

Do Engineers Use an International Language? Construction Drawing as a Way of Communication Between Engineers

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Abstract. On October 1, 2017, the project “Development of Interactive and Animated Drawing Teaching Tools” — DIAD-tools began. Partners from Estonia, Latvia, Lithuania, Slovakia, and Poland carry out project No2017-1-LT01-KA202-035177 as a part of the Erasmus + Key Action 2 program. The main goal of the DIAD-tools project is to create interactive tools to support the learning of technical drawing. Teaching materials will be developed in six language versions: English, Estonian, Latvian, Lithuanian, Slovak and Polish. These tools will be available on the project’s online platform, which will be available to students, students, and high school teachers from all European Union countries. Developed interactive and animated drawing materials should be universal to be a real didactic aid. The project has become an inspiration for the authors to ask themselves: Is the construction drawing a universal, international language for engineers? Are the drawing symbols recommended for use in the standards of the individual countries of the project partners homogeneous? The authors compare the adopted standard design construction symbols in the partner countries implementing the DIAD-tools project.

The comparative analysis carried out will enable the development of a maximally universal illustrative material for learning the principles of structural drawing. At the same time, it will enable the development of exemplary supplementary materials, which will contain information on possible differences in drawing symbols or rules used in the partner countries of the project.

Key Words: drawing, construction drawing, technical drawing.

MSC 2010: 51N05

1. Introduction

The idea behind the partners implementing the project “Development of Interactive and Animated Drawing Teaching Tools” — DIAD-tools No2017-1-LT01-KA202-035177 is the development of modern and universal didactic materials supporting the learning of technical drawing, including construction drawing. The partners implementing the project come from five European Union countries: Estonia, Latvia, Lithuania, Slovakia and Poland [7]. Project partners represent secondary technical schools and technical universities that teach technical drawing and construction drawings. In their professional practice, they meet the problems of teaching and learning the principles of preparation drawing technical documentation. Therefore, during the development of didactic materials, special attention was given to the compliance of the materials with the standards of technical drawing. All project partner countries belong to the European Union but belonging to the European Union and to the common European market, at present, does not mean full unification of individual elements of this market.

The design of a new building or structure presented by a technical drawing can be understood by engineers and contractors around the world, provided that it is made using standardized designations. Therefore, the role and importance of standardization cannot be overestimated in any area of human activity and particular in technique. The European standardization system is constantly being created and developed. It plays an important role in the development and consolidation of the European Single Market. All contemporary national standardizing organizations from countries of project partners are nowadays members of such organizations like ISO (International Organization for Standardization), CEN (European Committee for Standardization) and CENELEC (Committee for Electrotechnical Standardization) [9, 6]. CEN and CENELEC committees are developing and implementing European Standards. International standards, as for example ISO standards, can be adopted as European by CEN and CENELEC.

In accordance with the CEN / CENELEC internal rules, CEN members are required to give the European standard the status of a national standard without making any changes [12]. However, there are so many areas of action that require the introduction of unified rules, that works in the field of adapting national standards to European standards are still being carried out in many areas in European Union countries. The national standardization systems, obligatory in Estonia, Latvia, Lithuania, Poland and Slovakia until the early 1990s, are often still valid and recommended for us [2]. Therefore, it is still possible to find differences in the technical drawing standards applicable in these countries.

2. The main objectives of the project DIAD-tools

Interactive and animated drawing teaching tools materials should be prepared in four chapters:



Figure 1: Logo of the project DIAD-tools [7]

1. Execution of drawings. Geometric constructions;
2. Basics of projection drawing, Images – Views, Sectional Views, Section slices;
3. Joints of parts, Working drawing parts;
4. Construction drawing.

