

Geomatics Education in Belgium: 2011 Program Reformation at Belgian Universities

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SUMMARY

In 1990 a 4-year curriculum degree of "Licence in Geography option Land Surveying" was introduced at two Belgian academic universities: both at the "Université De Liège" and at the "Universiteit Gent" ("Ghent University"). Due to the BAMA revolution (2005), these degrees have been converted in Belgium into a 5-year curriculum finalised into an academic "Master in Geomatics and Surveying" (Universiteit Gent) or a "Master in Geography, option Geomatics and Geometrology" (Université de Liège).

The academic bachelor degrees that give direct access to the Master curriculum, so without additional compulsory courses, are the "Bachelor in Geography" (Université de Liège) and the "Bachelor in Geography and Geomatics, Main subject: Surveying" (Universiteit Gent). At academic universities in Belgium, the geomatics/surveying is related to geographical sciences and affiliated to the Faculties of Sciences.

On the contrary, University Colleges (also called Technical Universities) offer mostly professional Bachelor degrees and some academic Bachelor and Master degrees, while Universities only offer academic degrees. Typically at University Colleges, the studies in Surveying don't exist as an independent type of education. They are seen as a continuation of the academic Bachelor in Applied Engineering sciences in Construction option Surveying (Master in Applied Engineering Sciences in Land Surveying - the degree offered at University Colleges).

After 5 years, it has been decided (November 2010) to reform the programs, based on the experience with the former ones. This article will give - and comment on - the experiences with the old program and the changes made in November 2010 to form a new and better "Master in Geomatics and Surveying" program. Also the different trajectories a student can follow to obtain this type of master degree will be explained.

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1. INTRODUCTION

Education in Belgium is organised in three levels: a primary level (six years, typically 6-12 year old children), a secondary level (six years, typically 12-18 year old pupils), and higher education (18+ year old students), the latter provided by Academic Universities and University Colleges (the latter also called Technical Universities).

In view of the opening of the European Market in 1992, a level of Surveyor with a 4-year curriculum instead of the Belgian traditional 2-year curriculum was considered a high priority by the professional confederations of surveyors in Belgium. As a response, in 1990, two quite different high-level surveying educations were installed: one at University Colleges called "Industrial Engineer in Construction option Land Surveying" and one at Academic Universities called "Licence in Geography option Land Surveying".

Typically for the situation in Belgium is that the Surveying education is always strongly related with either geo-sciences or civil construction. At academic universities, the geomatics/surveying education has always been related to geographical sciences and affiliated to the Geography Department of the Faculty of Sciences. On the contrary, University Colleges (also called Technical Universities) have always considered surveying as a continuation of the academic "Bachelor in Applied Engineering sciences in Construction option Surveying", leading to the "Master in Applied Engineering Sciences in Land Surveying".

The Bologna declaration of June 1999 was introduced to create a common reference frame within the European Union to induce comparable education and diploma degrees. The structural decree of the Flemish Parliament of 4 April 2003 introduced the BaMa programs which started in October 2004. As a result, at Ghent University (ca. 32.000 students), the biggest Public Academic University in Belgium, the old 2+2 year curriculum (two years to become a "Candidate in Geography - Main subject: Surveying" plus two years to become a Licentiate in Geography - Main subject: Surveying") was transformed, according to the BaMa philosophy, into a 3-year curriculum "Bachelor in Geography and Geomatics" followed by a 2-year curriculum of "Master in Geomatics", almost totally different of the still existing and more traditional "Master in Geography".

Notwithstanding the fact that education policy autonomy was transferred to the three Belgian communities (Flemish, French, German) in 1989, the French speaking southern part of Belgium took similar decisions. The Academic University of Liège (ca. 20.000 students[1]) introduced the new BaMa degrees "Bachelor in Geographic Sciences" (3-year curriculum) followed by a 2-year curriculum of "Master in Geographic Sciences: Geomatics and Geometrology".

The first Master diplomas in Surveying at Academic Universities were delivered in July 2009.

