without their creativity and commitment, the actions of formulizing a unique set of initiatives become restricted. Besides working together and finding new opportunities, separate events such as the TTWW have encouraged peer-reviews in order to critique, revise and refine each other's ideas and documents. The writing process itself very much paved the way for self-management teams, where each team became self-sufficient in trying to meet deadlines and activities involved in the paper writing process. In addition to paper writing teams, each CIG also reflects the description of being a self-managed team that coordinates their activities and functions through learning, negotiations, and adjustments [18].
These factors also promote openness and sharing of the competitive environment where outer-directedness puts forward an operational organizational formula. Influenced by other research initiatives, PIEp's basic principle for the Research School is for individuals to innovate their research communities. In turn a number of Common Interest Groups (CIGs) were outlined to promote openness, each with an agenda to promote completion and fulfillment of existing and interrelated PIEp research areas. Based on the necessity to develop, nurture and maintain an updated innovation perspective, it is inevitable to emphasize a stronger PIEp presence in the research community. This can be established in a number of ways involving writing journal and conference papers, joint data collection/analysis through test beds, arranging workshops (inviting potential new PIEp members) and by establishing physical presence at external universities and research institutes (again, new potential PIEp members).
Reviewing the entrepreneurial behavior maybe it can be seen that risk-taking, innovativeness and pro-activeness are overlapping each other with innovativeness as the ultimate driver for change. Formation of CIGs constitutes a flourishing rise by committed individuals where actions taken reflect the status and true nature of the Research School as a whole. Innovativeness alone is however insufficient without acknowledging the way actions are outlined, therefore risk-taking and pro-activeness single out CIG growth potential. A wished-for effect with the CIGs is to promote synergies and more of an "out of the box" mentality. As yet, it is too early to state whether this is a common denominator between existing CIGs. Using a reference model figure 2 describes the relationships between factors entrepreneurial behavior of participants of the research school. Based on individuals' capability, change and innovativeness are attached to internal factors, thus from literature and prior experience we assume [A] five elements of such to have influencing roles. These elements are of interest as they could be used to determine the overall innovativeness of research school participants. All in all, the figure tries to visualize the positive [+] relationships and connectivity between key elements (i.e. communication, commitment, creativity, collaboration, and coordination), measureable success factor (i.e. innovativeness), and the ultimate success factor (i.e. Entrepreneurial behavior). Entrepreneurial behavior of involved PhD students is from experience [E] based on the balance between individuals' proactiveness and their willingness of taking risks.

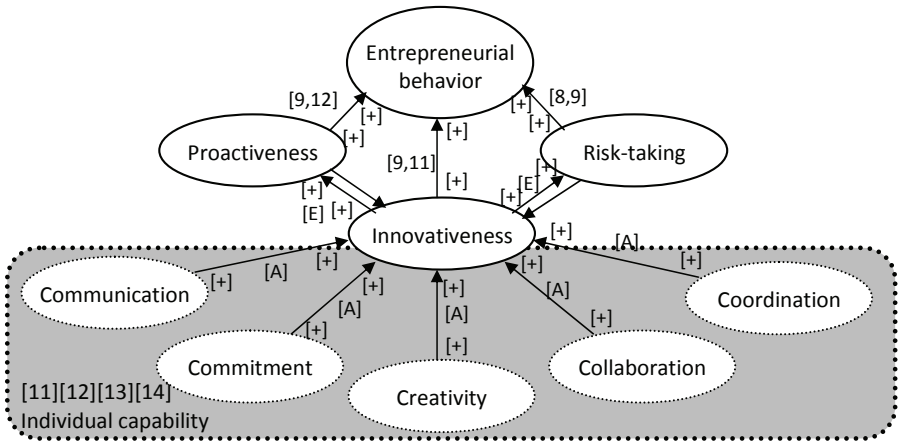

Figure 2. Reference model used to describe Entrepreneurial behavior

In a round table discussion, individual members' perspectives were cross-checked against the causes which drive CIG participants' attention, and the findings were consistent: the PIEp Research School faces two generic objectives. The first is *towards networking,* hooking up with the best and most committed ones in their respective field, which also would promote a greater insight with a plethora of *knowledgeable perspectives*. The second is to maintain the underlying enthusiasm for embracing new fruitful market opportunities, by shifting gear in each individual's ongoing research or drive and finding ways to commercialize their research.

Going back to the formation of different groupings into CIGs, active participation and commitment to work have been a central issue. Besides having committed participants that contribute in a give and get situation, this touches on crucial ground for the existence and continuation of CIG initiatives. Thus, each existing CIG bears the role of singling out preferences and uniqueness by exploring domains of relevance and interest.

