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Engineering Graphics Courses in the Light of the National Qualifications Framework

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Introduction

In recent years major changes have been introduced into the system of higher education in the common European Higher Educational Area (EHEA). On account of the Bologna Process the EHEA is leading to greater compatibility and comparability of the systems of higher education and is making it easier for learners to be mobile and for institutions to attract students and scholars from other continents.

In 2011, the Law of the Higher Education (Dz.U. No 84, poz.450) in Poland has implemented the 'National Qualifications Framework' (NQF) which assumes that the education in each of the EU countries is transferable and that every student gets the right, with no further conditions, to continue his/her studies in any other country within the community. The main assumption of the NQF is to develop and/or to re-construct the curricula by defining and taking into account the **learning outcomes** (Próchnicka et al., 2010). According to the NQF new curricula must be implementing **competence orientation** into programs. The **qualifications** necessary for contemporary graduates have been defined and classified in order to eliminate the content, which is no longer up-to-date, from the curriculum. The main advantage of these re-defined curricula in terms of learning outcomes is their transparency. Basically, the method 'bottom-up' has been implemented for the existing curricula reconstruction while the method 'top-down' was used to create new modules and subjects. The deadline for delivery of the new definitions of curricula at Polish universities has been set for October 1st, 2012.
The main assumptions for the curriculum construction according to the NQF are as follows (Report, 2010):

1. **educational objectives** are uniquely defined for a **major** (faculty), a **field**, a **specialty**, or a **subject**;
2. **learning outcomes** are classified in terms of various types of education: generic, field, and specific; **they** have been divided into three categories (EQF_LLL08a, 2008): **knowledge**, **ability** and **competence**.
3. **framework qualifications** have been classified (EQF_EHEA05a, 2005) into three cycles when the students are able to: **demonstrate knowledge** and **understanding** in a field of study; are able to **apply knowledge** and understanding to their work and vocation; have the ability to **gather and interpret relevant data**; can **communicate ideas**, i**nformation**, problems and have the **learning** skills. The NQF defines three various cycles of qualifications: level I – relates to qualifications received after

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graduation from the 1st level of studies (Bachelor degree, engineer); level II – completion of studies at the 2nd level (MSc), Level III – graduating from the PhD study level.

All these guidelines are crucial both in context of determining the syllabuses of newly designed subjects and re-modeling the existing programs. In this paper we describe two graphics courses: 'Technical Drawing'(TD) and 'Descriptive Geometry' (DG) which belong to a freshman level studies in Poland. Modifications introduced to the courses have directly resulted from the NQF recommendations.

Syllabuses and the Educational Objectives

The educational objectives for two of the mentioned graphics courses have been listed in Table 1. At the faculty of Civil Engineering, Cracow University of Poland, the total number of hours carried out in a classroom as a face-to-face instruction equals 30 for each of the DG and TD courses, while the workload resulting from the ECTS points respectively corresponds to 90 (for DG) and/or 60 (TD- regular studies) hours—see Table 2. The part of work includes studying online (blended) instruction. Both design projects and online content study is done at home individually by each student. This is especially important to the students who study in a system of 'distant' (extramural) studies, which in practice means that the classroom instructions are delivered during the sessions over the weekend days every second week.

Table 1. Educational objectives for graphics courses*.

Descriptive geometry course	Technical drawing course
Introduction of basic representation methods used in engineering practice in order to graphically describe three-dimensional (3D) objects on a two-dimensional (2D) plane.	Introduction of basic principles and terminology used for preparation of technical documentation in accordance with applicable standards. Designations and dimensioning on architectural and building drawings are introduced.
Introduction of the methods used in order to correctly read 2D technical drawings and to restitute spatial models in a 3D space.	Introduction of basic principles and terminology used for preparation of **reinforced** structures
Introduction to theory on spatial relationships between the planar and spatial elements of 3D constructions.	Introduction of basic principles and terminology used for preparation of **metalwork** structures.
Development of spatial visualization abilities.	Introduction of basic principles and terminology used for preparation of **wood** constructions.

* http://newsyllabus.pk.edu.pl/

Definition of the Learning Outcomes for Graphics Courses

The final evaluation of the performance on the graphics course consists of a few components. These are: 1) evaluation of the design projects delivered in a form of

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Table 2. TD and DG courses: Balance between classroom hours and students' individual work.

