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Bridging the gap from research to high-technology ventures with experienced entrepreneurs

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Abstract: The paper outlines an initiative undertaken to increase the number of spin-outs from a research university. The Bridging the Gap (BtG) model takes a systematic approach to identify and match experienced external entrepreneurs at a very early stage in the technological development process with university researchers to improve the technology spin-out process. The experiences, market insight and network connections of experienced entrepreneurs when combine with technical knowledge and capabilities of the researchers create a strong resource base for start-ups. This strong resource base can shorten the actual time taken to spin-out a technology and also increase the prospects for the emerging start-ups to achieve sustainable growth. The empirical evidence to support the model comes from two research departments at the Technical University of Denmark.

Keywords: Technology; university researchers; university spin-outs; experienced entrepreneurs; Bridging the Gap; start-up resources; time to spin-out.

1 Introduction

The emergence of successful new technology companies based on university research has focused the recognition of universities as breeding ground for entrepreneurship. Universities contribute to entrepreneurship development through different mechanisms that help to exploit technological opportunities created by research (van Burg et al. 2008). Some universities are much better at spinning out new companies than others (Di Gregorio & Shane 2003). Nerkar & Shane (2007) have shown that the 'scope and pioneering nature' of different technologies influence commercial outcome while van Burg et al., (2008) and Jain & George (2007) have explored how technology transfer units by providing access to resources and support services can impact the process.

Experienced entrepreneurs are accepted as key contributors to the wider university entrepreneurship especially through their involvement as mentors or advisers to students. Their involvement in the commercialization process as integral part of potential start-up teams, working closely with researchers, investing time and other resources into realizing commercial outcomes from university research is not widely researched. Key contributions concerning the role of surrogate entrepreneurs (a term used in the literature to describe entrepreneurs who are not academics/researchers and are brought into the university or incubator to help commercialize research results) such as the works of Franklin et al. 2001; Vohora et al. 2004; and Lundqvist 2014, have focused mainly on the presence of surrogate entrepreneurs and their impact on performance.

Experienced (or surrogate) entrepreneurs can bring accumulated experiences, knowledge about specific business environments as well as professional networks to the commercialization process (Lundqvist 2014). These competences aid the recognition and evaluation of opportunities emerging from research for new spin-outs (Davidsson, 2013). Individuals with start-up experiences and knowledge of operating in specific technology markets can help to improve the start-up situation which contributes to better resources and capabilities for new technology firms to navigate the many associated challenges (Shane & Stuart 2002).

The process of matching external experienced entrepreneurs (EE) with university researchers for a productive interaction leading to the spinning out of a university technology is mostly unexplored. The present study contributes to this gap in knowledge by exploring the question: How does having external experienced entrepreneurs (EE) in the research team

influence the spin-out process? In which ways do EEs influence the spin-out process? The analysis is based on the Bridging the Gap (BtG) model applied by two departments at the Technical University of Denmark to increase the number of spin-outs based on their research by incorporating EEs into research teams.

The paper is structured in the following way. This introduction is followed by the conceptual framework. Chapter 3 contains the study design and model description. Information on the cases in presented in chapter 4 followed by some results in chapter 5. Finally, chapter 6 contains conclusions and implications.

2. Conceptual framework

Universities are encouraged to engage in new venture creation for many reasons including accomplishing sustainable innovation with economic and societal impact and to diversify income streams through commercialization of knowledge through licensing technology and establishing new spin-outs (Mosey et al., 2007; Lundqvist, 2014). Spinning out new companies may create advantages over licensing both for the university and the academic inventor as equity holders. Many researchers are reluctant to leave university positions to concentrate solely on forming spin-outs. Maintaining an academic position with research, teaching and administration responsibilities and starting and running new technology venture is almost impossible. Other researchers are simply not interested in the commercial aspects of their inventions. This create challenges for start-ups based on their research since investors tend to look favourably on technology start-ups when the inventors are somehow involved, especially in the early stages when developing and testing are still crucial activities (Radosevich, 1995). Universities strive to create a balance between increasing commercialization of knowledge and maintaining academic reputation traditionally bases on publication in high/impact journals.

