

Surveying and Geomatic in Colombia: A Comparative Study of the Academic Programs of Engineering and echnology

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Key words: Surveying, geomatic, curricula, Colombia

SUMMARY

The European Community has been working in shaping its higher education to create a Europe of knowledge and contribute to the social and educational development of her inhabitants. The purposes are to strengthen the European System of Higher Education in an international competitive manner and promote and build an educational system based on quality and transparency.

This experience and development has led to the emergence of a similar project in Latin America, know as the Tuning Latin America Project.

The Tuning project provides a methodology known as the Tuning methodology which seeks to present structures and educational programs, respecting their diversity and autonomy, in such a way that they facilitate the understanding of the curricula of the various existing degrees and their mutual comparisons. This methodology is focused on the analysis of the structure and content of the studies. The study of the curricula of academic programs, which are offered by six universities in Colombia in the area of Surveying and Geomatics was realized. Two of these universities, “Universidad Distrital” and “Universidad del Valle”, offer programs in engineering and the “Universidad Distrital”, “Universidad del Tolima”, “Universidad de Cundinamarca”, “Unidades Tecnologicas de Santander”, “Universidad del Quindio”, offer programs in technology.

The main results were:

- All the academic programs of engineering and technology related to surveying are offered in public universities.
- None of the two universities with engineering studies offer the possibility to pass from a Technological program into a professional one, but in the “Universidad Distrital”, a mobility program from Surveying Technology to Surveying Engineering through a system of approvals is being established. “Unidades Tecnologicas de Santander”, on the other hand, has structured a technology program as a preparatory cycle, but currently does not offer a professional cycle.
- The curricula modernization processes in the Colombian universities emphasize flexibility. Thus, there is a larger percentage of electives. The percentage of elective

credits in Surveying Engineering is on average 7.4% for the “Universidad del Valle” and 16% for the “Universidad Distrital”. In regard to technology programs, while “Universidad de Cundinamarca” has no electives, the “Universidad del Tolima” has 1.9% and the remaining four universities have an average of 13% of elective credits. The “Universidad del Quindio” has only a 6.45% and the other two universities have an average of 13.8 % of elective credits.

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1. INTRODUCTION

At an international level, the European Community has been working in shaping its higher education to create a Europe of knowledge and contribute to the social and educational development of the Europeans. The purposes are to strengthen the European System of Higher Education in an international competitive manner and promote and build an educational system based on quality and transparency.

This experience and development has led to the emergence of a similar project in Latin America, known as the Tuning Latin America Project, an experience that moves with difficulty in this part of the world. Both experiences, European and Latin American, motivated the initiation of a comparative study of the academic programs of Surveying and Geomatic in Colombia.

As a result of the impact of globalization on education, knowledge and information, the “Universidad Distrital” in its development plan (2007-2016) expressed the importance of the internationalization of university activities. It states that internationalization of the university must take place while strengthening and redefining the relationship with the immediate environment. Namely, the university must create mechanisms to facilitate interaction with the surrounding society, identifying and developing fully all the opportunities of scientific cooperation, training, and culture.

In relation to its internationalization, the “Universidad Distrital” is in a period of academic renewal called curricular modernization.

Curriculum review and analysis of social needs are key processes for curriculum change in the university and they should be designed to train skilled, competitive and ethical professionals who provide answers to the challenges of economic competitiveness, and the use and development of new technologies. Given this point of view, the importance of revising the curricula, the assessment system, and agreements for the use of student mobility becomes necessary, tending to assess the quality of each program as a tool for improvement.

To advance the convergence curriculum in the field of Surveying and Geomatic, a research was developed to know the curricular reality of the various institutions of higher education in the country who offer these programs, taking into consideration their history, curricular structure, length, credit systems and skills. It was necessary to compile and process the curricular information of the programs for Surveying and Geomatic Technology that are offered by the following universities: “Universidad Distrital Francisco José de Caldas” in Bogotá, “Universidad del Quindío” in Armenia, “Unidades Tecnológicas de Santander” in

Bucaramanga, “Universidad de Cundinamarca” in Fusagasugá, Cundinamarca, “Universidad del Tolima” in Ibaguè and SENA (National Learning Service). The final product was used to realize some curricular adjustments in the curriculum of Surveying Technology at the “Universidad Distrital”.

2. EDUCATION IN COLOMBIA

According to the 1991 Colombian Constitution, education is an essential and mandatory right for the first nine years of school. In Colombia three educational levels exist: basic, middle and higher education. Higher education is regulated by Law no. 30 of 1992 which states: “It is conceived like a permanent process that enables the development of the potentialities of humans in a holistic manner and seeks the full development of students and their academic or professional capacities” and establishes the autonomy of universities to fulfill their mission.

