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**Entrepreneur Education for Engineers –
A Case Study of Academic Working Capital
Program**

**Diogo D. Dutra
Master Student
University of Sao Paulo
Brazil**

**Marcos R. P. Barretto
Professor
University of Sao Paulo
Brazil**

**Jose Reinaldo Silva
Professor
University of Sao Paulo
Brazil**

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Athens Institute for Education and Research

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Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209 Email: info@atiner.gr URL:
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Entrepreneur Education for Engineers – A Case Study of Academic Working Capital Program

Diogo D. Dutra

Marcos R. P. Barretto

Jose Reinaldo Silva

Abstract

Professional alternatives for engineers graduating can be listed as (i) following an academic career, (ii) go to employment in a stable corporation and (iii) entrepreneurship. Final-year projects are considered traditionally as a link between the acquired knowledge and experience through practical projects. However, even if exposed to a few disciplines on entrepreneurship, the majority of the students go through the final-year project focusing on the first or second alternative. Thus the whole process is inefficient to insert entrepreneurship as an option, and to work on the attitude of young engineers. Traditional final-year projects do not follow a modern entrepreneurship approach, especially on technology-based product/services. In fact, for this kind of development it is necessary a new educational approach to stimulate a practical design and business innovation thinking on students. Concerning startups the problem could be even worse if we consider that such initiatives could be a solution to the innovation process of bigger corporations. Thus, the conclusion is that it is necessary to move from the traditional methods, probably using extracurricular initiatives. The Academic Working Capital (AWC) program was conceived to offer an alternative that could improve the process of the final-year project. Students are exposed to the design of a technology-based business putting together knowledge associated to new products, processes and business innovation. It is a national program in Brazil, open to students from all public and private universities. In this paper we discuss the strategy of working with an open list of professional alternatives and present AWC programs in 2015 as a case study, based on the experience acquired in its first year, especially in what concerns design and business thinking education. This approach is described on an entrepreneurship learning process applied to 12 final-year projects, from different engineering courses of 3 top Brazilian universities.

Keywords: Entrepreneurship education, Entrepreneurship program, Final-year project.

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Introduction

Traditionally, graduate students, especially at engineering schools, have been expected to pursue careers in prestigious stable corporations. In fact, the curriculum and disciplines tend to focus on large company experience, models and challenges, giving strength to this career path (Galloway & Brown, 2002) (Fletcher, 1999). On the other hand, a second, encouraged and well-established, carrier path for graduates is the academic employment, which may include different positions and roles, such as teacher, researcher, administrator, or a combination thereof (Sieger & Monsen, 2015).

Even if, worldwide, entrepreneurship education (EE) programmes have given growth in higher education in the last decades pointing to students as a viable new career path. The main reason for the increasing number is that university-based EE programmes are expected to provide a promising vehicle to support a range of potential entrepreneurial and innovation outcomes (Liñán, 2016). However, there are still some challenges to consolidate the entrepreneurial path as a concrete career choice for graduate students.

Galloway et al. (2002) points some reasons why the immediate entrepreneurship (after graduation) rate is still low despite several Universities efforts:

The most important reason why rates of immediate graduate entrepreneurship remain low is, however, that students themselves rarely claim to want to start a business upon graduation. This is not particularly surprising, as upon graduation students most often have debt, no collateral, lack of industrial experience and alternative personal priorities. Indeed, for many science and technology students opportunity cost can completely prohibit personal investment in business ownership upon graduation, as a pre-registration period within a particular industry can be necessary before practitioner status is gained. Carter (1998) found in her focus group study of alumni perceptions of entrepreneurship education in HE, that many «believed it was important to gain some work experience prior to start-up as it not only gave them detailed sectorial knowledge, it also provided a network of business contacts, the appropriate finance to start-up».

The biggest majority of entrepreneurship education initiatives have been focused, at the university level, in offering entrepreneurship disciplines. Some initiatives even created entrepreneurship centers and institutional departments (Morris, Building university 21st century entrepreneurship programs that empower and transform, 2014). In spite of some recent initiatives, the majority of those initiatives tend to replicate traditional business-plan courses (imported from management schools) that are seeing as an inefficient entrepreneurship education approach (Neck, 2011).

