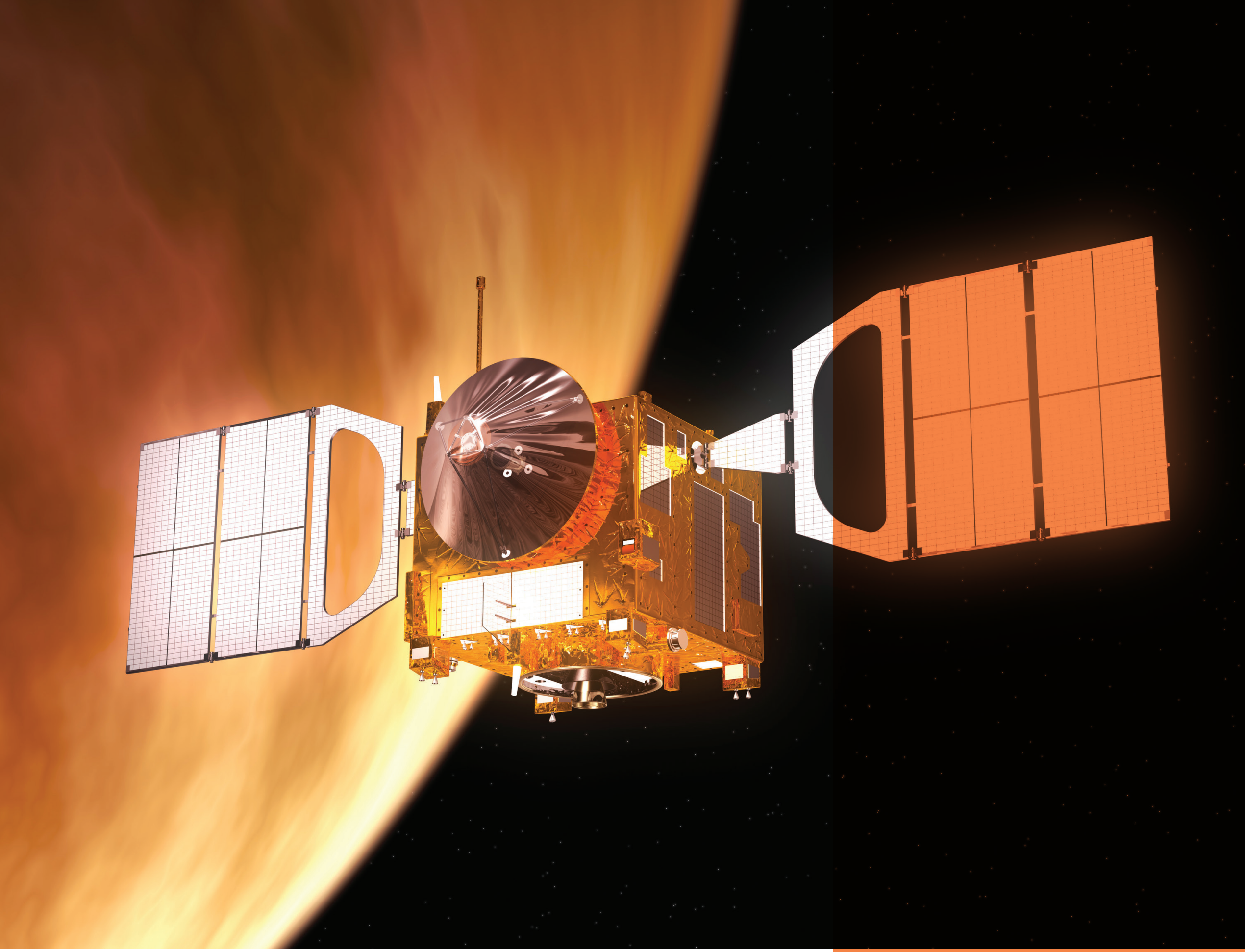

GIS IN HIGHER EDUCATION IN POLAND
CURRICULUMS, ISSUES, DISCUSSION

edited by Iwona Jażdżewska

WYDAWNICTWO
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ŁÓDZKIEGO

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ENGINEERING TASK-ORIENTED GIS EDUCATION, EXAMPLE OF THE COURSE AT THE AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY AGH IN CRACOW

