

# **CARTOGRAPHY IN UNIVERSITY EDUCATIONAL PROGRAM**

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## Abstract

Cartography as a scientific and educational subject in universities is in a crisis in many countries. The development of digital technology has introduced new fields like Geoinformatics/Geoinformation Science and even some academics seem to think that Cartography is something old fashioned and as a university curriculum can be replaced or at least included in Geoinformatics or GIS. In this paper the emphasis is in the opinion that Cartography educational programs should be strengthened. The need for cartographic knowledge is all the time increasing. However, the contents of the curriculum should be carefully designed and the educational goal consciously defined. Cartography curriculum should be developed – not overlapping but parallel – with the curriculum of Geoinformatics.

As an example of educational program in Cartography the curriculum of Cartography and Geoinformatics at Helsinki University of Technology is introduced. Cartography and Geoinformatics are both individual majors and their educational contents are different. Because the teaching environment is Technical University the difference is even more clear. However, it shows that Cartography has contents enough to be an individual subject and field of science and a clear difference between Cartography and Geoinformatics can and should be recognized.

## Introduction

Modern cartography is a technical subject but includes creative design and communication aspects. It is easy to compare modern cartography to new media – both require technical and creative skills - also in the education these both should be represented.

If we compare Cartography to Geoinformatics the difference is clear. Geoinformatics is applied information technology where the main emphasis is in GIS design and implementation. Of course user interfaces and maps used in the applications make links to Cartography, but the majority of the substance in Geoinformatics is in the

technology: analysis, data management, data collection and of course a lot of Internet and mobile technology.

Cartography has clear main subjects: map production in general, generalization, special cartographic problems like name placement with their algorithms, coordinate systems and projections, web map design, screen map design, printed map design, topographic and thematic maps, colours on maps, typography. Also more and more important is to recognize the style of the map as a part of a multimedia or other information system. Human spatial behaviour and social questions are raised as new challenges.

Cartographic students must learn modern technology, but they are users of cartographic applications. Cartographic students are not GIS technicians nor programmers – for those purposes we have GIS engineers. Cartography is a modern tool for communication and map reading skill becomes more and more important in the visual world. The difference between educational goals of GIS users, GIS developers and GIS engineers has been described more in (Artimo, 1992).

In Helsinki Technical University, Department of Surveying we have taught both Cartography and Geoinformatics for twenty years. During those years the development of the curriculum has passed several phases. The need for Cartography educational program was first recognized among Photogrammetry and Geodesy, some courses were organized on Topographic Mapping and Thematic Cartography as well as an elementary course of Cartographic production. In the late 70's when digital production took the first steps the need for more advanced teaching contents was realized. The first course on Computer Assisted Cartography was established in 1980. Since that the amount of course has increased so that today we have an educational package with two majors, Cartography and Geoinformation Technology with altogether twenty courses. In this article the contents of the curriculum of Cartography is introduced and compared to the "sister" curriculum of Geoinformation Technology.

#### General structure of the Master's program at HUT

In Helsinki University of Technology the masters program lasts for four years plus masters thesis project, altogether 180 credits. Teaching is organized in fall and spring terms, fall term includes 11 weeks, spring term 13 weeks of teaching. Typical course lasts for one term and gives in average two-three credits. Both lectures and exercises are included, the tendency is towards interactive learning as well as use of e-learning tools (Virrantaus,2000). We offer less traditional lectures and more individual project works and studio sessions. Our recently re-organized educational program at Department of Surveying is described in (Virrantaus & Haggrén, 2000).