In Brazil, just 11.2% of undergraduates had (or have) a real entrepreneurship experience in comparison with 57.9% that expect to create

a business in the near future¹. From those students that will graduate, 63% have already attended an entrepreneurship course on the university. However, even if we attest that those approaches improve their confidence to start a business in the near future, it is not effective to create a real career option just after graduation.

One of the diagnosis of an Endeavour Brazil's report about Entrepreneurship in Brazilians Universities, points for a «lack of support for students». In fact, about six in ten public institutions surveyed do not offer mentoring, networking or help out sessions for students' business. For the private institutions, the ratio is four in ten institutions. One of the 4911 students interviewed by this survey states that what he misses is not a discipline but a program that instigates the students to change, to think differently.

On the other hand, final-year projects, especially at engineering schools that expects for working prototypes are undervalued as a possible entrepreneurship endeavor. In fact, we argue that it could be better explored to enhance the rate of immediate entrepreneurship (after graduation) offering to the student an extra support to develop a startup that, after graduation, shows real business potential.

However, the students are required to undertake projects that “demonstrate that they can apply the knowledge, skills and attributes developed during their program of study at a professional standard” (Nouwens, 2013). That final-year project's requirement, thus, pushes for an extracurricular activity that combines, in parallel to curricular activities, entrepreneurship methodologies in order to create a professional alternative in entrepreneurship for those who are graduating.

An important problem is that traditional final-year engineer projects do not follow entrepreneurship methods, especially on technological-based product/services. The project often involves one year. In the first semester students scope and prepare a project proposal, conduct a literature review and plans implementation. During the following semester students implement their project plan and prepare a formal project report or thesis. A project supervisor is available for regular meetings and feedback during the project.

A survey with 17 universities made by Nouwens et al. (2013) identified the following general structure to the final-year project:

- Literature review
- Project proposal
- Project scope
- Project plan
- Project files/design workbooks
- Reflective Journal
- Work Breakdown Structure and Gantt Charts
- Posters
- Project technical paper

¹ Extracted from an Endeavor Brazil's report on entrepreneurship in Brazilian universities. "Empreendedorismo nas universidades brasileiras." (2014) São Paulo: Endeavor

- Project final report/Thesis

That structure does not apply for modern product/service development based on the user-centric and supported by the design methods approach. Besides that, iterative techniques, as Customer Development (Blank & Dorf, 2012) or Lean Startup (Ries, 2011), apply better for business innovation through technology.

Therefore, there is a need for an extracurricular program for students that seek for an entrepreneurial experience based on the final-year project applying modern design and startup techniques to transform a technological project into a real product/service.

The Academic Working Capital (AWC) program² is an initiative conceived as a partnership between the TIM Institute³ and the Polytechnic School of the University of Sao Paulo⁴. It is a national program in Brazil that proposes an entrepreneurship experience during the development of the final-year project in order to propose a professional alternative in entrepreneurship for those who are graduating.

With an experiential educational approach, based on practical activities, the students are supported by classes, workshops and a team of expert consultants and monitors with weekly meetings. They are exposed to the design of a technology-based business putting together knowledge associated to new product, processes and business innovation.

In this paper we discuss the strategies of entrepreneurship education in a final-year project context supported by an extracurricular program for engineers. As a case study, we will present the results of the first year experience of the AWC in 2015, applied to 12 final-year projects, from different engineering courses of 3 top Brazilian universities.

Entrepreneurship Education

Both in format and content, the entrepreneurship education has been evolving fast in the last decades: from theoretical lectures, professor-centric, to acceleration practical programs based on decentralized mentors connections; and respectively, from management and psychology topics to a design and cognitive approaches and methodologies.

From the format evolution perspective, the polarizing discussion between theory versus practice is always a controversial topic. In fact, the concepts of education, learning and pedagogy are the middle of an extensive debate that places the need for a different education model, more open, decentralized and practical. Entrepreneurial education essentially needs to be an experiential learning activity given that “in order to learn entrepreneurship, one must do entrepreneurship” (Neck H. G., 2014).

From the beginning, without formal theoretical background, entrepreneurial activity was a practice related to tacit knowledge. The

² <http://awc.institutotim.org.br>

³ <http://en.institutotim.org.br>

⁴ <http://www.poli.usp.br>

entrepreneurship research related it to a set of abilities developed through practice that could not be taught (Gartner, 1988).

