GEOSPATIAL DATA VISUALISATION IN GEOMATICS CURRICULUM

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Abstract

Studies of Geomatics have been founded in 1995 at the Faculty of Applied Sciences of the University of West Bohemia in Pilsen (the Czech Republic). But a teaching of geo-related sciences has longer history at our university. It was Czech cartographer Jiří Pyšek, who had founded studies of mathematical cartography at the Faculty of Education in 1991. Presently there are three main specializations at the Section of geomatics: surveying and cadastre of real estates, geographic information systems and mathematical cartography. There is the one connecting link of all three specializations – the need of visualisation of geospatial data via cartographic methods.

The purpose of this paper is to introduce our cartographic curriculum, to arouse a discussion and to offer, share and gain experience and knowledges. Last but not least there is an attempt to the emphasis of the importance of cartography in geoinformation sciences.

Our curriculum offers two types of courses – the courses directly focused on cartography or mapping (e.g. thematic cartography, computer cartography, mathematical cartography, mapping, topography mapping etc.) and the courses applying the cartographic pieces of knowledge (e.g. introduction of geographic information systems, application of computer technology in surveying, cadastre of real estates etc.). Our section also supports distance learning and e-learning – on the server gis.zcu.cz there are at disposal many documents, presentations, links, examples and other materials (mainly in Czech). Among the development tendencies in cartography processing in the Geomatics section of the University of West Bohemia there are map servers, application of XML in cartography, visualisation of dynamic data sets, transformation of reference systems, visualisation of thematic geodatabases or georeferencing and presentations of

historical maps. These focuses would conform to the Research Agenda of International Cartographic Association published in 2007.

The education (not only cartographic courses) on the University of West Bohemia is focused on information technologies (commercial and open-source) and their benefits for particular branches of science. Students can apply and verify their skills not only during exams, but also by the cooperation on various projects (e.g. maps for handicapped, mapping of the temporal development of hiking routes, visualisation of Jewish cemeteries, algorithm development of isolines from triangulated irregular network etc.). Our section is involved in large international projects (e.g. Humboldt or Plan4all) – these projects are partially concerned in portrayal rules of spatial planning data. The "mainly cartographic" project VisualHealth focused on cartographic visualisation of health data is introduced in independent entry. Some projects are described on the pages git.zcu.cz.

The aim of this paper is to present the trend of both teaching and scientific activities focused on cartographic visualisation of the Department of Mathematics – Section of Geomatics at the University of West Bohemia at the beginning of 21st century. Our graduates, the geomatics engineers, will have to have the above standard knowledges of cartographic visualisation of geospatial data sets. Any present-day GIT expert does not get along without maps and other cartographic products. Because cartographic outputs form the basis of the majority of geoinformation processes and these products are most often evaluated and of course shopped by public.

Introduction

Cartography (and geospatial data visualisation) will be significantly influenced by the development of information technologies. It seems that it will be above all a service for cartographic visualisation of geospatial data processed by GIS technologies. The map in paper form will not loose its significance entirely but it will be one of tools for education, free time activities and common military purposes only. Other more frequent forms will be electronic maps and atlases, 3D models of landscape, animations, virtual models and intellectual geoimages of multimedia character. Internet will facilitate quick access to cartographic products and it becomes a global geoinformation system. Abandonment of cartographic know-how when creating the GIS software by IT-people only (e.g. principles of cartographic generalization, application of sophisticated map language) could lead up to distribution and using the impressive and quick working software but not always giving meaningful outputs. [5]

The previous introductory paragraph shows the importance of an education in cartography or in geospatial data visualisation in general. This paper should specifies the other reasons of this type of education and introduces the concrete example of the submission of the cartography or geospatial data visualisation to the curriculum of the study programme Geomatics in the University of West Bohemia in Pilsen, Czech

Republic.

This paper is divided into four basic chapters (except Introduction). In the first two sections the study programme Geomatics in the University of West Bohemia and its curriculum is introduced. The third section is focused on cartographic courses and courses with cartographic and geospatial data visualisation aspects. The conclusion summarizes the importance of this type of education and the approaches being able to improve cartographic and similar education.

Geomatics on the University of West Bohemia in Pilsen

The University of West Bohemia is located in Pilsen (about 78 km southwest of Prague), the largest city in West Bohemia and the fourth largest city in the Czech Republic. The University of West Bohemia was established by the decree of the Czech National Council in 1991 when the Institute of Technology in Pilsen (founded in 1949 as a branch of the Czech Technical University in Prague, in 1960 divided into the Faculty of Mechanical Engineering and the Faculty of Electrical Engineering) and the College of Education (founded in 1948 as a part of the Faculty of Education of the Charles University, Prague) were merged.

