

ENGINEERING AND ENTREPRENEURSHIP: THE EXPERIENCE AT UNIVERSIDAD ICESI

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Abstract

For the last 20 years, the Center for Entrepreneurship Development at Universidad ICESI en in Cali (CDEE-ICESI), Colombia has had experiences in teaching Entrepreneurship Courses that integrated Engineering, Business Economics, and Industrial Design's students, and. through Wthem we had to develop an integral methodology for our engineering students that solved some of the traditional limitations of the previous professional training.

The activities of the Center include many other activities related to entrepreneurship in terms of research and extension, which makes easier the process of motivating and orienting the engineering students to an entrepreneurial career.

Some longitudinal studies that we have been done shows that initially (1984-1994) the propensity frequency of business students to starting establish their own companies was higher than the propensity frequency of the engineering students.; however However, in the last three years we are finding that many of the engineering students are really starting their companies even before they finish their undergraduate studies and in more substantial business which makes us believe that the situation is changing

The action of the Center for Entrepreneurship Development has been very important at the regional level because many other universities had takenve adopted our methodology to use it in their courses. , but aAlso, many support mechanism for entrepreneurs and especially for technology based entrepreneurs has been established with our support.

1. The Center for Entrepreneurship Development at Universidad ICESI

The Universidad Icesi was founded in 1979, by the main entrepreneurial leaders from the Valle del Cauca, with the purpose of contributing to the harmonic development of the region, shaping the new entrepreneurial leaders, under the basic principles of: free enterprise system, entrepreneurship, democracy, social responsibility, ethics and justice.

The “Centro de Desarrollo del Espíritu Empresarial” (Center for Entrepreneurship Development) (CDEE) was created on January 1st 1985, as an academic unit of the university, with the mission of forging a new Entrepreneurial Culture through academic processes and with the permanent

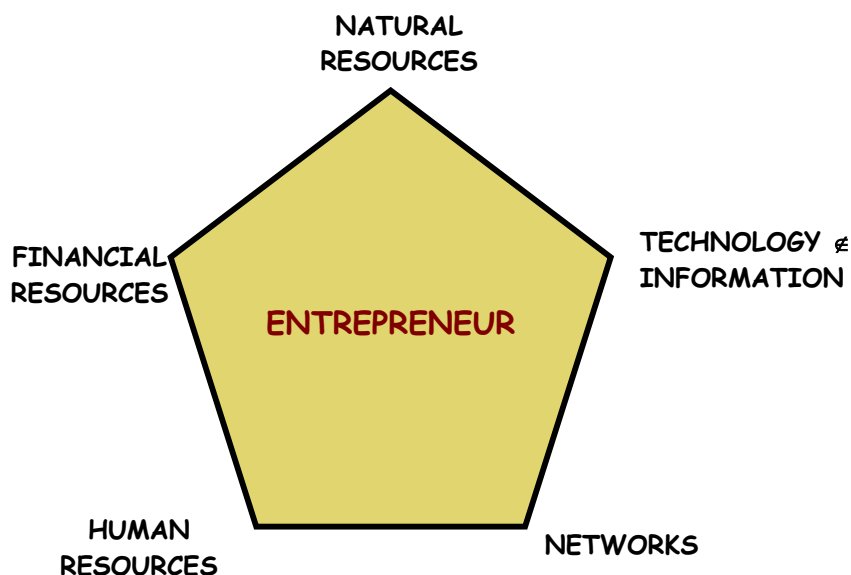
participation of the academic and entrepreneurial community. The entrepreneurial culture should be full of innovation and social responsibility and able to become an engine of development in all its facets.

The fundamental purpose of the CDEE is to motivate and to shape, through educational activities, the members of the community under its area of influence, in the development of innovative and creative actions that will allow them to become, throughout their lives: creators of new and competitive organizations, leaders of the existing ones, creators of: wealth, productive employment, social wellbeing and personal, professional and social satisfaction.

Through special educational processes denominated Entrepreneurial Education, the CDEE is committed to provide a learning, motivational, developmental and support environment, which will significantly improve the conviction and the disposition of the members of the community to act, towards the surge of new competitive organizations and to the preservation and growth of existing ones, whether they may be private or public, profit or non-profit and from any of the sectors of the economy.

