

## PREPARATION OF DESCRIPTIVE GEOMETRY COURSE IN ENGLISH

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**Abstract:** The transformation of the educational system and adaptation to European standards, resulted in developing range of studies in English in many universities of technology in Poland. In recent years, foreign students coming to Poland were usually students of higher semesters, hence they had already completed Descriptive Geometry or Engineering Graphic courses before they came. However, permanently growing offer of undergraduate studies for foreign students, as well as demand for studies in English for native students, allow to predict, that they will become common in short time. Teaching Descriptive Geometry or Engineering Graphics in English language will soon become standard.

**Keywords:** engineering education, descriptive geometry

### 1 Introduction

Due to a year-stay of foreign students from Spain at the Faculty of Civil and Environmental Engineering in Gdansk University of Technology in academic year 2010/2011, there was a need to develop an appropriate Descriptive Geometry course. According to the students expectations, the course should include extended content and be conducted in English. The preparations for the course covered the selection of topics of lectures and translation of the course-content into English. Despite prior knowledge of English vocabulary for geometry, translation of lectures and conducting classes proved to be a challenge.

The article presents remarks arising from practical experience in translation and work with the students in class. While searching for the appropriate scientific terms of strict geometric construction, it appeared essential to use the English-language literature. Unfortunately, English textbooks on Descriptive Geometry, available in the library of Gdansk University of Technology are volumes dating back on the early twentieth century, there have been no contemporary works. The variety of records used in geometric constructions in different countries is also related to historical circumstances.

Students taking Descriptive Geometry courses in English language may come from different countries and have various experience or interest related to the graphic methods of solving practical engineering problems. It may also happen that the number of ECTS credit points required to complete the course differ according to universities syllabus. Therefore, the offer of Descriptive Geometry course for foreigners should be flexible in order to adapt to the needs and interests of students. The students visiting Gdansk University of Technology wanted to practice particular topographic projection, geometry of roofs and perspective. Since the course took into account the interest of students and covered a wider than usual scope of program, it was named an extended course.

## 2 Available Descriptive Geometry Workbooks in English

The materials available in the university library and on the website can be divided into 4 categories: open-source old classic workbooks, descriptive geometry websites, videos and modern textbooks.

Despite the available technology, it is rarely possible to find a video on the appropriate level. Websites are often fragmentary presentation of lectures containing mostly pictures and little text. On some of the pages that have already been subject of translation from national languages into English, sparse inconsistencies in the names of geometric constructions were encountered. Therefore, in order to seek the most correct and precise terms, only the books originally published in English speaking countries were taken into account.

Fortunately, browsing the network many free old geometry textbooks are available, mostly American, not too many from England.

As we know, descriptive geometry has grown from the need to improve construction work, namely cutting stones for the building and construction of vaults. Both issues were resolved by two Frenchmen: Girard Desargues and Amadeo Francesco Frezier. Further development of the geometric theory was brought by another Frenchmen Gaspard Monge. His lectures in the Journal of The Ecole (1795), and then workbook (1799) gave the foundations of descriptive geometry [3]. Immediately the engineers and educators saw the potential of the projection methods, and soon in many countries, the first textbooks in national languages appeared: firstly in Russia, USA and Spain, and finally in Norway and the United Kingdom [6].

In America, the first to introduce descriptive geometry textbook was another Frenchman Claude Crozet, Monge's student [3]. The book presented his own interpretation of Monge theory, which he studied at the Imperial Artillery School in France. Some years after his graduation he resigned from military duty and moved to the United States. Almost immediately after arriving to the USA, Crozet began to work as a professor of engineering at the U.S. Military Academy at West Point, New York, where he taught descriptive geometry. Thus the title of the textbook was *Treatise on Descriptive Geometry for the Use of the Cadets of the United States Military Academy* (1817). One of the editions of this manual is available on the Internet, but the advantages of this publication are more historical than educational. Layout of the book is typical for all of the old classic workbooks, the explanations gathered in the following paragraphs refer to the drawings posted at the end of the book.

The list of early American textbooks for Descriptive Geometry which are available on the Internet is long. (Table 1) It can be assumed that each individual professor conducting courses on descriptive geometry wished to develop or give his own interpretation of Monge science in the form of their own textbooks.

This is not surprising, as such phenomena occurred in the other countries. In Poland in the first period of development of the science (1795-1851) at least 10 textbooks were issued [6]. Also later in the 70's of twentieth century distinguish professors of the Lviv Polytechnic School wrote their own textbooks which became the basis for the whole post-war engineering education of this subject in Poland.