The following statistical data shows some basic data to describe the University of West Bohemia in more detail.

- Number of faculties: 8 (Faculty of Applied Sciences, Faculty of Economics, Faculty of Electrical Engineering, Faculty of Philosophy and Arts, Faculty of Education, Faculty of Law, Faculty of Mechanical Engineering, Faculty of Health Care Studies)
- Number of departments: 64
- Number of institutes: 3 (New Technologies – Research Centre in the West Bohemian Region, Institute of Art and Design, Institute of Language Studies)
- Number of students: 18 898
- Number of Ph.D. students: 1 090
- Number of academic staff: 1 218
- Number of administrative staff: 836 [7]

Student can choose the study programme Geomatics, which belongs to the Department of Mathematics of the Faculty of Applied Sciences (founded in 1990). The history of Geomatics at the University of West Bohemia is not very long. The study programme Geomatics has been existed since 1995. But a teaching of geo-related sciences including cartographic and geovisualisation disciplines has longer history at our university. It was the eminent Czech cartographer Ing. Jiří Pyšek, CSc, who had founded studies of mathematical cartography (as the predecessor of Geomatics) at the Faculty of Education in 1991.

This section was created with using of following resources [1], [2] and [7].

Geomatics Curriculum on the University of West Bohemia in Pilsen

First of all it is necessary to state the term “geomatics” for better understanding.

- International organization for normalization (ISO) defines geomatics as "scientific and technical interdisciplinary branch focused on collecting, distributing, storing, analyzing, processing and presenting of geographical data or geographical information". [5]
- The Oxford English Dictionary defines Geomatics as "the mathematics of the earth; specifically the science of the collection, analysis, and interpretation of data, especially instrumental data, relating to the earth's surface". [6]
- The Division of Geomatics at the University of Gävle defines Geomatics as "an integration of the sciences: geodesy, photogrammetry, remote sensing, cartography and geographical information technology in order to collect, process, understand, analyse, store and present geographical information". [6]

Geomatics represents the characteristic interdisciplinary scientific branch. Geomatics deals with collecting, distribution, storing, analyses, processing, interpretation and visualisation of spatial data and geographical information. Those data comes from many different sources and are collected by various ways of surveying, cosmical surveying, mapping, cartography, remote sensing and photogrammetry. For their processing, administration and analyzing information technology GIS is used. And their final representation and distribution are managed by cartographic methods and tools.

Presently there are offered following specializations of different types and forms of study programme Geomatics:

- Bachelor study programme
  - Geodesy and cadastre (Attendance and combined form of study)
- Master of Science study programme
  - Geodesy and Geographic Information Systems (Attendance form of study)
  - Cartography (Attendance form of study)
  - Cadastre and civil law (Attendance form of study)
  - Geodesy and cadastre (Combined form of study)
- Doctoral (postgradual, PhD.) study programme
  - Geomatics (Attendance and combined form of study)

Geospatial data visualisation in Geomatics

The visualisation of geospatial data does not mean only the traditional cartographic methods. Expect topographical or thematic maps there are also modern sophistical technologies like 3D terrain models, surface modelling, scene animation, virtual reality, context cartography or temporal mapping. Courses relating to geospatial data visualisation could divided into three groups (the courses of the two most important groups in term of cartography and their main topics are itemized in following paragraphs):

1. Cartographic courses (Mathematical cartography, Thematic cartography, Computer cartography)
2. Mapping courses (Mapping, Topographical mapping)
3. Other courses implemented some approaches of cartographic or geospatial data visualisation (e.g. GIS courses, Application of information technologies in geodesy). These courses are not focused on visualisation methods, but they use these methods for a construction of outputs of analyses or collected data sets. There are also some other courses (e.g. computer graphics, geodesy, photogrammetry, remote sensing etc.) marginally using some methods or approaches of geospatial data visualisation.

- Mathematical cartography 1

Form of Earth solid, reference surfaces, deformations laws, kinds of projections. Conical, cylindrical, azimuthal projections. Polyconical projection. Significance of geodesic line in cartographical projection, geodesic curve.

- Mathematical cartography 2

Problem formulation in mathematical cartography, first quadratical form and consequences. Theory of projection, class of orthogonal projections (TJ2) and properties, kinds of projection in TJ2. Optimalization and classification of cartographical projection, choice of projection for different purposes.

- Thematic cartography

Cartography as the science, contents and cartographic conveying tools in the map of medium and large scales. map language, map symbols (examples and development) , map stylistics, history of cartography till the 18. century, thematic maps at medium and large scales, creating of atlases, globes, relief maps.