For all elaborated parts of materials, the main sources of graphic markings used are general standards of technical drawing connected with such items as: lines, views, cut and sections, projection methods, dimensioning and scales. For the third and fourth parts, the additional sources of graphical symbols used in the materials are the standards referring to the mechanical engineering and construction drawings [7]

3. Comparison of graphic symbols used in the partner countries of the project based on source materials

3.1. Lines

The rules regarding the used lines in technical drawings are described in the standards ISO 128-20:1996, ISO 128-21:1996, and ISO 128-23:1996. The individual standards define: basic conventions for lines, preparation of lines by CAD system and lines of construction drawings. Two of these ISO standards were adopted as the EN standards in 2001:

- the standard ISO 128-20:1996 “Technical drawings — General principles of presentation – Part 20: Basic conventions for lines” started to be the EN standard, EN ISO 128-20:2001, and
- the standard ISO 128-21:1997 “Technical drawings — General principles of presentation – Part 21: Preparation of lines by CAD systems” was introduced as the EN standard, EN ISO 128-21:2001.

That is why these standards have their equivalents in the form of national standards in all countries of project partners (see Tables 1 and 2).

The standard ISO 128-23:1999 has not been introduced as an European and perhaps therefore has its equivalents of national standards only in three of the countries of project partners: Lithuania, Poland and Slovakia (see Table 3).

Table 1: ISO, European and national standards for basic convention for lines [9, 6, 8, 10, 11, 12, 13]

ISO 128-20:1996 Technical drawings — General principles of presentation – Part 20: Basic conventions for lines, adopted 2001 as EN standard – EN ISO 128-20:2001			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 128-20:2002	English language version	Oct. 2001	Estonia
LST EN ISO 128-20:2002	English language version Lithuanian language version	July 2002 July 2002	Lithuania
LVS EN ISO 128020:2001 A LVS EN ISO 128:20:2008 L	English language version Latvian language version	Nov. 29, 2001 Oct. 16, 2008	Latvia
PN-EN ISO 128-20:2002	Polish language version	Dec. 27, 2002	Poland
STN EN ISO 128-20:2002	Slovak language version	June 01, 2002	Slovakia

Table 2: ISO, European and national standards for preparation of lines by CAD system [9, 6, 8, 10, 11, 12, 13]

ISO 128-21:1997 Technical drawings — General principles of presentation – Part 21: Preparation of lines by CAD system; adopted 2001 as EN standard – EN ISO 128-21: 2001			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 128-21:2002	English language version	May 06, 2002	Estonia
LST EN ISO 128-21:2001 LST EN ISO 128-21:2002	Lithuanian language version English language version	May 01, 2001 June 2002	Lithuania
LVS EN ISO 128-21:2001 A LVS EN ISO 128-21:2008 L	English version language Latvian language version	Nov. 29, 2001 Oct. 16, 2008	Latvia
PN-EN ISO 128-21	Polish language version	July 11, 2002	Poland
STN EN ISO 128-21	Slovak language version	Oct. 01, 2001	Slovakia

Table 3: ISO and national standards for lines of construction drawings [9, 8, 10, 11, 12, 13]

ISO 128-23:1999 Technical drawings — General principles of presentation Part 23: Lines of construction drawings			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
no version of the national standard			Estonia
LST EN ISO 128-23:2002	English language version Lithuanian language version	Sept. 03, 2002 Sept. 03, 2002	Lithuania
no version of the national standard			Latvia
PN-EN ISO 128-23:2002	Polish language version	Nov. 12, 2002	Poland
STN EN ISO 128-23	Slovak language version	July 01, 2001	Slovakia

3.2. Dimensioning

The basic dimensioning principles used in all types of technical drawings were de-scribed in the standard ISO 129:1985 Technical drawings - Dimensioning - General principles, defini-

tions, methods of execution and special indications. In 2004, it was replaced by standard ISO 129-1:2004 (Technical drawings - Indications of dimensions and tolerances - Part 1: General principles), and in 2018 by ISO 129-1:2018 - Technical product documentation (TPD) - Presentation of dimensions and tolerances - Part 1: General principles. The last version of ISO standard was published in February of 2018. The standard ISO 129:1985 was the basis for the development of national versions of standards - Polish and Slovak. ISO 129-1:2004 has been introduced into the Slovak standard's system in Slovak version of language. The latest version of ISO standard related to general principles of dimensioning, ISO 129-1:2018, has been introduced to the national standards systems of the project partners only in Lithuania. (see Table 4.)