## Educational goals in Cartography

The main goal in Cartography studies is **to learn the cartographic design and production process whatever the medium is, paper, workstation screen, Internet terminal or smart phone of personal trusted assistant.**

Then main problem is the representation of geospatial data – in most cases in visible, but also audible form. The main educational goal is to teach *:cartographic, aesthetic design, management of human visual perception process, combination of maps and other graphic images.*

Other important core topics of the Cartography curriculum for engineers are:

- technical production process,*
- generalization, name placement and other problems in computational cartography,*
- map digitising and scanning,*
- traditional printing and digital printing and other output techniques,*
- management of colours,*
- typography,*
- creative design, manual drawing,*
- team work, discussion groups and writing.*

The creative part is emphasized here very strongly. The artistic part of Cartography gets more space in the educational program now when the technology is a mature tool and does not take the main role in Cartographers' education. – For the technical problems and development there is another group of professionals, graduated from Geoinformatoics/Geoinformation Technology.

One special area where Cartography students are especially taught information technology is *Internet cartography*. Maps are already in a big role in various Internet applications. In order to make cartographers able to co-operate in the Web –projects they need to know the basic technology. Maps are not images as other visual material in the Internet. Maps are geospatial data and their use as well as presentation needs professional knowledge and skill. Mobile terminals bring the most recent challenge for cartographers – from presentation to real time generalization.

## Educational goals of Geoinformation Technology

The primary goal in the educational program of Geoinformation Technology (GT) is ***to learn how to design and implement Geographical Information Systems in various application areas.***

Geoinformation Tehcnology is applied Information Tehcnology as such and students have to study a lot of pure IT courses (Virrantaus, 2000) in addition to the courses on Geoinformation Science. The most important basic topics from IT are of course:

- programming,
- data structures and algorithms,
- information system design,
- data base management systems and
- user interfaces.

Applied courses on geospatial data processing are on the following topics:

- spatial data algorithms,
- geographical data management,
- GIS analysis,
- GIS system architecture,
- GIS design and implementation, customisation.

The analysis of users' requirements and user oriented system design are the main approach. *Object oriented programming, Java language and Internet – applications* are the recent keywords also in education. Knowledge based systems design and other computational fields like modelling, statistics, neural networks, fuzzy modelling, fractal modelling, genetic programming make an important new contents called GeoComputation (Openshaw & Abrahart, 2000).

#### Common topics in Cartography and Geoinformation Technology curricula

Cartography and Geoinformation Tehcnology have, of course, some overlap in the curricula contents. In our example from Helsinki University of Technology, Department of Surveying the overlap is in the basic courses, mainly in the 1<sup>st</sup> and 2<sup>nd</sup> year studies. The common topics which can not be avoided whenever the question is about geospatial data are:

- introduction to Cartography and Geoinformatics,
- introduction to theories and techniques in Geoinformatics,
- GIS design and GIS architectures,
- geographical data administration and map production processes in principal.

Also in both curricula the students have to learn:

- basic courses in programming and computer use,
- basic courses in mathematics,
- basic courses in surveying and mapping (photogrammetry, remote sensing, geodesy and positioning and navigation)
- languages
- basic courses in law and real estate techniques
- basic courses in economics

-project work and communication.

Especially geodesy courses on projections and coordinate systems as well as reference systems are important for both Cartography and Geoinformation technology students.

By viewing the course list in the Appendix 1 one can see that these overlaps between Cartography and Geoinformation technology happen during the 1<sup>st</sup> ad 2<sup>nd</sup> study year. In major studies there is not overlap – no common courses.

## Conclusion

Our experiences about having two distinct major programs, Cartography and Geoinformation Technology, are very promising. We have enough students for both programs and especially Cartography students are better profiled and motivated than before. When a student selects Cartography instead of Geoinformation Technology (or vice versa) he or she knows exactly what the topic is. Cartography students are going to learn how to produce professional maps in all media. They learn also about printing technology and artistic design. They use computers, but they are GIS users, not engineers who design and implement GIS systems. Programming and other technical matters are taught for Geoinformation Technology students – students of GT often come also from other departments like Information Technology, Civil Engineering or even Geography or Forestry.

We wish that in the future Cartography will be of interest to students from other “design” fields like Graphic design, Multimedia design. Cartography certainly is more than the “contents” for example in the new media products. Internet and mobile systems make a new challenge for cartographers, both in research and practice. Maps will get new dimensions and new audience, the revolution is much stronger than was the coming of the screen map. Now it really is the time for cartographers to show their skills and the power of maps.

