THE CHOICE OF EXERCISES ON TECHNICAL GRAPHICS AT THE SPECIALIZATION OF GEODESY AND CARTOGRAPHY

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Abstract. The paper presents the contents and methods of teaching the technical graphics module (TGM) within the frame of the subject Technical Graphics and Elements of Descriptive Geometry The subject has been taught at Geodesy and Cartography, Faculty of Civil and Environmental Engineering at Gdansk University of Technology, since 2009. The module's two main objectives are: 1) to develop students' skills in creating standardized and conventional geodetic technical drawings and 2) to enable work with different engineering documentation during geodetic surveys. The whole course and modules are under constant monitoring what allows identification of both their weaknesses and advantages. This paper describes the evolution of TGM module in terms of course content.

Keywords: Engineering graphics, geodesy and cartography, education

1 Introduction

The tree-year programme of Geodesy and Cartography prepares individuals to work as geodetic surveyors. Technical Graphics and Elements of Descriptive Geometry course is based on defined requirements [1] and it is divided into two modules: 1) descriptive geometry relating to solving spatial problems within the perspective, Monge projections, topography issues and 2) technical graphics (TGM), which is widely presented in this paper. The main objectives of TGM are to teach students to:

1 prepare geodetic sketches for different surveying purposes,
2 interpret technical drawings, charts, and graphs,
3 use different techniques in drafting (freehand, mechanical and with computer applications),
4 present the basis of AutoCAD software C-geo software,
5 read and understand architectural, building and construction documentary,
6 participate constructively in a team engineering activity.

The rich contents made it difficult to deal with and select the focal points of the contents. A set of exercise sheets was elaborated to cover the main topics presented in Table 1. The module is constructed in such a way that as many topics as possible are repeated within the following exercises and labs. The same skills are also mastered using different techniques in drawing. The balance of the content is still being improved.

All exercises and lectures are based mainly on geodetic instructions [4,5,6], and professional literature [1,2,3].

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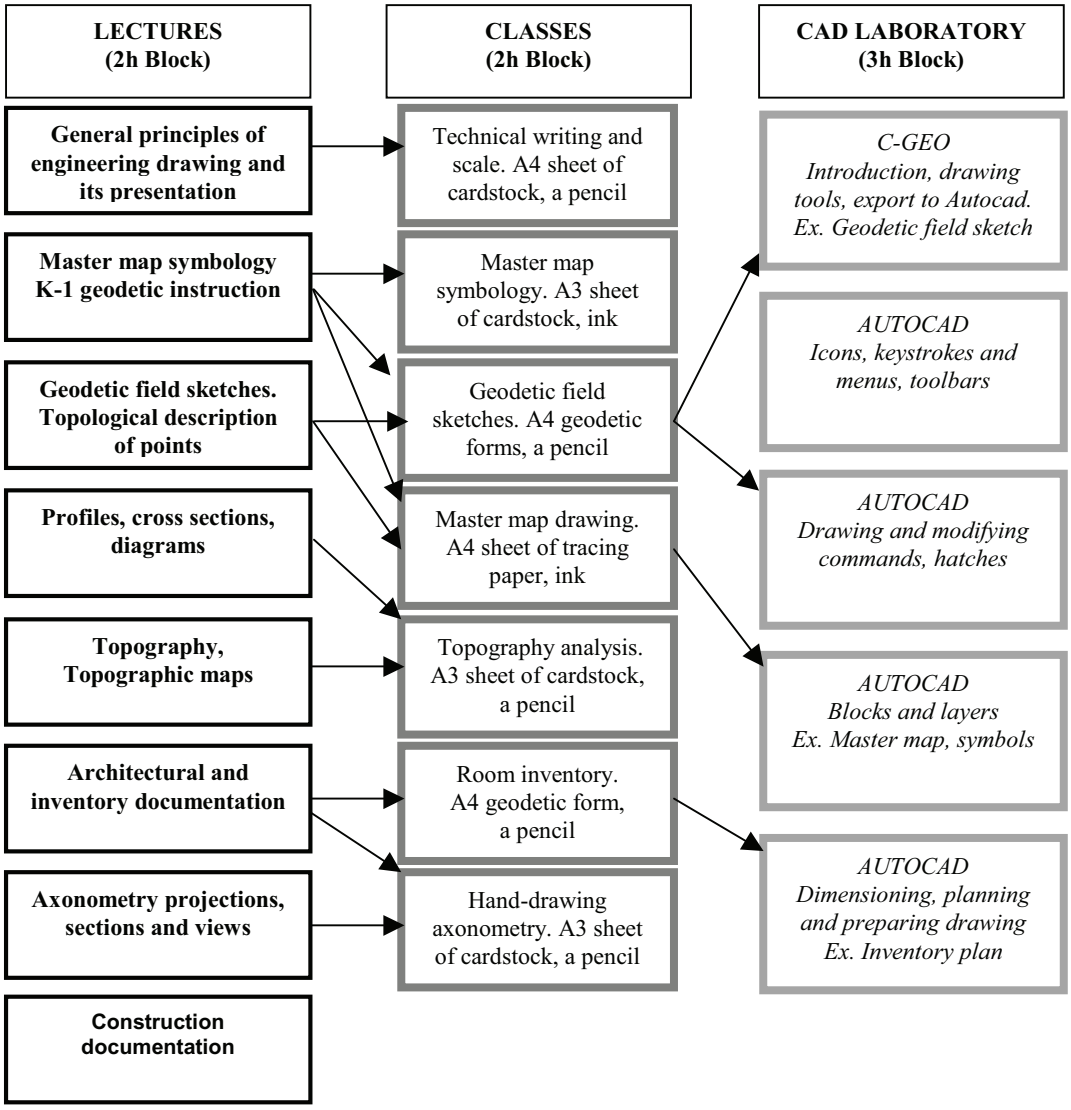
Table 1: TGM module contents and its contents network