Table 4: ISO and national standards for general principles of dimensioning [9, 8, 10, 11, 12, 13]

ISO 129:1985 Technical drawings — Indication of dimensions and tolerances Part 1: General principles			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
no version of the national standard			Estonia
no version of the national standard			Lithuania
no version of the national standard			Latvia
PN-ISO 129:1996 Polish language version	(the standard withdrawn	Dec. 30, 1996 Sept. 25, 2017)	Poland
STN EN ISO 129:1996 Slovak language version	(the standard withdrawn	Dec. 01, 1996 Sept. 01, 2006)	Slovakia
ISO 129-1:2018 Technical drawings — Indication of dimensions and tolerances Part 1: General principles			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
no version of the national standard			Estonia
LST ISO 129-1:2018	English language version	Sept. 28, 2018	Lithuania
no version of the national standard			Latvia
no version of the national standard			Poland
no version of the national standard			Slovakia
still valid STN EN ISO 129:2006	Slovak language version	Sept 09, 2006	

3.3. Projection methods

The rules for presenting spatial objects in the graphic part of the technical documentation are described in the following standards:

- ISO 5456-1:1996 Technical drawings – Projection methods – Part 1: Synopsis,
- ISO 5456-2:1996 Technical drawings – Projection methods - Part 2: Orthographic representations,
- ISO 5456:1996 Technical drawings – Projection methods – Part 3: Axonometric representations, and
- ISO 5456-4:1996 Technical drawings – Projection methods – Part 4: Central projection.

All these standards were adopted as European Standards in 1999 and as a consequence, as national standards in all countries of the project partners (see Table 5).

Table 5: ISO, European and national standards for projection methods [9, 6, 8, 10, 11, 12, 13]

ISO 5456-1:1996 Technical drawings — Projection methods – Part 1 Synopsis; adopted 1999 as EN standard – EN ISO 5456-1:1999			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 5456-1:2000	English language version	Jan. 01, 2000	Estonia
LST EN ISO 5456-1:2001	Lithuanian language version	May 01, 2001	Lithuania
LVS EN ISO 5456-1:1999 A	English language version	Nov. 05, 1999	Latvia
LVS EN ISO 5456-1:2008 L	Latvian language version	Oct. 16, 2008	
PN-EN ISO 5456-1:2002	Polish language version	July 11, 2002	Poland
STN EN ISO 5456-1	Slovak language version	Oct. 01, 2001	Slovakia
ISO ISO 5456-2:1996 Technical drawings — Projection methods – Part 2 Orthographic representations; adopted 1999 as EN standard – EN ISO 5456-2:1999			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 5456-2:2000	English language version	Jan. 01, 2000	Estonia
LST EN ISO 5456-2:2001	Lithuanian language version	May 01, 2001	Lithuania
LVS EN ISO 5456-2:1999 A	English language version	Nov. 05, 1999	Latvia
LVS EN ISO 5456-2:2008 L	Latvian language version	Nov. 13, 2008	
PN-EN ISO 5456-2:2002	Polish language version	July 11, 2002	Poland
STN EN ISO 5456-2	Slovak language version	Oct. 01, 2001	Slovakia
ISO 5456-3:1996 Technical drawings — Projection methods – Part 3 Axonometric representations; adopted 1999 as EN standard – EN ISO 5456-3:1999			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 5456-3:2000	English language version	Jan. 01, 2000	Estonia
LST EN ISO 5456-3:2001	Lithuanian language version	May 01, 2001	Lithuania
LVS EN ISO 5456-3:1999 A	English language version	Nov. 05, 1999	Latvia
LVS EN ISO 5456-3:2008 L	Latvian language version	Nov. 13, 2008	
PN-EN ISO 5456-3:2002	Polish language version	Aug. 12, 2002	Poland
STN EN ISO 5456-3	Slovak language version	Oct. 01, 2001	Slovakia
ISO 5456-4:1996 Technical drawings — Projection methods – Part 4 Central projection; adopted 1999 as EN standard – EN ISO 5456-3:1999			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 5456-4:2002	English language version	May 06, 2002	Estonia
LST EN ISO 5456-4:2002	English language version	Sept. 03, 2002	Lithuania
LVS EN ISO 5456-4:2002 A	English language version	Jan. 17, 2002	Latvia
LVS EN ISO 5456-4:2008 L	Latvian language version	Nov. 13, 2008	
PN-EN ISO 5456-4:2006	Polish language version	May 08, 2006	Poland
STN EN ISO 5456-4	Slovak language version	June 01, 2002	Slovakia

