CURRICULUM OF GEOINFORMATICS – INTEGRATION OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION TECHNOLOGY

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ABSTRACT

This paper describes the development of Geoinformatics at Helsinki University of Technology as an independent curriculum in surveying studies. Geoinformatics includes Geoinformation Technique and Remote Sensing. The goal of this curriculum is to produce graduated students who have knowledge both in vector and raster based geoinformation processing. GIS design and software development, vector based data base management as well as algorithms for analysis and methods of visualization are representatives of the educational contents of Geoinformation Technique. Remote Sensing includes image processing methods, satellite technologies and use of images in different application areas. This paper outlines the structure and contents of this curriculum. We also discuss the need of Geoinformatics as an independent curriculum in the network of university curricula.

1 INTRODUCTION

1.1 BACKGROUND

In most universities the curricula of Remote Sensing (RS) and Geoinformation Technique (GIT) are separated into different laboratories under different professorships. While Remote Sensing is closely related to digital image processing and thus to raster data model of spatial information, most GIT curricula are limited to deal with vector based algorithms, management and analysis.

In practical applications and projects, however, both digital aerial and satellite images and vector format map data are processed and used together. Also most modern software products tend to be able to manage both raster and vector data models and include both digital image processing functions as well as vector functions – the boundary between raster and vector data processing seems to be fading out. It seems at the moment very artificial and also outdated to organize university education separating Remote Sensing and GIT as strongly as it used to be.

The historical development is easy to understand: GIS data modeling and algorithm development was strongly effected by the knowledge of computer graphics and computational geometry while Remote Sensing received the theoretical basis from general image processing. The short history of RS and GIT curricula in most universities is about 10-15 years. During that period courses have been developed and also updated, students have graduated and brought the feedback from the field. The general status is that both GIT and RS experts are needed and not enough produced by the ”university production line”. It seems to be an urgent need to strengthen these curricula and also integrate them into a more compact and competent curriculum of Geoinformatics.

1.2 STATUS OF GEOINFORMATICS

RS and GIT are taught in both surveying and geography departments of universities. Surveying departments seem to have a tendency to modernize their facade by renaming the department or educational program as Geomatics. So we have several new terms like Geomatics, Geoinformatics and Geoinformation Technique, which need to be well defined and then marketed to the students. Continuous discussion is going on for example around the term Geomatics – whether the becoming students will understand it correctly or not. In this article we will deal with the definitions and contents of the new terms.

Geoinformatics as an educational package is a combination of introductory courses on Remote Sensing and Geoinformation Technique: basics of image processing as well as remote sensing technology, introduction to other digital spatial data collection methods like GPS, field measurements and digitizing and scanning of maps; more sophisticated courses on spatial data algorithms and geographical data management, visualization and spatial analysis as well as advanced courses on satellite image interpretation methods. In exercises student both develop algorithms and use RS and GIS software. For example spatial analysis is a field in which image processing and GIS software tools are mixed and used together. It is very good experience for students to realize how same functionality can be achieved by using either image processing software tool or traditional GIS analysis tool.

Geoinformatics is not only for surveying or geography students but recently more and more students from other disciplines like Computer Science, Civil Engineering, Architecture, Geology etc. want to study Geoinformatics (RS + GIT) as their minor or even as their major subject. For that reason it has been most important to develop the contents of Geoinformatics curriculum towards more scientific subject and less being related with traditional surveying and mapping. Students who wish to apply RS and GIS technology in their own problem among landscape design, geology or software development do not want to get profound knowledge on field measurements or printing technology. Geoinformatics as mathematically and computationally oriented subject will mainly concentrate on data modeling and management, analysis and visualization processes and algorithms, spatial statistics and operations research applications, development of geographical information systems (GIS), image interpretation and satellite mapping technology. All this together is very useful in several application fields and must be offered as a compact package on the university curriculum plate.

As an example of the above-described Geoinformatics the curriculum at Helsinki University of Technology, Department of Surveying is introduced. We have been developing this curriculum together with the Institutes of Photogrammetry and Remote Sensing and Geodesy and Cartography. In this article the main contents and structure of the courseware is introduced as well as the latest experiences and feedback on the new curriculum. Geoinformatics has been developed in close connections with other departments like Space Technology, Computer Science and Electronics.

