

**TEACHING AND RESEARCH ACTIVITIES IN CARTOGRAPHY UNDER  
FACULTY OF RURAL AND SURVEYING ENGINEERING OF THE  
NATIONAL TECHNICAL UNIVERSITY OF ATHENS**

B. Filippakopoulou, M. Kavouras, B. Nakos and L. Tsoulos

Department of Surveying, National Technical University of Athens

**ABSTRACT**

The Faculty of Rural and Surveying Engineering at the NTUA offers a diploma in engineering (equivalent to a MSc degree), after a five-year program of studies, including the implementation of a diploma thesis. At the beginning of the academic year 1998-1999, a new program of two years graduate studies in Geomatics was introduced. According to this program, graduate level courses are offered for a period of three semesters and during the fourth semester the graduate students are working on a thesis. The introduction of the new program was a direct response to the evident needs of the national developing projects for graduates with a wide knowledge and understanding of GIS and their applications in Geo-Sciences. The Faculty is also offering PhD degrees after research oriented studies.

In this presentation the philosophy, the objectives and the various cognitive aspects of the educational program are briefly stated and the role and importance of cartography is analysed. The curriculum contents of the cartographic courses and their impact on the profile of the studies are presented in detail. Of main importance are the students' topic theses relevant to cartography, which are also presented. Finally the research interests of the Faculty members and the graduate students working in the area cartography are discussed and the research cartographic projects and the dissertations topics are briefly mentioned.

**1. A brief introduction to the educational program of the Faculty of Surveying and Rural Engineering**

The Faculty of Rural and Surveying Engineering at the NTUA offers a diploma in engineering after a five-year program of studies, including the implementation of a thesis. The Faculty is divided into three departments:

- The Department of Surveying,
- The Department of Geography and Regional Planning,
- The Department of Rural Technology and Development.

The three departments cover relevant topics of scientific and engineering fields, by offering taught Diploma courses and PhD degrees by research. A new program of graduate studies in Geomatics was introduced in the academic year 1998-1999, offering graduate level courses for one and a half years and the implementation of a thesis. The graduate students attending the program receive a diploma in Geomatics.

*1.1 Objectives of the Department of Surveying*

The prime objectives of the educational program of the Department of Surveying are to provide the following:

- Exposure of students to the entire scope of career opportunities in the surveying field.

- Introductory and advanced courses in geodetic sciences, photogrammetry, cartography and remote sensing.
- Skills in handling spatially referenced data and an understanding of the concepts involved.
- Appreciation of data quality.
- Understanding of the basic principles of GIS.

### *1.2 Objectives of the Department of Geography and Regional Planning*

The prime objectives of the educational program of the Department of Geography and Regional Planning are to provide the following:

- An understanding of the spatial information sciences.
- Exposure of students to the methods and technics applied to the analysis and processing of the qualitative and quantitative characteristics of spatial phenomena.
- An appreciation of data and information quality within a GIS framework.

### *1.3 Objectives of the Department of Infrastructure and Agricultural Development*

The prime objectives of the educational program of the Department of Infrastructure and Agricultural Development are to provide the following:

- Exposure of students to the design / construction methods and technics of road and hydraulic works for the development of rural areas.

During the first two years of their studies, the students are taking obligatory courses offered by the three departments. At the same time they are attending courses in Mathematics, Physics, Computer Sciences and Social Sciences, given by other faculties of the NTUA. During the third, fourth and the first half of the fifth year, the students are taking elective courses from Surveying Department and from one out of the other two Departments of the Faculty. Through the implementation of the diploma thesis, which lasts the last half year of their studies, the students achieve competence in research methodology, research implementation, and report writing.

## **2. Cartography Courses**

### *2.1 Objectives*

The prime objectives of the taught courses in the area of cartography are to provide the following:

- Exposure of students to the basic elements of cartography.
- Skills in handling spatial data, by means of transformation, processing, manipulation, analysis, storage, and visualisation on a computer screen or on a paper, in a form of a map.

### *2.2 Diploma Cartographic Courses*

There are four taught cartography courses in the Department at the diploma level, structured to meet the objectives of the Surveying Department and give the essential knowledge to support the implementations of the courses offered by the other two Departments. The curriculum of the cartography courses is as follows:

#### *2.2.1 General Cartography*

Introduction to Cartography

- The Nature of Cartography
- The History of Cartography
- Map Classification
- Technology in Mapping

Data Collection and Manipulation

- Data Sources

- Data Collection Methods

### Theoretical Principles of Cartography and Cartographic Practice

- Principles of Map Projections
- Generalisation
- Principles of Cartographic Design
- Principles of Graphic Perception
- Symbolisation Methods
- Lettering the Map

Portraying the Land-Surface Form

Map Production and Reproduction

Map Reading,

Maps of Greece

### 2.2.2 *Thematic Cartography*

Introduction to Thematic Maps

- Spatial Data and Thematic Mapping
- Cartographic Principles and Thematic Mapping

Thematic Data

- Data Sources
- Locational Aspects of Data Collection
- Simplification and Classification Processes
- Statistical Measurements

Base Map in Thematic Mapping

- Mapping the Landform

Methods of Symbolisation

- Symbolising Qualitative Data
- Symbolising Quantitative Data
- Portraying Combined Data to Show Relations
- Graphs and Diagrams

