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Design and Academic Entrepreneurship. The Role of Design in Spin-off Processes

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Abstract: This paper investigates how design contributes to the development of entrepreneurial competencies at academic spin-off teams. Building on the entrepreneurial competency framework of Rasmussen et al. (2011), we analysed eight start-up teams composed of people with expertise in design, the natural sciences and business management. Our study shows that design supports the start-up process on both a conceptual and transformational level. By enhancing user research and by facilitating ideation processes and early testing of ideas, design helps in identifying business opportunities. Through its ability to further vision building and experience creation, design can strengthen championing competencies. Furthermore, design contributes to resource acquisition through the use of prototypes and mock-ups that make ideas more tangible. The propositions we derive from our study can serve to guide future research, while also carrying practical implications.

Keywords: academic spin-offs, innovation, technology transfer, design expertise, entrepreneurial competencies

1. Introduction

Decision-makers from the scientific, business and political communities have long recognized the key role and varied potential of academic spin-offs in knowledge and technology transfer (KTT). Academic spin-offs are particularly effective at fostering innovation and technological development, and at creating jobs and promoting economic growth – all of which help in addressing global challenges (Auer & Walter, 2009; Dickel, 2009; Lautenschläger, Haase, & Kratzer, 2014; Rasmussen & Wright, 2015). Despite these benefits, the frequency of academic spin-off formation from research institutions remains unsatisfactorily low. The European Commission likens European technology transfer today to an emerging industry with "many valuable product ideas; a highly fragmented landscape; a lack of critical mass; wide disparities in terms of performances and developing practices" (European Commission, 2016).

Scholars from various disciplines have analysed the wide discrepancy in performance of academic entrepreneurship of different research institutions (Grimaldi, Kenney, Siegel, & Wright, 2011; Perkmann et al., 2013; Siegel & Wright, 2015). However, with the exception of the tendency of success in academic entrepreneurship to be preceded by prior success, no successful organisational

practices and structures have thus far been identified (Rasmussen & Wright, 2015). Team characteristics of academic spin-offs have not been studied extensively either (Visintin & Pittino, 2014). Academic spin-offs have been criticised for their homogeneity in terms of technical and educational backgrounds (Ensley & Hmieleski, 2005; Franklin, Wright, & Lockett, 2001), and scholars argue that teams need to comprise academic as well as non-academic profiles and different fields of expertise (Knockaert, Ucbasaran, Wright, & Clarysse, 2011; Rasmussen & Wright, 2015; Visintin & Pittino, 2014). While the importance of entrepreneurial know-how and business skills for successful technology start-ups is well known (Meyer, 2003; Mosey & Wright, 2007; Samsom & Gurdon, 1993), little work has been carried out to explore the role of design competencies (Driver, Peralta, & Moultrie, 2011). Designers, however, can help commercialise new technologies, if they are involved from an earlier stage in the research process (Black & Baker, 1987; Gemser & Leenders, 2001; Hertenstein, Platt, & Brown, 2001). Building upon the findings of existing research into innovation and academic entrepreneurship, we analysed the role of design in academic founding teams. In particular, we attempted to answer the following question: *How does design contribute to the development of three entrepreneurial competencies, namely opportunity development, championing and resource acquisition (Rasmussen, Mosey, & Wright, 2011; Rasmussen & Wright, 2015) in academic founding teams?*

Adopting a competency-based perspective, we combined expertise from design, natural science and business management in founding teams so as to enable them to develop marketable, technology-based business ideas. Our findings are not merely theoretical, but will also contribute to the approaches research organisations develop to promote academic spin-off formation.

2. Related Work

Following Auer and Walter (2009), we define academic spin-offs as autonomous organisations that are formed by or with the help of employees of publicly funded research institutions, in order to commercialise scientific findings and technological products originating in these institutions.

In order to successfully initiate an academic spin-off, academic founding teams must develop a specific set of entrepreneurial competencies. Aiming to analyse how design contributes to the evolution of such competencies, we build upon the entrepreneurial competency framework of Rasmussen et al. (2011, 2015). Through longitudinal observation of the initial formation and development of four university-based start-ups, Rasmussen et al. (2011) identified three basic competencies that academic spin-offs must develop in order to reach a certain credibility threshold for their ventures: (1) opportunity development competency, which refers to the need to identify a viable business idea; (2) championing competency, which refers to the need for team members who provide energy and meaning to the start-up process; and (3) resource acquisition competency, which describes the ability to gain access to necessary resources.