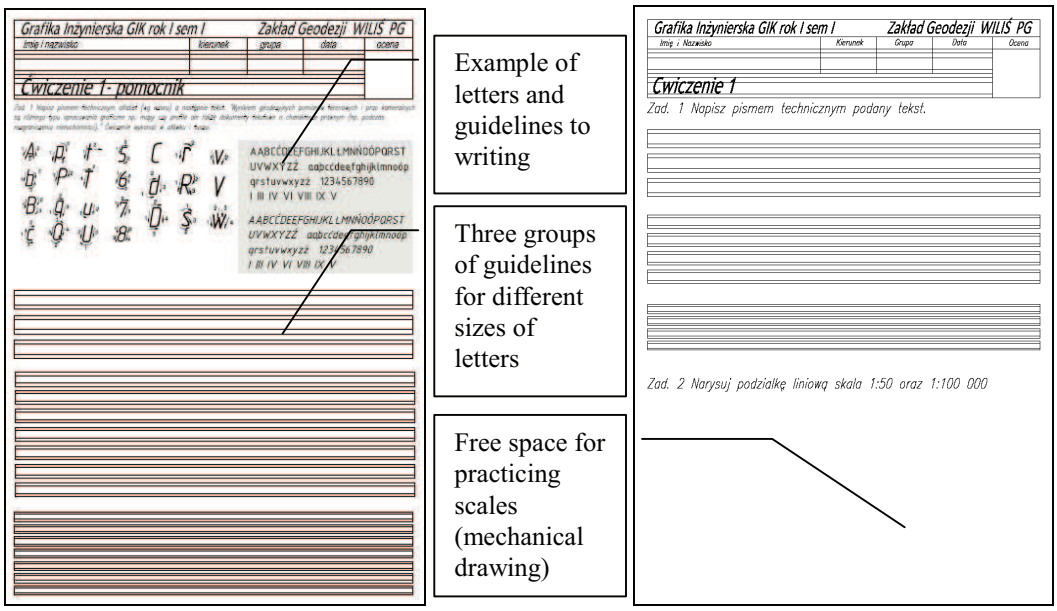


2 Technical Graphics Module Contents

2.1 General principles of engineering drawing and its presentation

The first lecture introduces the basis for technical drawing such as sheet formats, thickness and types of line, dimensioning rules and schemes, scale of the drawing. The exercise paper is devoted to practical technical writing. Students are to fill the A4 white block paper (see Figure 1) with the text using different styles, size of technical writing as well as different writing tools (an ink pen and a pencil). The evaluation of the exercise is based on aesthetics and correctness of the letter shape and size.

The experience indicated that at least two sheets of paper should be written in order to exercise the handwriting and to remember the shape of the letters. Thus, students were obliged to fill the additional paper, which was done as homework and not assessed. What is more, in most cases left-handed students had problems with writing technical letters. The problem especially occurred while writing with an ink pen. Thus, additional introduction how to properly hold the paper and the writing tool for this group of students was made and now is added in lectures of the contemporary course.