Map Composition

- Choice of Scale
- Choice of Projection
- Map Layout
- Base Map Characteristics
- Map Legend
- Lettering the Map

Atlases

- National and Regional Atlases
- School Atlases
- Special Purpose Atlases
- Electronic Atlases
- Multimedia and Thematic Maps

### 2.2.3 *Analytical Cartography*

Part 1. **Mathematical Cartography**

Mapping the Earth

- Spheroid, Ellipsoid
- Coordinate Systems
- Principles of Map Projections
- Deformations in Map Projections

- Types of Map Projections

#### Map Projection Systems in Greek Maps

- Hatt Projection
- Mercator Projection
- UTM
- TM (3°)
- Greek Geodetic Reference System (GGRS 87)

#### Part 2. **Analytical Cartography**

##### Map Projection Transformations

##### Measurements in Mapping

- Measuring Lines
- Measuring Areas
- Measuring Angles
- Errors in Map Measurements

##### Interpolation Methods

- One-dimensional Interpolation
- Two-dimensional Interpolation
- Digital Terrain Models – Applications

##### Data Smoothing

##### Hill Shading Algorithms

##### Geometric Transformations

- Similarity Transformation
- Affine Transformation
- Projective Transformation

##### Transformations of Cartographic Objects

- Points and Lines
- Polygons
- Data Structures
- Generalisation

#### *2.2.4 Digital Cartography*

##### Introduction

##### Data Structures

- Vector Data
- Raster Data - Compression
- Raster to Vector

##### Data Collection

- Manual and Automated Digitisation
- Editing

##### Cartographic Data Base Design

- User Needs Assessment
- Logical Design
- Normalisation
- Physical Design
- Cartographic Libraries
- Cartographic Data Bases Networks
- Accuracy and Error in Cartographic Data Bases

##### Algorithms for Map Generalisation

- Geometric Algorithms for Simplification
- Knowledge Based Generalisation

## Methods of Data Representation

- Digital Mapping of Cartographic Phenomena
- The Concept of Color and the Display of Computer
- Color Separation
- Multi-media and Cartographic Applications
- Electronic Map-Atlas

## Data Exchange Standards

### *2.3 Graduate Cartographic Courses*

Cartography is of main interest in the Geoinformatics graduate program of the Faculty. There are some cartographic topics covered within the basic course given by the title “PROCESSING, ANALYSING AND REPRESENTING SPATIAL DATA”, and two pure cartographic elective courses having a curriculum as follows:

#### *2.3.1 Special Topics In Cartography*

Visual Perception

Visual Cognition and Visual Memory

Visual Perception and Maps

Elements of Graphic Semiology and Optical Variables

The Cartographic Symbols

The Color in Cartography

Methods of Representing Thematic Data

Cognitive Cartography – Design and Reading Maps

#### *2.3.2 Analytical And Digital Methods In Cartography*

Map Data Structure

Dynamic Mapping and Multi-Media

The Color in Digital Mapping

Cartographic Interpolation

Analytical Methods of Shading

Generalisation

Data Classification

Thematic Representations

## **3. Research**

### *3.1 Theses Topics*

Of special interest are the projects done by the students who work for their thesis in the field of cartography, covering all the above mentioned areas. A list of theses topics carried out lately, indicating the areas of interest, is given below.

- Design of a national atlas of Greece using GIS technology.
  - Part 1. Atlas of the physical environment.
  - Part 2. The demographic atlas.
  - Part 3. The industrial atlas.
  - Part 4. The atlas of education.
- Design of special purpose atlases.
- Design of digital tourist maps.
- Cartography and primary school children.
- Software development for the creation of electronic atlases.
- Cartographic generalization of point and area symbols.

- Digital techniques for hill shading.
- Algorithms for the determination of optimal paths in linear networks.
- Digital image processing for cartographic applications (R to V conversion).
- Road network management using GIS technology.
- Algorithm for computing equidistant lines.
- Zoning methods on socio-economic data.
- Digital archiving of historic maps.

### *3.2 Dissertations Topics*

The graduate students working on a PhD in cartography at the present time, are covering the following topics of research:

- Maps for children
- Spatio-temporal modeling
- Map accuracy
- Cartographic expert systems
- 3-D visualisation
- Cartographic visualisation

### *3.3 Research Projects*

The Faculty members working in the area of cartography have participated in the analysis and implementation of the following research projects:

- The development of wave energy resource atlas in Europe with pc Arc/Info.
- Design of symbols for town planning.
- A comprehensive study of hydro-aquistic elements of Aegean Sea-Amphitritie.
- A GIS application for the road network of the Municipality of Athens.
- Greek national road network databank.
- Gisco cartography

### *3.4 Interest For Future Research*

Interest for future research is focused on the following topics:

- Cartographic generalisation.
- Fractal geometry applications in cartography.
- Map visualisation.
- Hill shading.
- Visual perception.
- Human-computer interaction in terrain visualisation.
- Cultural and social aspects in special purpose mapping.
- Study of historical data in old maps of Greece.
- Mapping archaeological data using GIS technology.
- Electronic atlases and electronic charts.
- Three dimensional modelling in geoscientific applications.
- Database design.
- Modelling of objects with undetermined boundaries.
- Accuracy issues of spatial data bases.
- Integrated solutions utilising GIS tools.