2 THE STRUCTURE OF CURRICULUM OF GEOINFORMATICS

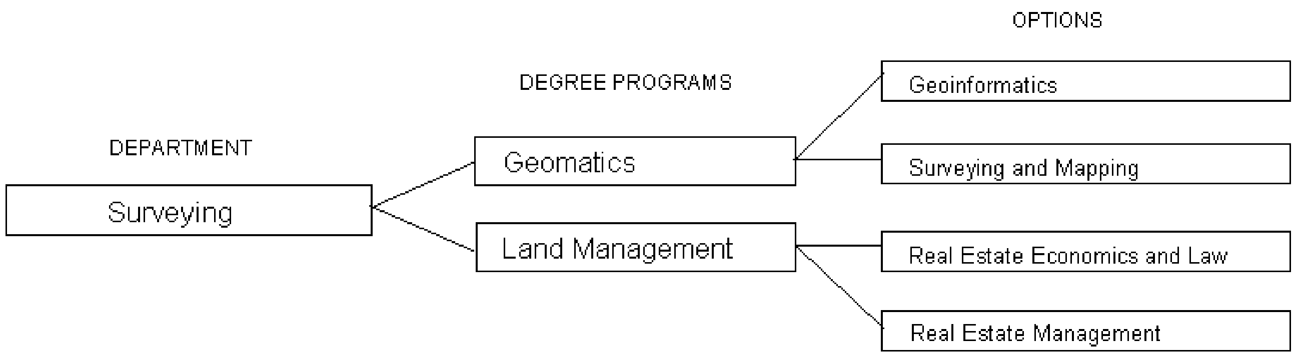

Figure 1. Proposed organization of the Geomatics degree program within the surveying curriculum at Helsinki University of Technology.

The Department of Surveying is divided into two main study programs: Geomatics and land management. Geomatics is divided into two options: Geoinformatics and Surveying and Mapping. In this paper we mainly deal with the curriculum of Geoinformatics but when dealing the majors we give also a brief introduction to the major of Surveying and Mapping.

Table 1. Master's degree 160 credits	
Part I (undergraduate level, engineering sciences and languages)	70
Option (undergraduate level, geomatics)	30
Major (graduate level, geoinformatics)	20
Minor (graduate level, geomatics and engineering)	20
Optional studies and practical training	20
Master's thesis	20

The Master's Degree at Helsinki University of Technology consists of 160 credits (plus diploma thesis of 20 credits) of which the first 70 credits (about the two first study years) consist of general engineering studies like Mathematics, Physics and Information Technology, basic geomatics courses on Geodesy, Photogrammetry, Cartography, Geoinformation Technology and Remote Sensing, Real Estate Management and Law. Languages, introduction to Industrial Management as well as Environmental Protection are included. One credit counts approximately for one week of full studies. (Table 1 and 2)

Table 2. Part I, at least 70 credits		
Mathematics		18
Physics		4
Information science		12
Computer as a tool	1	
Basic course in programming L1	5	
Basic course in programming L2	3	
Data structures and algorithms	3	
Applied mathematics		8
Geomatics		13.5
Basic course in geodesy	4.5	
Fundamentals of photogrammetry	2	
Fundamentals of photo-interpretation and remote sensing	2.5	
Map production techniques	2.5	
Introduction to digital cartography and geoinformatics	2	
General studies		11.5
Real estate economics		
Law		
Industrial management		
Environmental protection		
Languages		3

After the basic studies students have to decide their selection of their major and minor subject and according to the selected subjects they need to study some prerequisites for the option. If they select major in Geoinformatics they have to study more digital image processing and photogrammetric mapping, digital map production, GIS hardware and GIS design. They are also suggested to study - according to their selection of major - some supporting courses like media technology, software engineering, and programming. (Table 3)

Table 3. Option (undergraduate level, Geomatics) 30 credits

Group	Subgroup	Course	Credits	Subgroup credits	Group credits
Geomatics	Geoinformatics	Digital image processing	2,5	11	15
		Fundamentals of microwave remote sensing	2		
		Photogrammetric mapping	2.5		
		Digital map data sets	2		
		Introduction to GIS	3		
		GIS hardware	2		
		GIS design	1,5		
	Surveying and Mapping	GIS-GPS	2	4	
		General photogrammetry	2		
Geoinformatics		Communication			10
		Media technology			
		Content production			
		Software engineering			
		Geoinformation technique			
		Imaging science			
		Remote sensing			
Special assignment within Geoinformatics					5

Both major and minor has to include 20 credits minimum. After the basic studies, prerequisites for major studies the student have ca. 100 credits and in most cases he or she has stayed at the university 3 years.