A) B)

Figure 1: Technical writing. A) A self-practice technical writing sheet given before lectures. It includes the three types of letter size lines and also presents shapes and way of writing, B) class sheet paper

2.2 A master map and its symbols

Master maps, their contents, drawing symbols and graphical rules are the subject of the next section of the module. Information is based on K-1 instruction [4]. The main emphasis is put on proficient use of instruction: finding the proper symbol according to the scale, interpreting it and putting down correctly according to the required scale. Previously students were to fill the paper with required symbols and write an explanation of its meaning using technical writing. The exercise was found too long for the two-hour class and had to be finished at home. Thus the new exercise was introduced. Students train the symbols by creating the legend to a given copy of a master map's fragment using the K-1 instruction. The exercise is done by one student but two students are given the same exercise sheet. This should encourage them to discuss their interpretation of the symbols and help each other to draw the legend. However, the experience of previous year proved that two-hour class is not enough to memorize all the symbols. Students get familiar with the contents and the scheme of the instruction K-1 and at the same time practice technical lettering. The process of mastering the acquired skills is continued during the next lectures and classes devoted to geodetic sketches.

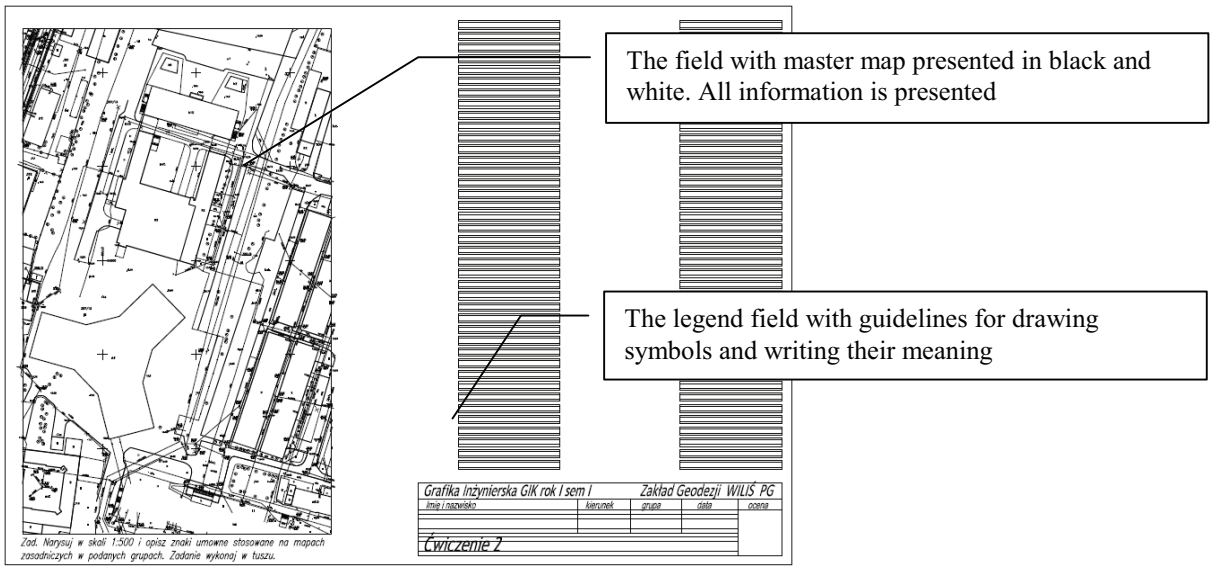


Figure 2: Master Map - the example of the exercise sheet including a fragment of the master map and guidelines for drawing and writing the legend

2.3 Geodetic sketches

Different kinds of drawings used in geodetic survey are presented. Students are familiarized with the contents, standards and form of drawing field sketches, topological description of the point, graphs and profiles of the terrain. Almost all examples are based on real sketches. Prior to practical classes students were to draw a sketch of the terrain at home. The task was to draw the sketch of any terrain of a maximum surface of 100m×100m. Students had to compose the paper and present the terrain by symbols learnt during the previous class. The first exercise on sketches involved redrawing the previously prepared sketch using standardized symbols. The exercise allowed students to verify their homework and improve their sketches by themselves.

During the next class students were instructed how to add dimensions to the sketch acquired in geodetic survey. As the ability of surveying is not the subject, after the explanation how to put down the measure dimensions on the sketch, students had to redraw the full field sketch with measurements.

The next course innovation is a ready sketch given to students instead of assigning it as their homework, which used to be forgotten. What is more, the task is to redraw and divide the contents of a given sketch into two sketches and prepare an additional comprehensive one. The aim of this exercise is to learn how to correlate the surface of the terrain and the amount of information with the number of sketches and to apply the knowledge of symbols.

