PROPRIETARY SOFTWARE IN TECHNICAL HIGHER EDUCATION

A. Janowski¹, A. Sobieraj², J. Szulwic², B. Wróblewska²

¹ University of Warmia and Mazury, Faculty of Geodesy and Land Management (POLAND)
² Gdansk University of Technology, Faculty of Civil and Environmental Engineering (POLAND)

Abstract

The authors present a relatively easy way to extend the quality of education in professional studies (engineering) on major “Geodesy and Cartography”. They indicate the possibility to deepen students’ knowledge by using in the educational process proprietary software enriching education. The authors use their own experiences, results of the cooperation with employers, as well as the effects of scientific research to introduce into the learning cycle IT solutions using in typical student assignment with reference to modern technology (including mobile solutions, computer vision, image processing).

Within the theoretical considerations the authors draw attention to the problem the quality of education in the context of engineering studies. They indicate the quality of equipment in companies and in universities. At the same time, they start discussion about the solutions to improve the quality of studies and competitiveness of graduates.

Within the frames of the article, authors present some examples and try to indicate methods to improve the quality of graduate education using their own software solutions.

Keywords: teaching aids, educational software, practical education.

1 INTRODUCTION

Graduate of the higher engineering studies should represent a high level of knowledge and possess practical skills sufficient to work with the remuneration of the financial level to enable him to act safely in society and allowing for the permanent further education. Lifelong learning [1] is one of the principles associated with the Bologna process and should be especially strongly emphasized in case of the professional development of technical studies graduates, and these include the major of “Geodesy and Cartography”. In the process of education realization at higher education it should be kept in mind that modern man lives in the world of knowledge and information. Capital, labour, land and natural resources cease to be the basic economic resource. In the first place there is a knowledge and a team of professionals making up the information. This is the primary source of business success, and the mechanism to effectively compete in a world of increasing globalization is a knowledge-based economy (KBE) [2]. In their experience, authors recognize that shaping the future professional success of engineer surveyor shall be at the stage of learning. And that knowledge is one of the grounds for justifying the economic success of the engineer who graduates recognized universities.

On the other hand, the support for a better start of the graduate in the labour market are his practical skills, the possession of which is widely expected in the labour market. This brings a critique of actual knowledge: academic education is extensively revised and universities become a kind of business intended to produce graduates. Academic teacher ceases to function as a master in student’s consciousness, becoming only the “transmitter” of the knowledge and competence desired by the employer [3]. It seems that there is a common feeling that this phenomenon is negative. The weakness of this state of affairs is recognized by teachers with high educational achievements and representatives of the companies in which education and new employees implementation procedures act. Unfortunately, a wide range of young academy teachers, well-established in their belief by employers expecting for a graduate who is not educated in depth, but is who immediately after graduation familiarized with available software on the today market and modern measuring equipment and these teachers agree to be a teacher of software and hardware usage. It is also a convenient solution and it produces fast effects: Student and graduate sees the ability to quickly acquire knowledge and skills expected by employers. In the process of learning, the ability of problem self-discovery and causes removal is lost. On the other hand, the ability to use software and hardware used by the employer is an important feature and often this is the pass to get a job immediately after graduation.
The authors develop the idea expressed in the article [4], taking into account the advancement of education and changes in the labour market and technological development of the profession, as well as their own experience in the field of teaching and researches. A graduate of the "Geodesy and Cartography" major should be not so much a 'craftsman' in a particular specialization but rather a modern specialist with a general knowledge concerning various technologies of data measurement, processing and presentation for their appropriate selection and integration. Therefore, all students, regardless of the chosen specialty, should obtain the basic knowledge to prepare them for the proper design and resolve of any geoengineering problem in their future professional career [5]. In today's realities it is impossible to achieve such effect without supplementing knowledge transferred in the context of studies with the experience acquired during practical projects in cooperation with operators.

Consultation between lecturers – surveyors and commercial environment of geoengineering companies – is a matrix of good education of engineers. In the course of discussions with employers it results that the graduate who is educated in the mode of becoming familiar with software and hardware is finally an employee of worse quality and in the course of his professional development he can not get the position due to a well-educated engineer who is equipped with an appropriate knowledge. Therefore, it is important to enable students to learn how to use commercial software and modern equipment. However, the education of the surveyor should also be based on the student's familiarization with universal algorithms implemented inside commercial applications, procedures and rules of solving theoretical and field surveying tasks.