EDUKACJA GIS UKIERUNKOWANA NA ZADANIA INŻYNIERSKIE NA PRZYKŁADZIE KURSU W AGH W KRAKOWIE

Introduction

Geographic space may be described as a model which is an extraction of essential objects in this space. For wide objects, such a model is built at various levels of detailing.

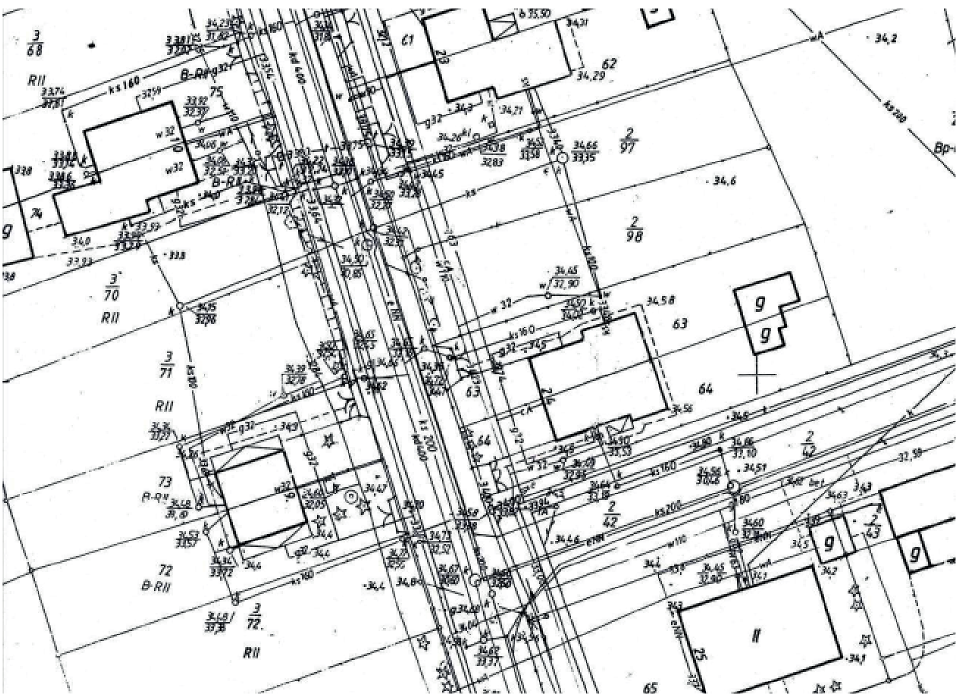


Fig. 1. A fragment of a large-scale map of an urbanised area, 1:500 map shows the above ground and below ground infrastructure in the area and land boundaries

There are two fundamental reasons for building such a model with a high degree of detailing, so it may be shown in a large-scale environment – for extensively developed areas – e.g. at the scale of 1:500 (fig. 1).

The first argument stems from the need for a detailed description of above ground and below ground engineering objects in order to provide rational spatial activity as well as safety. Such a description of spatial objects is ensured by a spatial information system which in the case of such a huge scale is called a terrain information system (SIT).

The second argument for detailed description of space stems from the need to provide a highly detailed plot boundary network, i.e. plots of the earth's surface that have clearly de-fined legal interrelations. The earth's surface is a particular kind of value as the limited extent and significant price of it forces high precision in registering plot boundaries. Apart from a land information system, the plot registry is another description of geographical space, also known as land registry. In this case, the boundary grid is overlaid with the grid of useful land and land valuation.

Both descriptions of the geographic space, the land information system and land registry, have their own separate, specific objectives, differences and similarities but they have to co-operate in any action taken in terms of the local space.

