From Engineer to Entrepreneur – Entrepreneurship Education for Engineering Students: The Case of the Entrepreneurial Campus Villach

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Abstract—Entrepreneurship education is quite a novel phenomenon that is gaining in-creasing importance in academia and practice alike. Entrepreneurship education aims to provide the necessary skills and knowledge that enable students to successfully found a new venture. Hitherto entrepreneurship education has not received much attention in engineering pedagogy. This finding is quite surprising because through proper entrepreneurship education engineers can be enabled to exploit entrepreneurial opportunities that result from technological innovation. Thus, we argue that entrepreneurship education should be a cornerstone in engineering education. The paper introduces the 'Entrepreneurial Campus Villach' located at the Carinthia University of Applied Sciences (CUAS). The campus is among the first in Austria that provide an extensive and scientifically sound entrepreneurship program. The campus focusses on the four core areas 1) research, 2) teaching, 3) coaching and support, and 4) infrastructure. The paper provides insights for other university and institutions that aim to set up similar concepts.

Keywords—Entrepreneurship, entrepreneurship education, entrepreneurial campus, innovation, startup, new venture

1 Introduction

Today's educational and pedagogical landscape is facing major changes. The advent of the internet, for instance, has fundamentally changed the way how content is taught. But also the content itself has been adapted to global trends. New work, for instance, is one of these global megatrends that de-scribes the changes in the working environment. According to this trend, the workplace of the future will be more dynamic and knowledge intensive than today. Thus, adaptations are needed. History has shown that often it is the entrepreneur that reacts timely and effectively to changes. The entrepreneur is often able to exploit entrepreneurial opportunities based upon these changes [1]. In this context, it is evident that entrepreneurship and entrepreneurship education are gaining significant importance.

In order to effectively prepare students for these altered working environment top-notch entrepreneurship education needs to be implemented throughout the entire edu-

cation system. Entrepreneurship education refers to the education for entrepreneurial attitudes and skills of students [2]. Due to their specific role in the education system, universities are typically among the first to reveal and adapt to changes. In the context of entrepreneurship education the term 'entrepreneurial university' has been coined. Famous entrepreneurial universities such as Stanford, MIT, and Harvard are among the leaders of entrepreneurship education. These universities have implemented entrepreneurship education in their study programs and extra-curricular activities. Today, their entrepreneurship education programs often function as blueprints for other universities aiming to install similar concepts.

Unfortunately, the situation in Europe is quite different. In Europe entrepreneurship in general and entrepreneurship education in particular are not that common yet. However, the topic is rapidly gaining importance as various institutions start to acknowledge the importance of entrepreneurship and actively promote entrepreneurial activities of students. Among the first academic institutions in Austria the Carinthia University of Applied Sciences (CUAS) has set up a comprehensive entrepreneurship education program in the Alps-Adriatic region, namely the 'Entrepreneurial Campus Villach'. The aim of this paper is to introduce the concept of the entrepreneurial campus in order to provide valuable insights for universities as well as corporate and public institutions that strive to set up similar concepts.

The paper proceeds as follows. In section 2 we briefly introduce the concept of entrepreneurship and discuss the crucial role of universities in fostering entrepreneurship. In section 3 we introduce the entrepreneurial campus. In section 4 we present results of the evaluation. In section 5 we close the article by providing conclusions.

2 Fostering entrepreneurship - The crucial role of universities

Entrepreneurship is quite a novel phenomenon in academia. Entrepreneur-ship is basically about the exploitation of entrepreneurial opportunities by the entrepreneur [1, 3-5]. An entrepreneurial opportunity provides the possibility to serve customer needs in a more satisfactory way. An entrepreneurial opportunity can lead to competitive advantages [6]. They are able to either enhance market equilibrium [7] or destroy entire industries through the introduction of novel offerings [8].