2. ACTUAL SITUATION OF GEOMATICS EDUCATION IN BELGIUM

In the paper "Education in Land Surveying at Belgian University Colleges: Master in Applied Engineering Sciences in Land Surveying" [2] the context of education in Belgium, more specifically the surveying education, has been analyzed and commented in detail. The complex situation in Belgium results in the fact that three quite different types of surveying education are offered, all leading to acceptance by the official national "Institute of Surveyors" (Fig. 1):

- The degree of "Professional Bachelor in Real Estate Option Surveying", obtained after a 3-year curriculum (180 ECTS credits) at a College or University College. This degree is offered by two Dutch speaking University Colleges (University College Ghent and University College Artesis (Mechelen) [3,4]) and four French Speaking Colleges [5] (Institut d'enseignement de promotion sociale la Communauté française (Uccle), Institut Reine Astrid Mons (IRAM), Institut commercial d'enseignement technique des travaux publics (Liège) and Institut d'enseignement de promotion sociale de la communauté française IEPSCF (Namur)).

- After obtaining the degree of "Bachelor in Applied Engineering Sciences in Construction Option Land Surveying" by means of a 3-year curriculum (180 ECTS), a "Master in Applied Engineering Sciences in Construction Option Land Surveying" can be obtained after one extra year (60 ECTS credits) at University Colleges (= "Technical University") of the Dutch speaking community in Belgium, or, after two extra years (120 ECTS points), at French speaking University Colleges. These degrees are offered by three Dutch speaking University Colleges (University College Ghent, Catholic Technical University KAHO Sint-Lieven Ghent and Catholic University College De Nayer Mechelen) and three French Speaking University Colleges (Haute école Léonard De Vinci, Haute école de la communauté Française du Hainaut, Haute école de la province de Liège).

- After obtaining the degree of "Academic Bachelor in Geography and Geomatics - Main Subject: Surveying" at Ghent University or an "Academic Bachelor in Geographical Sciences" at the University of Liège, by means of a 3-year curriculum (180 ECTS), a degree of "Master in Geomatics and Surveying" can be obtained after two extra years (120 ECTS credits) at an academic University of the Dutch speaking community in Belgium, or a degree of "Master in Geographical Sciences - Main Subject: Geomatics and Geometrology" after two extra years (120 ECTS) at a French speaking University. This degree is offered by one Dutch speaking Academic University (Ghent University) and one French Speaking Academic University (Université de Liège).

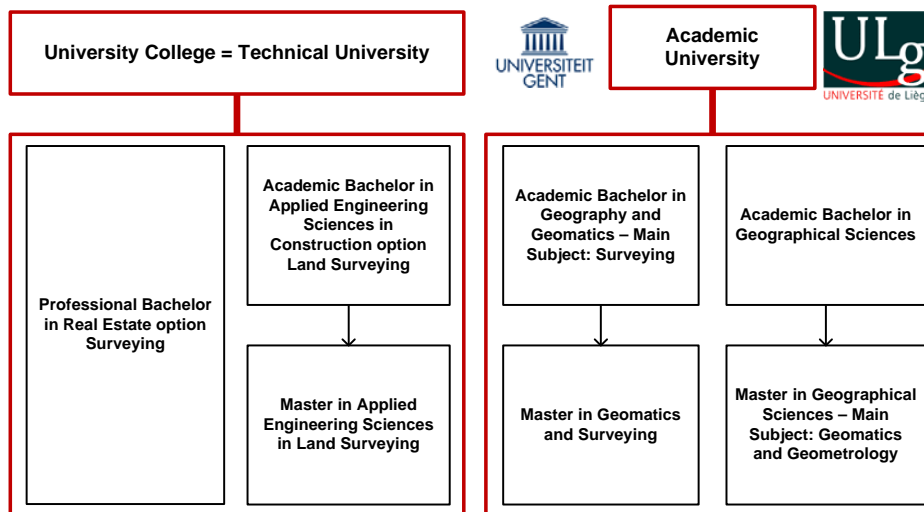


Fig. 1. The types of surveying education, leading to acceptance by the Belgian National "Institute of Surveyors". [2]

It is interesting to compare the number of graduates in the three different types of surveying education (Fig.2a). This leads to the following observations:

- The total number of graduates is approximately 120-160 graduates per year (Fig. 2b) on a total population of approximately 10 million people or one graduated surveyor per year for 70.000 inhabitants. This number appears to be low in comparison to other countries, and may lead to the conclusion that potentially more students should be attracted to start the studies of surveyor.
- The total number of graduates at Master level at (Academic) Universities (approximately 20) is significantly less than graduates at University Colleges. This is due to the fact that there are only two Academic Universities versus six University Colleges offering a surveying degree and the fact that the Master at Universities takes two years compared to only one year at University Colleges in the Flemish part of Belgium.
- Since 2007, the difference in Master duration (two year Master at Universities compared to an only one year Master at University Colleges) in the Flemish part of Belgium has a significant negative influence on the number of students at the Flemish University.
- Moreover, since 2007, the Professional Bachelors are also accepted by the Belgian National "Institute of Surveyors" as full surveyors on the same level as the Masters in Surveying. This has lead to a significant rising of students at Professional Bachelor Institutions and a significant loss of students Surveying at the Master level (fig. 2c).
- In the near future (around 2014) the University Colleges will be integrated into the Universities in Belgium. It is not clear if both the existing 5-year curriculum at Universities, based on Geo-information topics, and the "integrated" 4-year curriculum (from the