The analysis of the illustrative materials of the first-angle projection method, from the Polish and Slovak textbooks of geometry and engineering graphics, shows that the standard ISO 5456-2 is used in didactic of these subjects (see Figures 2 and 3).

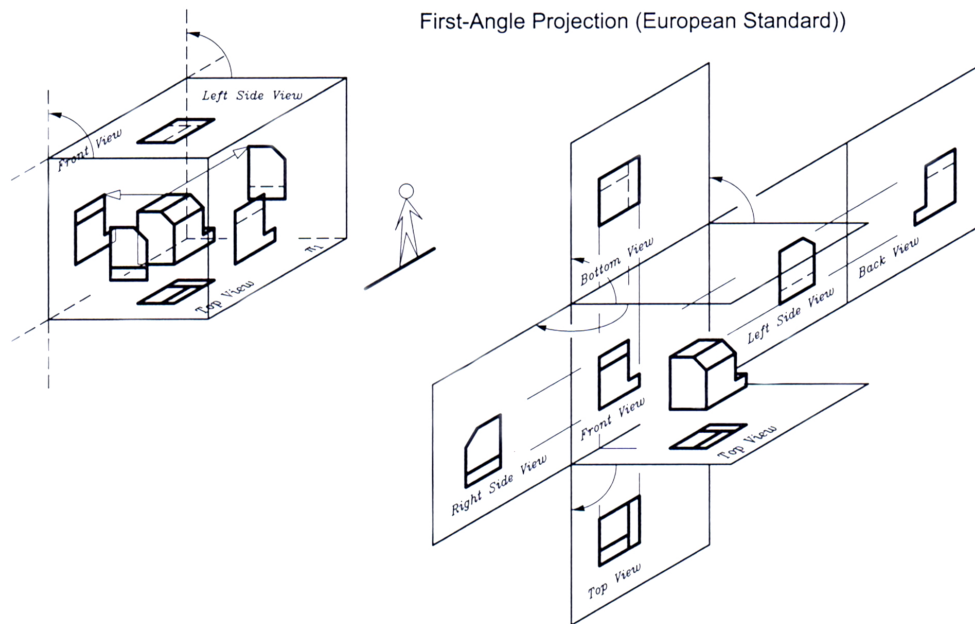


Figure 2: Orthographic representations, example from the Polish textbook [3]