## References

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## APPENDIX 1

### **COURSES FOR BOTH CARTOGRAPHY AND GEOINFORMATION TECHNIQUE – THE FIRST, SECOND AND THIRD STUDY YEAR**

#### **Maa-123.110 Introduction to Cartography and Geoinformatics (2 cr)**

spring term, 24 hours lectures

Status: The course belongs to the part 1 of the degree and should be listened during the 1<sup>st</sup> year of studies.

Contents: Introduction to digital techniques in data collection, management and visualization. Conceptual and theoretical basics of cartography. Introduction to Geoinformatics and GI

#### **Maa-123.210 Cartographic Production (2.5 cr)**

fall term, 24 hourse lectures

Status: This course belongs to the mandatory studies for the degree. It should be listened during the 2<sup>nd</sup> study year.

Contents: Introduction to cartographic design and production. Printing colours. History of cartography. Finnish topographic maps.

#### **Maa-123.220 Geographic Data Administration (2 cr)**

spring term, 24 hours lectures

Status: The course is mandatory for the degree, the 2<sup>nd</sup> year of studies.

Contents: The themes of the course: metadata descriptions, quality factors, data collection processes and quality control, pricing of data, copyright, products and product development, cartographic quality. An exercise work is made on defining suitable data sets for specified projects, in the exercise students use the web-based metadata services.

#### **Maa-123.310 Theories and Techniques in Geoinformatics (3 cr)**

fall term, three modules, partly virtual course

Status: The course belongs to the mandatory courses in Geomatics and should be listened during the 3<sup>rd</sup> of studies.

Contents: Theoretical and technical basics of Geoinformatics and GIS are introduced. GIS as an information system and its design process. GIS analysis methods and approaches.

Standardization.

#### **Maa-123.320 GIS Architectures (2 cr)**

fall term, 20 hours lectures

Status: The course belongs to the mandatory courses in Geoinformatics and should be listened during the 3<sup>rd</sup> study year.

Contents: The course introduces students to the data collection equipment from map digitizing to positioning, data output and publishing devices, networks, computers. MobileGIS equipment and architecture is one of the recent new topic in the course. An exercise work is made on selection of a hardware configuration to a specified purpose.

#### **Maa-123.433 GIS Design (1,5 cr)**

Spring term, studio course

Status: The course belongs in the studies of the sections of Geoinformatics as mandatory and of Surveying and Mapping as optional, should be listened during the 3<sup>rd</sup> year of studies.

Contents: The course gives an intensive “squeezed” package on the methods and processes on GIS design, especially on the feasibility study with alternative solutions and their evaluation.

## **COURSES FOR GEOINFORMATION TECHNIQUE STUDENTS**

### **Maa-123.340 Spatial Data Algorithms (3 cr)**

spring term, studio course

Status: The course belongs to the major studies of Geoinformation technique, should be listened during the 3<sup>rd</sup> year of studies

Contents: The course introduces basic spatial operations as well as application oriented problem solutions in the field of spatial data handling in general, GIS analysis and visualization digital cartography as well as other application areas. To pass the course the student has to take part into the studio sessions, pass the exam and also make a programming exercise: either by using C++, Java or other accepted language.

### **Maa-123.373 Geographical Data Management (3 cr)**

fall term, 26 hours lectures

Status: The course belongs to the major of Geoinformation technique, during the 4<sup>th</sup> year of studies

Contents: The course gives an introduction to the theory and practical implementations of GDM. The special problems of spatial data are: 3D and 4D data, data quality, vector- and raster data models, long transactions and version management, large data bases. The modern practical solutions in software on the market: tailored solutions, the use of standard RDBMS's as well as hybrid systems, spatial data engines and spatial versions of RDBMS. An exercise work on the design and implementation of a SRDB.

