

**S. Peters** ▶ Technische Universität München (TUM), Arcisstraße 21, 80333 München, [stefan.peters@bv.tu-muenchen.de](mailto:stefan.peters@bv.tu-muenchen.de)  
**J.M. Krisp** ▶ Technische Universität München (TUM), Arcisstraße 21, 80333 München, [jukka.krisp@bv.tu-muenchen.de](mailto:jukka.krisp@bv.tu-muenchen.de)  
**L. Meng** ▶ Technische Universität München (TUM), Arcisstraße 21, 80333 München, [liju.meng@bv.tu-muenchen.de](mailto:liju.meng@bv.tu-muenchen.de)



# EDUCATION PAPER: DEVELOPMENT OF AN INTERNATIONAL MASTER PROGRAM IN CARTOGRAPHY AND GEOINFORMATICS

## ABSTRACT

THE ONGOING TECHNOLOGICAL DEVELOPMENT SINCE THE INTRODUCTION OF COMPUTERIZED DATA PROCESSING AND INCREASED ACCESS TO THE INTERNET HAS INCREASINGLY BLURRED THE BOUNDARIES AMONG THE INDIVIDUAL DISCIPLINES IN THE GEO-SCIENCES. AS A CONSEQUENCE, SOME TRADITIONALLY INTERDISCIPLINARY AREAS, SUCH AS GEOINFORMATICS AND CARTOGRAPHY, HAVE BECOME PARTICULARLY ACTIVE OR PARTLY REVITALIZED. IN THIS PAPER WE DOCUMENT THE ESTABLISHMENT OF A NEW COOPERATIVE INTERNATIONAL MASTER PROGRAM IN "CARTOGRAPHY AND GEOINFORMATICS". WITH A COOPERATION OF 3 TECHNICAL UNIVERSITIES, TU MÜNCHEN, TU DRESDEN (GERMANY) AND TU WIEN (AUSTRIA), THE PROGRAM HOLDS UNIQUE FEATURES. THE PROGRAM IS ROOTED IN THE TRADITIONAL GERMAN OR AUSTRIAN DIPLOMA PROGRAM "GEODESY AND GEOINFORMATION", BUT IT HAS BEEN PROGRESSIVELY RESHAPED AS INTERDISCIPLINARY AND NON-CONSECUTIVE MASTER PROGRAM. THE CURRICULUM OF "CARTOGRAPHY AND GEOINFORMATICS" INCORPORATES AND HIGHLIGHTS THE METHODS AND APPLICATIONS IN SPATIAL DATA MODELING, ANALYSIS AND VISUALIZATION OF GEOGRAPHIC INFORMATION. ADDITIONALLY THIS PAPER RELATES TO THE EUROPEAN EDUCATION REFORM WITH THE BOLOGNA DECLARATION ISSUED IN 1999. THE DECLARATION AIMS AT MAKING EUROPEAN HIGHER EDUCATION MORE COMPATIBLE, COMPETITIVE AND ATTRACTIVE FOR STUDENTS FROM EUROPEAN COUNTRIES AND OTHER CONTINENTS.

## KEYWORDS

CARTOGRAPHY  
 GEOINFORMATICS  
 EDUCATION  
 MASTER PROGRAM  
 UNIVERSITY REFORM

## 1. BACKGROUND & INTRODUCTION

Concerning the spatial or "geo" related sciences; it seems to be a classic way to divide the corresponding education programs into a number of disciplines such as geography, geomorphology, geodesy, geology, geophysics etc. Each discipline has a clearly definable profile and a major study area dealing with the subject "Earth" such as its surface, form, size, structure, and dynamic processes. This diverse composition with its wide application field has presented a challenge for a structured, comparable education system for cartography. As David Forrest pointed out in 2003, the last four years have been a difficult period for cartographic education in the UK, with admissions suspended to one of the leading postgraduate courses and the decision to close the only dedicated undergraduate course. In contrast to this, there has been a significant expansion of courses in Geographic Information Systems or Science (Forrest, 2003). Cartography alone seems to have a difficult stand, but in combination

with Geoinformatics it may well be a prosperous discipline. The rapid technological development with the introduction of computers, powerful data processing algorithms and improved sharing of data, information and knowledge via the Internet, has increasingly blurred the boundaries among these individual disciplines. As a consequence, some interdisciplinary areas such as remote sensing, geoinformatics and cartography have become particularly active or revitalized (Krisp, et al., 2009).

Cartography can act as an interdisciplinary field as many of the earth related subjects involve the use of cartographic representations. The Commission on Cartographic Education of the International Cartographic Association (ICA) defined Cartography as the totality of investigation and operations - scientific, artistic and technical - which have as their aim the making of maps as well as the use of maps (ICA, 1999a). The ICA strategic plan for 2003-2011 offers a definition of cartography as: "The art, science and technology of making and using maps" or a more comprehensively, defining "Cartography as a unique facility for the creation and manipulation of visual or virtual representations of geospace – maps – to permit the exploration, analysis, understanding and communication of information about that space" (ICA, 1999b).

