LINGUISTIC AND TECHNICAL COMPARATIVE ANALYSIS OF SCIENTIFIC TERMS USED WITHIN THE SCOPE OF CENTRAL PROJECTION

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Abstract. Adaptation of the European standards has brought into the field of design a bunch of new standards which are to be implemented into design practice. In particular, our attention will be focused on the standard PN-EN ISO 5456 – where the definition, some terms and particular properties of a central projection are introduced. A comparison of the terms implemented in this standard to those that have been traditionally used throughout the decades of teaching descriptive geometry courses in Poland will be made. A critical analysis of new definitions and terms has been done.

Keywords: didactics, perspective projection, Polish standards

1 Introduction

Already almost 20 years ago, professor Januszewski (1996) expressed his concern about the correctness of the new standards which have been introduced into Polish market by the Polish Standardization Committee (PKN). Since 2004, when Poland joined the EU as a member state, the PKN was bound to answer to the EU call for the harmonization of technical specifications in the field of construction. In consequence, a set of technical rules for the design and construction works have been established to serve, in the first stage, as an alternative to the national rules in force in the EU Member States, and ultimately, were designed to replace them. Adaptation of the European standards has brought into the field of design a bunch of new standards which are to be implemented into design practice. In this publication we will focus our attention on the standard PN-EN-ISO 5456 - Part 4 (2001) in which the definition and particular properties of a central projection are introduced. A comparison of the terms implemented in this standard to those that have been traditionally used throughout the decades of teaching descriptive geometry courses in Poland will be made.

2 Central projection

The standard PN-EN ISO 5456-4 (2006) provides the instructions how one can construct an image in a central projection, which is one of the basic projection methods applied in technical drawing in order to illustrate and to visualize a design project. This method is commonly used by all architects to make presentations of their design architectural developments, which is commonly used by each of the BIM or CAD software, and it is unimaginable that the architects remain left without the skills to create a perspective image. What has happened today is that the European ISO standard 5456-4 (2006) has been directly translated into Polish language and we seem to be losing the clue of understanding geometrical principles and basics which lie at the background of the perspective images construction. To be more precise, the figures which are supposed to illustrate the problems are not adequate to the problems, have numerous mistakes and do not help the reader to

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understand the method of a specific perspective image construction. To give an example it is easy to take a look at Figure 4 on page 9 in PN-EN ISO 2006, where the so called "viewing lines" (symbol **Vl**) are not parallel to the principal dimensions of a 3-D object. Here we can cite Professor Januszewski who already in 1996 expressed his opinion that *„…each **standard's content** which should be **corresponding** to the **title** is becoming understandable and clear only to those among all readers who are **well trained** and **competent** in a particular subject.*

2.1 On some terms used in (PN-EN ISO 5456-4, 2006) to define the elements of central projection

2.1.1 Projection definition and vanishing points

Central projection has been typically defined (Bartel 1958, Górska 2013, Leopold 1999) as that type of representation in which a three dimensional (3-D) object will be projected on a 2-D medium, i.e. onto a picture (or projection) plane, by means of a bundle of rays that are passing through the vertices of the object and converge at a fixed point which is the center of projection ***O*** (the eye). All these projectors are usually called the ***lines of sight*** (LOS) (Bertoline et al., 2006) as they meet in the center of projection ***O***. In a 3-D space we specify the picture plane (or projection plane) which has been traditionally designated with the small Greek character $\boldsymbol{\tau}$ (Pałasiński 1998). The points of intersection of the LOS with the picture plane $\boldsymbol{\tau}$, which are also called the piercing points, create the perspective image of a 3-D object.