### **Maa-123.420 GIS Analysis (2 cr)**

fall term, 26 hours lectures

Status: The course belongs to the major in Geoinformation technique and should be listened during the 4<sup>th</sup> year of studies.

Contents: The course introduces to GIS analysis operations, functions and applications. Graph data, raster data, polygon data and point set data are analysed by different methods and also by using different software. GIS analysis design and applications.

### **Maa-123.450 Grid-analysis (2cr)**

spring term, 20 project work

Status: The course belongs to the major in Geoinformation technique as mandatory and it should be listened during the 4<sup>th</sup> study year.

Contents: Grid-analysis is an exercise course in which students learn to program GIS-analysis applications by using map algebra-based professional platform. The course is organized as a studio course and will take place in mid spring term.

### **Maa-123.470 GIS software engineering (5 cr)**

fall and spring, project work

Status: The course belongs to the major in Geoinformation technique, should be listened during the 4<sup>th</sup> study year.

Contents: Students design and implement a GIS application in a working team. In the work programming abilities as well as knowledge about database management is required.

### **Maa-123.520 Special assignment in Geoinformation technique**

Contents: Student makes a research paper or other study on a specific topic in Geoinformation technique.

### **Maa-123.610 Postgraduate Seminar in Geoinformatics (1-4 cr), L,V**

Contents: Organized together with postgraduate students and visiting lecturers. Includes research topics of students as well as other interesting projects. Organized according to a special agreement.

**Maa-123.620 Postgraduate Course in Geoinformatics (1-4 cr), L,V**

Contents: Lectures on special actual research topics in the field of geoinformatics. Organized according to a special agreement. Visiting lecturers.

**COURSES FOR CARTOGRAPHY STUDENTS**

**Maa-123.350 Computational Cartography (2cr)**

spring term, studio course

Status: The course belongs to the major in Cartography, it should be listened during the 3<sup>rd</sup> study year.

Contents: The course introduces the most important mathematical methods and computational algorithms in cartography. Cartographic generalization, contour smoothing, name placement, transformations.

**Maa-123. 430 Visualization of Geographic Information (3 cr)**

fall term, 24 hours lectures

Status: The course belongs to the major in Cartography as mandatory and Geoinformation techniques as optional, should be listened during the 4<sup>th</sup> year of studies.

Contents: The course provides the knowledge necessary for producing informative and aesthetically high quality maps. Different types of statistical thematic maps are introduced as well as the modern digital map types. Practical training in using some software is included as well as graphical design exercises.

**Maa-123.440 WebTopGIS (3)**

Spring course, 20 hours lectures

Status: The course belongs to the major in Cartography as mandatory and Geoinformation technique as optional, should be listened during the 4<sup>th</sup> study year.

Contents: The course introduces to the technologies of implementing map and GIS applications for internet including virtual models and animations. Standardization, software products and cases are treated.

**Maa-123.460 Topographic Maps (3 cr)**

spring term, 24 hours lectures

Status: The course belongs to the major in Cartography, should be listened during the 4<sup>th</sup> year of studies.

Contents: The course gives more advanced approach to topographic map presentation as well as in some special questions like generalization, multi scale presentations and databases and the use of geomorphological knowledge in mapping. Thematic topographic maps (soil maps and nautical charts) are also dealt with. The history of cartographic presentation is dealt with.

**Maa-123.513 Development of a Cartographic Information System (3 cr)**

fall and spring, project work

Status: The course belongs to the major in Cartography, should be listened during the 4<sup>th</sup> study year.

Contents: In the course students learn how to design and implement a cartographic information system on the top of commercial software platforms. Team work, software development tools, project management.

**Maa-123.510 Current topics on Cartography (2 cr)**

Contents: Current topics in Cartography. Visiting lecturers. Themes and schedules are given when the course is organized. Potential topics: map generalization, geomorphology in mapping.

**Maa-123.530 Special assignment in Cartography**

Contents: Student makes a research paper or other study on a specific topic in Cartography.