Considering opportunity as the core of entrepreneurship (Shane & Venkataraman, 2000; Haynie, Sheperd and McMullen, (2009); universities must facilitate and support the recognition/discovery, evaluation and exploitation of entrepreneurial opportunities to increase spin-outs. Researchers with no prior business ownership and associated credibility, financial resources or business networks must find ways of circumventing these shortages/liabilities. Experienced entrepreneurs can potetially meet these needs in an emerging start-up (Mosey, Westhead and Lockett, 2007). Radosevich, (1995) used the term surrogate entrepreneurs to describe experienced entrepreneurs who in the absence of inventors takes

'ownership' of technologies developed in public research institutions to launch new ventures.

Surrogate entrepreneurs can potentially reduce challenges associated with the liabilities of newness and smallness with credibility, financial resources dense social and business networks gained from prior entrepreneurial undertakings (Lundqvist, 2014). Several studies on entrepreneurial opportunity confirm that prior knowledge is beneficial for the process of opportunity recognition (Grégoire, Barr, & Shepherd, 2010; Vaghely & Julien, 2010). Others have shown positive relations between 'years of industry experience' and venture emergence (Dimov, 2010) and between entrepreneurial networks and experience and new firm outcome (Haug et al. 2013).

These and other observations contribute to the present proposition that the addition of EEs with complementary knowledge and industry experience to researcher teams will accelerate spin-outs. The emerging spin-outs should have better interaction with product and market systems to improve both technology and product development in the start-up. This resource base would contribute to spin-outs that can achieve sustained development and growth.

3. Study design and model description

The study takes a design anthropology approach combining observations, iterative actions in the development process and reflections over the span of 2 years to create a longitudinal perspective. Design anthropology allow us to study and produce a theoretical framework by observing the existing practice regarding the development of high tech start-ups, while being able to change this practice and to design a new model based on the active involvement and engagement of the participants. Design anthropology allows us to follow dynamic situations and social relations throughout the project and iterate the overall framework for the Bridging the Gap (BtG) model (Gunn, 2013).

Three co-authors worked in the field observing existing practice and developing and implementing the model, a process which will continue in the coming year. Triangulated evidence collected from various sources using the design workbooks also contributed to the development of the model. The quasi-participatory nature of the design workbook provides participants with the possibility to interpret, react to and elaborates upon ideas as they emerge over time (Gaver, 2011). The design workbook enables the documentation and iteration moving from the original concept of the model through the various development stages. Participant

observations, qualitative interviews, analysis and co-creation with the researchers and EEs facilitated a transformative process for innovation and entrepreneurship practice in the university.

3.1 Bridging the Gap – The Model

The BTG model was initiated in 2013 by the Department of Chemistry and the Department of Photonics Engineering at the Technical University of Denmark. During a one year trial period, the framework for the model was developed and tested. This provided the input to create a model for bringing EEs into the university to work with researchers to create spin-outs. The final model was implemented in April, 2014. The model is divided into the following five phases with some overlapping of the activities:

1. Screening and Patenting
2. Matching EE to research team
3. Connect to potential lead customers and Develop prototypes
4. Spinning out, and
5. Follow-up (see Table 1).

EEs are introduced in-spe CEO positions as an integral part of the innovation and commercialization process for university owned technology. The EEs do not get paid, but are becoming cofounders of a potential company. The model focuses on both the early phases (where the technology is patented) and on the life beyond the university. The goal is to create growth-sustaining companies which requires following the companies for period of up to two years. The trial model had a strong focus on the matching and connect and develop phases which were changed during the trial year to the present state where the EEs of the BTG Model now entered at an earlier stage than the pre-organization phase, i.e. before the entrepreneurial commitment juncture (Vohora et al.2004).

The model explores the effect of bringing EEs into the commercialization process earlier at the late research phase or the opportunity framing phase. The rationale is that EEs with relevant technical, market and business competences can ensure a more efficient opportunity framing phase, hence having a positive effect on the acceleration of the spin-outs from research to company and their growth potential due to finding the right business potential early in the process. A cornerstone of BtG is therefore the creation of trust between EEs and academics, and mutual acceptance of the EEs as venture champions. As described in Table 1 the technology is

at a Technology Readiness Level (TRL) of 1-2 in the first phase, so the possibility to influence the technological development is crucial.