Only recently the importance of entrepreneurship to the economy has be-come subject of intensified empirical investigation [9]. In a nutshell, to exploit an opportunity entrepreneurs found new ventures that often create new jobs. Further, they increase competition within an industry as they are able to challenge dominant industry logics with their often novel and innovative products, services, and business models [10]. Taken together, the activities of the entrepreneur translate into economic growth [11]. Thus, recently a growing number of nations intensify their activities to support entrepreneur-ship. As a result there are numerous organizations today, for instance, Global Entrepreneurship Monitor (GEM), Global Entrepreneurship and Development Index (GEDI), Regional Entrepreneurship and Development Index (REDI) that aim to identify both prerequisites and critical success factors that promote entrepreneurship. Via surveys these organizations assess and compare the individual capacity of the

subjects under study. Furthermore, they reveal public and societal capacities of nations and regions. These capacities are described through various indicators. Among these indicators are, for instance, the speed of the knowledge transfer from science to public and the ease of access of novel technologies; the perception of entrepreneurs and the connotation of entrepreneurship within a society; the ease of hiring and retaining well-trained staff; the degree of bureaucracy to start a business; the size and proximity of expert networks to support information and knowledge exchange; the ease of access to financial capital in the individual founding phases; as well as the amount and quality of public funding.

Besides the aforementioned indicators the quality of entrepreneurial training and education available is another crucial success factor. Ideally entrepreneurship education should already start at the kindergarten level and is then further intensified in high school and at the university level. Especially, universities are of major importance in the promotion of entrepreneurship. To-day, universities are institutions of higher learning as well as important catalysts of technological development and economic growth [12]. In order to fulfil this important responsibility study programs have to be designed with respect to further enhancing students' creativity, original thinking, leader-ship, and initiative taking [13, 14]. As a result entrepreneurship-oriented study programs have been implemented in management as well as engineering curricula [15, 16].

Today also public policy makers acknowledge the crucial role of universities in fostering entrepreneurship. As a result they are seeking viable options to encourage the entrepreneurial activities at the university level. Among the favored options to foster entrepreneurship at the universities is the installation and public funding of academic business incubators that focus on specific areas. In entrepreneurship literature the invention and further development of novel technologies is discussed as a key source of entrepreneurial opportunities [6, 17]. Thus, these academic business incubators predominantly aim to support technological university spin-offs in order to increase their future market success [18]. Because of this technological focus, academic incubators especially welcome engineering students, graduates, and faculty. As a result the supported startups and university spin-offs in these incubators often have a strong technological background. However, these ventures also have specific needs in order to live up to their full potential. Studies [e.g. 19] identified the following pressing needs of technological startups:

- They need consulting in various areas. Among the most important are, for instance, business and economic knowledge and legal advice.
- They need rich expert networks.
- They need special equipment and labs in order to develop and test their prototypes.
- They need a vivid and inspiring entrepreneurial environment and proximity to universities.
- They need financial sources and access to investors and financiers.

3 Introducing the Entrepreneurial Campus Villach

CUAS is a young university of applied sciences in the south of Austria. The university runs campuses in four of the major cities of Carinthia, namely Klagenfurt, Villach, Spittal, and Feldkirchen. CUAS runs about 30 bachelor and master programs in its three core fields: engineering and IT, health, and business. Currently, there are about 2,200 active students enrolled. The study programs have been established in accordance with the demands of industry and economy and are therefore designed to provide students with a fundamental scientific as well as specific vocational training. The faculty is recruited from experts of both industry and academia with heterogeneous backgrounds. What is common is that they possess teaching experience at university level.

CUAS has a strong technical background and is well-respected for its engineering education. In order to provide top-notch entrepreneurship education CUAS decided to implement the 'Entrepreneurial Campus Villach'. The overall aim of this campus is to support and secure state-of-the-art entrepreneurship education that helps to translate technical inventions into innovative products and services that create competitive advantages. Even though the 'Entrepreneurial Campus Villach' is not an academic incubator per se. The support that entrepreneurs and future founders receive is based on the aforementioned needs of startups in academic incubators.

The campus is located in the Technology Park Villach (tpv). Ever since its foundation the tpv has positioned itself as a high-tech hub in the Alps-Adriatic region. The park focusses especially on electronics, energy, mechatronics, information and communication technologies, as well as corresponding suppliers and services. The overall aim is to strengthen and further improve the position of the park. Thus, interested companies have to add to either of tpv's three main strategic areas: first-class teaching, high-level re-search and development, and innovative businesses. Integrating these three areas helps to enable efficient communication structures, to connect companies, to pool resources, and finally to discover and utilize synergies.

The following chapter describes the implementation of the strategy at the CUAS. Special emphasize is put on the following areas: 1) research, 2) teaching, 3) coaching and additional services for entrepreneurs, and 4) infra-structure.

3.1 Entrepreneurship research

Due to its strong technological background, a significant amount of research at the CUAS is conducted in the fields of entrepreneurship as well as innovation and technology management. The majority of research projects are embedded in the intersection of technology, business, and organization. Primary research subjects are technology-oriented startups and small and medium-size enterprises (SME).