“integrated” University Colleges), based on the construction engineering topics, will continue to co-exist in a longer term.

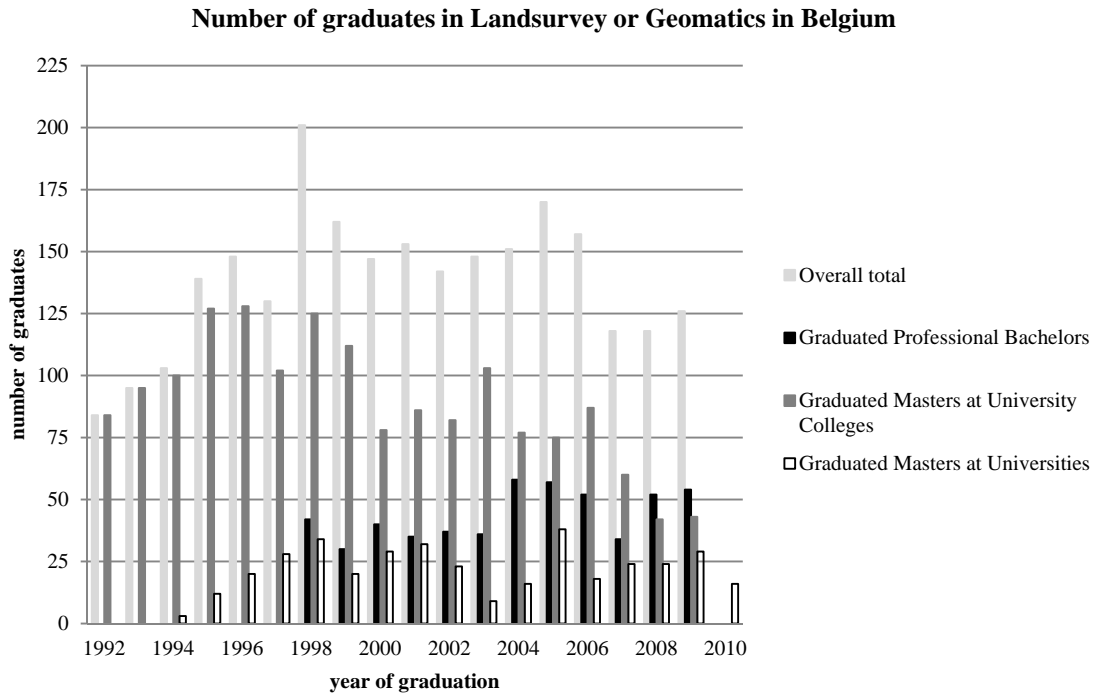


Fig. 2a: The number of graduates (Master) at Academic Universities versus the number of graduates (Master) University Colleges and of Graduated Professional Bachelors (1992-2010) (own research)