Therefore, the university is defined as an institution which provides evidence of performance with universal criteria in the following activities: scientific research or technological training in professions or academic disciplines and the production, development and transmission of knowledge and universal and national culture. The universities are in the capacity to offer and conduct training programs in occupations, professions or disciplines, specialized programs, masters, doctoral and post-doctorates.

Under the law, the system consists of three types of institutions of higher education: vocational skills, academic or technical schools and universities, which can be public or private

Colombian higher education is offered to those who graduated high school. The following categories are then offered: intermediate vocational training, technical training, university training, and postgraduate and doctoral training.

According to the Colombian Association of Universities (ASCUN) to advance to a higher education system, one requires:

- An open and flexible education, which ensures greater access and permanence to areas of low-income population
- To provide quality training and to enable mobility of the different educational agents
- To provide high scientific and technological development to the Colombian society, so that the country can be inserted in a globalized world and compete in it.
- To encourage and value the diversity of educational projects or programs and institutions that pose solutions to social needs, with financial viability, governance and capacity of modern management, for which it is necessary to have coordination and management bodies to ensure long-term public equity and transparency policies.

The “Universidad Distrital” shares the proposal by ASCUN and it brings two new elements to advance in a quality higher education: To provide graduates with an adequate insertion in the

productive world and to train people in integrity and civic awareness, which are related to society and its problems.

Responding to the current situation in higher education, it is necessary to have an explicit commitment by the various institutions to direct their actions towards the achievement of objectives in order to achieve the construction of a national project to respond positively and in a timely manner to solve the most pressing problems of Colombian society, in order to ensure the introduction of the country in the globalized world.

In conclusion, the need to focus on institutional efforts to contribute to the mobilization of different sectors of society in the pursuit of knowledge production becomes evident.

3. THE TECHNOLOGICAL EDUCATION IN COLOMBIA

A look at the historical evolution of technological education in Colombia allows us to identify aspects that have characterized it since its emergence as a form of training for work that is fundamentally related to occupational purposes, aimed at the training of "intermediate" personnel "in the productive sector. That is, it emerges as technological or intermediate education, becoming an option for sectors of the population who cannot attend traditional university courses.

The intermediate or short careers emerged as a strategy to meet the needs of the productive sector that required skilled labor. Later, to fulfill the needs of qualified staff, technological learning emerged, aimed at obtaining a "senior technician" who was called "technologist". HERRERA, M. (2000) noted that "From the late fifties, the development paradigm was oriented towards technical training, as market demand prompted to enter the country on the orbit of strategic planning and technical progress as cornerstones of national development."

It then notes that in Colombia, the tech comes linked to the modalities of technical education and job training (vocational and non-formal), separated from an undergraduate program. However, at certain moments and experiences, some universities have tried to develop a concept of technology as a field of knowledge linked to engineering, thus provoking a conceptual ambiguity. Little differentiation between the technical arrangement and the tech situation has limited the development of the latter and has been strengthened by the same official regulations, (Decree 80 of 1980, Law 30 of 1992). Gomez, V (2005)

The little differentiation between technical education and technological education, and the classification of modalities of post-secondary education in academic, technical and technological education allowed the traditional university to be favored in both the demand and student enrollment and created the conditions for the proliferation of various types of educational institutions, training programs and non-university institutions.

As Victor Gomez (2002) states, "Since its conception, a major problem with these methods (technical and technological) settled in the low social status, offering them an education that favored traditional university intellectual work, the ideal being a doctor or professional and, therefore, undervaluing technical and technological education.

4. METHODOLOGY

The Tuning project provides a methodology known as the Tuning methodology which seeks to present structures and educational programs, respecting their diversity and autonomy, in such a way that they facilitate the understanding of the curricula of the various existing degrees and their mutual comparisons.

The Tuning methodology is focused on the analysis of the structure and content of the studies. Based on the above, for each academic program, aspects such as history, structure of cycles, duration, credit system and skills were examined. This methodology was chosen for this research and some of its elements were used.

Moreover, to analyze the curricula, a classification that groups the subjects into four categories was adopted: Basic Science, Common Subjects to Technology and / or Engineering, Specific Related Subjects, and Cross-sectional Subjects. According to the classification that was done in “Libro Blanco Título de ingeniero en geomática y topografía en Europa”, the research project was coordinated by the “Universidad Politecnica de Valencia”. Each of these groups will be defined later.

This project was a qualitative research which was made in two phases, each with a specific purpose. The first purpose was to apply a template for curriculum analysis in surveying. It was referred to the curriculum structure. Initially, the research was conducted by collecting information on curriculum documents produced in higher education institutions.

This collection of documentary information was guided by the definition of curricular aspects which was considered of the fundamental importance in the comparative study. It included documentary sources like books, articles, newspaper articles and documents found on public and private and private files.