- Computer cartography

Types of thematic maps, terminology of thematic maps (Czech and English), map

composition, maps on the Internet, e-publishing, web publishing, creating of maps on the Internet (XHTML, CSS), dynamic maps (DHTML, JavaScript), XML and data structures based on XML (GML, LandXML), transformation languages in cartography, schema languages, semantics of geospatial data, formats of graphics data (raster, vector), colours on maps, generalisation of digital maps.

- Mapping

History of creating the maps and plans at large scales. Cadastral mapping based on scientific kowledge (Stabile cadastre, Land cadastre in the Czech Republic, Instruction "A"). Application of the results of large scale mapping to the compilation of topographic maps. State Map of the CSR. Technic-Economical Mapping.
Maintenance and updating of large scale maps. The Large Scale Basic Map. Cadastral Map. Thematic large scale maps (the Basic Town Map, the Uniform Railway Map, the Basic Motorway Map, the Basic Airport Map, the Basic Map of the Factory). Geodetic documentation of completed constructions. Survey sketch and updating of digital cadastral maps.

- Topographical mapping

Topographic maps - typical features. History of topographic mapping. State base and thematic map series at medium scales. Methodology of topographic map evaluation. Historical and up-to-date methods of planimetric and altimetric survey in topographic mapping. Forms of terrain relief. Methods of topographic map (Basemap of the Czech Republic) updating till 2000 and now. Fundamental Base of Geographic Data (ZABAGED). Digital terrain model - methods of creating and its applications. Cartographic processing and editing of state map series - conventional and digital technologies. [4]

All courses disposes of lectures and exercises – students create concrete outputs and they have possibilities to try on methods and tools. The selection of concrete software tools (or hardware) depends on every teacher, but the commercial software (e.g. ArcGIS) and free software products (e.g. OpenJUMP) are in balance. Students can use a large number of supporting materials (e.g. books, elearning materials, supporting texts, slideshows etc.).

Conclusion

Bachelor study programme Geomatics has two main objectives:

- to prepare the graduate for continuing in master study at the Faculty of Applied Sciences or for similar study programme at other Czech university or abroad,
- to prepare the graduate for practically oriented professional activities particularly in the field of acquisition and processing of geospatial data, filling

up the geospatial data funds and their updating, maintenance of cadastre of real estates, surveying for land consolidation projects, land evaluation and real estate market etc.

The purpose of master study programme Geomatics is to prepare engineers capable to manage challenging work in geodesy, photogrammetry, remote sensing, cartography and cadastre of real estates using modern means of information technologies. [5]

All possibilities of practical application of graduates necessitate the knowledges of cartography and methods of geospatial data visualisation. Because all results of geomatic activities (e.g. GIS analyses, remote sensing, sensor measuring, field survey etc.) are accessible in the form of maps or related products. It is very important on the part of public. These products represent very an attractive and intelligible conversion of complicated data to graphic view. But the visualisation outputs are very important for experts not only in cartography. The reasons are very similar to public, but there is another reason resulting from the conception map as model. Maps and other related products make possible to eliminate margin components of real world, to emphasise important objects or to interconnect phenomenons and events without real relationships.

Except courses, lessons or exercises student can meet cartography and geospatial data visualisation within the scope of different project, which are or were processed in the Geomatics section (with other partners). From the large list of these projects the following items can be selected:

- VisualHealth project (cartographic visualisation of health data)
- Developing of the server describing of old maps and history of cartography in the Czech Republic
- Publication Atlas of International Relationships
- Spatial registration of cultural heritage
- Georeferencing and cartographic analyses of historical mappings of Czech, Moravia and Silesia
- Maps for handicapped
- Flood GIS
- Using of XML in cartography
- Dynamic visualisation in the Google Earth environment

Cartography and spatial data visualisation in the scope of Geomatics curriculum of the University of West Bohemia in Pilsen, Czech Republic will focus on practical activities increase, upgrading of supporting materials, link between other courses, including solutions to joint projects.

The education in the field of spatial data visualisation is very important in the light of overall improvement of cartographic culture and standards. Its signification is still growing in connection with new geotechnologies (e.g. navigation tools, cartographic

mashups, Earth browsers etc.). In 2004, the US Secretary of Labor named geotechnologies (along with biotechnologies and nanotechnologies) as one of the three fields most in demand for 21st Century decision-making [3]. The importance of education the Research Agenda of of International Cartographic Association (ICA) [8] emphasizes. The education represents one items of ICA priorities. The education accordance with Research Agenda should address map searching and their using, distance learning and teaching, e-learning, professional education and university curricula.

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