Only recently an interdisciplinary research group on entrepreneurship has been implemented. Members of the group have heterogeneous backgrounds in technical, social and economic science. In the area of entrepreneurship research special emphasize is put on the entrepreneur and on entrepreneurial teams. Further the relationship between technology and business model is a major research subject. The relationship

between technology and the business model is of particular importance. Studies [e.g. 20] have highlighted the importance of a strong nexus between technology and business model to secure market success. The main purpose of the business model is thus to create value by translating technical success into market success [21]. The research group puts further emphasize on the analysis and the design of framework conditions such as infrastructure, coaching, and funding models for innovative and growth-oriented startups.

The research field of innovation and technology management focuses on the development and optimization of systems, structures, processes, and methods to increase the innovative capacity of SME. Furthermore, also trend studies, feasibility analyses, and business model development within the context of specific innovation projects are conducted.

The results of the conducted research are then continuously implemented in the entrepreneurship education.

3.2 Entrepreneurship education

In general, teaching is performed in small groups (max. 30 students), which increases quality and secures a high level of individual support by the teachers in class. Further, special emphasize is put on new media and the application of novel and innovative ways of teaching. CUAS is involved in national and international projects on e-learning and focusses on technology-enhanced learning.

For several years CUAS has been actively engaged in the implementation of entrepreneurial classes. Overall those classes aim at providing state-of-the-art entrepreneurship education. In sharp contrast to other study programs the productivity of entrepreneurship programs cannot be properly evaluated by the number of students graduated. According to [22] the only proper measure is the socio-economic impact that these programs produce. Thus, we aim to increase the number of startups founded.

Studies [e.g. 23] show that entrepreneurship education is able to positively influence entrepreneurship knowledge and skills, the perception and connotation of entrepreneurship, and the intentions to become an entrepreneur. In general, the continuum in entrepreneurship education ranges from business planning classes to venture creation classes [24]. Business planning classes are by far the most common [25]. New venture creation classes teach students to take initial steps to found a venture over the course of at least one semester [26]. CUAS offers a variety of entrepreneurial classes along the entire continuum.

3.3 Coaching and services

In order to increase the number of new ventures founded, in 2013 CUAS has set up its own ‘Start-up Initiative’. The ‘Start-up Initiative’ offers an extensive program to foster entrepreneurial activities of primarily students and graduates. The main aim of the initiative is to provide its members with comprehensive individual coaching and support along the entire founding process. There are specific services that can be

aligned to the five phases of the founding process. There are offerings for each phase starting from the awareness and motivation phase as well as the growth phase. These offerings support the entrepreneur and his actions from idea generation until business development (See table 1). The services provided by the initiative are free of charge.

Coaching is performed by internal program managers as well as by distinguished experts within the network. The program managers have a strong background in entrepreneurship research and practice and are experienced in technology transfer. Even though the initiative supports entrepreneurs along the entire founding process, special emphasize is put on the pre-foundation phase. In the foundation phase the founders are connected to the local academic incubator 'build!' where they get the necessary support to further improve and grow their business. In this phase the experts of the CUAS take one step back. However, due to their intensive knowledge on both the project and the founder they often still function as mentors and give valuable advice. Further they provide their industry and academic contacts and are often connecting startups with relevant contacts within their networks. In the growth phase startups primarily need individual advice regarding business development. Further they need to grow their problem analyses skills. Often they also need kind of guidelines that enable them to develop adequate solutions for their problems. Here the program managers also bring in their personal and professional networks to support the entrepreneurs.

Table 1. Start-Up Initiative's offerings

Phases of founding process					
	Awareness and Motivation	***Orientation, Strategy, and Vision***	***Pre-foundation***	***Foundation***	***Growth***
Coaching / Service	Startup events (2x per year)	Individual coaching and support: - Idea-check - Feasibility studies - Strategy and positioning	1) Individual coaching and support: - Business modelling - Marketing and sales - Pitching > Business planning 2) Group Workshops (6x per year)	Connecting with relevant partners (Chamber of commerce, local incubator build!, funding agencies, and banks)	Individual coaching and support: - Business development - Trend mapping - Business model innovation
Networks / Partners	Marketing department at CUAS	Community building and external partners (Chamber of commerce, local incubator build!, funding agencies and banks)	Community building and external partners (Chamber of commerce, local incubator build!, funding agencies and banks)	Connecting with experts within the network	Connecting with experts within the network

3.4 Infrastructure for entrepreneurs

CUAS offers a variety of modern infrastructure to support technology-oriented startups in their entrepreneurial endeavors. The entire infrastructure is located at the 'Entrepreneurial Campus Villach'. This spatial proximity of the infrastructure and its

location at the CUAS enables efficient prototyping and product development. Furthermore, it guarantees social encounters with likeminded peers and increases communication speed. These are prerequisites that facilitate efficient networking.