Cartography is more than displaying results of a spatial analysis. It does also relate to the concept of Geovisualization, which provides theory, methods and tools for the visual exploration, analysis, synthesis and presentation of data that contain geographic information (MacEachren and Kraak, 2001). Additionally cartography may to some extent be linked with concepts of Visual Analytics (Thomas and Cook, 2005). As suggested by Andrienko e.a., "Visualization and interactive visual interfaces, as an effective way to provide material for human analysis and reasoning, are essential for supporting the involvement of humans in problem-solving. However, a simple combination of visualization with computational analysis and modeling is not sufficient for facilitating the mutual reinforcement of the abilities of humans and computers. New methods are needed, and such methods can only result from a focused cross-disciplinary research based on the achievements in the fields of geovisualization and information visualization, human-computer interaction, geographic information science, operations research, data mining and machine-learning, decision science, cognitive science, and other disciplines, so that a synergy of approaches and technologies could lay a basis for a synergy between humans and computers in solving complex decision problems." (Andrienko et al., 2007) The growing technical spectrum makes the current cartographic education a non-trivial task as the new emerging ideas of using data representations still have to find the way into the current software tools and into the heads of the researchers, teachers and students.

The European education reform includes the Bologna Declaration issued in 1999. The three priorities of the Bologna process are: Introduction of the three - cycle system (bachelor/master/ to some extent also the doctorate), quality assurance, recognition of qualifications and periods of study. Additionally the Bologna declaration aims at making European higher education more compatible, competitive and attractive for students from European countries and other continents. The Declaration states to promote mobility by overcoming obstacles to the effective exercise of free movement with particular attention. This applies to students, as they should have access to study and training opportunities and to related services and additionally to teachers, researchers and administrative staff, with their recognition and valorization of periods spent in a European context researching, teaching and training, without prejudicing their statutory rights (European union, 1999).

Cartography education in Europe changes as the conversion to Bachelor/Master system within the ongoing Bologna process continues. Currently the number of dedicated Bachelor/Master programs in this field has been reduced. There are universities throughout the world where cartography and GIS courses are given, most of them are introductory courses just set up to give a basic idea how to deal with geospatial

information and visualize it with the help of some software modules. A limited number of Universities and advanced technical colleges offer a border specialization in cartography and GIS on top of a basic program in geography or in geodesy. Beside this, there are only a few schools specified on cartography and GIS worldwide, for example the cartography program at the "Institut für Kartographie" at the Dresden University of Technology. It constitutes one of these specific schools of cartography, as well as the Moscow University for Surveying and Mapping (MIGAIG) and the Wuhan Technical University of Surveying and Mapping (WTU-SM) in China (Ormeling 2008).

To keep the education and research in cartography on a very high level in Europe, it is necessary to bundle the existing competence. An international Master program in "Cartography and Geoinformatics" is conceptualized, to which 3 universities, TU München, TU Dresden (Germany), TU Wien (Austria) jointly contribute with teaching modules that are reasonably integrated into a curriculum.

## 2. CURRENT SITUATION OF CARTOGRAPHY EDUCATION

### 2.1 CARTOGRAPHY STUDY PROGRAMS IN GERMAN-SPEAKING COUNTRIES

A detailed analysis can be found in the publication of (Koch et al, 2009) investigating the "recent developments in cartographic curricula in German-speaking countries", also presented in the ICA Symposium on Cartography for Central and Eastern Europe (CEE), Vienna, 16-17 February 2009. Figure 1 gives an overview of study programs in Germany, Austria and Switzerland, where cartography can be studied or specialized. All together there are 38 locations.

The TU Dresden is the only university in Germany where cartography can be studied as an independent program. 13 universities provide the opportunity to specialize in geoinformatics within a program in geodesy



FIGURE 1. Universities with programs containing cartography and geoinformatics

and geoinformation (GI). Two of them, the University of Salzburg and the University of Münster offer Master programs in English, whereas the one in Salzburg is an e-learning program (UNIGIS). Furthermore, ten universities offering geography programs provide specialization in GIS (Geographic Information Systems) by subdivided cartographic departments or research groups.

Beside a university program, cartography Bachelor programs are offered by five universities of applied sciences, or "Fachhochschulen (FH)". The Master programs provided by these universities of applied sciences are either in geoinformatics or in geoinformation. Within nine geodesy and geoinformation programs offered by universities of applied sciences, specialization in GIS is possible.