The areas of creation, appropriation, and diffusion of knowledge in which the CDEE works are: the development of the entrepreneurial spirit and culture, the creation of enterprises, the shaping of entrepreneurial leaders, entrepreneurial education, the management of family businesses and the management of SME (Small and Medium Enterprises).

The CDEE firmly believes that the socio-economic development is basically a human process, in which people find the appropriate ways to use production resources: natural, human, financial, networks, technological and informative information.



These creative and innovative human beings, capable of overcoming the limitations that the

environment presents them with, skilled to take advantage of opportunities independent of the volume of their own tangible resources, eager to transform their ideas into actions capable of nurturing the economy, the business activity and the quality of life, are the business leaders that the CDEE seeks to shape.

2. ENTREPRENEURIAL EDUCATION

The Latin American education and especially the higher education in the economical, managerial, engineering and scientific areas have been oriented in the last 40 years towards:

- a) Generating good employees: executives, directives, and bureaucrats.
- b) Favouring big organizations against small ones.
- c) Strengthening the already established enterprises and not creating new organizations.
- d) Backing on- going enterprises.
- e) Producing followers and not leaders or independent innovators.
- f) Generating crews and drivers who work very well with well-defined non-risk routes, but not producing creative men and women willing to run moderate risks.

At the world level, big changes have been happening in the context of entrepreneurial education at the elementary, high school, university and continuing education levels either in the formal and the informal sector, .and. Latin American universities and specially Engineering Schools cannot be out of this process. That would mean letting it go the best and maybe the last opportunity to be a significant actors in the real development of Latin American countries.

The basic idea behind entrepreneurial education is to be able to produce more and better entrepreneurs in the long run. Differentiating them from those of the past who had no help from the educational system. The objective has to be for new entrepreneurs, provided with an entrepreneurial education, to know better where, how, with whom and with what, they should start their new business.; h How to follow their entrepreneurial careers and how to maximize their entrepreneurial objectives , not just in terms of personal advantage, but also as well as in terms of sharing their special abilities with the society.

Latin America requires human beings, able to act independently in many innovative forms, with high levels of achievement motivation, tremendous capacity to carry on their ideas, ready to run moderate risks and fully determined to generate new wealth and new jobs under an ethical and socially responsible framework. They should have the capacity to adapt their businesses to the changing environments and be determined to identify and use all the market opportunities., They must seek interested in continuous learning and improvement processes. This should be the profile of the people we will form at our engineering schools.

The time wWhen young people is are at the university, this is a period of transformation in which we should provide to each one a general formation. We should, opening their minds to many new concepts theories and practices. , but aAbove all, we must to provide them a very productive way of being, of doing, of behaving.

Entrepreneurial Education is a matter of attitudes, of culture, which doesn't accept the actual structure, which prones for constructive change and revolution, which provides people with a leadership, oriented toward the definition of a feasible vision in the business environment, which gives them capacity to marshal resources to transform their vision in real productive business.

In Entrepreneurial Education the focus has to be firstable in the development of persons people and then in the development of operating tools. Thus it is to work on the attitude, on the culture. Provide entrepreneurial education is to empower the students toward the full realization of their potential as productive transformers of our society.

The Entrepreneurial Education, as any other education, has to be given in a specific cultural framework and in a real environment. These input conditions will establish the constrains to the formulations of the educational process and the variables that should be modified in order to obtain the result that we are looking for. The idea behind entrepreneurial education is to be able to offer to the Latin American engineers the capacities and abilities needed to become a social economical development factor., tTo be fully trained as entrepreneurs. It's to train him them as an innovative, independent, creative, leader, original, risk oriented, visionary, person which is able to fulfill its personal goals bythrough its actions.

We cannot in entrepreneurial education make the same mistake that we have done in managerial education of moving directly ideas, methods, concepts, theories and tools from one culture totally different to our cultural setting. We have to study all the environments and then define which ideas and processes are adequate for our environment.