During the implementation of the various activities it was found that special support for teaching is the use (in the context of studies) of computer programs and software solutions arising in the course of university research projects or for the immediate needs of geodetic studies. Improving the quality of education can also be obtained by using the effects of implementation and presentation of projects realized under the partnership between the university and the prospective employer and in the course of researches conducted at the university as a research unit.

The article presents the classification of the software used in the teaching of geodesy on the example of the major of "Geodesy and Cartography" of the Civil and Environmental Engineering Faculty at the University of Gdansk. It was indicated the main advantages and disadvantages of the use of particular software suites in the context of the acquisition of both knowledge that practical experience and knowledge of the software normally functioning in the surveying tasks market.

2 PROPRIETARY SOFTWARE IN THE PROCESS OF STUDENTS EDUCATION

The programs used in the course of engineering higher education can be divided into three main groups:

- developers software: commercial software suites used today in the profession of surveyor and related fields;
- educational software: developed by didactic teams; it allows a broad analysis of the chosen problem, identifies issues that require extended reflection and introduction from the teacher;
- R & D software: created in the course of research and development at the university allows for the presentation of prospective solutions that do not exist currently in the profession of surveyor and may be prompted for the solutions used in the future

2.1 Developers software

Within the frames of the education at the "Geodesy and Cartography" major, computer classes are realized with the use of professional developer suites. At the Faculty of Civil and Environmental Engineering at the Technical University of Gdansk there is a one large computer lab (34 workstations) and 4 smaller (1 to 23 stations and 3 for 17 workstations). There are available, among others, full software package of Leica GeoOffice (for data transmission and processing from electronic measuring instruments and for the realization of geodetic calculations including GNSS (Global Navigation Satellite System)), Cyclone (to process data from laser scanning), PhotoModeler and PhotoModeler Scanner, workstations of Topcon ImageMaster and Dephos (for digital photogrammetry), TatukGIS editor, C-GEO software geodesic (as a standard in Polish surveying companies, available in the full version for each student). The faculty has also its own GNSS reference station [6]. Information Technology], together with the Leica Spider software in the full version) and the university has the satellite station of satellite images acquisition from meteorological satellites. Since 2013, there is a
unlimited type of license of Site type for ESRI ArcGIS software along with a suite of courses and trainings.


There is also MATLAB 2011b available (for numerical computation and data visualization - 35 licenses - the program is updated for each new version created during the term of the subscription agreement, renewed every 3 years). Students also use the wide set of software available through the MSDN library and open licenses including the Linux operating system and utilities as among others ILWIS, Lazarus.

The computer labs are also equipped with other programs dedicated to the fields of education existing at the Faculty of Civil and Environmental Engineering at the Technical University of Gdansk: "Construction" (civil engineering), "Environmental Engineering" and "Transport" [7].

The above mentioned software suites make it actually easy start for those graduates who want to expand their own skills with knowledge of the software. Purchase of current licenses, however, involves a large financial burden of the Faculty. Another problem is the limited access to training for teachers and hence despite the availability of software, it is not used correctly within its full scope. It also seems that too much depends on the individual skills of the person who runs concrete classes. It is also difficult to expect the teacher to move freely in several software suites and this is a clear signal to employers and software vendors to implement procedures in cooperation with the university to improve the efficiency and availability of programs by establishing cooperation and co-realization of trainings within the frames of studies or next to them.

2.2 Educational software

As part of own works of teachers and cooperation with external companies, it is possible to create programs that are not intended for commercial or professional solving of tasks and surveying problems. They also allow for the implementation of tasks that are important from the point of view of graduate education at the "Geodesy and Cartography" major.

At the Faculty of Civil and Environmental Engineering at the Technical University of Gdansk, there are two suites allowing to improve education in the field of photogrammetry and remote sensing [8][9]. For the didactic purposes, suites have been enriched with an electronic guide on how to use the software and in the theoretical part they refer to the current items of the Polish language literature in the field of remote sensing and photogrammetry (with reference to specific problems, chapters, and even formulas). It is important that the student could easily find a theoretical solution of problems, referring to recognized literature published in Polish language [10] [11] [12] or giving references to materials and articles available on the Internet. Educational suites have modular construction and they facilitate work with students and topics division in the individual laboratory classes.