	Type of Activity:	Number of hours assigned to activity			
		DG: Regular studies	**DG: Distant Studies**	**TD: Regular Studies**	**TD: Distant Studies**
Contact-hours	Classroom hours (lectures & labs)	**30**	**30**	**30**	**30**
	Office hours	**7**	**5**	**0**	**0**
	Partial and Final Exams	**3**	**0**	**0**	**0**
Self-study	Self-study hours	**10**	**15**	**5**	**15**
	Results' elaboration	**0**	**0**	**0**	**0**
	Project's elaboration	**30**	**30**	**25**	**35**
	Online-content studies Moodle	**10**	**10**	**5**	**10**
Overall number of hours assigned to a subject		**90**	**90**	**60**	**90**
ECTS		**3**	**3**	**2**	**3**

monochrome printouts and completed into a file-folder (DG & TD) accompanied with the attached CD of the recorded drawings – this is only the case for the TD course, 2) two partial and one final test completed at the end of the course (DG & TD), 3) practical exam on the skill of using the CAD system (TD). Some examples of students' projects have been shown in Figures 1 and 2.

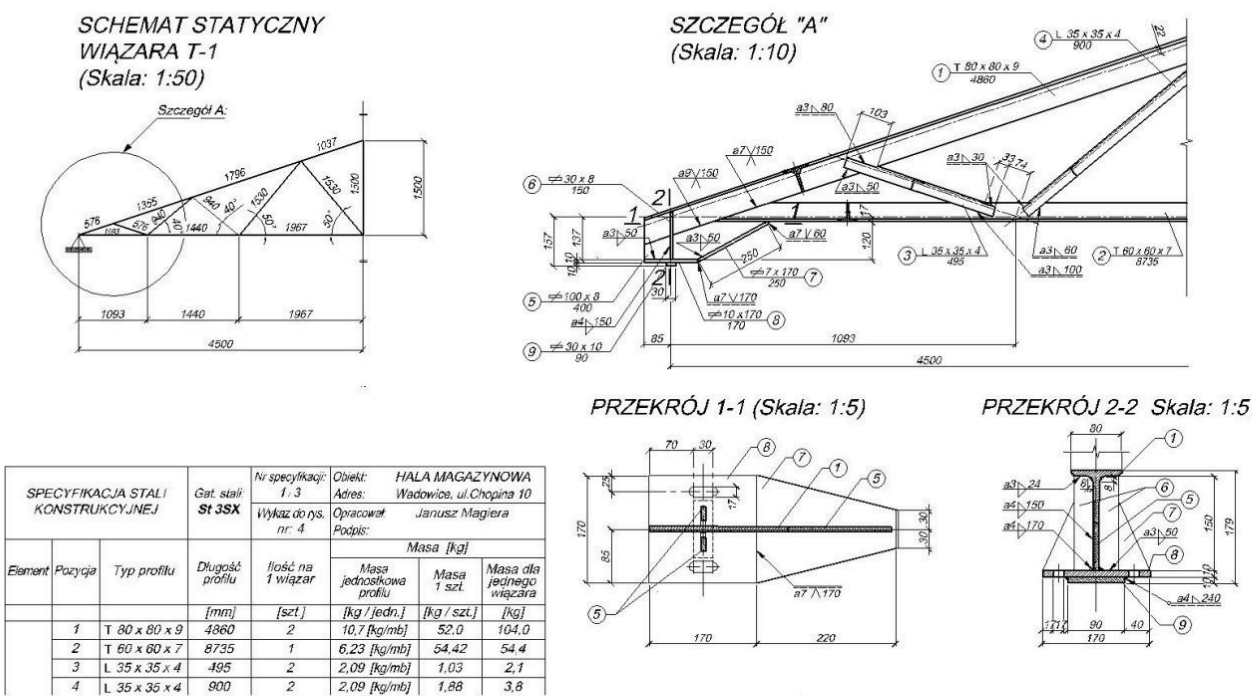

Figure 1. Example of a welded steel truss assignment – welds' designation.