The second phase’s purpose was to establish the current state of Surveying and Geomatic in Colombia through a comparison of different curricula in engineering and technology programs.

5. RESEARCH RESULTS

In Colombia, Surveying Technology is offered in public universities. The SENA offers the Surveying Technology program. This institution belongs to the Ministry of Social Protection and it was assigned tasks related to Higher Education by the government; it has introduced a debate in the field of higher education in Colombia, political, social and pedagogical desirability and background of this relationship.

As shown in Table 1, the programs related to Surveying and Geomatics Technology were born in the 60’s, and the first was in the “Universidad Distrital”. On the other hand, with the exception the “Unidades Tecnológicas de Santander”, which has structured a technology program as a preparatory cycle, but currently does not offer a professional cycle, none of the programs has the structure of cycles (3 year +2 years). Regarding admission, all universities require the state examination for admission to higher education known as the ICFES.

Additionally, the “Universidad del Quindío” and the “Universidad del Tolima” take into consideration certain areas of the exam more than others.

The number of credits for technology programs is between 94 and 108. The length of the program is six semesters, with the exception of the “Universidad de Cundinamarca” which has one additional semester. In conducting the analysis of documentary information and interviews with program manager, one can say that the technology programs are in process of adopting the skills system.

rogram	History		Structure of cyckes		Lenght	Credit system	
	Born	Mechanism of admission	Cycles	3years+2years		yes	
Surveying Technology "U.D"	1948	State examination	no	no	6 semesters	yes	104
Surveying Technology "U.Q"	1964	State examination	no	no	6 semesters	yes	93
Surveying Technology "U.T"	1961	State examination	no	no	6 semesters	yes	108
Surveying Technology "U.T.S"	1964	State examination	yes	no	6 semesters	yes	99
Geomatic Technology "U.C"	1969	State examination	no	no	7 semesters	yes	107

Table 1. Main aspects of Surveying Technology

As shown in table 2, in the engineering field, the programs related to Surveying and Geomatics were born in 1998. One exception is Mapping Engineering, which was born in 1968. None of the two universities with engineering studies offer the possibility to pass from a technological program into a professional one. However, in the “Universidad Distrital”, a mobility program from Surveying Technology to Surveying Engineering through a system of approvals is being established. In it the content and time intensity are reviewed.

In all cases, programs are ten semesters long and the number of credits required is around 160.

Similar to what happens in the Technology Programs, the engineering programs are in the process of adopting the skills system and the ICFES test is used for admission.

One problem encountered is that although 1195 of 2010 (before Decree 2566 of 2003) establishes the definition of “credit”, in reality, each university assigns a different value to each subject.

Program	History		Structure of cycles		Lengt	Credit system	
	Born	Mechanism of admission	Cycles	3years+2years		yes	
Surveying Engineering U.D	1998	State examination	no	a system of approvals is being established	6 semestres	yes	161
Surveying Engineering U.V	1998	State examination	no	no	6 semestres	yes	162
Mapping Engineering U.D	1964	State examination	no	no	6 semestres	yes	160

Table 2. Main aspects of Surveying Engineering

As mentioned above, the classification of the “Libro Blanco” was adopted for the analysis of the curriculum. The groups are defined below:

“Basic Science: Basic sciences include subjects such as mathematics, physics, chemistry and biology

Common Subjects for technology or engineering: to be understood as common materials and engineering technologies related to academic areas of computer science and programming, among others.

Specific Related Subjects: Specific subjects related to the career such as statistical and fitting methods, geosciences, geography, topography and mining, and land management planning, civil engineering and construction, geodesy, photogrammetry and remote sensing, cartography, GIS, among others.

Cross-sectional Subjects: Contents do not directly relate to engineering or technology, but offer the graduate a greater range of knowledge that will be useful during the development of his/her careers. Reference is made to subjects such as business administration and management, project management, labor law, etc”.

In the technological field, a 16.7% of the credits for the curriculum on average belong to the basic sciences, as shown in Table 3. The “Universidad Distrital” has the lowest percentage of loans in these subjects: 12.87%. The specifically related subjects have the highest percentage of credits and vary between 48.39% for the “Universidad del Quindío” and 59.6% for “Unidades Tecnológicas de Santander”. The transversal subjects have the highest percentage of difference in credits, while the “Universidad Distrital” has the highest percentage with 26.92% the “Unidades Tecnológicas de Santander” offer only 9.09%.

rogram	Basic Science Subjects			Common Subjects for technology			Specific Related Subjects			Cross-sectional Subjects			Total		
	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits
Surveying Technology "U.D"	4	13	12.87	6	12	11.54	18	51	49.04	12	28	26.92	40	104	100
Surveying Technology "U.Q"	6	17	18.28	4	11	11.83	22	45	48.39	11	20	21.51	43	93	100
Surveying Technology "U.T"	5	18	16.67	3	7	6.48	17	62	57.41	9	21	19.44	34	108	100
Surveying Technology "U.T.S"	6	19	19.19	5	12	12.12	22	59	59.6	5	9	9.09	38	99	100
Geomatic Technology "U.C"	7	18	16.82	5	12	11.21	20	60	56.07	10	17	15.89	42	107	100