In the context of spin-offs, design has the potential to transcend purely verbal expression and foster insights into technological developments (Krippendorff, 2005). Designers apply an iterative process that continually questions underlying assumptions and solutions (Leavy, 2010). With their ability to embody ideas and knowledge in artefacts, designers can stimulate others to develop and evaluate new ideas (Rust, 2004). Following Denef (2012), we understand design as the process of creating form, and thus following Alexander (1964), creating form is the task of the designer. Form, in its most general sense, is the result of actions taken by the designer. Here, ‘form’ does not only include the physical shape of things, but also refers to all the characteristics of the thing that is being created: not only its appearance, but also its structure, inner workings and other features that its designer(s)

might impart to it. Every form resides in a context that is composed of a manifold set of properties. These properties lead the designer to find a form that fits the context in question (Alexander, 1964). Learning about the context helps in building an understanding of what actually is or should be achievable for the designer. The object of design is to achieve an optimal fit between form and context, which also means that the form helps the context itself evolve further. Thus, we understand design as all activities that create form and optimize contextual fit (Alexander, 1964; Denef, 2012). In what follows, we analyse how design contributes to the development of the entrepreneurial competencies outlined above.

3. Method

3.1 Context and Sample

The start-up teams were analysed in the context of a six-month incubation programme. The programme was designed to create and support interdisciplinary technology-based start-up teams. After an ideation and teambuilding phase, participants formed eight interdisciplinary start-up teams (see Table 1), each comprising expertise from design, the natural sciences and business management. During a four-month incubation phase, the teams developed their technology-based business ideas and created business plans. Throughout the programme, participants took part in team coaching and expert consulting activities. Finally, an interdisciplinary jury evaluated the teams on the basis of a final presentation. The two winning teams were awarded additional research and development resources to the value of €80.000.

23 founders (10 designers, 7 business managers and 6 natural scientists) participated in the incubation programme. The mean age was 30.64 (*SD* = 5.21), 47.8 % of the participants were male, and 52.2 % were female. Roughly half of the participants were students; the others were permanent employees or freelancers (with an average working experience of 4.67 years, *SD* = 4.49). Two of the eight teams (5 participants) aborted their projects during the programme (see Table 1). Each team followed a different technology-based business idea in the areas of health, healthcare or renewable materials. Each technology emerged from academic research (a university research project, or a master's or PhD thesis).

3.2 Data Analysis

In order to analyse how design contributes to the development of entrepreneurial competencies, we followed a case study approach (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). This approach is inductive in nature and provides a means of analysing qualitative data in unexplored research areas, with the aim of answering “how” and “why” questions (Yin, 2009). In using this approach, new theoretical concepts can be derived and new propositions formulated.

Table 1. Characteristics of the cases.

Case	Technology	Product/Service	Number of founders	Industry experience	Status
ASO1	Medical device	Product	2	Yes	Ongoing

ASO2	Damping panel	Product	4	No	Ongoing
ASO3	Psychological gaming	Service	4	Yes	Ongoing
ASO4	Patient management service	Service	4	Yes	Ongoing
ASO5	Data Mapping	Service	3	No	Ongoing
ASO6	Smart hardware vendor	Service	1	Yes	Ongoing
ASO7	Medical device	Product	3	No	Aborted
ASO8	Healthcare App	Service	2	No	Aborted

Following the multiple-case study principle (Eisenhardt, 1989; Yin, 2009) this study is comprised of eight cases, which falls within Eisenhardt's recommended range of four to ten (Eisenhardt, 1989). In order to explore the influential role of design, we conducted two semi-structured interviews with each participant. We conducted the first round of interviews in the middle of the incubation phase (two months after the initial workshop) and the second round at the end of the programme, after the final jury pitch. We also interviewed those participants who dropped out of the project, to assess their reasons for leaving. To evaluate the quality and market potential of the start-up ideas and the strength of the respective teams, we also conducted interviews with the three coaches who had been involved for the duration of the programme, and with five members of the jury. In total, we conducted 60 qualitative interviews of between 20 and 60 minutes in length throughout the program with 38 persons (30 participants, 5 jury members and 3 coaches; 16 women and 22 men). In the interest of objectivity, the interviews were not analysed by the same researchers only who conducted them. All interviews were transcribed and their content qualitatively analysed using Mayring's (2010) method.