In the last years, many professionals had have become entrepreneurs, producers of employment, and social and economical well-being. The continent, the professions and the existing enterprises are in need that the number of engineering entrepreneurs be multiplied., that a Start a chain reaction is started tothat allows the professions to get back to its their advanced position in society. , to sFixolve its problems and to helping to solve fix the problems of the continent. It is necessary to enrich the traditional educational system with the purpose of getting the students closer to the real world, that without forgetting some of the conventional procedures, we get the students close to the real world.

3. The Experience At The Universidad Icesi

In December 1984, the Universidad ICESI make made a very strong decision: Aall the curricular programs in the university should have at least one required course in Entrepreneurship and all our students should be oriented to become entrepreneurs.

Initially in early 1985 we started with our fully developed program: B.A. in Business Administration. , butFollowing in 1988 we started to teach also to the our B.Sc. in System Engineering and later in the 90's to the B.Sc. in Industrial Engineering and Industrial Design. andFinally, in the last years to the B.A. in Economics and International Business, the B.A. in Accountancy and International Finance and the B.Sc. in Telematics Engineering.

For many years we mixed the students in our entrepreneurship course without any consideration to their academic program. , but iIn the last three years, due to the curricular change in the Business Administration program, which included two required course they are separated from the rest.

, we mix all student different that the Business students.

Through the years we also had experiences with engineering professional doing graduate studies, either in the following programs: MBA, or e-business, or production management, or logistic management, and or environmental management. We also have had experience with engineering professional in some of our extension and continuing education programs, . However, but this paper will be fully oriented to engineering undergraduates.

As will be presented later the approach has included also an extracurricular approach to foster entrepreneurship further alongoutside of the classroom.

3.1 Curricular Activities

The entrepreneurship course that we actually we teach to all the Business, Engineering, Economics and International Business, Accountancy Accountancy and and International Finance, and Industrial Design programs has four main pillars:

- a) Development of an entrepreneurial spirit motivation that incite the engineering student to become a social responsible and ethical entrepreneur.
- b) Understanding of the entrepreneurial environment in which he/she is going to work as an entrepreneur.
- c) Development of a new business concept.
- d) Development of a business plan that evaluates all the potentials risk, resources, strategies, milestones, etc. that he/she requires to take a final decision about his/her venture.

The education objectives of the course are that Aat the end of the course the students will be:

- Able to understand the economic social, historic, psychological and professional implication of entrepreneurship world wide and in Colombia.
- Able to decide if an entrepreneurial option should be or not included in the goals, strategies and tactics for his/her professional career.
- To understand the importance and the use of the values, belief and attitudes of the entrepreneurial spirit in all his/her activities.
- Able to develop multiple, different and innovative business ideas to evaluate them and to develop and evaluate business opportunities.
- Able to develop a full business plan that allow him/her to understand all the key components of the new business, the resources required and the support system to carry on the new business.
- Able to determine the quantity, quality, value, time, moment and feasibility to obtain the resources to establish the new business.
- Able to evaluate the potential, risk, strategies, advantages, and disadvantage of the new business and able to take the decision to start the business.

- Able to work in an entrepreneurial team

The course is supported by the book “Innovación Empresarial: Arte y Ciencia en la Creación de Empresas” published by Pearson Education in 2001 and specially designed for the Latin American environment. Also and by papers published in national and international magazines and journals. The basic content of the course is indicated included in Annex No. 1.

In terms of methodology we use active learning and project oriented learning. This is, enriched by invited entrepreneurs, workshops on creativity and business opportunity generation, real business activity, deep interview to entrepreneurs, support mechanism institution’s and presentations of the support infrastructure available.

The students are required to read all the material previous to each session and to be ready to discuss the different concepts that are included in each session. Through the semester they had have to develop individually multiple, different and innovative business ideas. These ideas, that a after a group evaluation, allow them to choose and to develop the main business opportunities. and fFrom these, they select one for each entrepreneurial team (maximum three students). They develop to do the full business plan and later, at the end of the semester, they have to present and to defend it.