In England descriptive geometry textbook appeared as the last in Europe. The first textbook was written by Greinger Thomas Hall entitled *The Elements Of Descriptive Geometry, Chiefly Designed for Students in Engineering* (1841). [3] It might be surprising that a textbook dealing with such an important subject, was published in England so late. Still it should be noticed that initially geometric knowledge was related to the military systems and considered as a secret. What is more in England it was associated with Freemasonry [3]. Additionally it also might have been hindered by relatively late implementation to technical

education. Such a late introduction of descriptive geometry in England might have occurred because it was considered as too theoretical and not enough pictorial. Consequently, it could possibly have adopted better if it had been presented in the form of more visually attractive pictures. Such view may be confirmed by the fact that methods of visualization were soon developed in England. At the technical universities in England besides Monge projection two other projection systems were also taught.

One of more pictorial systems of projection was Isometric Perspective of Wiliam Farish, a professor at the University of Cambridge. The second was a technique known as „British System of Projection” invented by Peter Nicholson, an architect and mathematician. In this system (later called Parallel Oblique Projection), to the usual orthogonal views of the object its oblique axonometric view was added. This view was obtained by the introduction of additional oblique reference plane [3].

It seems that also for the professors working in England it became important to add their individual contribution to the development of descriptive geometry. Such an approach was reflected in the structure of textbooks with large sections of isometric projection. However technique of Nicholson did not spread over the years and is weakly known in Poland.

Table 1: Selected American classic workbooks available on Internet or at the library of GUT

Author	University	Title	Edition
Crozet C.	University of Michigan	Treatise on DG for the use of the Cadets of the United States Military Academy	New York 1821
Warren E.	Rensselaer Polytechnic Institute	General Problems from the Orthographic Projections of Descriptive Geometry	New York 1860
Church A. E.	US Military Academy	Descriptive Geometry and Shades & Shadows	New York 1867
Mahan D. H.	US Military Academy	Descriptive Geometry as Applied to the Drawing of Fortification and Stereotomy for the Use of the Cadets of the US Military Academy	New York 1864/1868
Smith F. H.	Virginia Military Institute	Elements of DG with its Applications to Shades, Shadows and Perspective and to Topography	Baltimore 1868
Young G. Baxter H. E.	Cornell University Cornell University	Descriptive Geometry	New York 1921
French T. E.	Ohio State University	A Manual of Engineering Drawing for Students and Draftsmen	New York London 1929
Bradley H. C. Uhler E. H..	Massachusetts Institute of Technology Lehigh University	Descriptive Geometry for Engineers	Scranton, Pennsylvania 1937
Pare E.G. Loving R.O. Hill I. L.	Washington State University Illinois Inst. Of Technology	Descriptive Geometry, Metric	New York, 1977

### 3 Differences Between American and Polish Textbooks

The differences appearing in the textbooks stem from a slightly different development of descriptive geometry as a science and an academic subject in each country. They relate to the visibility, notations and approach to selected types of projections. Some features of American textbooks distinguishing them from the Polish manuals are enlisted below.

#### FOLDING LINE BETWEEN REFERENCE PLANES

The central part of the drawing in orthographic projection, from which we start construction is the folding line between two reference planes. In Polish textbooks it is called the axis and marked eg.  $x_{12}$ , where the numbers apply to the planes of reference. In American textbooks it is marked as RL1, RL2 – as shortcut of Reference Lines with successive numbers [1], or as HF meaning folding line between Horizontal – Front reference planes [5]. Top and front view are commonly called Plan and Elevation [3] (Fig.1, Fig.2).

#### NOTATIONS OF OBJECTS

Points in space are usually marked with capital letter: eg. A. Since a plan is drawn on a horizontal plane, the plan view will be indicated by the small letter h used as an index:  $A^h$  [1]. For a change, in other textbooks the views of the points are marked with small letters  $a^H$ . However the index of the view is marked only for one point of the object, as a result other points are signed identically on more than one view [5] (Fig.1, Fig.2).

#### ADDITIONAL NOTATIONS, (Fig.1, Fig.2)

Specific location of geometric elements such as edge or true-length view of line or plane are not marked in the drawing, students must notice those dependencies themselves. In American textbooks shortcuts are often used to show natural size: TL-true length, EV- Edge view, TS - true size of the polygon. Transferred dimension value is often marked as D [5] (Fig.1, Fig.2).

#### DETERMINATION OF VISIBILITY

Originally in Monge theory the visibility of the object was set according to the first angle/quadrant method. A line was drawn cross the middle of the drawing, the plan was placed in front of this line and the elevation above the line. However in American textbooks determination of visibility established by the third-angle/quadrant method is prevailing. In this case reference planes are placed in front of and above the object.