The infrastructure is also open to incumbent companies. This openness enables entrepreneurs to timely connect themselves with experienced entrepreneurs and managers. This can lead to important strategic partnerships. Often these incumbents become the initial customers of the startups. Thus they crucially contribute to the startups' proof of concept which provides credibility on the market.

In the following paragraphs the specific infrastructure that entrepreneurs can use to start and grow their ventures is briefly presented.

Innovationswerkstatt. The 'Innovationswerkstatt' is a room fully dedicated to creativity. The room is designed to perform and support innovative and creative tasks, for in-stance, idea generation or problem-solution-fits. The flexible concept and the provided materials (e.g. flipchart, whiteboard, smart boards and smart TV) support an efficient workflow. Workstations provide access to trend and pa-tent databases that accelerate decision processes. Further, the room also offers the possibility to build first prototypes, for instance, from cardboard.

The overall rationale is to offer an inspiring meeting place where novel and innovative ideas can be discussed and further elaborated along the innovation process. Major steps within this process are idea generation, idea evaluation and finally idea execution. All steps are supervised by experienced innovation managers and entrepreneurship experts. Their professional guidance regularly results in a reduced time-to-market and increases the chances for market success. Ideas that make it past this initial cut-off can be refined and further improved, for instance, through the development of an adequate and innovative business model that translates the mere invention into an innovation and thus enables market success in the first place.

Smart Lab Carinthia. The 'Smart Lab Carinthia' is designed for rapid prototyping and follows the well-established fab lab concept. The lab provides a meeting room for inventors, tinkerers, makers, and entrepreneurs alike. Further there are all the necessary machinery (e.g. 3D printers, 3D scanners, laser cutters, and CNC mills) and tools to transform ideas into physical products.

In order to use the 'Smart Lab Carinthia' interested users have to take a compulsory training. In these trainings the lab heads introduce the future users to the correct usage of the machinery. Further they give advice on, for instance, design issues. Users are then enabled to operate machines on their own. After taking the compulsory training most of these services are free of charge. Users are only charged if they need additional support by the lab heads or if they want to use special and expensive equipment.

Gruendergarage. Especially startups with a strong technical focus have a pressing need for first-class prototyping facilities to develop and refine their innovative products. These prototypes do not necessarily need to be small in size. More than often these prototypes are big and heavy and thus hard to transport and store. In order to provide the necessary space and privacy conditions for prototyping CUAS installed three garages. The so called 'Founders' Garages'. Startups can rent one of these gar-

ages for a predefined period of time. In most cases the garages are rented for six months. However, prolongations are possible.

These garages are made out of refurbished cargo containers and provide all the necessary functions that the future entrepreneurs need. The containers are located at the parking lot right next to the building where the 'Smart Lab Carinthia' and the 'Innovationswerkstatt' are located. Thus, they provide entrepreneurs with efficient prototyping and testing. Due to this spatial proximity the results from tests can be implemented immediately into the next version of the prototype or product.

Besides for prototyping the 'Gruendergarage' can also be used as a pop-up store. One of the short sides of the containers is equipped with glass. So the entrepreneurs can decide whether or not to open the containers' doors to unveil what they are working on.

Science and Energy Labs. Besides the aforementioned facilities CUAS also offers the 'Science and Energy Labs'. These labs offer various possibilities for prototyping and testing as well as producing small-scale badges in the following areas among others: manufacturing engineering, mechatronic, electronic and electrical engineering, thermodynamics, bionic, robotic, lightweight construction, material testing. These labs can only be used by student founders in the presence of the respective experienced lab head. External founders have to commission the lab heads.