Land Information System and Land Registry – Similarities, Differences and Cooperation

The land information system (as a large-scale GIS) contains comprehensive information avail-able to all users. On the other hand, the land registry is based on an elementary fragment of the land, i.e. a plot. The land registry requires updating after each operation on the plot grid. For legal reasons, the land registry data is confidential to some extent in order to protect per-sonal particulars.

A common feature of both systems is the description of objects in real space. The land information system is aimed at a comprehensive description of space – it contains a description of the above ground and below ground infrastructure as well as descriptions of natural fea-tures, and above all the representation of topographic surface. In addition to formal data, the land registry only describes the spatial boundary grid, for which the grid of arable lands and evaluation outlines are complementary. The land information system provides up-to-date data, while the land registry also has to store historical data on legal changes of real space. The land information system is aimed at serving the purposes of a wide range of users showing versatile interests, while the land registry is intended for the administrators of given pieces of space in order to guarantee the related rights and allow them to use the property at their discretion. The land registry also serves the fiscal purposes.

These two descriptions of the real space in many cases must be used in conjunction as every action taken in the local space has to be linked to its ownership and thus it requires the geom-etry of the surroundings, the descriptions of infrastructural elements, and the ownership dis-tribution in the local space.

These two descriptions may be integrated in two ways. In the case of historical develop-ment, the description of space – a traditional land registry – has been computerised and served as the basis for the description of infrastructural elements. This is how the so-called multitask-ing land register was created. Nowadays, due to the terrain information systems that widely describe the real space, such systems are usually expanded on the basis of the land registry data, thus creating a complete and coherent description of the geographical reality.

Characteristics of Education in the Field of Geodesy and Cartography in the Course of First Degree Studies

Education in the field of Geodesy and Cartography comprises a group of vocational subjects concerning techniques for determining the position of objects and description of the real space as well as a group of subjects needed for general engineering education, especially those di-rectly related to geodesy.

This first group corresponds to the basic tasks of geodesy and cartography, namely: de-termining the position on the earth's surface on a global, national, regional and local scale, mapping and creating descriptions of objects, bringing objects into the real space and research-ing the behaviour of objects in time.

When commenting on this fundamental group of vocational subjects, we should empha-sise that a large part of this group represents the modern measurement techniques such as the GPS, laser scanning technology and the use of electronic direct measurement equipment as well as the utilisation of source materials such as satellite and aerial images.