Through a theoretical step, entrepreneurship research took place in management schools. Importing content from business and strategy content to leadership behavior studies. From an educational perspective, entrepreneurship was taught in a linear fashion. The process was taught of identifying an opportunity, developing the concept, understanding resource requirements, acquiring resources, implementing, and exiting (Neck H. G., 2014). It was a theoretical-based approach to entrepreneurship.

Several advances have been made in entrepreneurship research and the main focus pointed to understanding how entrepreneurs think and act opened for a cognitive research approach.

Neck et al. (2014), influenced by cognitive approach, proposed to view entrepreneurship not anymore as a process, but as a method:

Approaching entrepreneurship as a method means teaching a way of thinking and acting built on a set of assumptions using a portfolio of techniques to encourage creating. The method forces students to go beyond understanding, knowing, and talking. It requires using, applying, and acting. The method requires practice.

In fact, their proposition applies for an “actionable theory” that embraces visions, theory and practice, and its pedagogical essence connects to the concept of experiential learning (Morris, Building university 21st century entrepreneurship programs that empower and transform, 2014).

As stated by Morris & Kuratko (2014), entrepreneurship education essence is going toward a pedagogy guided by a method that “is teachable, learnable, but it is not predictable”.

Entrepreneurship Practices

The method-based approach for entrepreneurship education is based on the concept of practices (Morris, Building university 21st century entrepreneurship programs that empower and transform, 2014) (Neck H. G., 2014).

Practice-based learn is a very complex and a deep subject, however we will state a partial-simple definition given by Morris & Kuratko (2014):

Practices are meaningful performances governed by social rules and norms. (...) Practices become the background of culture formation and the platform for social structure construction.

In fact, the practices of entrepreneurship can create a culture of entrepreneurship among students, in the classroom and beyond.

Our analysis will concentrate on the set of practices that we consider the most important for an entrepreneurship program: Design-based and Reflexive practices.

Design-based Practices

The basic argument is that entrepreneurs think, and perhaps act, similar to designers. Design-based practices encourages student to observe the world through a different lens and create opportunities. Neck et al. (2011) defines Design as follows:

Design is a process of divergence and convergence requiring skills in observation, synthesis, searching and generating alternatives, critical thinking, feedback, visual representation, creativity, problem-solving, and value creation. Teaching entrepreneurship through a design lens can help students identify and act on unique venture opportunities using a toolkit of observation, fieldwork, and understanding value creation across multiple stakeholder groups.

Also, according to Goldsby et al. (2014), design approaches do have a number of common characteristics including:

- Problem definition
- Research
- Prototyping
- Feedback
- Iterations
- Acquired knowledge
- Intuition
- Proof of concept

The term currently used for the application of the several design principles, methods and tools in other knowledge areas is «Design Thinking» (Buchanan, 1992). The application of design thinking to entrepreneurship practice empowers the entrepreneur to understand user problems empathetically, generate several creative alternatives and test the concepts through experimental action on the field. In fact, those practices not only apply to entrepreneurship but stand also for an innovative entrepreneurship practice (Brown T. J., 2015) (Brown T. , 2008).

Reflexive Practice

Reflective practice gives permission to our students to take time, think, and absorb the learning (Morris, Building university 21st century entrepreneurship programs that empower and transform, 2014).

Morris & Kuratko (2014) define reflective practice as:

Reflection is an important process by which knowledge is developed from experience. When reflecting, one considers an experience that has happened and tries to understand or explain it, which often leads to insight and deep learning—or ideas to test on new experiences.

Reflection is particularly important for perplexing experiences, working under conditions of high uncertainty, and problem-solving. As a result, it should not be a surprise that reflection is an integral component of entrepreneurship education and also a way of practicing entrepreneurship.

Entrepreneurship as a continuous cycle of action, learning, testing, and experimenting, requires the practice of reflection-on-practice and reflection-in-practice. One as the cycle do–learn–think as a process and the other as the cycle do–learn– think as a behavior.

The Academic Working Capital

The incentive to innovation has been considered worldwide as the only way a country could remain at the forefront and competitiveness. Economic growth and the creation of new jobs are linked to strategies that foster an innovative economy, that develop the industries of the future, and that make innovations that help meet the major challenges of the nation.