We ensured that our findings have a high degree of validity by means of data triangulation (Leech & Onwuegbuzie, 2007), in that each unit of analysis was interpreted by four researchers from different fields. Our understanding of the various entrepreneurial competencies are hence based on shared interpretations among multiple research perspectives. To complement the collected qualitative data, we took field notes for each case throughout the entire six-month programme, including during consultation hours, pitches, emails and telephone communication. Additionally, we took into account further documents such as the teams' one pagers, business plans and pitch decks. This approach allowed us to include observations from outside the immediate context of the interviews into our research (Ritchie, Lewis, Nicholls, & Ormston, 2013).

4. Findings – Development of Propositions

4.1 Design and Opportunity Development Competency

A successful start-up always relies on a viable business idea that meets the needs of a particular user group. Academic researchers have often been found to lack the necessary market knowledge or industry experience to spin out a company based on their research activities (Bercovitz & Feldman, 2008; Marion, Dunlap, & Friar, 2015; Sinell et al., 2015). In investigating eight academic founding teams at an early stage of their respective start-up projects, we found that design contributes to the identification and refinement of business opportunities by *enhancing user research*, *facilitating ideation processes* and through *early testing* of ideas.

Enhancing user research. While defining their technologies' specific application scenarios, those team members who had an educational background in design were very determined to understand the context and application scenarios in full. Accordingly, all teams started their projects with user research, and conducted interviews or user journeys. ASO1 additionally held a one-day workshop in order to assess all relevant areas for their technology. By taking into account different perspectives, the teams were able to understand the broader contexts in which their technologies were relevant. One of the founders of ASO8 described the process of better understanding the context for their technology as follows:

> "When we discussed our idea again, we realised that our assumptions about it and understanding of it were too simple, and that we had to break the concept down into its constituent parts in order to identify particular technological challenges. In doing so, we were better able to focus on the users' needs." (ASO8)

In the case of ASO1, this in-depth research led the team to change their business idea completely. Remaining in the women's health sector, they switched their initial focus from pregnancy to female intimate care. ASO3, ASO6 and ASO8 were likewise observed to change their initial ideas.

Facilitating ideation processes. Thanks to their user research, the teams had little to no difficulty in identifying additional areas in which their technologies could be applied. One of the founders of ASO1, for example, stated that thanks to their having integrated knowledge from the fields of both design and medicine, "interesting new things automatically emerged very quickly". The design expertise within the teams helped them generate diverse concepts and remain open to further ideas. Sometimes, however, this also led to challenges and dissonance within the teams. In the case of ASO7, the team fell apart because the designer who initially championed the technology wanted to keep the ideation process open and generate more application scenarios for her idea. The other team members, however, wanted to accelerate the business process and stick to the initial application scenario. The following comment by the designer of ASO6 illustrates this openness to new ideas:

> "I am definitely open to completely changing ideas and choosing a different direction – as long as the idea gets better than it was in the first place. In this sense, our project has developed immensely. When I recall what our first idea was, then, OK, I mean, we stuck to the basic idea, but the whole context changed as we considered feedback from different sources. We changed directions quite a few times…" (ASO6)

Early testing. For an in-depth assessment of the user's opinion of a technology and its functionality, prototypes or minimum viable products are essential. Almost every team (except for ASO5)

recognized the vital role of a viable prototype to test their idea at an early stage, as the following quote illustrates:

> "[The prototype] doesn't have to be perfect. It just has to work as a first step, so you can test it, and then you keep working on and improving it." (ASO3)

Such a design-oriented approach is helpful in early testing and further development of ideas. ASO3 used a paper-based prototype to test the concept and underlying assumptions of their self-optimisation game. All teams that aimed to develop a product (ASO1, ASO2, ASO7) integrated testing phases as key elements in their process, in order to further develop and understand the characteristics of their respective products. While technological development within the teams was strongly theory-based, the application of said technologies in a user-oriented and business context was rather practically driven. Design methods helped the teams in furthering this process, as stated by one of the founders of ASO5:

> "The doing is what counts. We just start doing and trying things out. Our approach is very much practically driven. And that's why it's really important to test things early on. It's actually like learning by doing… more learning and then again more doing…" (ASO5)

Based on the observations outlined above, we propose the following:

Proposition 1a: Design helps in understanding the broader contexts in which technologies and users interact, and thereby furthers opportunity development competency.