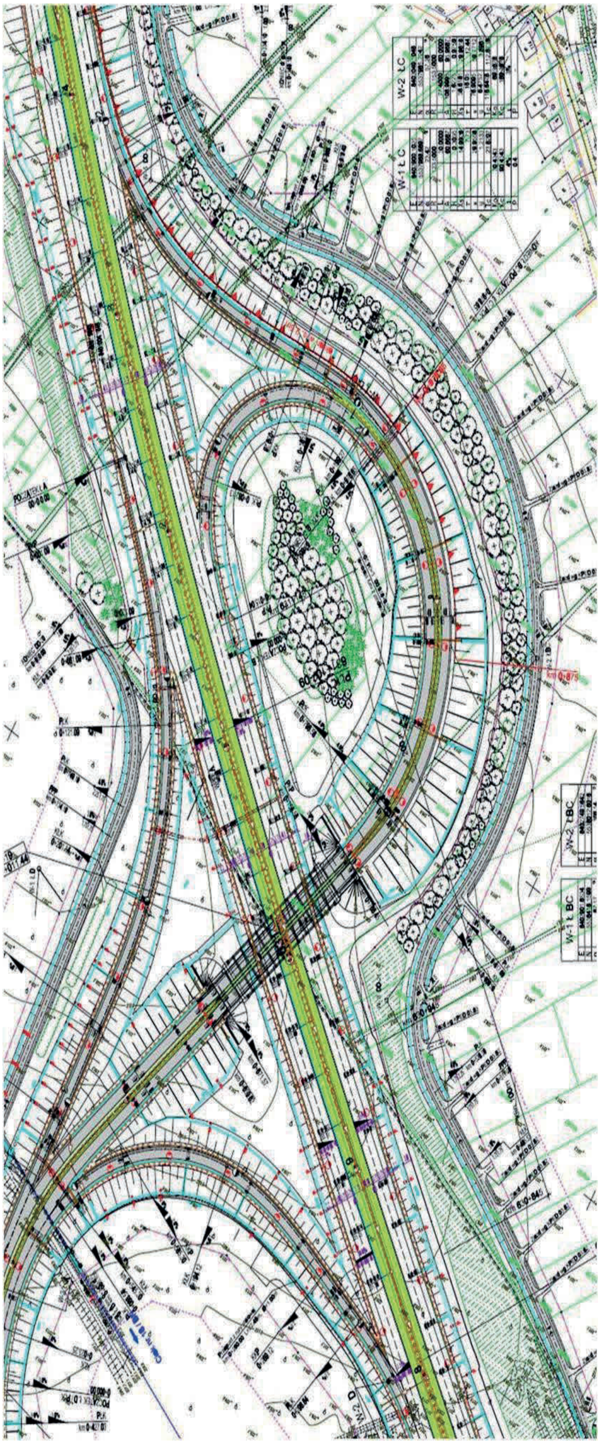


Fig. 2. Education in the field of computer graphic editors plays an important role in civil engineering design visualisation, the sample drawing contains a fragment of a highway junction plan (the drawing has been made available by the contractor of the A-4 for teaching purposes)

A leading role in the training programs is played by computer methods, including general computer education, engineering task programming, computer graphics editors (Figure 2) and the digitisation of the real space descriptions. This last group includes the GIS – with its sub-ject of the "terrain information systems" (SIT) or the large-scale GIS.

Further groups of subjects include engineering subjects, such as construction and engineering, as well as specialised measurements in these fields.

At the same time, students are educated in the field of the land registry, property admin-istration, and geodesic and cartographic law.

This last group of items includes issues of planning and arranging space in urban and rural areas.

GIS Education in Multi-level Engineering Studies

The GIS education in the field of Geodesy and Cartography at the Faculty of Mining Survey-ing and Environmental Engineering at the AGH University of Science and Technology in Cracow at the first-level education is included in the subjects of the "terrain information sys-tems" and GIS. The major subject of the SIT includes approximately 60 hours of classes. The approximation stems from the fact that the Department is now switching to 14-week semes-ters. Given the fewer hours of classes, the GIS includes elements of remote sensing data ac-quisition. Those training courses are expanded using electives that offer a more thorough in-sight into chosen specialised applications.

Other earth science-related faculties also include the basic GIS courses. The Faculty of Geology, Geophysics and Environmental Protection includes a subject named the "spatial in-formation systems and GIS". In the case of the major of "spatial management" (which also includes many engineering features at the Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, the mandatory GIS education is split into two train-ing course subjects, with 60 hours of lab classes.

At the Faculty of Mining Surveying and Environmental Engineering of the Academy if Mining and Metallurgy (AGH), the second stage of education includes the specialisation in the field of "geomatics". By means of this specialisation, students are taught subjects that ex-pand their knowledge in the advanced GIS tools and various applications of the spatial infor-mation systems.

As far the third degree education is concerned, namely in the case of post-graduate edu-cation programmes, there is a subject named the "spatial information system" which is taught at various levels: it either expands the knowledge of less advanced students (who have taken various majors) or students with some experience gained in their first and second degree edu-cation.

We should add, that the employees of the Faculty of Mining Surveying and Environmen-tal Engineering of the AGH University also provide the one-on-one GIS training courses as a part of the first degree engineering studies as well as for the purpose of MA theses ending the Master's studies.