Among the various forms of action and government strategies, it has been encouraging the construction of technology-based companies ("startups") as one of the most important tactical actions. From this perspective, both the Silicon Valley, as the ecosystem of startups in Israel, show very impressive results in its economy.

Brazil has several programs to stimulate the construction of technology-based companies, highlighting, for example, those supported by FAPESP and FINEP and also some acceleration government programs such as Start-up Brazil. Also, the country is gradually forming an ecosystem of venture capital firms, incubators and accelerators that complement and support those public strategies.

All these programs have a focus on professional groups with some experience that is already organized around a formal structure company. Programs like PIPE / FAPESP⁵ require, for example, the participation of a researcher, or a professional with a graduate degree. Also, the Start-Up Brazil requires structured companies that are already in operation.

However, when analyzing the trajectory of some of the most successful names in the world of technological innovation, it is seen that they started their projects while still in university, before graduating. This is the case of Bill Gates (Microsoft), Steve Jobs (Apple), Larry Ellison (Oracle), Mark Zuckerberg (Facebook) and many others.

The investor and writer Paul Graham, in some of his essays⁶, discusses the factors that make this stage a very propitious moment to technological developments of success: "I now realize queue something does change at graduation: you lose a huge excuse for failing". Graham deepens his analysis, identifying the following factors that indicate the features that make this stage of life a more favorable stage for that entrepreneurship format:

⁵ <http://www.fapesp.br/pipe/>

⁶ <http://paulgraham.com/articles.html>

- Stamina: provision for many hours of continuous work without sleep;
- Asceticism: few luxuries are needed at this stage of life;
- Rootlessness: easy to move because there is a lot of luggage (physical and emotional) charging;
- Colleagues: an environment conducive to cooperation among colleagues, even without the fears and legal protections of corporate thinking
- Ignorance: anything that makes it seems impossible.

Analyzing this scenario, the TIM institute with the Polytechnique School of the University of São Paulo conceived the AWC-Academic Working Capital program, which aims to support students in the final-year project phase, design your technology-based business. This is a program that aims at a national coverage opened to students from all public and private universities in Brazil.

The AWC, in this scenario, absorbs theories, methods and tools of various acceleration programs, as well as various entrepreneurial and technological education programs.

In the 1st year of implementation of the project (2015), students from the universities of São Paulo and Rio de Janeiro states (USP, Unicamp, UFRJ, UFABC, UFF and PUC-Rio) were invited. In its second year (happening now) this expanded to over 5 states (Minas Gerais, Espírito Santo, Paraná, Santa Catarina, Mato Grosso do Sul), and the Federal District.

The Program

The AWC program aims to support students wishing to transform their final-year projects into products having a potential business impact.

AWC is aimed at students who are in the final phase of graduation in Brazilian excellence university's courses. The teams of participants should be formed exclusively by students and contain at least two and a maximum of four people, where at least one of its members should be performing the final-year project.

The purpose of the program is to show a professional alternative in entrepreneurship for those who are forming. For this, expert consultants and monitors accompany the group throughout the year in order to help them to develop products and businesses with high potential for innovation.

The program offers the teams during the period of one year:

- Orientation held by experts on the development of value proposition for products which aims to attack real consumer's needs;
- Financial resources for the purchase of consumables and hiring professional services related to the project in order to materialize the prototype and deliver a first version of the solution;
- Resources and time for the presentation of the product to investors, acceleration and other entities of entrepreneurship ecosystem, in order to further boost the project and bring the product to market.

The Structure

In order to achieve the goal set with the groups, the program structure of the AWC respects both a design discipline with different possible paths for different technologies and businesses (called acceleration tracks); as well as adapts actions and development to the singularity of each team. The program includes moments of individual work and moments of collective exchanges, too rich for the relationship of learning and networking of establishment between groups.

The AWC orientation process consists of two formats: Workshops and Weekly orientation.

The selected teams participate in three (presential) workshops (three days each) throughout the program. Each workshop, held during the school holidays (January, July and December), presents content and provokes practical work with specialist support.

Between workshops, groups are supported weekly by the AWC monitors (program specialists) that work with the teams to influence their learning reflections and to help their prioritization on planning activities. During the orientation meetings the AWC monitor suggests and adjusts the group's activities according to the uniqueness of each project.