	Screening and Patenting	**Matching**	**Connect and Develop**	**Spinning Out**	**Follow Up**
Description of the different phases of the BTG model	Researchers and business developers within the university secure IPR and perform initial opportunity search. Typically TRL level 1-2.	Experienced entrepreneurs (EE) from outside the university are matched to potential spin-out cases. The EEs dedicate significant resources in terms of their own time to understand the details of the technology. Typically TRL level 1-4.	The EEs seeks to connect the technology to potential first customers. Development of prototypes and project-based feasibilities studies to clarify market demands. Typically TRL level 3 to 5.	EE and university researchers form founding team and establish a new venture. License agreements with the university for IPR. Securing of seed funding and/or customer-financing for spin-out. Typically TRL level 4 or higher.	Following the new spin-out via individual meetings and/advisory board roles. Collecting data on time from spin-out to receiving first commercial order, and on team dynamics between EE and university co-founders. Typically TRL level 5 or higher.
Legal activity	Draft Term Sheet developed by the university	NDA between EE and university. LoI between Uni and founder group. Uni states intention of spinning out a company	MoU among future founding team (Uni not part). Consultancy agreement between EE and University	Term Sheet. Shareholder agreement for New Company. License agreement between New Company and University	
Patent activity	Patent filed		Patent developed with a business perspective		
EE actions	No EE	Overview of business potential	Business plan and patent	Responsible for legal process and possible investments	
EE level of commitment	(0 EE)	EE participates via advisory boards or individual meetings (1-4 EEs)	EE is part of the team working at the university (1-2 EEs)	Part of the team away from university (1-2 EEs)	
Researcher actions	Filing of patent	Dialogue with EEs about technology and business potential	Working on the development of the technology for market	Part of the team away from university	

Table 1: The five phases in the BTG Model and main activities

Often the researchers are not motivated and even the motivated ones do not know which are the most important tasks necessary to create a strong foundation for the future business.

4. The cases

In this section, we will present 6 cases representing key features in the BTG model with emphasis on the EEs; their characteristics and their level of involvement in the future spin-outs. The cases have been chosen based on how far they are in their development, since the programme is ongoing we focus on the cases that have spun out, or are in the process of spinning out during spring 2015

Case 1: The technology for this case involved a new concept for lasers in the medical device market. However, the researchers had no interest in going full time into a new venture, and the case was lacking industry insight in order to find the right market approach. A BTG advisory board was established comprising 3 experienced entrepreneurs. After 6 months the EEs and the researchers reached a mutual understanding about the future venture and the sharing of equity among them. Furthermore, one of the EEs had committed to serve as CEO. The team also engaged two business school students to serve as personal assistants to the CEO. Seed funding from this group of 11 individuals (on average €5k each) funded the hiring of the CEO for one year. Within the first 3 months, the company made its first sales, and within 11 months, they secured a further investment of around €500k from business angels and a venture capital firm. The founding group holds around 75% of the company. The company has 4 employees today, including a sales representative in the US. The success of this case is seen as a result of the combined competencies of the EEs and the researchers, and of the relatively large founding team being able to distribute the workload among them.The total period from engagement of the EEs to spinning out the company was 12 months.

Case 2: The research team for this case comprised three individuals, two with previous experience from a spin-out, albeit with hesitation to join the start-up full time. The last researcher had an interest in joining the start-up, but lacked business or management experience. Working on maturing the technology, the team had realized significant improvements compared to present solutions on the market, and filed a total of 7 patent applications. The team was approached by an EE, who was looking for a new venture that he could engage in fully and committed 1 year of dedicated work with the research team to understand the technology, develop the business

foundation and to gain mutual confidence. During this year the EE and the research team decided to form a company with shares split equally between them and to pursue a business strategy without need for investments, hence a fully customer-financed start-up. The company further secured IPR form the university and today has two employees, the EE as CEO and one researcher as lead engineer. The total period from engagement of the EE to spinning out the company was 18 months.

Case 3: The academic team spotted a potential application for the technology in sports equipment but had no interest in joining a spin-out. They were happy to see the technology sold off, either as a license agreement to an existing company or as a spin-out headed by someone else. A BTG advisory board was set up with three individuals; a sales and marketing person with specific market insight, an experienced entrepreneur with technical background, and a business angel with focus on management of start-up teams and executive sales. After 4 months of involvement, two of the EEs decided to engage full time to spin-out the technology. The third EE had a different perception of the right business strategy and after mutual agreement left the team. A series of customers meetings were held during the first 6 months which lead to company formation. Hence, the total period from engagement of the EEs to spinning out the company was 12 months. Ownership of the new company comprised; the EEs 80%, researchers 10% and the university 10%. During the follow-up, the new technology exhibited unforeseen disadvantages prompting the EEs to move to existing technologies based on a promising business model. One of the EEs decided to pursue the business case alone and the other decided to quit. With the university IPR and technology no longer playing a role going forward, the original company was liquidated. Today, the EE who continued the course has demonstrated a prototype based on existing technology and secured partnership with a leading player in the market.