FIGURE 2. Participating universities in the international master Cartography & Geoinformatics

## 2.2 CARTOGRAPHY STUDY PROGRAMS IN EUROPE AND WORLDWIDE:

Beyond the borders of the German-speaking countries there are many universities worldwide where cartography and GIS courses are given, most of them are introductory courses just set up to give a basic idea how to deal with geospatial information and visualize it with the help of some software module. There are a limited number of universities and advanced technical colleges where students may specialize in cartography and GIS, on top of a basic program in Geography or in Geodesy. In Europe, university Master programs in geoinformation taught in English are offered in a couple of universities located in the UK, the Netherlands, Denmark, Sweden and Finland. But a program focusing on cartography is offered only at very few universities, such as the University of Moscow (MIGAIG) and outside Europe the program at WUHAN University in China. However, they are not given in English. Even in North America, many geoinformation courses have been established, but no program is dedicated to cartography.

## 3. PROGRAM CONCEPT

Following the successful example of a study program on Earth Oriented Space Science and Technology (ESPACE) at the Technical University Munich (TUM) and on the basis of an extensive demand analysis in German speaking region, we have conceptualized a new international non-consecutive Master program Cartography and Geoinformatics. Being coordinated at TUM where the academic degree Master of Science will be conferred, it attempts to bundle the existing competence from other universities such as Technical University of Dresden and Technical University of Vienna in Austria. The locations of the participating Universities are shown in figure 2.

One of the main objectives of this program is to maintain and to improve the high level of cartography science in Europe and to create a "spearhead" in cartography and geoinformatics by means of collaboration of three universities. Another goal is to enhance international relations and university collaborations in Europe, using the synergetic effects of three universities and combining their advantages. Furthermore, the program shall improve exchanges of students and scientists worldwide. The program is intended to start in October 2011.

This Master program will make an optimal use of the existing education modules and human resources at the 3 cooperating universities. With a very high concentration of scientific competence in cartography and geoinformatics, the program holds a unique feature not only in Europe, but also worldwide. It will be the first Master of Science in "Cartography and Geoinformatics" taught in English within the participating universities. The academic degree is planned to be a joint degree. The conceptual idea is a 4-semester English-language Master program which has an intake between 15 and 25 students per year. Students obtain altogether 120 ECTS credit points.

Target students are high-qualified students from all over the world especially from Asia and Europe, holding a bachelor or diploma degree in cartography or related subjects. The Master program will accept high-quality and top-level educated students to prepare them for current workforce demands while giving them a life-long career path. One important aspect is an intensive and individual supervision of the students.

Higher education at German and Austrian state universities such as TUM, TU Dresden and TU Wien is in general financed through taxes. The tuition fee is about 500 EUR per semester. Already during their studies, some students may work as assistants for research activities or as tutors for lectures in lower semesters. Funding for the accepted students may be provided by DAAD (German Academic Exchange Service) or by different foundation such as Konrad Adenauer Foundation or Heinrich Boell Foundation. Furthermore Erasmus-Mundus offers financial aid for students, scientists, guest-lectures and cooperating universities. Therefore the KTH Stockholm is mentioned as an additional cooperation partner.

Holding a Master of Science in Cartography and Geoinformatics, alumni are qualified to work in research institutions, universities or as engineers in the industry, e.g. Geoinformation field. The graduated students will be motivated to pursue a PhD in any of the cooperating universities or at research institutions.

## 4. PROGRAM STRUCTURE

As shown in figure 3 students will absolve their first semester at the TU Munich, the second semester at TU Wien and the third semester at TU Dresden. Writing the Master thesis will be possible in any of the universities. Additionally the KTH Stockholm respectively the ITC (University of Twente, Netherlands) is a partner for Master thesis supervision. Students need to be very mobile as three universities at different locations are involved in this program.