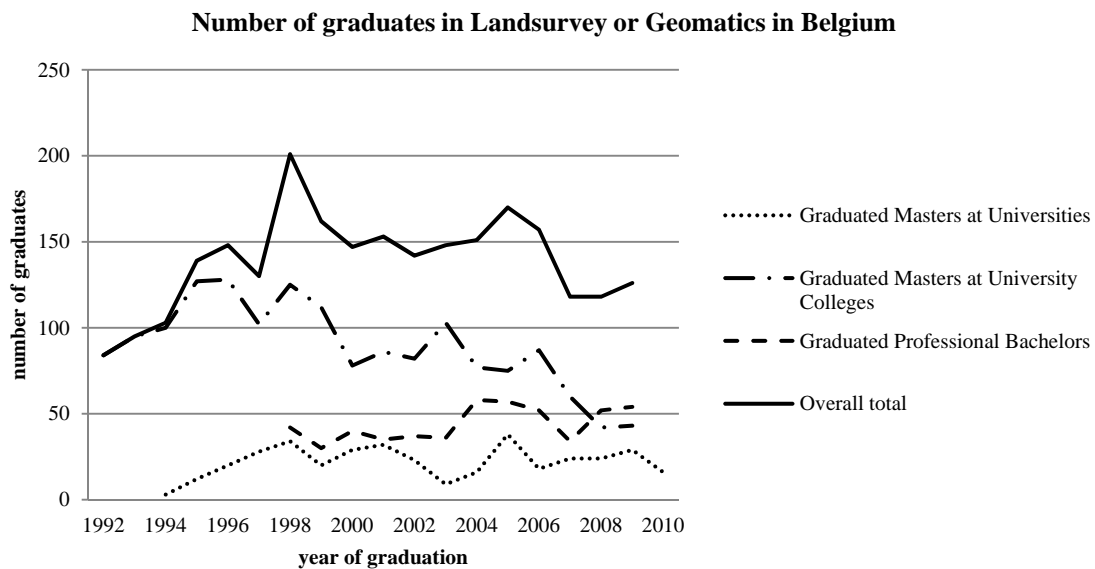


Fig. 2b: The number of graduates (Master) at Academic Universities versus the number of graduates (Master) University Colleges and of Graduated Professional Bachelors (1992-2010) (own research)

Graduates in Landsurvey or Geomatics in Belgium

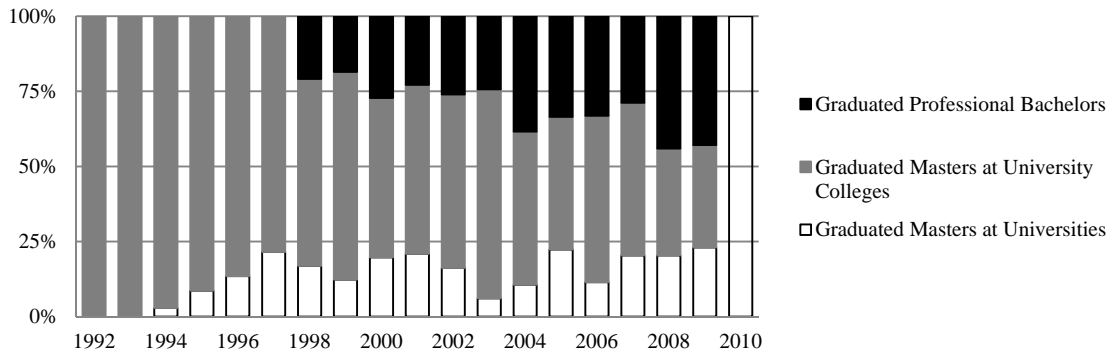


Fig. 2c: The percentages of graduates (Master) at Academic Universities versus the number of graduates (Master) University Colleges and the graduated professional bachelors (1992-2010) (own research)

According to the BaMa philosophy, special attention was paid to the interconnection of the different possible trajectories (Fig. 3). For example, at Ghent University, "Special Programs" of typical 60-90 ECTS points allow the students to combine a broad range of Bachelor programs with a "Master in Geomatics and Surveying" or the inverse.