Table 3. Classification of groups the subjects for each Surveying Technology

As shown in table 4, engineering programs are consistent with those suggested by the Colombian Association of Faculties of Engineering (ACOFI) over the required number of credits, which suggested that the number of credits for an engineering program may range between 160 and 180 credits. The difference lies in the distribution of these in each of the areas because of the emphasis that each program established in the field of engineering. On average of 16.7% of the curriculum belongs to the basic sciences. The specific area has the highest percentage of credits in all programs on average -53.3%. Similar to the case of technology programs, the cross-sectional area in engineering programs has the highest percentage difference of credits. While the program of Surveying Engineering of the “Universidad Distrital” has the highest percentage with 20.37%, the same program at the “Universidad del Valle” has the lowest percentage with 15.43%.

Program	Basic Science Subjects			Common Subjects for engineering			Specific Related Subjects			Cross-sectional Subjects			Total		
	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits	Subjects	Credits	% credits
Surveying Engineering U.D	8	25	15.43	9	23	14.2	29	81	50	16	33	20.37	62	162	100
Surveying Engineering U.V	10	29	17.90	7	18	11.11	32	90	55.56	10	25	15.43	59	162	100
Mapping Engineering U.D	9	27	16.88	8	17	10.63	31	87	54.38	17	29	18.13	65	160	100

Table 4. Classification of groups by subjects for each Surveying Engineering

The curricula modernization processes in Colombian universities emphasize flexibility. Thus, there is a large percentage of electives. In regard to technology programs, while the “Universidad de Cundinamarca” has no elective credits, the “Universidad del Tolima has a 1.85% , the “Universidad del Quindio” has only a 6.45% and the other two universities have on average 13.8 % of elective credits. (Shown in table 5).

Program	Credits			
	Mandatory Subjects	% credits	Elective Subjects	% Credits
Surveying Technology "U.D"	34	86.5	6	13.5
Surveying Technology "U.Q"	40	93.5	3	6.5
Surveying Technology "U.T"	34	98.1	1	1.9
Surveying Technology "U.T.S"	31	85.9	7	14.1
Geomatic Technology "U.C"	42	100	0	0

Table 5. Mandatory and Elective Subjects for Surveying Technology

The percentage of elective credits in engineering programs are shown in table 6. The Surveying Engineering program at the “Universidad Distrital” has the highest percentage of elective credits with 16%, followed by Mapping Engineering with 14.4% and 7.4% for Surveying Engineering of the “Universidad del Valle”.

Program	Credits			
	Mandatory Subjects	% credits	Elective Subjects	% Credits
Surveying Engineering U.D	50	84.0	10	16.0
Surveying Engineering U.V	55	92.6	4	7.4
Mapping Engineering U.D	56	85.6	9	14.4

Table 6. Mandatory and Elective Subjects for each Surveying Engineering

Finally, there is uniformity in the curricula of technological programs. Thirteen common subjects are offered at all institutions: Planimetry, Altimetry, Drawing Surveying, Photogrammetry, Photointerpretation, Special Surveys, Hydraulic Works, Roads I, Roads II, Mapping, Civic Construction, Geodesy, and Geographic Information Systems.

The three academic programs offered by the “Universidad Distrital” have high academic quality accreditation. The Surveying Engineering Program of the “Universidad del Valle” is working on the paperwork to gain recognition for high quality accreditation; the technological level in the Surveying Technology Program at the “Universidad del Tolima” is conducting the same procedure.

6. CONCLUSIONS

All the academic programs of engineering and technology related to surveying are offered in public universities.

None of the two universities with engineering studies offer the possibility to pass from a Technological program to a professional one, but in the “Universidad Distrital”, a mobility

program from Surveying Technology to Surveying Engineering through a system of approvals is being established

By comparing the curricula of engineering programs, the Surveying Engineering program at the Universidad del Valle is the most rigid curriculum, because it has few elective credits: 7%, while the Surveying Engineering Program of the “Universidad Distrital” is more flexible with 18% of these same credits, which may explain why the program offers several subjects of profundity.

The Universidad del Valle’s Surveying Engineering career is the only one which requests a degree of knowledge in English.

Although all programs in technology and engineering have skills in their curricula, there are differences in the way of conceiving them.

There is uniformity in the curricula of the various technology programs. For example, there are 13 specific similar courses which are offered in all the institutions studied.

Also there is uniformity between two Surveying Engineering Programs. There are 34 specific courses, which have 69 common credits.

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