After this exercise the additional sketch is to be drawn by students as homework. The area to be covered by the sketch can be chosen by students or given by the teacher. During this exercise students practice to scale the area and compose it properly on the sketch sheet using master maps' symbols.

The next step is based on the previously redrawn sketch. The task is to draw the given information in scale as a map. The mechanical drawing is done with the use of an ink pen and a sheet of tracing paper. Students gain the new experience of drawing on tracing paper. As the drawing is based on their previous work they find out how detailed measurements are required as well as the fact that aesthetics and the clarity of the sketches and maps are important. During this class students also practice the symbols and basis for drawing simple maps.

2.4 Topography

The next section is devoted to topography, topographical maps and symbols used for presenting topography based on map's legends and an instruction [5,6]. Students also gain the ability to interpret the shape and features of the terrain and their depiction in maps. The graphic representation of the landform on a map is introduced. Reading the distance between two points, terrain slope, drawing slope lines and izolines are introduced as well as graphical methods of interpolation and drawing profile. The exercise paper consists of exercises devoted to the elements mentioned above (see Figure 4).

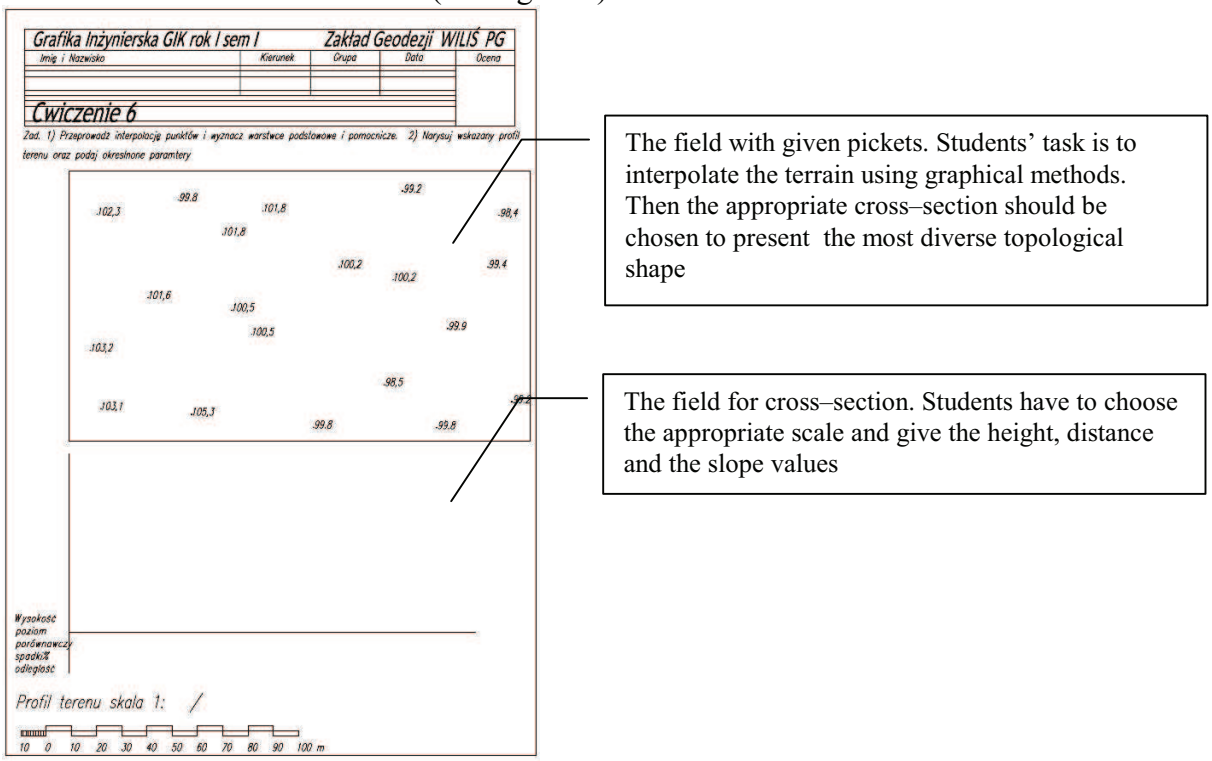


Figure 3: Topology - an example of an exercise sheet including following tasks to be solved: an interpolation, a cross – section of the terrain with calculating parameters: height, distance, slope, scale

2.5 Architectural, building and construction documentation

Geodetic surveying is strictly connected with engineering surveying of man-made structures such as buildings, bridges, tunnels, roads and others. The survey includes reconnaissance, preliminary, location, and layout surveys. Thus the ability of fluent working with different sorts of structure documentations is necessary and obligatory. What is more, the effective communication among specialists in different fields during the process of surveying and documentation is also essential

Thus, students learn to read different types of documentation sheets of engineering buildings [3]. They get familiar with sets of rules of architectural, building and construction drawings. Students learn also to read details of building plans and cross sections as well as architectural details. Additionally, a simplified representation of reinforced concrete, metal construction and drawings for the assembly of prefabricated structures are also presented.