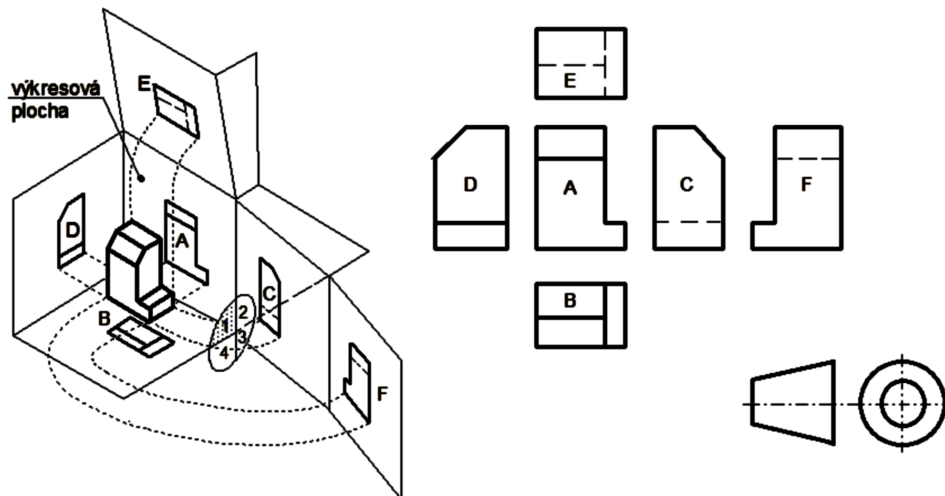


Figure 3: Orthographic representations, example from the Slovak textbook [2]

3.4. Construction drawings

The basic principles of presenting construction drawings have been described in ISO 7519:1991 Technical drawings – Construction drawings – General principles of presentation for general arrangement and assembly drawings. Standard, which was published in November 1991, was last reviewed and confirmed in 2018, still remains current. The standard ISO 7519:1991 was adopted as EN standard, EN ISO 7519:1999 and as European Standard was announced at national level in all countries of partners project (see Table 6).

The standard ISO 11091 for construction drawing, which is related to landscape drawing practice has been introduced to the international system in 1994, and in 1999 it was adopted as European standard. As a European standard, it has been introduced into all national standardization systems of project partner countries (see Table 7).

Table 6: ISO, European and national standards for general principles of construction drawings [9, 6, 8, 10, 11, 12, 13]

ISO 7519:1991 Technical drawings — Construction drawings – General principles of presentation for general arrangement and assembly drawings; adopted 1996 as EN standard – EN ISO 7519:1996			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 7519:1999	English language version	1999	Estonia
LST EN ISO 7519:2001	Lithuanian version language	May 01, 2001	Lithuania
LVS EN ISO 7519:1996 A	English version language	Nov. 01, 1999	Latvia
LVS EN ISO 7519:2008 L	Latvian language version	Nov. 27, 2008	
PN-EN ISO 7519:1999	Polish language version	Sept. 02, 1999	Poland
STN EN ISO 7519	Slovak language version	Aug. 01, 2001	Slovakia

Table 7: ISO, European and national standards of construction drawings - landscape drawing practice [9, 6, 8, 10, 11, 12, 13]

ISO 11091:1994 Construction drawings — Landscape drawing practice; adopted 1999 as EN standard – EN ISO 11091:1999			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 11091:2000	English language version	July 1999	Estonia
LST ISO 11091:1999	Lithuanian language version	1999	Lithuania
LST EN ISO 11091:2001	English language version	May 01, 2001	
LVS EN ISO 11091:1999 A	English version language	Nov. 01, 1999	Latvia
LVS EN ISO 11091:2008 L	Latvian language version	Dec. 18, 2008	
PN-EN ISO 11091:2001	Polish language version	Feb. 19, 2001	Poland
STN EN ISO 11091	Slovak language version	Dec. 01, 2001	Slovakia

A comparison of two drawing examples (see Figures 4 and 5) regarding to the construction drawing in the Polish and Lithuanian textbooks allows to conclude that the basic principles of this drawing and graphic symbols described and presented in the standard EN ISO 7519:1996, and in its national equivalents, are applied in practice.