Lectures and presentations as a part of the annual GIS Day in November are another form of education. This form of education is dedicated to the high school and primary school students. As a part of universal education organised by various institutions, especially Univer-sities of the Third Age, there are the GIS lectures provided as a part of open social education.

Special Features of Description of Real Space in Large-scale Environment

Engineering education should include not only the existing state of knowledge but should also take into account the future that the students will face after they graduate. Education should therefore expand the graduate's knowledge in subjects of scientific developments and applications in a given field. This paper, while tackling education, includes an outline of two exemplified trends in the development of the terrain information systems (chapters 5 and 6). Another argument for discussing the trends in scientific development is to show a university not only as an education institution but also as a centre for scientific research which includes its own and others' achievements to the extent of education.

The principles of documenting buildings in large-scale maps that are now commonly used represent buildings as outlines at the ground level (fig. 1 and 3). The interior of the building usually has a separate, detailed documentation. This way of documenting buildings in large-scale maps is widely acceptable. However, representing a building as an outline leaves an empty field in a map where its interior should be depicted. Empty fields in building outlines create discontinuity in mapping, that may account for as much as 30% in densely developed areas. According to the author, this creates a disintegration in the description of the land development and interior descriptions. There are many tasks that require determining the

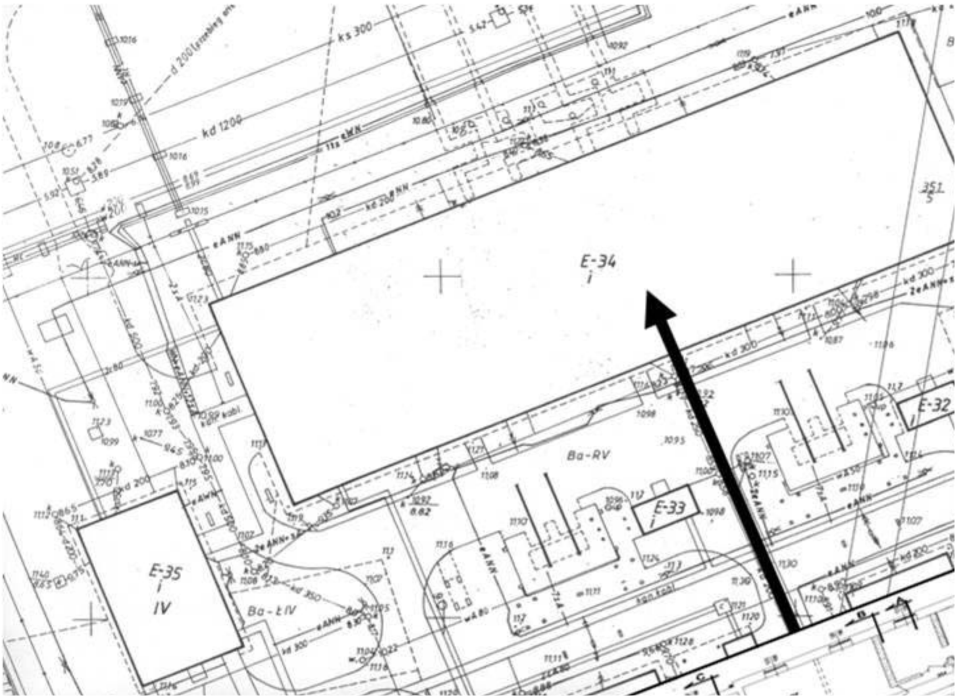


Fig. 3. Integration of the representation of a building, in the form of a contour, with plans of its interior, that ensures the continuity of documenting space and allows for the performance of many analyses in terms of the GIS for disaster management (Eckes, 2008a and 2008b)

relationship between the interior of a building and the surrounding terrain, including decisions in crisis management.