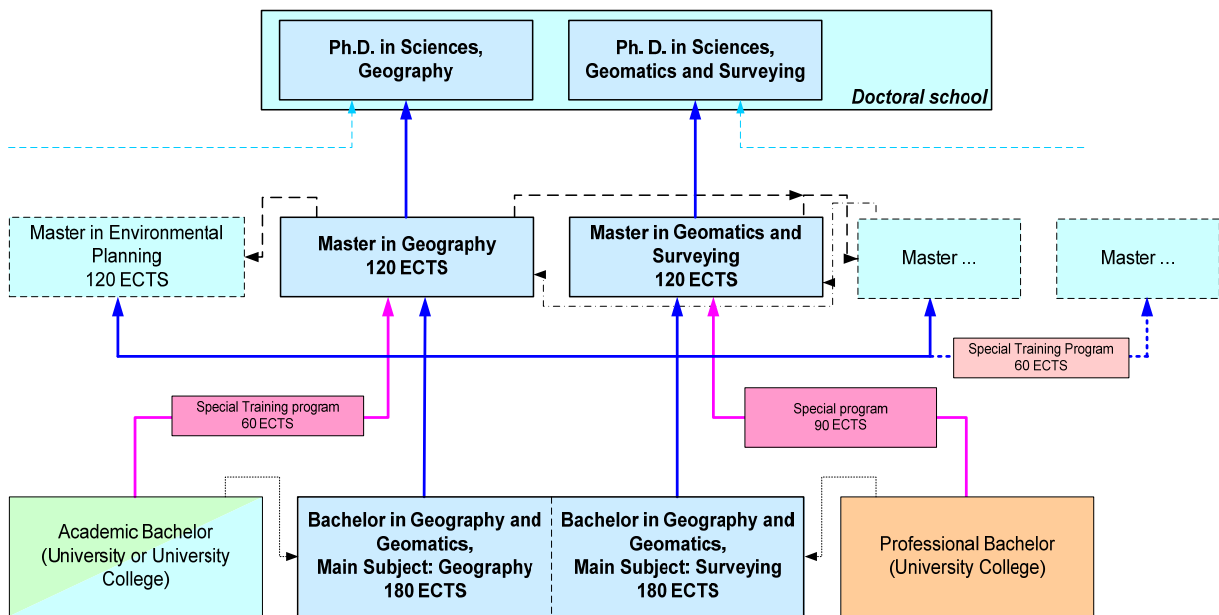


Fig. 3. Interconnection of the different types of Surveying/Geomatics education (referring to Ghent University) (own research)

3. STUDY OBJECTS FOR THE “MASTER IN GEOMATICS AND SURVEYING”

As stated earlier, the old 4-year curriculum "Candidate/Licence in Geography - Main subject: Surveying" was transformed in October 2004 into a "Bachelor in Geography and Geomatics" followed by a "Master in Geography" or a "Master in Geomatics".

The vision that lies at the origin of this program is het FIG definition [6] of a surveyor (23 May 2004):

“A surveyor is a professional person with the academic qualifications and technical expertise to conduct one, or more, of the following activities:

- to determine, measure and represent land, three-dimensional objects, point-fields and trajectories;***
- to assemble and interpret land and geographically related information,***
- to use that information for the planning and efficient administration of the land, the sea and any structures thereon; and,***
- to conduct research into the above practices and to develop them.”***

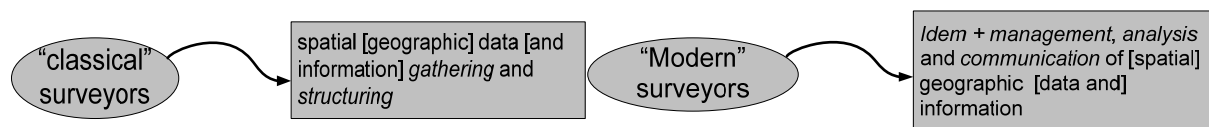


Fig. 4 "Classical " surveyor versus "Modern" surveyor (own research)

The three pillars (data acquisition, information management and real estate (construction, law, value estimations,...)) were used as the basis for the Geomatics program at Ghent University and were worked out even more in the reformed program of 2011 (as decided in November 2010). It is based on the view that a "Modern Surveyor" has to focus not only on data acquisition but also on the analysis, management and communication of spatial and geographic data and information. With other words, the "Modern surveyor" focuses on "Geomatics". Geomatics, as defined by the Canadian Institute of Geomatics ***“is a field of activities which, using a systematic approach, integrates all the means used to acquire and manage spatial data required as part of scientific, administrative, legal and technical operations involved in the process of the production and management of spatial information”***. *Source??*

As generally accepted by EEGECS, Geomatics is closely related to the fields of remote sensing, geodesy, computer sciences, photogrammetry, cartography, law, spatial planning, construction,...

The research field of Geomatics and Surveying is very broad and includes both the localization and identification of objects on the Earths surface as the management of this spatial information in geographic information systems. Also legal aspects relating to property, land administrative law and construction aspects are part of the field of surveying. The master program is based on a strong interdisciplinary and applied science. This applied research is consistent with basic research. Both are also practiced in an integrated manner within the Department of Geography.

Geomatic models and knowledge are used in a wide range of application fields: policy, spatial planning and urban planning, regional development and administrative organization. Several basic and applied disciplines are deepened in the Master of Geomatics and Surveying: geographic information, as well as application-oriented science, topography, bathymetry, photogrammetry, satellite positioning, remote sensing, digital image analysis. But attention also goes to the legal, organizational and geographical context such as register, estimation of real estate, landscape science.

These disciplines are essential in many parts of the knowledge society and have become indispensable in identifying and managing the space surrounding us, especially the property. Graduated Masters in Geomatics and Surveying are highly valued in the labor market because of their broad scientific training, their strong solution training, both on the field and in the office, and their strong time-spatial thinking.