2.2.1 TELEDETEKCJA (English: REMOTE SENSING) software suite

Software designed for the analysis of images and remote sensing of images allows you to analyze raster acquired in different spectral bands, mathematical operations (logical and arithmetic) in images, filter images, generate histograms, convert images to basic raster file formats, geometrization (basic geometric transformations) of images.

The program consists of the following modules:

1. Data import and export module:
   a. Data loading and saving in graphics formats: BMP Windows, JPEG/JPEG2000, GIF, TIFF/GeoTIFF.

2. Math operations module:
   a. logical operations (e.g. AND, OR, XOR, NOT) (Fig. 1),
   b. arithmetic operations (e.g. sum, intersection, brightening / dimming).
3. Filters module:
   a. Strengthening of the informational value of the image (low-pass filters, high pass filters, noise reduction filters - the median, sigma, Lee, Frost, Gamma-MAP, Fourier and others).

4. Spectral modelling module:
a. histogram (Fig. 2) and its equalization and stretching, narrowing, moving, fitting to analyze and combining images within different spectral bands.

5. Geometrization module:
   a. a change of image resolution (resampling),
   b. Images transformation options:
      i. single image transformation to the field / XY reference coordinate system with the method of least squares with the objective function \( vv \) = minimum with the use of various geometric transformation models
      ii. transformation of photo into the pixel system of the second photo.

6. Vectorization module:
   a. Length measurement,
   b. surface area measurement,
   c. drawing vectors with the option of saving vectors to the file.

2.2.2 FOTOGRAMETRIA (English: PHOTOGRAMMETRY) software suite

Photogrammetric software to realize the fundamental issues of digital photogrammetry allows for the development of aerial photographs from metric cameras, determination of the internal, mutual and external orientation of photos as well as absolute orientation of models, development of colour and monochrome images.

The program consists of the following modules:

1. Project module:
   a. preview of the photo and pyramid of images creation,
   b. project creation of opening:
      i. the program allows you to set up two types of projects: single-image or double-image,
      ii. each work with the program should begin by opening the existing or starting a new project (with the specification of its parameters),
      iii. each project has its own folder, the opening of which determines all the parameters associated with the project: title, time of last modification and creation, the names of pictures and their locations and the project type,
      iv. after opening the project, the software informs what is included in the project and what you can do more with the project (e.g. "Alpha" project is: two pictures [left, right], the internal orientation of the left is present, lack of right picture orientation, lack of absolute orientation),
   c. loading one image or one stereo pair of images (left and right),
   d. pixel coordinate measurement: module that reads on a regular basis the pixel coordinates of the image.

2. Module of the internal orientation of the image (the same for single-image and double-image project – each picture is developed independently).

3. Module of external orientation of images (available only when the elements of internal orientation are determined or provided and when the project is started for a single image).

4. Module of mutual orientation of images (available only when the elements of internal orientation are determined or provided and when the project is started for two neighbouring images – a stereo pair).

5. Module of absolute orientation of images (available only when the elements of internal and mutual orientation are determined or provided and when the project is started for two neighbouring images – a stereo pair).

Module of spatial modelling (available only when the elements of internal, external and mutual orientation are determined or provided and when the project is started for two neighbouring images – a stereo pair).

Main window of the program with the selection and preparation of the project is presented in the Fig. 3 and Fig. 4.
Fig. 3. View of the main window of FOTOGRAMETRIA software with left photo of stereogram loaded.

Fig. 4. View of the FOTOGRAMETRIA software window allows to realize the tasks related to the mutual orientation of photos.
2.3 R & D software

The tasks carried out within the framework of researches funded by state and EU institutions, or the projects implemented commercially for the needs of the economy are also use in the course of training students of geoengineering faculties. Through the creation of own - dedicated to specific projects – IT applications, it is possible to familiarize students with practical opportunities to use acquired knowledge and the results of scientific researches. The authors use this method to improve the quality of education practically since the beginning of the work at universities [4].

Below, we present a few examples of experiments concerning current implementations, whose inclusion into the learning process can improve the development and awareness of students.

The latest solution is the software which allows measuring the coordinates or the field length in the non-metric digital photos with reference to the principles of computer vision [13]. This software is an effect of evolution of the doctoral dissertations approach and the experience acquired in creation of 3D objects models with the use of close range photogrammetry [14].