In order to integrate the description of the interior of the building with descriptions of the surrounding area, the author has suggested in his work (Eckes, 2008a) to expand the functionality of the terrain information system to include documentation of the internal space of buildings (fig. 3). This method of documentation ensures contiguous description of space, technological coherence and document storage in a single place. Furthermore, this method of documentation, based on the GIS technology, allows for performing numerous analyses using system tools. The record of buildings' internal geometry made using the principles of the GIS has allowed for running a series of analyses for the purposes of crisis management. The results of these analyses are presented in Eckes's works (Eckes, 2008a and 2008b).

Integration of Land Information Systems With Expert Systems

Large-scale maps are characterised by their genesis – these maps are created as a result of di-rect field measurements or laboratory studies. At this stage of data acquisition the land details are generalised. Due to the high accuracy of these measurements, up to 1 cm for a certain group of field details, the shapes of mapped objects remain highly similar to the shapes of real objects (fig. 1 and 3), all the more so, as the large-scale map creation uses a formalised proce-dure for creating such images: a clear procedure for shaping the map image, a set of principles, and a certain library of signs.

In the geographic reality, there are a lot of geometric, physical and functional principles and so, by virtue of a high degree of similarity between the mapped objects and real life ob-jects, these principles are reflected in a large-scale map.

In the traditional version, the map image as an end product of the process of land imag-ing was only controlled by a man. Such control is not objective and depends on numerous personal factors: experience, perception, reliability, and fatigue.

The author used his work (Eckes, 2007), among others, to present a concept of building an expert system which could help control the map image. In this work, he summarises the attributes and relations that may serve as the basis for forming expert principles. These attrib-utes and relations are classified in four groups:

- the attributes of the structure of objects' images,
- the relationships among various objects in a map,
- the relation of objects to physical or geographical factors,
- the relationship among objects and the externally binding standards – norms, regulations, and development plans.

The Figure 4 provides examples of these principles in a large-scale map. These principles may be verified by an expert system integrated with the land information system. Such an expert system may detect errors that were created in the process of data acquisition and may thus support a man in checking the correctness of a map. It may also detect irregularities that exist in the real world.

The integration of the land information systems with expert systems is a great opportuni-ty for improving the quality of the data acquisition pro-