Case 4: The research team consisted of one PhD-student and two master students therefore it was crucial to find an EE with significant experience and knowledge of entrepreneurship and sales and marketing. The research team wanted to set up a webshop and sell their technology worldwide primarily focusing on the R&D segment. They expected turnover of €1m after three years selling devices at €4k pr. unit. The research team had already met with a potential investor, who wanted to provide them with the first early investment for 25% of the shares in the company. The team met with two potential EEs and it was clear that they had very different visions. EE1 wanted to move forward with the existing business model. EE2 did not see any potential in the current business model but instead

suggested that the team focus on a specific B2B segment, develop a large scale installation where test results did not have to be analyzed by other researched but were presented as finished results. Instead of €4k pr. unit this would represent a value of approx. €70k pr. unit based on feedback from potential customers in the EEs personal network. The team decided to go with EE2, who was also responsible of applying for a soft funding grant. This grant allowed the team to bootstrap early activities, keeping the company shares for a potential future investment round, when the company has increased its value. From the point when the EE became part of the team it took the joint team six months to spin-out. The company currently employs two full-time researchers and one part-time and the EE together with a part-time programmer.

Case 5: The research team had a two year old patent, when they were included in the BTG programme. They wanted to the technology to be spun-out, but they were not interested nor believed they had the skills to lead the process. An advisory board with five EEs with networks and expertise within this area was set up. After the first meeting one EE became lead and the rest of the board were unwilling to spend time on the case. The remaining EE set up bi-weekly meetings with the EEs and engaged a business graduate to conduct sales and set up a website for the product. During the process it became evident that the current patent would not provide the necessary protection for the company and the EE co-wrote a new patent together with the researchers and a patent attorney. This provided a crucial foundation for both the company and the investment secured by the EE. The company will employ the business graduate full time together with a technician and the EE will continue as CEO. The EE spent approx. one year with the team before spinning out.

Case 6: The EE approached the university with an idea for a potential business. He was matched with a research team, who had specific knowledge within the area. They worked together intensively for six months during which the EE brought in potential investors and board members. This focused the development of the technology and within the first month a common goal was set paving the way for developing the technology specifically for this goal. This made the research team very focused and driven. At the same time the EE was setting up a production line, sales channels and future customers. After six months the research project finished and the EE took over and after nine months the product was available in stores. This case is not a traditional BTG case since it's not based on an idea coming from the university, but rather a close collaboration between research team and an experienced entrepreneur, who wanted to pursue a new research-based venture. However, the early

commitment from the EE to find customers and create sales channels provided a fast track from research to market.

5. Results

The identification of EEs occurs through various means. The launching of the programme and a press release generated a substantial amount of applicants. To participate, EEs needed to be able to spend at least 500 hours on a case; to invest at least €7k of their own funding and committed to attracting customers, preferably within the first six months from spin/out. Furthermore, the EEs had to have experience with entrepreneurship, sales & marketing and insight and network within the specific technology area. Project managers screened EEs and matching is done either through an advisory board or individually. Table 2 outlines key aspects of the working of the model.

Advisory boards usually comprise 3-5 EEs having different profiles and backgrounds. The starting point is always to find the right market for the technology demanding EEs with broad expertise. The advisory board and the research teams usually meet every month which generates deliverables for each party for the next meeting. In addition, frequent individual contact is initiated between research team and EEs. The advisory boards become an important forum for discussion and progress – and from the EEs point of view, a way to get to know the technology and its potential. Within six months one or two EEs from the advisory board become strongly involved in the case due to either personal interest and/or shared goals and take lead becoming co-founders of the spin/out together with the researchers. The rest of the EEs in the advisory board typically transition into board member role of the new company (often as seed investors).

The individual matching is used when the fit is more obvious or if the research team needs a specific profile, for instance sales and marketing experience within a certain area. Usually the research team meets with 2-3 potential EEs. At the first meeting the researchers present the technology and their visions in an informal setting. At the second meeting the EE present a potential business case based on the knowledge gained about the technology earlier. Based on this presentation the researchers decide to work with the EE, whose vision, knowledge, profile and personality fits best with their personal vision.