Our educational model is an adjustment of Shapiro’s model, and it includes five basic variables:

- Motivational variable : Liking, will
- Situational Variable : Opportunity
- Psychological Variable: Decision to follow an entrepreneurial career
- Socio Psychological Variable: Credibility and Feasibility (Business Plan)
- Economical Variable : Resources

We also use the Vesper’s concept of the basic ingredients for any business:

- Opportunity
- Clients
- Technological Knowledge
- Networks
- Resources
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In addition to the required course, the engineering curriculum does allow the students several other curricular activities for their entrepreneurial development:

- a) Each semester three elective courses are offered: Ggeneration and evaluation of business opportunities, Ffamily business management, and SME’s management. These options are oriented to allow the interested students to complete their formation in the entrepreneurial area.
- b) Our entire engineering student must have one internship semester before graduation. and wWe offer the opportunity that the internship is donebe done: carrying out in the process of starting their own business, just refining their business plan, or getting the financial resources, or starting their business. We provide tutoring and technical assistance for these processes.

- c) All our engineering students must develop a final project to fulfill graduation requirements.

and We offer the opportunity that this project can be done in entrepreneurship related areas or in the development of their own business. Some of the options are: to improve market research, to do all the prototype development and evaluation, to design the final production/service sequence, to evaluate suppliers, to improve business plan, etc.

3.2 Extracurricular Activities

Maybe the most important part of our activity with all our students is our extracurricular Entrepreneurial Program, because it keeps the entrepreneurial goals in the mind of the students through out all of their 10 semesters in at the university.

The main actions we offer them to fulfil this extracurricular goals are:

- a) When the students come to the university for professional orientation (usually when they are in grades 10 juniors and 11 seniors of their in high schools) the values and orientation of the university are presented. The University Entrepreneurship Orientation one that is greatly stressed. As well as is the entrepreneurship orientation, and the very important role that the Center for Entrepreneurship Development plays not only inside the university but also outside at the national and international level.
- b) In the induction During freshman orientation, week that our first semester students had attend there is a workshop about the Entrepreneurship Orientation of our university and the support they can obtain from the Center for Entrepreneurship Development.
- c) Every semester we offer the extracurricular seminar “Entrepreneurial Spirit at the University -Level ONE”. It is a 12 hrs seminar for the students. In it the basic ideas of entrepreneurship are provided. It also includes some invited guest entrepreneurs and many times a visit to the business of the invited guest entrepreneurs. The students can attend this seminar in any of their first 8 semester in at the university.
- d) Every semester we offer the extracurricular seminar “Entrepreneurial Spirit at the University- Level TWO”. It is a which usually take 10 hrs. Seminar with the Level ONE seminar as prerequisite. it requires that the students had taken level ONE. This The content of this seminar change varies a little bit every semester. , because tThe idea is that the students who is are interested in entrepreneurship can be exposed to different elements and relevant topics. Some of the subjects of the last semesters had been: technology based business,; financing schemes for new business, trade marks – patents and property rights, entrepreneurs entrepreneurial support organizations, sources of new business, etc. The only prerequisite for level TWO is to have taken level ONE. The concept behind level TWO, allows the students to have the possibility to take as many as 9 different subjects meanwhile they are being undergraduate engineering students.

- e) Every semester we had have the Business Opportunity and the Business Plan Internal Competition. The first one is opened to all the students of the university independent of their semester they are. The second one, due to the requirement of a full business plan is practically open only to the Entrepreneurship's course student.

The winners of the business plan internal competitions are motivated to inscribe register their business plan in the main National Business Plan Competition that is administered managed by then main business magazines in Colombia: Revista Dinero.

In the 2004 edition of this contest, called Ventures 2004, a group of four Telematicss Engineers (Two who got this their BS in August 2004 and two who are actually fourth semester students) were the winners in the "Public Service Category". with hisTheir business plan PSIDIUM oriented was targeting to mobile marketing using text messages to cellular phones.

Some other of our students has has sent, with our support, their business plans to international competitions. In one case, one of our undergraduate teams from Systems Engineering got asfinished as one of the 20 finalist of the New Venture Championship that organizes the University of Oregon (All other 19 groups were graduate students mainly from MBA Programs). In another instance,case with a group of graduate engineering graduate students of the specialization in e-business program we got intofinished in the final top twenty in the New Ventures Championship – University of Oregon.