As part of own works, the software for smartphones was established. It allows to calculate the terrain surveying [15]. The application allows the adjustment of railway tracks, based on geodetic measurements was established upon outside ordering party [16].

Authors also participate in projects for the purpose of which the smaller suites of software are created. They can be used to familiarize students with the essence of the problem or detailed task. In recent times, the software which enables the reduction of the data dimension was created (here: the transition from 3D to 2D), i.e. the transition from surface analyses to the reduced 2D charts. This approach was used by authors in the analysis of cliffs [17], as well as in studies of geometry of roofs, made of technical fabrics. This approach is an extension of earlier works, referring to the analysis of numeric terrain model [18] [19].

In works performed with students it is worth to refer to IT systems that arise for companies within the framework of economic cooperation and help students to identify the necessity to understand not only the principles of operation of the software, but especially the weight of the knowledge that is necessary to create or co-create a fully functioning systems, e.g. concerning the spatial analyses [20-22].

3 CHANGES TO THE CONCEPT OF TEACHING GEODESY

The collected facts and statements after being confronted with the current state of geodesy education in an environment of geoengineering disciplines have contributed to the formulation of the postulate of teaching concept modification. The authors have indicated previously [4] the necessity to increase the number of hours devoted to exercises or laboratories at the cost of decreasing the number of hours devoted to the lecture part. Since this time, it was possible to slightly improve this ration and implement the cooperation with companies and geodesic institutions. It seems to be especially valuable the experience based on incorporating students into the process of research and development and the creation and use of proprietary software created for the purpose of teaching and researches.

This often means a significant change in teaching philosophy at the major of "Geodesy and cartography". The weight of the knowledge presented during the lecture should be postponed for the duration of classes and laboratories and lecture hours may be the time to realize the mission of teaching the geodesy in the environment of related engineering disciplines. The mission of teaching geodesy should be understood as the promotion of surveying towards the solutions of highly specialized problems that will be certainly met by graduates in the course of their professional career. The superior goal is to show the possibilities of geodesy and to notify future engineers the sources of solution to their problems related to measurements or analyses. At the same time, lectures should be not only the immediate introduction to exercises, but in some part they may become the source of knowledge which is indeed the author's knowledge, transferred by both the authorities of the surveying branch and people connected with geodetic production and offices during their regular working days. Lectures allow for the implementation of sensitization and mutual understanding of the needs arising from the collaboration of engineering discipline experts (i.e. the cooperation at the stage of studies) with experts in geodesy-related fields of engineering. Thus, for example, it seems to be intentional to present the constructional investment process on the background of the legal aspects and
consequences of this or student preparation to create an algorithm that will be understandable and workable by computer software engineer.

4 SUMMARY AND RECOMMENDATIONS

Considering the advantages and disadvantages resulting from the use of the software in the course of education at technical studies, it is necessary to continually keep in mind the training of modern engineering staff who will have the ability to appeal both to knowledge and, second, to practical solutions. It seems right that the education of students should be based on the use of the software only as a tool allowing to gain new and deeper areas of knowledge, emphasis on the practical application of knowledge and collaboration with experts from other research centres realizing the surveying studies and cooperation with commercial entities. Maintaining a sensible balance between the parties of such a course of training will lead to the promotion of engineers who are able to take up the challenge of work at the highest level, expected by the economy and science.

Modification of the education system generates advantages that include:

- emphasis on implementing methods that activate the teaching process;
- combination of theory and practice into one block of practical teaching;
- allowing for natural selection of students for a group of people interested in deeper knowledge and skills and average students avoiding mental effort;
- increase and stimulation of students’ interest as a result of the presentation of the effects of teacher’s own work when realizing the practical solutions (for the economy or within the frames of the study);
- being outside classrooms and breaking the stereotype of the presence inside the walls of the university.

Such attitude also involves the negative elements such as:

- non-uniformity in the implementation of the content of the geodesy subject, e.g. due to the personal factor of lecturer;
- increase the range of exercises and laboratories;
- increase of education costs.

However, it seems that especially the use of proprietary didactic software and research and development software in conjunction with the developer software can significantly improve the quality of education and deepen the effect of well-established knowledge of "Geodesy and Cartography" major’s graduates. And this effect entails better job prospects and salary for a graduate, which can be directly translated into the assessment of studies quality and level of education.

REFERENCES