Results of AWC15

The AWC 2015 edition had the participation of 12 teams originating from universities in the states of São Paulo and Rio de Janeiro. Those projects had a wide range of characteristics, from a technological nature (from software and apps, through small gadgets and devices coming to large automatic machines) and value propositions that reached a multitude of potential consumers (B2B or B2C) in areas such as agriculture, education, feeding, among others. The 7 finalist teams presented at a demoday with the presence of investors and business specialists.

After the program, from the 7 finalists groups, 5 of them are running their startups in 2016.

Design and Orientation Results

In terms of orientation, the program has conducted more than 200 hours of monitoring. In addition, throughout the acceleration tracks, the teams produced 49 documents (deliverables) and reached a 70% interest in the activities proposed by AWC.

Among workshops and investment fair, the events were attended by 8 external guest speakers. Each having different specialties and experiences in technological entrepreneurship that have been shared with the teams in talks about 40 min. For the investment fair/demoday, there were invited people from the business and startup scene. Their evaluation about the projects pointed for improvements on the business model and entrepreneurial posture, however they praised the prototypes and the technology developed.

AWC as an Entrepreneur Education Program for Engineers

In a typical portfolio of 10 investments of angel investors, half of the companies fail without giving any return to investors, and three or four give a return of capital. Only one or two are those that reach large returns⁷. Thus, in comparative terms, the results of AWC2015 are quite satisfactory. In terms of the program's main objective, the result is related to five projects that will continue in 2016. In 2015, one of the teams received a prize of 100 thousand reais in a second program after passing through the AWC. This result adds to the entrepreneurship process developed by the AWC program.

In fact, looking the number of Endeavor's Survey in Brasil, where 63% of the under graduation students attend entrepreneurship but only 11.2% really took an action and 57.9% presents the intention to create a business, the AWC program seems like a transversal structure to promote a faster entrepreneurship career path.

The characteristics as an extracurricular activity, during the last year and taking the final-years project as a platform for a real technological entrepreneurship practice seems to create a more real link approximating the intention to viability. It tends to be presented as a real career alternative on the last year.

From an entrepreneurship education, AWC program seems to apply Design based and Reflexive Practices with theoretical basis. The tracks and orientation structure support the teams into a path of problem definition, research, prototyping and feedbacks, based on Design Thinking methods. On the other hand, the AWC monitors are prepared to instigate reflection on the teams during their weekly meeting.

Therefore, in terms of the acceleration and educational program, the AWC seems to be a quite satisfactory initiative in Brazil. There is still a lack of criteria and measurement to measure its effectiveness. Those are been researched to be applied on the 2016 edition.

Conclusions

Even if exposed to a few disciplines on entrepreneurship, the majority of the engineers graduating goes through the last year wishing, but not envisioning entrepreneurship as a carrier just after university.

Final-years projects seem to be an important alternative as they are considered traditionally a link between the acquired knowledge and experience through practical projects. However, the whole process is still inefficient to insert entrepreneurship as an option of the young engineers.

An alternative could be an extracurricular activity that could complement the traditional final-year project's methods and insert the modern approaches of technological entrepreneurship.

We discussed the strategy of entrepreneurship education today and presented some numbers, especially in Brazil, that point for improvement on graduation entrepreneurship.

⁷ <http://entrepreneurship.org/resource-center/startup-premoney-valuation--the-keystone-to-return-on-investment.aspx>. Last access in 5th May 5, 2016.

We analyzed either the modern proposals for entrepreneurship education highlighting a method-based approach (in opposition to theoretical and practical polarization) and entrepreneurship practices. The design-based and reflexive practices pointed for an entrepreneurship program that should be flexible and customized to each individual/project.

In the end, we presented, as a study case, the experience at the AWC program in 2015. It was conceived to offer an alternative to entrepreneurship education using the of final-year project as a starting point. Students were exposed to a design-based practice (called acceleration tracks) and through weekly meetings with the AWC staff they instigated a reflexive practice on design and business.

The program needs improvements, already in the study for the 2016 version, and could expand their activities to more states and universities in Brazil. However it already presented promising results to create a real situation that could present entrepreneurship as a real career alternative at the end of University.

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