Now that a A new approach government program has been developed in Colombia to support business created by University Students and recent B.Sc.graduates. , manyMost of our entrepreneurial teams are already registered in that system. and wWe hope that in the following years many of our entrepreneurial teams will get financial support from "FONDO EMPRENDER – SENA"

- f) Every year we organize EXPOICESI, a trade fair in which ICESI's entrepreneurs had the opportunity to present to the community their business and to sell their product and service. This is also an excellent forum and to share with students and professors their ideas, their way of life, their accomplishments and their problems. This is a very useful role model activity, because many of the entrepreneurs that take a booth in EXPOICESI are students.
- g) The Center for Entrepreneurship Development has an excellent relationship with the three incubators we had have in our city. We are members of the Board of Directors of FUNDAEMPRESA (an open incubator and new business support organization created in 1986) and of INCubarFUTuro (a technology based incubator created in 2002) and we have very good relationship with PARQUESOFT, . The last one is a software oriented incubator with more than 100 business and 400 entrepreneurs working in different cities of the south west of the country. Actually about six ICESI's engineering entrepreneurial groups are at Parquesoft developing their business.

- h) We are members of the board of the COMFANDI's seed capital fund which has just been established and is going to provide financial resources to new projects.
- i) We are the founders of the Latin American Congress on Entrepreneurship. The congress has been held , of which we had organized 16 in of the last 18 years. It has had the following geographical distribution:, 11 in Colombia, 2 in México, 1 in Chile, 1 in Puerto Rico, and 1 in Costa Rica. These This Congresses are is always open to our students. and in them tThey had have the opportunity to learn of from top world wide leaders in Entrepreneurship, to get in touch with the developments that are happening in Latin America in the field, and to meet with fellow students of other universities interested in the entrepreneurship subject. In 2005 we will be organizing the 4th Rresearch Conference on Entrepreneurship in Latin America
- j) Through the “Boletin ICESI” a bi- weekly internal publication we keep our students informed about all the entrepreneurship activities that the Center for Entrepreneurship Development of the Universidad ICESI is executing and also about the new ICESI's entrepreneurs that we are able to identify. Also through the bulletin “INTERACCION” that every two months the university send to the alumni, we keep sending information to our alumni about our activities, and support mechanisms, and also presenting the entrepreneurial achievements of our alumni.
- k) We keep trying, not always succeeding, that the entire faculty keeps restrengthening the entrepreneurial message in all the courses and academic activities independent of the academic field in which they work. We believe that in order to get really impressed engrave this message in the minds and hearts or our students the diffusion activities should be reinforced permanently.
- l) We have started the development of support material for our courses. In that sense we had already have one of our courses web enabled in MOODLE. to be able to support by internet our students and wWe are also in the final stages of setting a Business Plan Course in MOODLE and in Web CT. We also developed business plan software HAZPLANN, to help our students with all the financial projections and with all the project evaluation analysis. This tool is very useful for the engineering students because they do not master these techniques.
- m)All our engineering programs, as all our programs, has have in their curricula curriculum design a “Common Core”. This core , which provides the students among other aspects with knowledge's in Microeconomics, Macroeconomics, Financial accountancyAccounting, Marketing principlesPrinciples, Organizations, Colombian Economy, and Colombian Law. In addition to that all engineering students take Engineering Economy Economics and Project management Management courses as part of their professional trainingeducation.

4. Our Results

In the 1999 – 2000 period a research was conducted whose main goal was to measure the percentage of entrepreneurs among our alumni for the 1984 – 1993 period. However iIt also characterized their businesses and identified the main aspects that were decisive in their entrepreneurial orientation.

From an alumni population of 1152, a stratified random sample of 500 alumni was designed and interviewed by phone in the first stage of the research. This, which allowed us to classify our alumni in three main groups: Entrepreneurs, Employees, and Unemployed. Then, in the second stages of the research 175 alumni were asked to fulfill answer detailed questionnaires in order to collect data about their professional development. Finally, in the third stage an in-depth interview procedure was applied to 49 alumni in order to write up detailed cases about their careers.