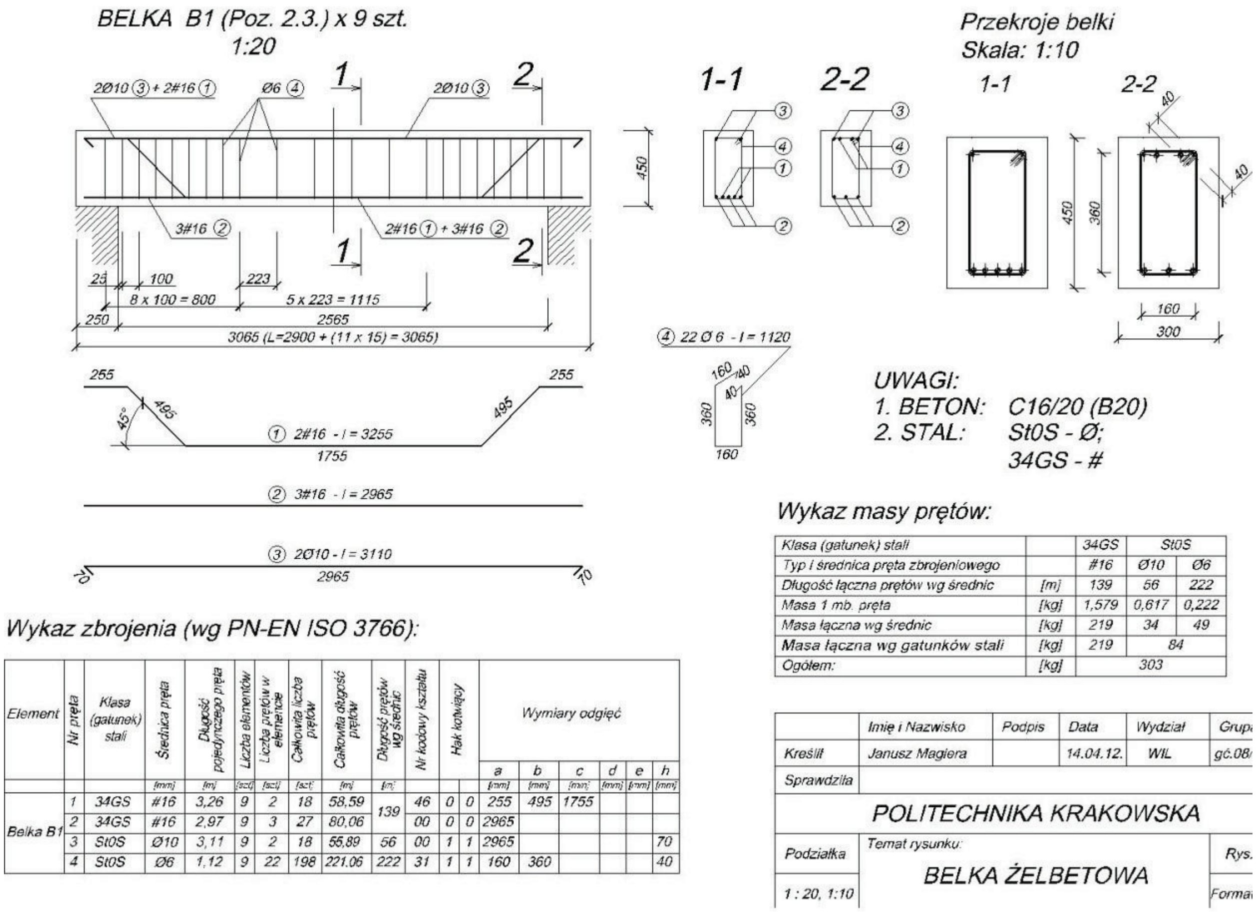

Figure 2. Example of a reinforced concrete structure: Beam and Bill of materials

The expected learning outcomes must undergo evaluation and verification after the course has been completed in context of the planned educational objectives. It is worth noticing that 'Descriptive geometry' courses stay alive within the programs for architecture and civil engineering at most universities in Poland, while they have disappeared or were changed into graphics courses at other technical faculties in Poland. As a **learning outcome** of both a graphics and a descriptive geometry courses one can identify development and fostering knowledge, abilities and competence. The student will be able to:

1. effectively communicate engineering concepts and problem solutions for civil engineering design both in a teamwork and in the interdisciplinary communities,
2. create technical documentation, i.e. to provide representations of 3D constructions on a 2D media, and to be able to read technical drawings of the designed constructions, i.e. to restitute planar drawings into a 3D space, according to related drawing standards and conventions of engineering graphics,
3. develop spatial thinking and spatial imagination.

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Prerequisites for the courses listed here are: basic knowledge of planar and spatial Euclidean geometry, planar geometric constructions and basic planar theorems, properties of spatial solids (descriptive geometry) and knowledge of major projection methods used for structures' representation (technical drawing). Schematic drawings, assembly drawings, working drawings and detailed drawings will be done and specified at various degrees of accuracy.