The standard PN-EN ISO 5456-4 (2006; p.4) provides the following description of a central projection: "Rzutowanie środkowe (perspektywa) jest realistycznym przedstawieniem rysunkowym, otrzymanym w wyniku rzutowania przedstawianego przedmiotu z punktu w skończonej odległości (środek rzutowania) na jedną płaszczyznę rzutu (zwykle powierzchnię rysunku). Rzutowanie środkowe daje doskonały rzeczywisty wygląd przedmiotu (widzenie jednooczne) i jest często stosowane w rysunku architektonicznym". Polish text has been directly translated from the ISO standard (ISO 2001) where we can read: *Central projection (perspective) is a realistic pictorial representation obtained by projecting the object to be represented from a point at finite distance (projection center) on a single projection plane (normally the drawing surface). Central projection provides excellent visual appearance of the object (monocular vision) and is often used in architectural drawings.* However, as far as the English definition sounds correctly, we are not able to conclude from Polish version what the notion "at finite distance" refers to? Is it the distance between the object and the projection plane or the distance between the center of projection and the picture plane?

Let us now take a look at the definitions of central projection taken from the well known textbooks. To give the example we will cite two definitions after Bertoline et al. (2006): "*perspective projection – a projection technique in which some or all of the projectors **converge at predefined points**. This pictorial projection technique is used to replicate closely how humans perceive objects in the real world.*" (Bertoline et al., 2006; p.365)" and "*Perspective drawings are a type of a pictorial drawing used to represent 3-D forms on 2-D media. Such drawings create the most realistic representations of objects because the human visual system creates images that closely resemble perspective drawings."* (Bertoline et al., 2006; p.738). The first cited here definition does not emphasize a geometrical principle according to which the image will be constructed but rather a specific property of perspective projection which is the existence of the so-called vanishing points. Bertoline et al. (2006) define a **vanishing point** to be "*an imaginary point in a perspective*

drawing or sketch, often on the horizon line, where all projection lines of one dimension of the object converge" (G-23 p.735). Polish (Bartel 1958), Pałasiński 1998) and German (Leopold 1999, Weiss 1999)) textbooks provide respectively the definitions: "punkt zbiegu Z_a" and "der Fluchtpunkt"[1)] (Leopold 1999, Weiss 1999) which is the representation of a point at infinity in perspective image. In the standard PN-EN ISO (2006) no definition of a vanishing point has been given. Figure 4, (p.9) shows only two vanishing points V_1 and V_2 on the horizon line but from the drawing no one can conclude how they are constructed.

2.1.2 Station point or the center of projection?

As it has earlier been defined, the center of projection will be a point specified at the fixed distance from the picture plane. Standard (PN-EN ISO 5456-4, 2006) provides Table 1 (p.5) with the symbolic designations of perspective elements. The center of projection has been noted with the character ***O*** while the orthographic projection of the center onto the ground plane with the symbol ***S***. According to Bertoline et al. (2006) the "*station point is the eye of the observer"*. The definition is becoming the more confusing for those who do not have background education in descriptive geometry and may not see the difference between the station point and the center of projection. If we go further with our discussion we are noticing that the letter symbols used in the standard (PN-EN ISO 5456-4, 2006) are directly copied from the English ISO standard (ISO 2006). All the symbols are different from those which have been used in a traditional Polish literature since ages. Table 1 gives the symbols used in the standards PN-EN ISO 5456-4 (2006) and ISO (1996), which are the same, and provides the comparison of them to those traditionally used in Polish (Pałasiński 1998, Bartel 1958) and German (Leopold 1999, Weiss 1999) descriptive geometry textbooks.

In addition, a number of specific definitions has been provided in paragraph 3 of PN-EN ISO 5456-4 (2006; p.4). According to those definitions we have:

- **alignment line** – "*linia orientacyjna*" (symbol: **Vl**) – Line parallel to a given line passing through a projection center. Its intersection with the picture plane gives the **vanishing point** of all lines parallel to the given line (ISO 1996).
- **height of projection H** – "*wysokość rzutowania*" (symbol: **H**) – Vertical distance of the projection center from the ground plane (ISO 1996).
- horizontal **distance d** – "*odległość pozioma*" (symbol: **d**) - Distance between the projection center and the projection plane (ISO 1996) – why there is not used the notion "głębokość tłowa" in (PN-EN ISO 5456-4, 2006)?
- **projection angle** – "*kąt rzutowania*" (symbol: ***β***) - Angle formed by the projection plane and the horizon plane (ISO 1996).
- **scale point** (ISO 1996)– "*punkt pomiarowy*" (symbol: **MP**) – Vanishing point of the horizontal direction orthogonal to that bisecting the angle formed by the horizon line and the alignment line of the given horizontal line, and allowing the true length of the projection of the given line to be determined (ISO 1996) – why there is not used "punkt mierzenia" in (PN-EN ISO 5456-4, 2006)?