Proposition 1b: Design facilitates ideation processes and thereby furthers opportunity development competency.

Proposition 1c: Design facilitates testing of ideas and technologies early on in the start-up process and thereby furthers opportunity development competency.

4.2 Design and Championing Competency

As outlined by Rasmussen et al. (2011), entrepreneurial teams depend on individuals with championing skills to support and fight for early ideas, and ensure their survival and growth in the challenging start-up context. While this skill is certainly closely related to personal character and the broader social context of any individual, we have found a close correlation between championing and design in our teams. In other words: design is a championing tool.

A core task of championing is joint *vision building*. Internally, team members need to stay focused on a common, but dynamic goal. 'Pivoting', as this strategy is known in the context of start-ups, requires finding a new direction when the previous approach did not produce the expected results. Pivoting also requires constant vision building and making sure that the team stays focused. Externally, investors, customers and other stakeholders need to believe in the start-up's vision. As products often lack features or suffer from initial quality problems, and since business milestones are very often missed, future visions are crucial in spin-offs as a means of fostering and maintaining focus, motivation and support, both internally and externally.

In our research project, idea champions initially pitched their concepts to a wider audience to attract teammates. The ideas that created the largest interest were those that were presented with a focused vision that clearly described both context and form. While the successful presentations varied in structure and style, they all made extensive use of design methods that capture and give shape to ideas. The idea champion of ASO6, for instance, used videos to communicate his idea at a very early stage. In modified real-world images, he made his envisioned technology materialise in

public environments. ASO3 showed how their application would help all people in the room improve their social skills. During the process, as ideas were discarded, changed or refined, we witnessed the continuing importance of design as a tool that ensures that both team members and external stakeholders remain committed to a team's vision. The members of ASO1 radically altered their idea, yet they were able efficiently to communicate and demonstrate their contextual and form-related design rationale.

Closely connected to vision building is *experience creation*. Given that they typically create new solutions that are hard to compare to existing products or services, and given their initial lack of resources, academic spin-offs benefit greatly from creating user experiences very early on as a means of testing contextual fit. At the very beginning of the programme, ASO7's idea champion used experience prototypes as a tool to gain support for her concept and recruit team members. Although the team later encountered difficulties in effectively championing their idea – with the project in fact faltering as a result – their idea initially showed exceptional promise, thanks to the idea champion's design expertise. The idea champion of the ASO4 team used role-playing of patients' user experience as a key tool in building the empathy needed to understand the problem they sought to address, and as a means of maintaining constant focus on their idea. ASO5 used physical objects metaphorically as a means of explaining, in everyday language, complex new ideas in the fields of data analytics and information technology.

Based on the observations outlined above, we propose the following:

Proposition 2a: Design fosters vision building and thereby furthers championing competency.

Proposition 2b: Design enhances experience creation and empathy and thereby furthers championing competency.

4.3 Design and Resource Acquisition Competency

Especially in the early stages of the academic start-up process, access to resources within the university or from external sources is vital. Our case studies illustrate very clearly that design allows founding teams to produce something tangible early on. Design also contributes to the communication of ideas and acquisition of external resources through *the use of prototypes and mock-ups that make ideas more tangible* and *the creation of professional audio-visual aids*.