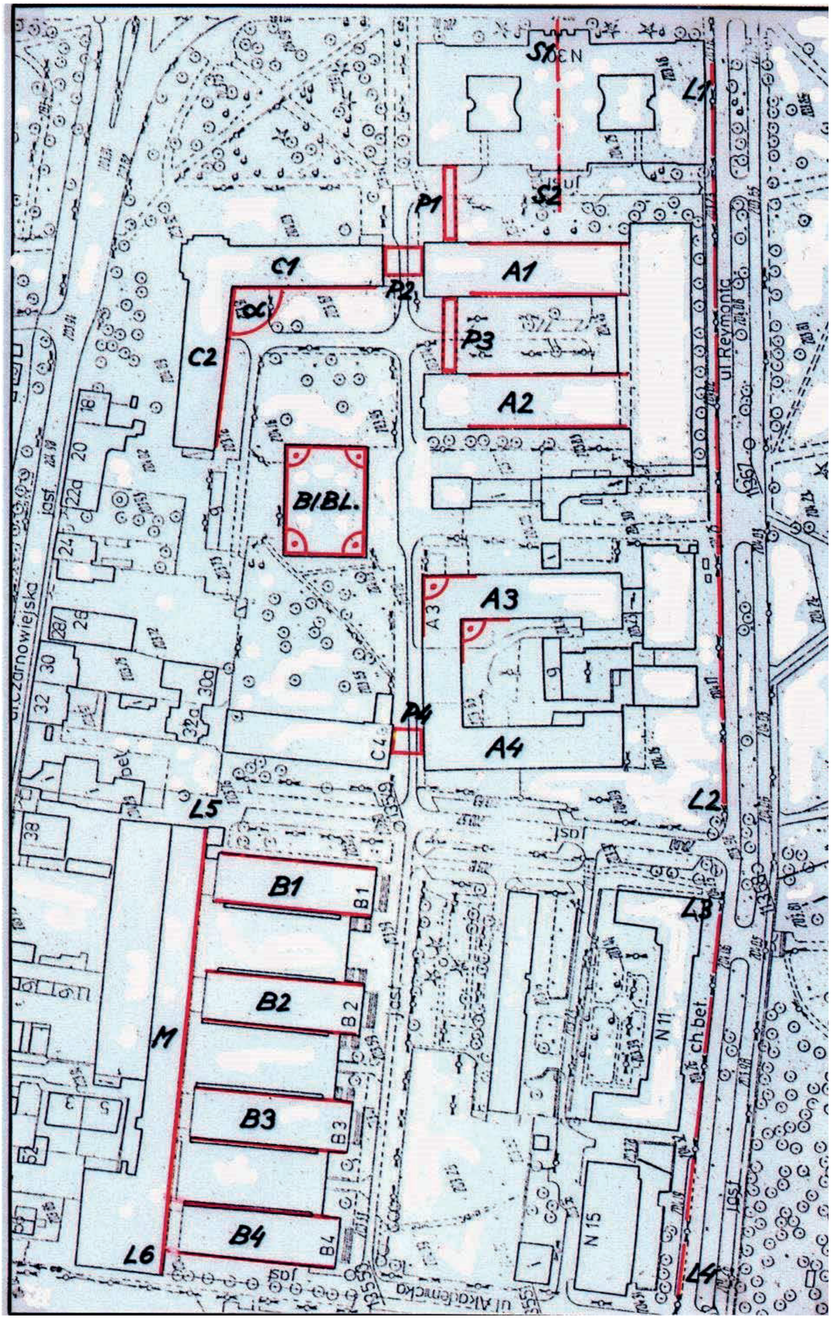


Fig. 4. The attributes of the structure of objects' images – the AGH campus buildings, marked in red: parallelism, squareness, symmetry, and the relationship among objects: repetition, parallelism, equal spacing. The attributes and relationships may serve as the basis for expert rules.

cess in terms of the GIS. The large-scale environment provides numerous factors for creating expert rules. In the case of medium-scale environments, due to the process of generalisation, we may notice a significant drop in the number of these factors, even though they still exist, and the integration of the GIS in a medium-scale environment with expert systems may also have many practical benefits.

Summary

The GIS education at technical universities is influenced by many internal and external fac-tors. Some of them have a negative impact but there are also positive external factors.

Based on personal experience (Eckes, 2009) at a university with a long tradition of teach-ing the GIS, several negative factors may be listed. The main one hampering regular updating and modernisation of curricula stems from the lengthy procedures for the curriculum approval. The development of new technologies does not support quick publication of new handbooks, either. Considerable effort made on writing them is wasted by a long publishing cycle, as a result of which the book is out of date after a couple of years. Another undoubtedly negative and important factor involves mass education in the field of Surveying and Cartography, es-pecially in universities lacking properly experienced staff, appropriate equipment and software (Gaździcki, 2014). The mass education and financial difficulties cause continual pressure to replace lab classes (in groups of a dozen or so students) with project groups that are double of that size. This affects the quality of education as the teacher is not able to personally address individual students.

On the positive side, we may above all refer to the general public's need for information about the environment we all live in. The GIS meets the needs of the information society. There are also relevant legal acts governing the circulation of information in the European Un-ion. There is also well-prepared staff with considerable experience.

The GIS technology as a computer method for describing and circulating information concerning the real space is included in computer education training courses and provides graduates with universal education, offering the large creative component. Such foundations allow the graduate to switch to working in related technical domains. At the moment of facing the demographic decline, we observe a positive phenomenon of eliminating the Survey-ing and Cartography training courses at universities lacking any tradition, experienced staff, and best available software. On the other hand, reputable universities have to compete for better performing secondary school graduates.