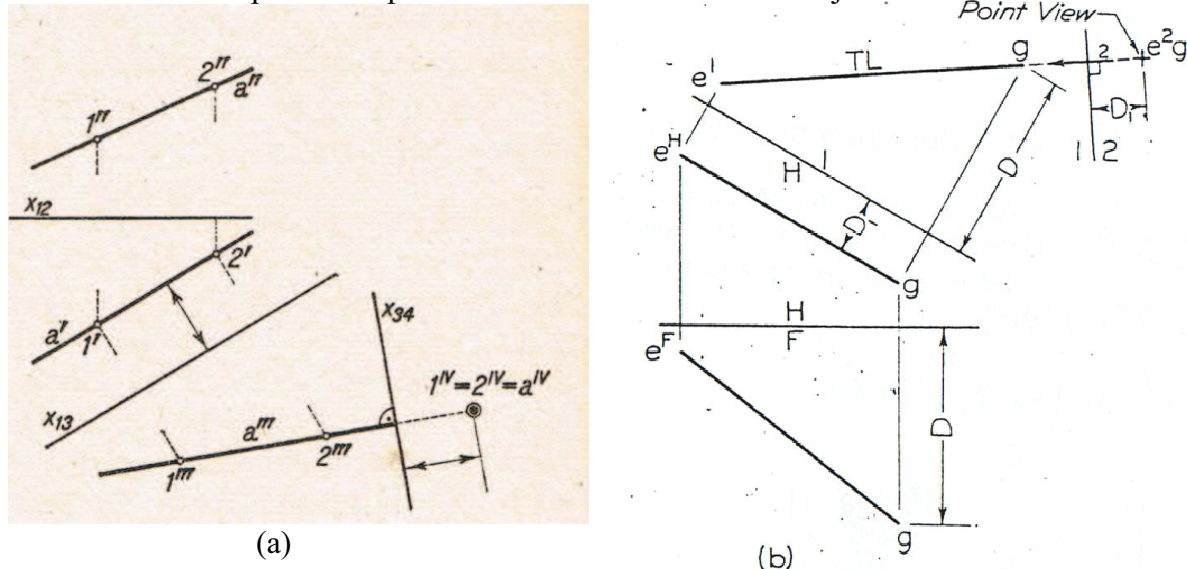


Figure 1: Comparison Polish-American workbooks: Point view of the line (a) [4], (b) [6]



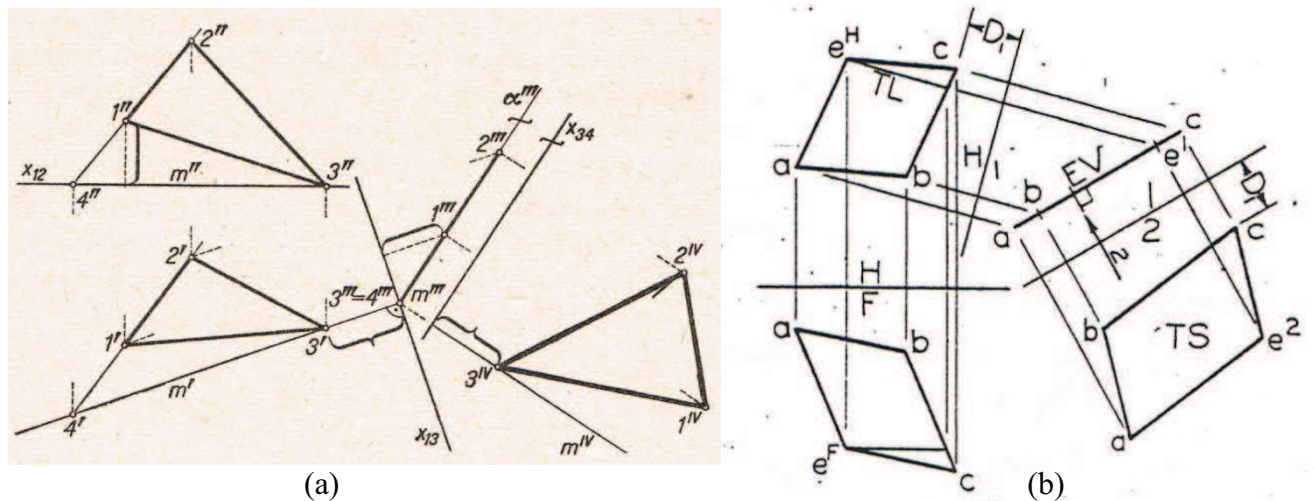


Figure 2: Comparison Polish -American workbooks: Normal view of the plane (a) [4], (b) [6]

#### APPROACH TO TOPOGRAFIC PROJECTION

In American, unlike in Polish textbooks, topographic projection is not treated as a separate technique, but just as an orthographic projection on two reference planes: horizontal and profile planes. Usually only the topographic surface, its profile and the construction of fills and cuts are presented. Various names are used such as: topographic, horizontal, marked projection and the first one seems to be the most appropriate. A plane is defined as two intersecting lines: strike line (horizontal line oriented to a north-south direction) and dip-line (the line showing a decline of the plane) (Fig.3). Planes are not presented as a system of contours, the contours are only used to define topographic surface.