There are many different opportunities for employment, mainly in the world of geographic information processing and management. As a specialized and scientifically trained surveyor, they are also valued for complex measurements. Thus, many graduates are active in bathymetric recordings at home or abroad. Graduates can also become an independent "expert sworn surveyor, estimator of immovable property". Besides a career as a professional surveyor or expert in GIS, in government or in engineering, there are also opportunities in education.

This is reflected in the "Bachelor Geography and Geomatics" program of Ghent University (Fig.6), consisting of two Main Subjects (or options) that can be chosen by the student: either "Main Subject: Geography" or "Main Subject: Geomatics". The latter has to be preferred if the student wants to continue with the "Master in Geomatics and Surveying".

Typically, each year, approximately 30 to 40 students start the first year with "Main Subject: Geography" and approximately 10 to 20 students start the first year with "Main Subject: Geomatics".

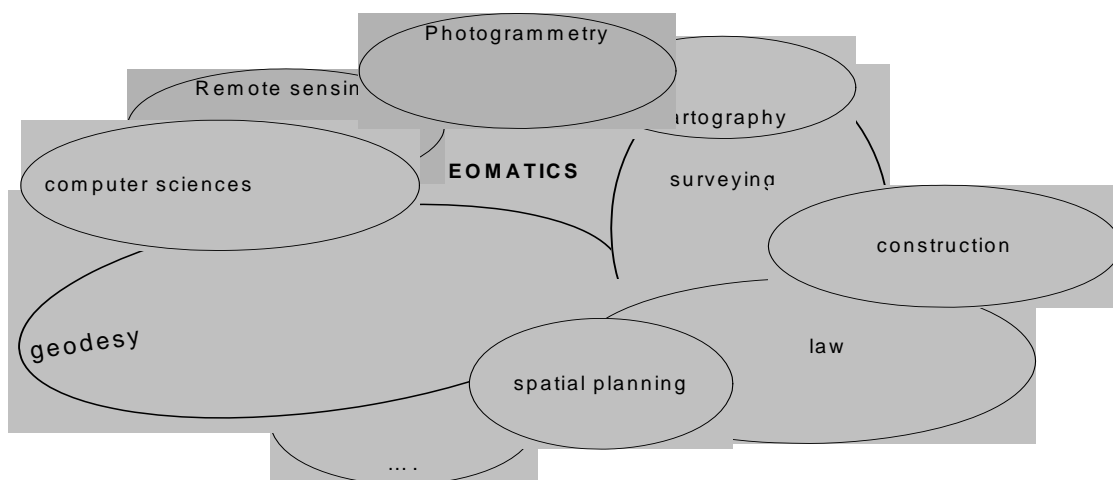


Fig. 5 Interacting disciplines of Geomatics (own research)

In the first year of their education, the difference between both options is non-existent, in the second year ca. 1/2 is different, in the third year almost all courses are different. Typical geomatics subjects as Topometry, Photogrammetry, Cartography, Law are therefore studied in the third year. An outcome to the professional market after the "Bachelor Geography and Geomatics - Main Subject: Geomatics" is theoretically possible, although almost all students continue their studies with a "Master" study, mostly the "Master in Geomatics".