4. CAD systems in technical drawing are giving the universal language for engineers?

International, European and national standards related to technical drawings and CAD systems have been successively introduced into application from the beginning of the 1990s. An example of a standard for CAD systems may be the ISO 128-21 standard: 1997 Technical drawings – General principles of presentation. Part 21: Preparation of lines by CAD systems, published in February 1997. In 2001, relatively quickly as for the speed of introducing standard solutions, the standard ISO 128-21: 1997 was introduced for use by CEN as a European standard (see Table 2). The issue related to the organization and naming of layers used in technical drawings made in computer technology, so by CAD systems, looks similar. The international standard ISO 13567-1:1998 Technical product documentation – Organization

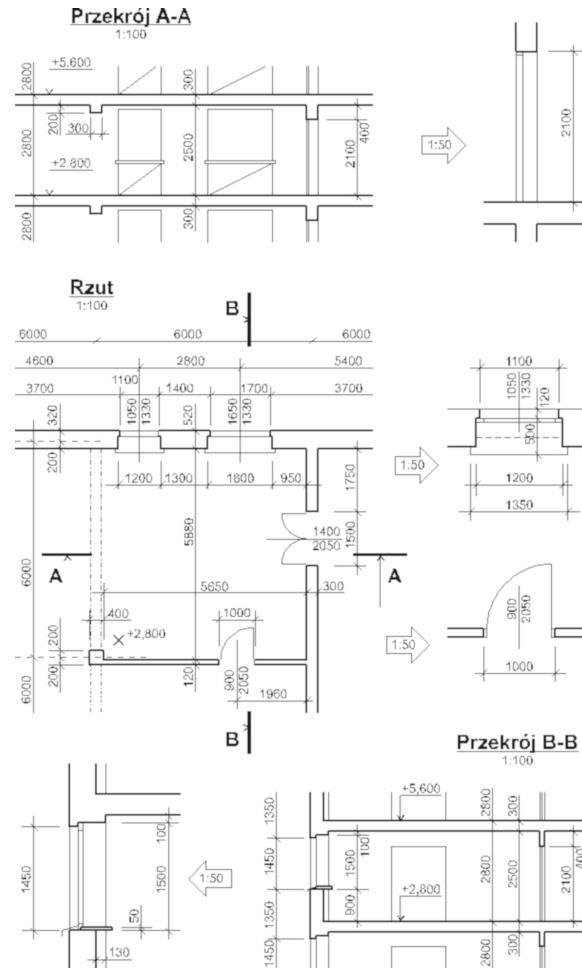


Figure 4: Construction drawing, example from the Polish textbook [1]

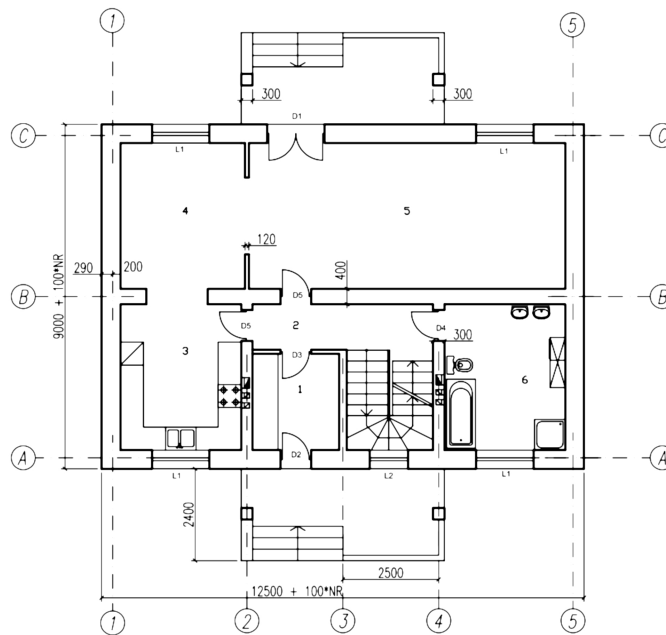


Figure 5: Construction drawing, example from the Lithuanian textbook [5]

and naming of layers for CAD – Part 1: Overview and principles, was developed and adopted for use in 1998, and in 2002 became the European standard (see Table 8).