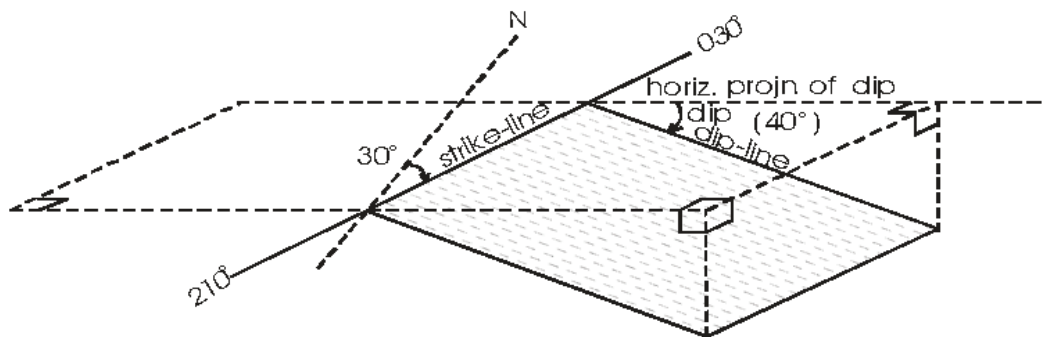


Figure 3: American workbook: description of the plane for topographic drawing [2], p.4

Our Descriptive Geometry courses usually contain topographic projection as a separate unit, moreover the introductory didactic materials give ideal foundation for further, more complex operations. This is the result of historical development of descriptive geometry in our country related to the improvement of didactic and methodological solutions. It seems to be our duty to promote this achievement as the Polish contribution to world's development of descriptive geometry.

#### 4 Conclusions

Preparing own teaching materials for descriptive geometry course for foreign students it is natural to search for proper names of constructions in original books in English. These books are mainly American publications, as in the USA descriptive geometry was implemented

earlier and there is a wider range of workbooks. However, the drawings in these books present different notations and visibility than those traditionally used in Poland.

It is very important that in all Polish universities of technology proper geometric terminology and ways of explanation are used. It would be beneficial if we could share our experience in teaching Descriptive Geometry in English and make sure that we all use the same terms and notations for the same constructions.

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## PRZYGOTOWANIE KURSU GEOMETRII WYKREŚLNEJ W JĘZYKU ANGIELSKIM

W wyniku transformacji systemu kształcenia i dostosowywania do standardów europejskich, w ofercie edukacyjnej wielu uczelni technicznych pojawiają się studia w języku angielskim. Odwiedzający nas w ostatnich latach studenci zagraniczni przybywali zwykle studiować na poziomie magisterskim na wyższych semestrach, a co za tym idzie wcześniej ukończyli już kursy geometrii wykreślnej i grafiki inżynierskiej. Obecnie jednak stale rosnąca oferta studiów na poziomie inżynierskim dla obcokrajowców, a także popyt na studia w języku angielskim dla rodzimych studentów, pozwala przewidywać, że w krótkim czasie staną się one powszechne. Nauczanie geometrii wykreślnej czy grafiki inżynierskiej w języku angielskim stanie się wkrótce standardem.

W artykule przedstawiono spostrzeżenia wynikające z doświadczeń własnych uzyskanych podczas przygotowania do wykładów i ćwiczeń prowadzonych w języku angielskim oraz pracy ze studentami obcokrajowcami. W poszukiwaniu odpowiednich ścisłych nazw konstrukcji geometrycznych nieodzowne stało się sięganie po podręczniki anglojęzyczne, w których przyjęte opisy symboliczne oraz założenia do oznaczania widoczności różnią się od tradycyjnie stosowanych w dydaktyce przedmiotu w Polsce. Ta różnorodność zapisów konstrukcji geometrycznych stosowanych w różnych krajach jest związana z rozwojem dziedziny i uwarunkowaniami historycznymi, których znajomość pozwala je łatwiej zrozumieć.