1st Bachelor Geography and Geomatics		2nd Bachelor Geography and Geomatics		3th Bachelor Geography and Geomatics	
GEOGRAPHY	Geomatics	GEOGRAPHY	Geomatics	GEOGRAPHY	Geomatics
MATHEMATICS I 5	MATHEMATICS I 5	INTRODUCTION TO LANDSCAPE SCIENCE 5	INTRODUCTION TO LANDSCAPE SCIENCE 5	SPATIAL ANALYSIS 6	SPATIAL ANALYSIS 6
MATHEMATICS II 5	MATHEMATICS II 5	GEOGRAPHIC INFORMATION SYSTEM 5	GEOGRAPHIC INFORMATION SYSTEM 5	GIT 5	GIT 5
PHYSICS I 5	PHYSICS I 5	REMOTE SENSING 6	REMOTE SENSING 6	BACHELOR DISSERTATION 10	BACHELOR DISSERTATION 10
PHYSICS II 5	PHYSICS II 5	STATISTICS 5	STATISTICS 5	CARTOGRAPHY 5	CARTOGRAPHY 5
INTRODUCTION TO GEOLOGY 5	INTRODUCTION TO GEOLOGY 5	PHILOSOPHY 5	PHILOSOPHY 5	SOIL SCIENCE 4	INTEGRATED EXERCISES 4
CHEMISTRY 5	CHEMISTRY 5	METHODS OF SPATIAL AND REGIONAL RESEARCH 4	METHODS OF SPATIAL AND REGIONAL RESEARCH 4	POPULATION – AND URBAN GEOGRAPHY 5	ADMINISTRATIVE LAW 5
ECONOMICS 5	ECONOMICS 5	SOCIOLOGY 4	DATABASES 6	ECOLOGY 5	PROPERTY LAW 5
INTRODUCTION TO INFORMATICS 5	INTRODUCTION TO INFORMATICS 5	INTRODUCTION TO CLIMATOLOGY AND METEOROLOGY 5	GLOBAL NAVIGATION SATELLITE SYSTEMS 5	QUARTAIR STUDIES 5	PHOTOGRAMMETRY 5
INTRODUCTION TO ENGINEERING SURVEYING 5	INTRODUCTION TO ENGINEERING SURVEYING 5	GEOMORPHOLOGY 5	INTRODUCTION TO LAW 5	LANDSCAPE SCIENCE 6	TOPOMETRY II 5
INTRODUCTION TO SOCIAL AND ECONOMIC GEOGRAPHY 5	INTRODUCTION TO SOCIAL AND ECONOMIC GEOGRAPHY 5	TRANSPORT GEOGRAPHY 5	NUMERICAL MATHEMATICS 5	INTRODUCTION TO HISTORICAL GEOGRAPHY 4	GEOMATICS APPLICATION PROGRAMMING 5
INTRODUCTION TO PHYSICAL GEOGRAPHY 5	INTRODUCTION TO PHYSICAL GEOGRAPHY 5	INTRODUCTION TO MINERALOGY 3	APPLIED INFORMATICS: COMPUTER ASSISTED DESIGN 4	ELECTIVE COURSES 5	ELECTIVE COURSES 5
INTRODUCTION TO GEOMATICS 5	INTRODUCTION TO GEOMATICS 5	INTRODUCTION TO PETROLOGY 3	TOPOMETRY I 5		
		PHYTOLOGY 5			

Fig. 6 New (2012-2013) Bachelor program "Geography and Geomatics" at Ghent University (Belgium). (own research)

Direct access to the "Master in Geomatics and Surveying" is possible for the "Bachelors in Geography and Geomatics - Main subject: Geomatics". Other students, with for example a "Professional Bachelor" or an "Academic Bachelor" can enter the Master after a "Special Program" of 60 to 90 ECTS points. The "Special Program" is tailor-made in function of the Bachelor program the student has followed.

Masterthesis (30)			
(30) Minor a RESEARCH Recommended Subjects	Internet applications (5) Communication networks (6) Historical cartography (5) Geographical Information Science (5) Information management (6) Multimedia techniques (6) Image processing (6) Constructive design and infrastructure (5) Practical Training II (1 month) (5)	Minor b EDUCATION	Minor c ECONOMICS AND BUSINESS ADMINISTRATION
3D- Acquisition and visualisation (5)			
Geographical Information Management (5)			
Over- and underground landregistration (4)			
Juridical instructions concerning Environmental Planning and Urban Development (5)			
House Building Technique, inventory of fixtures and valuation of real estate (5)			
Bathymetry (5)			
Mapprojections and Co-ordinate systems (5)			
Quality of measurements (5)			
Real Estate and Estimation Assessment (5)			
Integrated Geographical Information Applications (7)			
Practical training (1 month) (5)			
Geographical Information Platforms (4)			

Fig. 7: New (2012-2013) Master program "Geomatics and Surveying" at Ghent University (Belgium). (own research)

The Master program consists of 120 ECTS points or two years of study. It consists of three important parts:

- The Master thesis (30 ECTS), usually started in the first year of the Master. The thesis is a monograph with oral presentation and defence at the end of the second Master year.
- A "Minor" program consisting of 30 ECTS points, with three possible options:
 - 1) a "research" minor with a choice of 30 ECTS with a list of "recommended subjects" (these are not compulsory, a student can motivate why he wants to follow other courses).
 - 2) an "education" minor, as a preparation for a later "aggregation" diploma (= licence to teach in secondary schools and some types of higher education schools)
 - 3) an "Economics and business administration" minor with a number of courses focussed on business and economics.
- A "compulsory" program of 60 ECTS points with twelve courses including 5 ECTS points for "Practical training", mainly in private companies during 1 month.