Spin-out company	Technology	Time of EE entry	Means for EE entry	EE characteristics
Case 1: Photonics	Lasers for medical applications, sensors and lighting.	Opportunity framing	Member of advisory board established by business developer at the university. Serving 6 months on the advisory board to get comfortable with the team and 'hooked' on jumping to the spin-out.	Research background similar to academics. 15 years of industry experience (R&D engineer, product manager, technical sales support). Working in two early ventures (not founder). Technical and market insight.
Case 2: Imaging	Infrared cameras with high sensitivity. Based on nonlinear optics.	Research	EE approached university by own means and granted guest rights to scout for opportunities within the research groups of one department. Deciding to dedicate full time to future start-up after 3 months of scouting.	Engineer (non R&D). Entrepreneur in IT business (90'ies) Venture capital. Technical and market insight.
Case 3: Sensor	Laser-based structural sensor. Bend measurements of microscopic mechanical deformations.	Pre-organization	Members of advisory board setup by innovation officer at the university. Two EEs from the advisory board forming CEO and CTO (6 month timeframe).	Engineer from cell phone industry. Business angel with strong general management skills. General technical skills, but no market insight.
Case 4: IR spectroscopy	Measuring devices developed in order to conduct new in situ IR spectroscopy	Opportunity framing	EE identified by an individual selection process performed by the business developer and research team. Two entrepreneurs interviewed.	Engineer with a long history within management and development of new business areas in larger companies in Denmark and internationally
Case 5: Glycoscience	High-throughput solution for enzyme screening	Pre-organization	EE candidates identified through network search. Advisory board formed and one EE quickly got more involved and became lead,	Business training and very experienced in starting up companies within the overall research area.
Case 6: Formulation chemistry	New formulation for a greener cleaning product	Research	EE approached university and suggested a possible spin-out case.	Business training and experience with starting up companies.

Table 2: Overview of BTG cases and EE characteristics

5.1 Key findings

The presence of experienced entrepreneurs in the research team has developed what we considered to be a more 'entrepreneurial mindset' among researchers early in the technology development process. This mind-set helped to accelerate the progression from patent to spin-off by

setting more targeted goals based on specific product-market fit. The experienced entrepreneurs used their knowledge and experiences to connect the research environment with key stakeholders in specific markets contributing to more customer focused development activities. Successful co-existence helped to create a dynamic interaction between the research laboratory and the market structures which helped to eliminate much of the information asymmetry typically associated with new technologies. The relatively short time to market depicted in the 5 cases was due importantly to effective evaluation of the technologies. The relatively short time between evaluation and exploitation of the identified opportunities through spin-out ventures is directly related and influenced by the experiences of the EEs.
The cases demonstrate start-ups capable to attract needed resources through traditional investment as well as through innovative means such as customer-financing and soft funding grants .The EEs contributed to a strong focus on customers and co-development with potential customers which also helped the financing of the companies by bringing in unusual early sales. Altogether the BTG model contributed to the launching of companies with more innovative business models, better technology-to-market fit which should make them more sustainable over time.

Another outcome from the BTG programme is the development of a new entrepreneurship culture at the university. As researchers learn that they can receive committed and competent advice and have EEs take the lead in the commercialization process, they are becoming more and more interested in the commercial prospects of their research results. Some are more open to pursuing a life as an entrepreneur while others are happy to work along with EE to bring technologies to market. Since the launch of the BTG programme the numbers of researchers who have expressed interest in getting an advisory board or meeting with a potential EE have accelerated.

6. Conclusions and Implications

The results show that experienced entrepreneurs and researchers can create common commercial goals to improve the commercialization process. This co-operation requires concerted effort on the part of the university due to challenges aligning the goals of key parts of a research team and the entrepreneur and handling major divergences that can derail the process.

Furthermore, the co-operation requires facilitation of the network of EEs and matching them up with the right potential spin-out cases. Getting the right set of competencies in an advisory board is crucial for the success of the commercialization process.
The results can help those charged with helping universities create more spin-outs based on research by showing how more open structures for successful technology commercialization can be created without threatening their integrity and fundamental goals. The model presented may be adapted by other universities which are struggling to increase research/based spin/outs and contribute more directly to the economic conditions of their region.
The results may also help experience entrepreneurs see how they can create more successful technology based on new ventures by working with the research teams earlier and closer to shape technology development and opportunities.
While the spinning-out of technology and other research results continue to gather attention and importance, universities are still to a large extended rated and ranked based on publication and other traditional academic output. University leaders must therefore create the balance between these two kinds of activities and create the environment in which both can co-exists and remains a key challenge for many research universities.

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