3. MAJORS IN GEOINFORMATICS AND GEOMATICS

3.1 REMOTE SENSING

The major studies in Remote Sensing consist of following mandatory courses (altogether 13,5 credits): Remote Sensing I and II, Radar Remote Sensing and the seminar. They have to select at least 6 additional credits between some optional courses Estimation and Filtering of Signals, Neural Computing, Radio Engineering, Radar Engineering, and

Visualization of Geographical Information. Remote Sensing I contains theory and practices on statistical pattern recognition, whereas Remote Sensing II contains practical applications of remote sensing. (Table 4)

3.2 GEOINFORMATION TECHNIQUE

The major studies in Geoinformation Technique consist of following mandatory courses (altogether 16,5 credits): Spatial Data Algorithms, Geodata Management, GIS analysis, GRID analysis, GIS-design and GIS-software engineering. They have to select at least 3,5 extra credits between some optional courses like Data Base Management, Knowledge Management, Software Engineering, User Interfaces, Information Technology Law, Linear Programming, Graph Optimization, Project Management, Analytic and Digital Photogrammetry, GPS. Most of the courses give 2-4 credits. (Table 5)

3.3 MAJORS IN SURVEYING AND MAPPING

Surveying and mapping is the other option among Geomatics. Surveying and mapping consists of majors Geodesy, Photogrammetry and Cartography. This educational direction produces graduated students who aim to traditional surveying positions in municipalities and in mapping consultants. The courses of Geoinformatics are of course included in these majors but the emphasis is in the surveying and mapping subject.

Table 4. Major (graduate level, Remote Sensing) 19.5 credits

Remote sensing		13.5
Radar remote sensing	2	
Remote sensing I	4	
Remote sensing II	6	
Seminar on photogrammetry, photo-interpretation and remote sensing	1.5	
Optional courses		6
Principles of pattern recognition	2.5	
Estimation and filtering of signals	2.5	
Principles of neural computing	2.5	
Radio engineering	3	
Radar engineering	2	
Visualization of geographical information	3	

Table 5. Major (graduate level, Geoinformation Technique) 20 credits

Course	Credits	Total
Geoinformation technique		16.5
Spatial data algorithms	3	
Geographical data management	3	
GIS analysis	2	
Grid analysis	2	
GIS design	1.5	
GIS-software engineering	5	
Optional courses		3.5
Data base management	3	
Knowledge management	4	
Software engineering	3	
User interfaces	4	
Information technology law		
Linear programming	3	
Graph optimization	2-4	
Project management	2	
Analytical photogrammetry	2.5	
Digital photogrammetry I	2.5	
GPS positioning	2	

4. NETWORKING WITH OTHER CURRICULA AND DEPARTMENTS

The curriculum of Geoinformatics is mainly planned for surveyors to be combined with studies of Geodesy, Cartography, Photogrammetry or majors from Real Estate Economics study program. We also want to emphasize networking with other departments. For example students with basic education in Information Technology can take Geoinformation Technique or Remote Sensing as their major or minor. This requires, however, that we must plan the basic studies to be compatible with basic studies at the Department of Computer Science. This has been one of our planning ideas and reasons for the renewal of the structure of studies.

Networking is possible to the other direction too: surveyor student should be able to select his/her major at the Department of Computer Science or Electronics. An unofficial agreement on this kind of networking has already been made between professorships.

5. CONCLUSIONS

A university curriculum seems to be in transition and surveying curricula does not make an exception. Of course, not only curricula contents but also teaching and learning methods are changing. All international associations who have a commission on education surely have a working group on distance learning and virtual academies. The authors of this paper are involved with FIG, ICA and ISPRS and all of them seem to work for virtual academy. However, also the contents should be updated and this paper is on that topic. We really believe that graduated students with strong knowledge on Geoinformation Technique and Remote Sensing added with proper amount of Mathematics and Information Technology are for sure the surveyors of the future. Biggest need seems to be in the field on this type of experts.

The integrated and networked education gives also better abilities for young researchers. Most research topics today are IT-related and based on utilization of mathematics. The curriculum of Geoinformatics gives better possibilities to achieve research-oriented studies already during the basic education.

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