One definitely positive factor derives from the basic characteristics of the professional, advanced GIS software – it is universal and independent of scaling environment. The same software tools may be used to solve challenges in the local space, region, country, or even on the continent. This provides us with an opportunity to exchange experience among the users of the real space description to a varied extent as well as to bring about more universal educa-tion.

References

Eckes K., 2007: Kontrola obrazu mapy wielkoskalowej w systemie eksperckim. Główne problemy współczesnej kartografii 2007; Kartograficzne programy komputerowe – konfrontacja teorii z praktyką. Pub. University of Wroclaw, Institute of Geography and Regional Development, Department of Cartography, Wroclaw.

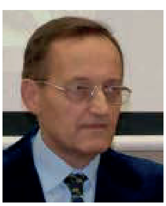
Eckes K., 2008a: Rozszerzenie funkcji systemu informacji o terenie o dokumentowanie wewnętrznej przestrzeni obiektów. Annals of Geomatics, Polish Association for Spatial Information, Warsaw, Volume VI, Issue 4.

Eckes K., 2008b: Modelowanie przestrzeni budowli w GIS dla celów wspomagania decyzji w zarządzaniu kryzysowym. Annals of Geomatics, Polish Association for Spatial Information, Warsaw, Volume VI, Issue 5.

Eckes K., 2009: Modernizowanie kształcenia na kierunku geodezji i kartografii w uczelniach Gaździcki J., 2014: Społeczna odpowiedzialność autonomicznych uczelni na przykładzie kształcenia geodetów i kartografów w Polsce. Annals of Geomatics, Polish Association for Spatial Information, Warsaw, Volume VII, Issue 2 technicznych. Annals of Geomatics, Polish Association for Spatial Information, Warsaw, Volume VII, Issue 3.

Gaździcki J., 2014: Społeczna odpowiedzialność autonomicznych uczelni na przykładzie kształcenia geodetów i kartografów w Polsce. Annals of Geomatics, Polish Association for Spatial Information, Warsaw, Volume VII, Issue 2.

About the author



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DIDACTICS: geographical information systems (GIS), land information systems (LIS), spatial analyses, land development planning

RESEARCH: informatics applied to geodesy and cartography, land information systems, expert systems, crisis management

The idea for this publication was born in June 2015, during a meeting of Polish teachers involved with Geographic Information Systems. The meeting was initiated by the Department of Geoinformation, Faculty of Geographical Sciences, University of Łódź, which received a grant to organize it. The discussion and presentations from academic teachers representing various universities in Poland were very interesting and sometimes heated. It would be advisable for other educators to familiarise themselves with the aspects of GIS education among Polish geographers, foresters, surveyors and other users. The experience of Geoinformation education in Poland is still modest, so the views of people who have been involved at Polish universities with it since the 1990s should be interesting to readers.

Geographic Information Systems (GIS) – the integration of environmental and climate issues as an important factor for economic development and quality of life – an innovative second-degree studies. Akronim GIS-E-QL: GIS for environment and quality of life

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Project objectives: The main aim of the project is to start-up attractive and innovative second-degree studies – geoinformation in mutual cooperation of the FGS and the FMCS, students education, improving the competence of academic teachers, conference organization, publishing, cooperation with practitioners and establishing contacts with partners from Norway. This aim is consistent with the "Analysis of the economy's demand for graduates in key field of strategy in the context of the Europe 2020" 2012 and "Strategy for development of higher education in Poland 2020", in the field of promoting innovative courses, formed collectively with practitioners, raising awareness of the environment. Joint actions of educators and practitioners, supported the by the strengthening of university's hardware, software and spatial data, will ensure a high quality project. The existing cooperation with practitioners indicate that further training is necessary and they would like to see postgraduates in their institutions. The final beneficiaries of the project will be the students and the academical teaching staff and indirectly the economy of the region. Students who graduate will be the main recipient of the project, the next will be teaching staff who will have contact with the practices and Norwegian partners with similar interests. In broad terms the project will benefit Polish and European economy and environment

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