2.6 An architectural inventory

In order to improve work on architectural documentation, students proceed and prepare documentation project of a small part of the building. The lectures present elements of the building that should be measured and the methods of measurements as well as the way of placing dimensions on the drawing. The classes' aim is to put into practice rules of making

architectural inventory drawings and documentation. During the practical class students make the inventory of simple rooms using Disto for acquiring measurement data. They practice hand-made sketches of plans and cross sections, dimension lines and put down the results of measurement data. These sketches are used later for practicing CAD laboratories.

2.7 Axonometric projection

The next section is devoted to axonometric projection and the basis of sketch drawing, which presents more than one side of the object, thus is useful for purposes of illustration. Three main types of axonometric projection: isometric, diametric and trimetric projection are presented. The aim is to practice sketch drawing of building elements, objects. Previously, this part of the course was followed by lectures devoted to reading architectural and construction documents. The innovation here is the change in the order of subjects. Students learn to read architectural and construction drawings first and then the axonometric projection is presented. This change enables students to understand building construction and architectural issues better by practicing axonometric projection and drafting. It also prepares students adequately for architectural inventory. All drawings should be done manually with the focus on visual accuracy. The visual accuracy is achieved by using different linestyles for help lines and main lines. What is more, the corners should be sharp and without overlap. The usage of basic shapes and forms for the construction of solids is required. The construction of penetration of solids should remain visible. It is required to ensure a pleasing drawing composition and layout.

3 Summary

All the sheets and works are based on real geodetic problems which should promote the interest in graphic education among students. What is more, the connection between the successive exercises indicates to students their progress or weaknesses in the spatial usage of their knowledge and allows them to practice their skills. This way of gaining knowledge also helps them to understand the responsibility for a good drawing. Working in groups on some tasks (e.g. architectural inventory) lets students gain social responsibility and practice communication skills based on graphics. Compared to other universities the TGM is more expanded than other courses. Apart from doing typical geodetic drawings students also acquire the basis for reading building, construction and architectural documentation. Their basic preparation, from graphical point of view, to other tasks within other courses is rated highly. The following professional development of their skills is continued during other courses such as geodesy and surveying, cartography or photogrammetry.

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[6] Instrukcja techniczna. *Wzory i objaśnienia znaków umownych i napisów stosowanych na mapach topograficznych w skalach* 1:5 000 *i* 1:10 000 (Patterns and explanations of conventional signs and symbols used on topographic maps in scales 1:5 000 and 1:10 000).

WYBÓR PRZYKŁADOWYCH ĆWICZEŃ Z GRAFIKI INŻYNIERSKIEJ REALIZOWANYCH NA KIERUNKU GEODEZJA I KARTOGRAFIA

W artykule zaprezentowano treści i metody nauczania modułu grafiki inżynierskiej (Technical Grafics Module) realizowanego w ramach przedmiotu *Grafika Inżynierska z Elementami Geometrii Wykreślnej*. Przedmiot jest nauczany na kierunku Geodezja i Kartografia na Wydziale Inżynierii Lądowej i Środowiska w Politechnice Gdańskiej od 2009 roku tj., roku uruchomienia nowego kierunku. W ramach modułu grafiki realizowane są następujące cele: 1) rozwinięcie umiejętności studentów w zakresie tworzenia i opracowywania rysunków geodezyjnych zgodnie ze standardami i z wykorzystaniem odpowiednich narzędzi; 2) wykształcenie umiejętności czytania i interpretowania dokumentacji technicznych budowlanych, architektonicznych i innych wykorzystywanych w pracy geodety. Zarówno kurs jako całość, jak i poszczególne moduły są monitorowane, co pozwala na identyfikację jego mocnych oraz słabych stron. Pozwala to na bieżące wprowadzanie zmian usprawniających proces dydaktyczny, które zostały również przedstawione w niniejszym artykule.

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