Some of the results of this research are:

- a.) As indicated by table # 1, the proportion of alumni who have become entrepreneurs is different for each one of our programs. , whichThis clearly indicates that there are some other variables that affect the rate of conversion: age, socio economical status, job market, job experiences, family support, etc.

a)

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TABLE # 1
Percentage of Alumni which actually are Entrepreneurs

Business Administration (Night Program)	23%
Business Administration (Day Program)	14%
System Engineering	9%

- b)b.) As indicated by table # 2, there are a significant proportion of alumni from each program who play s the two roles simultaneously: Entrepreneur and Employee.

TABLE # 2
Percentage of Alumni which actually are simultaneously Entrepreneur and Employee

Business Administration (Night Program)	7%
Business Administration (Day Program)	6%
System Engineering	3%

- c) As shown by table # 3, a high percentage of our alumni (on the average 35%) had donehave experienced entrepreneurial events. , at some time in their professional career, entrepreneurial events,They have either by establishing a new business by themselves, or by transforming their family business, or by developing intrapreneurial projects in the companies in which they are employees.

In 2005 we are starting a new longitudinal study of our alumni that will cover the students that got their undergraduate degree in the period 1984-1999. and iIt will allow us to have a more quantitative approach to the new trends we are observing in the engineering students in the last

years. It will target and gather more data on , and it has to do with the significant number of engineering students that are starting their business even before they finish their bachelor program. Hopefully by the end of 2005 we will have more robust information about our alumni and specially a bigger sample of the new engineering programs.

5. Conclusions

The main conclusions we have derived of our experience are:

- a) It's completely feasible and generates good excellent results to implement entrepreneurial education in the engineering programs in Latin America.
- b) The entrepreneurial education process has to go further that the "required course strategy". It has to have many curricular and extracurricular support mechanisms and infrastructure.
- c) The existence of a Center for Entrepreneurship Development with wide university coverage is aa very good vital operational structure which allows the interaction among students of different programs.
- d) The engineering schools in Latin America must study and implement strategies to increase the number of engineering and technology base new companies as a tool to support the needed economic development that allfor our countries need.

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7. Biographical Information

Rodrigo Varela is the founder and Director of The Center for Entrepreneurship Development at Universidad ICESI in Cali – Colombia. He holds a Ph. D. and M. Eng in Chemical and Petroleum Refining Engineering at Colorado School of Mines, a B.Sc. in Chemical Engineering at Universidad del Valle. He was the founder and Director of the Industrial Engineering Program at Universidad del Valle where he was also Associate Dean for the Engineering School.

ANNEX No. 1
UNIVERSIDAD ICESI
CENTRO DE DESARROLLO DEL ESPÍRITU EMPRESARIAL

ENTREPRENEURSHIP 15000

Objective

This course is oriented to motivate, to form and to train the students in the development of a creative action which allow them to act with entrepreneurial spirit in all the vital activities and specially in the process of conception, design, analysis and start up of a new enterprise either if you are the owner or member of the family that will own or an employee in an organization.

Content

1. Business Opportunities

Sources of business ideas. Creativity and Innovation. Business Ideas Evaluation. Business opportunity development

2. Entrepreneurial Spirit

Characteristics of the great human cultures, great historical moments, great leaders, and great organizations. The three main common words. The transformation model. The elements of an entrepreneurial spirit based culture. The new working ways. Entrepreneurship as new employment source. New trends in economical and social matters. The system of entrepreneurial culture.

3. Entrepreneurship and Development

The development objectives. Entrepreneurship and Development. GEM results. Latin American and ASEAN Countries development. Options for Colombia. New strategies for development.

4. The Entrepreneur

Concepts and myths about the entrepreneurs. Working definition. Characteristics, skill and competences. Entrepreneurial history.

5. Entrepreneurial Process

Theories and model to explain the entrepreneur actions: Shapero, Rondstadt, Timmons, Gibbs, McClelland.

6. Components and stages in the new venture set up

Basic components of every business. Stages in the development of a business. Entrepreneurial career.

7. Business Plan

Conceptual basis in a B.P. Internal and External reason. General Methodology. Market Analysis, Technical Analysis, Administrative and Legal Analysis, Social Analysis, Economic and Financial Analysis, Risk Analysis, Project Evaluation. Final Document. Business plan's evaluation. Business plan's presentation.