Facilitating the creation of prototypes and mock-ups. The majority of teams in our study used prototypes or mock-ups for the development and communication of their ideas. ASO2, one of the winning teams, continually used prototypes. They used a technical prototype to demonstrate their product's properties, functionality and material construction. Additionally, they developed a design prototype to showcase the future design of the fully developed product. Likewise, the ASO7, team used design prototypes to illustrate how their medical device worked, and so as to be able to discuss it with technicians and physical therapists. To visualise their basic idea, ASO5 created a mock-up. This was important since their proposed software-based service was very complex and there was no technical prototype available at the time. However, the team was able to establish cooperation in research and development with industry partners and potential customers. Using prototyping, the teams were able to make their ideas more tangible and easier to understand. This not only helps start-ups develop their ideas further, but also helps in attracting external support. Almost all teams were able to create an advisory board peopled with supporters from universities and from their target market. The importance of design for this process can be illustrated by the following comment by the designer of ASO8:

> "We went very quickly from conception to prototyping and this helped greatly in communicating our idea. And I think this is an advantage of having a designer in the team. When you build a prototype you can talk about it and develop it further." (ASO8)

Creating professional audio-visual aids. In order to secure external resources, it is important that audio-visual aids come across as having been professionally crafted. All teams were successful in this respect. They created well-designed pitch decks and business plans. They used graphics and schematic representations to illustrate their concepts, and worked with prototypes and mock-ups when pitching their ideas. With the use of logos and individual colour schemes, they were able to create a comprehensive picture of their future products and brands. Team members with design expertise were able to contribute not only know-how but also professional connections with others in the field, thus allowing the teams to keep the costs of creating audio-visual materials relatively low. Only one team (ASO4) stated a lack of design know-how, as illustrated in the following observation by one of their natural scientist:

> "I can work with [Adobe] Illustrator too, but it is not my focus. I would rather concentrate on other tasks. And a professional designer – someone who is creative – would be of great value and take a load off our shoulders." (ASO4)

This leads to the following propositions:

Proposition 3a: Through the use of prototypes, design helps make ideas tangible and easier to understand, and thereby furthers resource acquisition competency.

Proposition 3b: Design aids in the creation of professional audio-visual aids, and thereby furthers resource acquisition competency.

5. Conclusions

Despite the fact that academic spin-offs are held in high esteem and are recognised for their varied potential, they remain rare in Europe (European Commission, 2016). Aiming to develop an approach that fosters the development of entrepreneurial competencies at research organisations, we analysed how design contributes to the development of such skills.

Our study reveals that design supports the start-up process in all three important respects identified by Rasmussen et al. (2011). Firstly, a design approach helps open up the process of opportunity refinement and fosters an understanding of the contexts and application scenarios for the technology or technologies in question. In our study, the teams used design techniques to achieve an optimal fit between technologies and contexts. Design furthermore enhances ideation processes and thereby contributes to the creation of multiple and varied ideas. Secondly, through the creation of visions and experience, design furthers idea championing and helps convincingly convey concepts and visions for the future. In creating a shared vision, even when said vision needs to be revised, design is used to build commitment. Thirdly, design helps in the acquisition of resources with the aid of prototypes and mock-ups that translate intangible ideas into something that others can grasp and are willing to invest in.

Our findings also confirm the value of integrating designers and design competencies at an early stage of the innovation process in order to foster the development of entrepreneurial competencies at research organisations. Design can act as a research catalyst by enabling consideration of the application of technologies early on, placing the focus on customer needs and through the creation

of artefacts to aid understanding and stimulate ideas (Bonnafous-Boucher, Cuir, & Partouche, 2011; Kurvinen, 2005).

Our study carries implications for both theory and practice. By outlining how design contributes to the development of entrepreneurial competencies, our findings suggest that research institutions should deliberately set up multidisciplinary research teams in order to identify opportunities for exploiting their findings. As detailed above, design expertise benefits research institutions both internally, through developing entrepreneurial competencies within the institutions themselves, and externally, by furthering vision building and resource acquisition. We built upon Rasmussen's entrepreneurial competency framework (Rasmussen et al., 2011; Rasmussen & Wright, 2015) by adding design-specific competencies as requirement for a successful start-up process. We focused on the early stages of the process; whether design competencies have a positive effect on start-up performance in the long term is a question that merits further investigation. Clearly, our study is not without its limitations. We analysed start-up teams in the context of an academic research institution and provided them with access to the institution's infrastructure, resources and networks. All of the technologies emerged from research projects. Typically, however, the founders of an academic spin-off would themselves be employees of the academic institution in question. That was not the case in our programme, and should therefore form the focus of future research. Furthermore, by including spin-off teams without design expertise as control groups, future studies should be able to develop our conclusions further, and find even stronger evidence for the internal and external effects of design.

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