Reports

After completion of the course, an anonymous survey has been conducted among the students and then used to evaluate the impact of various teaching methods on the learning habits of our students. The survey included the following questions:

1. Did you use the online instructional material when you studied DG and/or TD content?
2. What is your instructional preference?
3. What is your preference for AutoCAD instruction?
4. What type of interactivity do you prefer: student-teacher or student-student when you study a specific content?

Figure 3 shows some data which was derived after evaluation of the survey. Forty students from the distant study course completed the survey. We can conclude that the on-line material delivery was the one most preferred by the students. However, in terms of AutoCAD instruction delivery the students preferred both face-to-face demonstrations during the meetings and written instructions which were uploaded to the Moodle system. What is interesting, the use of AutoCAD help has turned out not to be a means commonly used by the students.

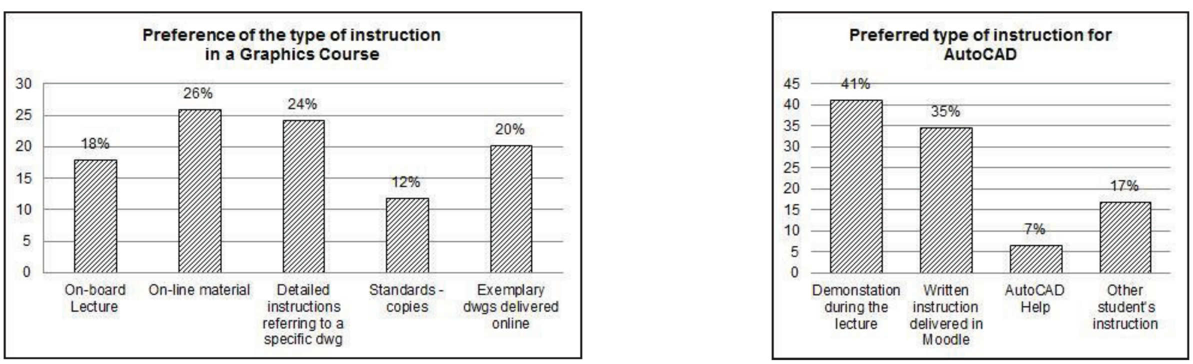

Figure 3. Preference of the type of instruction for the a) graphics course, b) AutoCAD

Figure 4 provides evidence on the activity of students during the semester course. The activity has risen at the times preceding the tests.

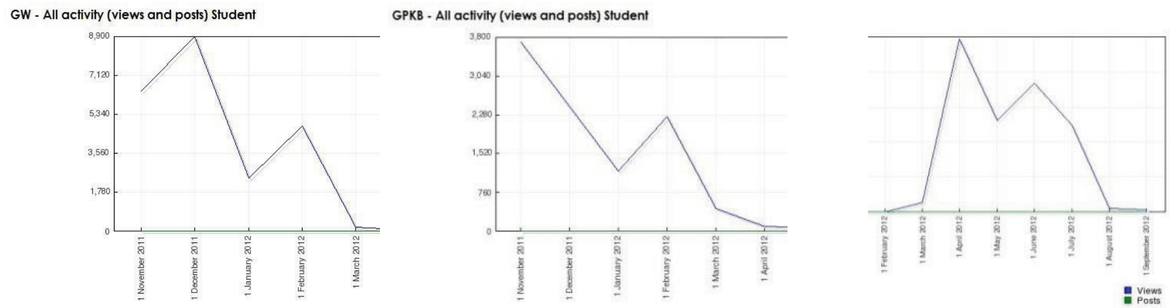

Figure 4. Reports on activity in DG course: Regular studies (left) and Distant courses (middle), TD - summer semester (right).

Conclusions

The article describes the rationale for introduction of the NQF into graphics courses teaching. New requirements set up by the NQF have caused a revision of the curricula at all universities in Poland. Much stress has been put on the load of knowledge, abilities and competences, which resulted in re-formulation of the courses. Delivery of the online content for the undergraduate engineering graphics (DG and TD) instruction in a form of blended courses for over 3 years has been beneficial to the students and it complies with a model of a student-centered education.

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programowa uczelni, Ramy kwalifikacji dla szkolnictwa wyższego (Qualifications Frameworks for Higher Education).

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