4 Evaluation

The foundations of the Entrepreneurial Campus date back to the installation of the 'Start-up Initiative' in 2013. Ever since, the Campus has been evaluated continuously in order to further improve it. Therefore we follow the lean startup approach [27]. According to the lean startup approach we initially define hypotheses. These hypotheses are then tested and the results are evaluated. This evaluation leads to either the verification or the falsification of hypotheses. In case of falsification we start an iteration process. Meaning that we adapt our hypotheses and test it again. We continue this process until our hypotheses is verified. We encourage trial-and-error processes because they provide us the possibility to learn and to improve. In the following paragraphs evaluation results of the four main areas of the Entrepreneurial Campus presented briefly.

The evaluation of the Entrepreneurial Campus has shown that through the installation of the interdisciplinary research group the amount of research conducted on entrepreneurship is growing. However, since it has been installed only recently the group is still in the consolidation phase and there is no clear research focus yet. Individual research interests might need to be adjusted to develop mutual research interests. Over time researchers will develop a clear profile of entrepreneurship research at CUAS.

The successful installation and positive evaluation of entrepreneurship lectures at CUAS has led to an overall increase in entrepreneurship education at the university. Especially the new venture creation classes lead regularly to the foundation of new ventures. The new venture creation classes provide students the ability to experience

entrepreneurship first hand and evaluate whether they like it or not. For those who decide to give it a try the Entrepreneurial Campus and especially the 'Start-up Initiative' provide a soft-landing spot. In the last years the number of new ventures increases.

The 'Start-up Initiative' currently supports between 20 and 30 startups. The number of startups supported is growing steadily since the employment of two program managers that work full-time on the improvement of the services. Startups primarily appreciate the individual support, the quick responses, and the access to the managers' network. The most common problem – not exclusively, but most often for engineering students - is the adjustment of their inventions according to meet market needs. Engineering students often strive for perfect products in terms of technological superiority. However, this might not be the customers pressing problem. Thus, it is an important learning for the engineers to focus more on the customers and their needs.

In terms of infrastructure the utilization is good. However, there are differences in the customer groups. The 'Innovationswerkstatt' is mostly used by incumbents to innovate their products, processes or services. The 'SmartLab Carinthia' is primarily used by students, graduates and SME for prototyping purposes. Due to the increasing awareness of the advantages of rapid prototyping and the further improvement of the technologies' the number of users is increasing steadily. The concept of the 'Gruendergarage' has attracted significant attention in Carinthia. All garages are currently rented out. The demand is so high that we had to put startups on a waiting list.

5 Conclusion

It seems as if entrepreneurship education is finally starting to attract significant attention from policy makers and education institutions. Students in general and engineering students in particular have been identified as promising candidates for entrepreneurship education. However, due to the novelty of the field, today extensive programs to foster entrepreneurship education at university level are still rather rare.

The installation of the 'Entrepreneurial Campus Villach' aims to contribute to the further development of the field. Through intensive examination four focus areas have been identified that are critical in the support of especially engineers that strive to become successful entrepreneurs. These four focus areas are: 1) applied research in entrepreneurship and innovation management to gain timely insights that can be transferred to the entrepreneurs, 2) high-quality entrepreneurial education that provides potential future entrepreneurs with the necessary skills and know-how, 3) first class support and coaching mechanisms for entrepreneurs including access to expert networks, and 4) high-end infrastructure that allows to transform intangible ideas into tangible prototypes and products. Taken together those four focus areas yield to an extensive entrepreneurship program for students, graduates and external founders.

Focusing on these three customer groups has shown to be fruitful especially in terms of networking. However, the primary recipients of the campus are students and graduates of CUAS that want to become entrepreneurs or that already have a concrete business idea. Besides that also potential founders that strive to team up with CUAS

to increase their chances for success are targeted. However, in the latter case, the business idea has to fit to the over-all strategy of CUAS and has to have potential synergies to the portfolio of supported startups.

The mutual vision was to install a campus that is internationally recognized as a melting pot for entrepreneurial activities. In order to guarantee a vivid entrepreneurial ecosystem, CUAS cooperates with the other public and private Carinthian entrepreneurship supporting institutions as well as with partners in the Alps-Adriatic region. These transnational cooperation are crucial to guarantee success in the long-run. Together the institutions aim to further develop and improve the entrepreneurial campus. What is particularly important is that every change and improvement is aligned to the afore-mentioned scientifically sound entrepreneurial success factors.

Despite the comprehensive strategic planning and the integration of state-of-the-art research as well as relevant stakeholders setting up such a campus is challenging. In a nutshell, the development of the campus can be compared to the founding of a new venture. It requires know-how, dedication, spirit, and persistence.

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