6 LESSONS LEARNED FROM PIEP RESEARCH SCHOOL

Although the PIEp Research School has been active for less than a year, several lessons have been learned during this short period. First of all, having a bottom up approach can be hard to sustain. The approach and its sustainment require a drastic change in the mindset of individuals, both on the student and on the management level. Although, we feel that having the freedom to realize changes and to come up with novel initiatives has its benefits, some level of control and assurance from the management is essential. This means a clear communication regarding the level of freedom and accountability between the management and the active students is indispensible.

Secondly, based on initiatives taken by the PIEp PhD students, some individuals have naturally been more open to change than others, and have shown a greater willingness 'to make change happen'. Acceptance to the Research School is, among other things, reliant on an applicant's interest in change, and thus innovation. However, this alone does not provide the critical mass for identifying someone as a visionary key-contributor to a research school's future. Individuals with the entrepreneurial attitude need to be carefully identified. In many ways the desired characters are leaders with the appropriate capability. On the other hand, the focus of the general management should not solely be directed towards leaders, as others need to be equally motivated. PhD students by default undergo different phases in their research and sometimes need to concentrate and prioritize for themselves, at least temporarily. During this time other students need to step in and keep up the flow in the CIG. So far an open and frequent dialogue between research school participants and the management has led to democratic and fair results.

Thirdly, at this point the formation of CIGs seems to be a highly effective and positive initiative to bind together researchers with similar interests. The challenge is to cultivate the use of synergies and to assure that no group starts closing up and that the openness and the sharing of knowledge remain intact. Again the management has to play a role in this point and provide guidance.
Fourthly, in alignment with the PIEp objective to promote new innovations and new businesses enrolled PhD students have starting to show interest in commercializing their research in one way or the other. This is an objective that needs to be evaluated later on, for now the formation of CIGs in relation to the goals of PIEp (i.e starting new innovative companies) seems to be fuzzy. It requires a diffuse combination of pro-activeness, risk-taking and innovativeness together with a great portion of commitment and creativity to turn a researcher into an entrepreneur, but in addition to teaching the value of this behaviour it also takes structure and funding, i.e. management considerations.
The networking amongst the participating PhD students has not ultimately led to a greater leverage in the respective research projects. Yet the fundamental desire to set up something lasting is nicely formulated, and is tested out by allowing an open democratic bottom-up approach in CIG formalization and by proposing events to others and encouraging them to take part in these events. "What's in it for me?" is a natural question to any commitment that, if not explicitly outspoken, is at least thought by participants and liable to weaken their enthusiasm if mishandled.
Problematic issues arise from the multidisciplinary perspective of creating an embracing research school that includes researchers with a design and innovation background as well as researchers with a medical engineering education. Again the need of matching different mindsets and fusing them into a bigger, more innovative community is challenging. So far the pieces have matched up well, although the process has been time-consuming and will continue to be. The invisible but mental wall separating the "MedTech" researchers and "the others" is a cause for frustration but also reflects the pivotal point for the innovative onset. The dedicated ones are simply those that put in efforts to radically change patterns from the past, opening up for knowledge sharing and new ideas.
Having the privilege of being part of this Research School, it should be noted that it has been far from a walk on the red carpet. Whether indifferent or just preoccupied with other concerns, the mindset of most participants originally did not meet the idea of different activities and workshops with eager interest. The content of any activity must bear a significant value to any active contributor if overall objectives are to be reached. As the PIEp Research School continues to evolve, the given boundary conditions for decisions are crucial to the dedication and the effort that each participant can be expected to make. Hence, strategic incentives and activities should harmonize well in order to create lasting effects.
In future research it would be interesting to identify the antecedent to entrepreneurial behaviour and innovativeness in other research schools. In combination with this study, such investigations would provide further valuable lessons as previous attempts have been scarcely documented in academic papers.

7 CONCLUSION

Although at this time only a short period has elapsed since the foundation of the PIEp Research School, the evaluation of the innovative attempt is very promising. The establishment of Common Interest Groups combined with a flat hierarchy, a high degree of self-determination (due to the management model), and a serious financial background are seen to be key parameters in the rapid growth so far. From management the entrepreneurial behavior is perceived as something fruitful and wished for. Still, the individual risk-taking is attached with inflexibility and constraints in relation to PhD's research projects, which is basically a question of prioritizing and time. Hence, components such as proactiveness, risk-taking and innovativeness are faced with a two folded dilemma: a) individual benefit, and b) interference with own project. Future motivation of work is therefore pushed in the direction to align such otherwise opposing elements, preferably by finding better ways to address individual contribution and implement management thoughts downwards so that conflicts, misunderstandings and other 'noise' is reduced in the process of creating change and impact in a joint research community as the PIEp research school.

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