4. COMPARISON OF THE CURRICULA AT UNIVERSITY COLLEGES AND AT ACADEMIC UNIVERSITIES

It is relevant to compare, by categorising in subject classes, the entire Surveying curriculum at University Colleges with the curriculum at Academic Universities (Table 1). For the University Colleges, the "average" course content of the 3+1 year combination of "Bachelor in Applied Engineering Sciences in Construction option Land Surveying" followed by the

"Master in Applied Engineering Sciences in Land Surveying" has been taken into account (based on EEGECS, National Report Belgium)[7]. This is valid for the Flemish part of Belgium only, as the French part has a 3+2 year curriculum at University Colleges. For each of both Academic Universities, Ghent (Flemish) and Liège (French), the results are specified in Table 1. Important differences appear clearly between both Academic Universities. These differences are made possible by a different education policy in the Flemish and French part of Belgium and a high degree of program autonomy for each Education Institution. While the Université de Liège focuses on Geosciences and Geodetic positioning and surveying, Ghent University focuses on Computer Sciences, Statistics, GIS, Cadastre and Law Management. Some geomatic courses are also attended by students of other Master degrees, especially from students of a "Master in Geography" and by some students of a "Master in Archaeology". The University Colleges/Technical Universities, in contrast, focus on Engineering Skills, Economics and Management. The Bachelor and Master thesis are clearly less weighted. More specific "geomatic" topics are less stressed, partly because of the 4-year curriculum (240 ECTS) as compared to the 5-year curriculum (300 ECTS) of the Academic Universities.

Bachelor/Master in Geomatics and Surveying (source: EEGECS, WG1)	Technical Universities	Academic Universities			AVERAGE Academic Universities
		ULg	UGent 2005	UGent 2011	
SUBJECT	AVERAGE University Colleges				
BASIC SCIENCES (mathematics, physics, chemistry)	60	59	25	30	44.5
COMPUTER SCIENCES - CAD	9	20	22	25	22.5
STATISTICS - ADJUSTMENT	4	9	25	11	10
GEOSCIENCES	2	48	21	25	36.5
GEODETIC SURVEYING	13	24	17	20	22
GEODESY - POSITIONING	5	14	10	10	12
PHOTOGRAMMETRY - REMOTE SENSING	2	13	17	11	12
CARTOGRAPHY	2	15	19	15	15
HYDROGRAPHICAL SURVEY	2	0	5	5	2.5
GEOINFORMATION - GIS	4	11	32	31	21
(CIVIL) ENGINEERING SKILLS	68	26	9	10	18
LAND MANAGEMENT	2	10	10	10	10
CADASTRE - LAND LAW	10	7	24	24	15
ECONOMICS - QUALITY MANAGEMENT - ENVIRONMENTAL MANAGEMENT	19	2	8	14	8
PRACTICAL TRAINING - PROJECTS	20	12	20	19	16
BACHELOR + MASTER THESIS	18	30	36	40	35
TOTAL	240	300	300	300	300

Table 1: Comparison between the ECTS granted to the different subjects at Technical Universities and Academic Universities [07]

At Ghent University, in the new 2011 program, computer sciences, geosciences, environmental management and the Bachelor/Master thesis have gained importance. Photogrammetry and Cartography (in the compulsory program) have a slightly reduced ECTS weight. It was felt that this is in accordance to what the market wants and what the visitation commission suggested. It should be stressed that as 30 ECTS are reserved for elective courses, the student can still specialise more on e.g. 3D-acquisition, or Cartography or Informatics.

5. CONCLUSION

In this paper the vision of the Bachelor/Master introduction in Belgium since October 2004 was explained. Important differences in the programs leading to Surveyors that are recognized by the National Institute of Surveyors appear. University Colleges and Academic Universities have undoubtedly different targets, the first focusing on engineering skills (particularly in construction), the latter focusing on geosciences, geomatics and geometrology. Even between both academic universities, important discrepancies arise: while Ghent University pays attention not only to the fundamental and applied geomatics, but also to the professional formation of the independent surveyor, requiring law courses and a lot of project work and practical training, the University of Liège is more centered around geo-information and geosciences. The 2011 tuning of the University programs focuses more on individual choices and stresses the importance of informatics and geo-sciences. The integration of University Colleges in the Universities during 2013-2014 is the coming challenge in the Belgian surveying education context.

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