An even faster pace of introducing standard solutions related to CAD systems can be noticed during the introduction of the new version of the international standard ISO 13567-1 from 2017 and the European version of it (see Table 9).

Table 8: ISO, European and national standards for organization and naming of layers for CAD from the beginning of the 1990s [9, 6, 8, 10, 11, 12, 13]

ISO 13567-1:1998 Technical product documentation – Organization and naming of layers for CAD, Part 1: Overview and principles; adopted as EN standard EN ISO 13567-1:2002			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 13567-1:2002	English language version	January 2002	Estonia
LST EN ISO 13567-1:2003	English language version Lithuanian language version	May 01, 2003 May 01, 2003	Lithuania
LVS EN ISO 13567-1:2002 A LVS EN ISO 13567-1:2008 L	English language version Latvian language version	Oct. 31, 2002 Nov. 13, 2008	Latvia
PN-EN ISO 13567-1:2004	Polish language version	June 04, 2004	Poland
STN EN ISO 13567-1	Slovak language version	Aug. 01, 2003	Slovakia

Table 9: ISO, European and national standards for organization and naming of layers for CAD from the 2017 [9, 6, 8, 10, 11, 12, 13]

ISO 13567-1:2017 Technical product documentation – Organization and naming of layers for CAD, Part 1: Overview and principles; adopted as EN standard EN ISO 13567-1:2017			
<i>National Standard</i>		<i>Introduction</i>	<i>Country</i>
EVS-EN ISO 13567-1:2017	English language version	November 2017	Estonia
LST EN ISO 13567-1:2018	English language version	Jan. 30, 2018	Lithuania
LVS EN ISO 13567-1:2018	English language version	Feb. 08, 2018	Latvia
PN-EN ISO 13567-1:2017-11	English language version	Nov. 28, 2017	Poland
STN EN ISO 13567-1:2018-05	English language version	May 01, 2018	Slovakia

5. Conclusions

- The analysis of the applicable technical drawing standards in the countries of the project partners allows us to state that the basic principles of preparation of technical drawings related to such problems like drawing lines are the same in all countries.
- Discrepancies that may occur in individual countries in the field of the drawing markings used may be related to the drawing lines used in the construction drawings because in this area there is no ISO 128-33: 1999 standard in all countries (see Table 3).
- An analysis of standards regarding projection methods and general principles of presentation in the construction drawings problems shows standardization of these issues in the countries of project partners.

- The rules for presenting dimensions in technical drawings may vary slightly depending on the country of the project partners. This is due to the lack of uniformity in the implementation of ISO 129: 1985, ISO 129-1: 2004, and ISO 129-1:2018 (see Table 4).
- A huge problem in the field of learning and teaching technical drawing is the lack of open access to standards. This also applies to the possibility of comparing the full content of drawing standards valid in the countries of project partners.
- In the scope of comparisons and analyses presented in the article, the authors rely heavily on the subject literature — textbooks and materials available on the Internet.
- A comparative analysis of technical drawing standards regarding computer techniques allows us to state that in this respect there is full unification in the countries of project partners (see Tables 2, 8 and 9). Therefore, it can be concluded that the widespread introduction of computer techniques supporting the design process that can be observed from the early 1990s, significantly accelerates the introduction of unified standards in partner countries.
- The comparative analysis of selected technical drawing standards allows concluding that it is possible to develop universal teaching materials supporting the learning of technical drawing relating to existing European standards.
- In the scope of discrepancies or lack of current European standards, this problem mainly concerns building construction drawing. The concept of developing language versions of didactic materials in the scope of the project, gives the opportunity to present graphic signs in force in a given country. It seems important to draw the attention of users of the materials that in a given thematic area, the universally binding norm in the European Union has not yet been introduced.

Acknowledgment

This publication has been funded under the project No 2017-1-LT01-KA202-035177, Erasmus + Key Action 2 program.

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Received December 5, 2018; final form April 10, 2019