As seen in the curriculum draft in figure 4 the first semester offers

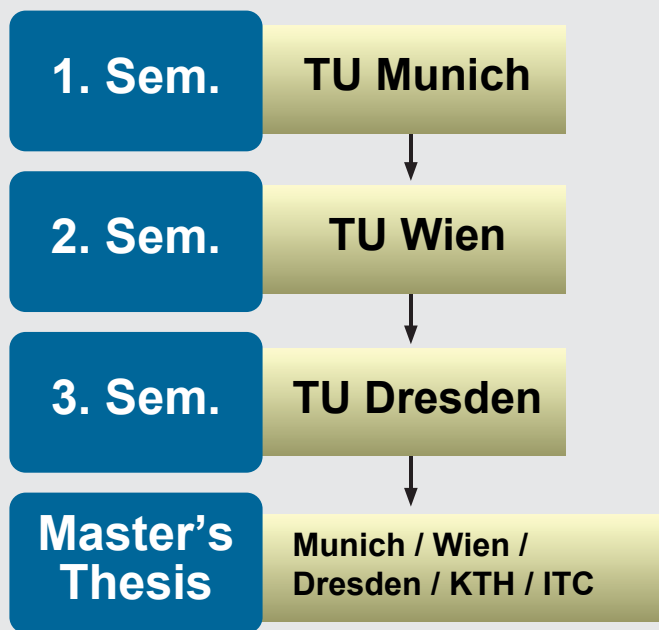


FIGURE 3. Program structure

different learning paths, addressing both the previous know-how and the requirements of the students (harmonization of knowledge). In general, the first 2 semesters contain mainly basic and advanced courses in cartography and geoinformatics. In addition, key competences (project management, research methods) are provided. Students also obtain introductory courses in various cartographical applications. Furthermore, a Summer School for special projects is planned.

In the third semester the students have the opportunity to specialize in three concentrations: 1) mobile cartography, 2) 3D visualization, 3) field specific GIS application & case studies.

It focuses on a comprehensive education in cartography and geoinformatics: spatial information technology, mathematic principles of mapmaking, spatial data handling, theories and technologies of geovisualization and communication of spatial information.

Besides capability of performing practical and development tasks in the fields related to cartography and geoinformatics, the students are supposed to be trained for taking part in research projects and aim for continuation of their studies for the PhD degree. Another advantage is that the program focuses on both, cartography and geoinformatics,

whereby students obtain excellent job qualifications. The cooperation of the different universities intends to give the graduates an access to an international research network and an optimal start to a scientific career.

### 5. CONCLUSIONS & FUTURE EFFORTS

In this article we have presented the establishment of a new international Master Program in Cartography and Geoinformatics. Hence, the new international Master program in Cartography and Geoinformatics shall be regarded as a rather complementary program than a competing program to the existing Master program Geodesy and Geo-information. This new Master program will set innovative standards in the international Cartography & Geoinformatics education and research. The technological and methodological developments in the geosciences are the driving forces to this new international Master. With its unique features, it is an innovative approach that provides excellent job opportunities. The first principal steps for the new program are set and the general agreement as well as the industrial and research demand is given. The program is supported by the ICA - International Cartographic Association.

### REFERENCES

- Andrienko, G., Andrienko, N., Jankowski, P., Keim, D., Kraak, M.-J., Maceachren, A. & Wrobel, S. (2007): Geovisual analytics for spatial decision support: Setting the research agenda, *International Journal of Geographical Information Science*, 21, 839 - 857.
- Boillot, Y. (2005): ERA Star - Outreach and Education, Report for the European Commission, RPT-ERA-002, HE Space Operations BV, Netherlands.
- European union (1999): The Bologna Declaration, Joint declaration of the European Ministers of Education.
- Forrest, D. (2003): Cartographic Education and Research in the UK, *The Cartographic Journal*, 40, 141-146.
- ICA (1999a): Definition of Cartography, ICA International Cartographic Association - Commission on Cartographic Education, (<http://www.msu.edu/~olsonj/overview.html>).
- ICA (1999b): Definition of Cartography, ICA - A Strategic Plan for the International Cartographic Association 2003-2011, As adopted by the ICA General Assembly 2003-08-16, ([http://www.icaci.org/en/ICA\\_Strategic\\_Plan\\_2003-08-16.pdf](http://www.icaci.org/en/ICA_Strategic_Plan_2003-08-16.pdf)).
- Krisp J. M., Peters S., Hedman K., Meng L. (2009): A Case Study of Education Reform in Earth Observation Technology and Applications,

Technische Universität München, Department of Cartography, EOGC2009 Conference, Chengdu, China, 25-29 May 2009.

- Maceachren, A. & Kraak, M.-J. (2001): Research Challenges in Geovisualization, Cartography and Geoinformation Science, Volume 28, 3-12.
- Ormeling F. (2008): Mapping the Changes in Cartographic Education in the Last 50 Years, *Kartographische Nachrichten* 4/2008.
- Thomas, J. J. & Cook, K. (2005) Illuminating the Path: The Research and Development Agenda for Visual Analytics, National Visualization and Analytics Center, <http://nvac.pnl.gov/agenda.stm>. ■

1. Sem. München	2. Sem. Wien	3. Sem. Dresden
Scientific Visualization	Multimedia Cartography	Mobile Cartography
Cartographic Presentation	Geomedia Techniques	Geodata Generalisation
Geo-Information	Geo-Communication	Subject-specific GIS Applications
Image processing, Photogrammetry & Remote Sensing	Cartographic Interfaces, GIS	Radar Cartography
Software programming	Web Mapping	Georelief and Cartography
	Location-Based Services	Visualisation of Dynamic Geo-Features
		True-3D Cartography

FIGURE 4. Curriculum draft