Let us notice that Bertoline et al. (2006) use the notion of a "measuring point" and probably for this reason the symbol used to denote this point is **MP** instead of SP.

- **station of observation** – "*punkt obserwacji*" (symbol: **SP**) – Orthogonal projection of the observation center onto the ground plane (ISO 1996).**Central projection methods**

There are several projection methods described in the standards (PN-EN ISO 2006, ISO 1996) according to which one can construct a perspective of a 3-D object. The mode of the central projection depends on the position of the object to be represented with respect to the projection plane (ISO 1996; p.2). Also in the Polish standard (PN-EN ISO 2006) the figures 1

through 19 illustrate various modes of central projection construction. Basically perspective drawing construction methods may be classified into four groups:

- **One-point method** – A one-point projection method is a central projection of an object having its principal face parallel to the projection plane (special position).
- **Two-point method** – A two-point method is a central projection method of an object having its vertical outlines and edges parallel to the projection plane (particular position). All horizontal lines of a representation converge at multiple vanishing points V_1, V_2, V_3,… on the horizon line.
- **Three-point method** – A three-point projection method is a central projection of an object having no outlines or edges parallel to the projection plane (any position). If the projection plane is inclined towards the projection center, i.e. $\beta>90^o$, the vanishing point for vertical lines is situated below the horizon line (see Figures 5, 16 and 17 in PN-EN ISO 2006).
- **Coordinate method** – Representation by the coordinate method is based on simple proportions. The coordinates, related to the main projector of all relevant points of the object to be represented, are taken by the graphic method from the basic plane and the elevation. From these points coordinates, the image coordinates are obtained by calculation method and entered to scale. The image points are connected to each other to provide a clear representation of the object (see Figure 6 in PN-EN ISO 2006, p.11).

In the paragraph number 7, the standard PN-EN ISO 5456-4 (2006) describes the principles of a perspective pictorial construction for the case when we have given three orthographic views of a 3-D object. The following methods are listed and illustrated with the figures 10 ÷ 16:

Figure 10: **Piercing points** - projection plane is perpendicular to the horizontal picture plane and parallel to the frontal picture plane. Based on the three orthographic views we construct the points of intersection (=piercing points) between the LOS and the projection plane. This method has been called as the "metoda tnąca".

Figures 11 and **12**: **Line trace** and a **vanishing point** - **Method A** in which we have an **object** in a **special position** (one face is parallel to the projection plane) in relation to the **projection plane; Method B** in which the object has a **particular** position in reference to the projection plane (only vertical edges are parallel to the projection plane).

Figure 13: **Distant point –** 3-D object represented in a two-view orthographic projection will be placed on a regular grid, whose cell's diagonals determine the so called Distance Point (DP) which in Polish literature has been known as the Z_{45} point. Obviously, a 3-D object has a special position in reference to the projection plane, i.e. its two principal planes are parallel to the projection plane.

Figure 14: **Measuring point –** the object has a **particular** position in reference to the projection plane (only vertical edges are parallel to the projection plane), while the measuring points (MP) are used to construct the true lengths of the edges in a central projection.

Figure 15 and **16** illustrate also the notion of a **measuring point**.

3 Conclusions

Introduction of new standards into Polish market was a direct answer to obligations set up by the Commission of the European Community (1995) who decided on an action program in the field of construction. The objective of the program was the elimination of technical obstacles to trade and the harmonization of technical specifications. The initiative was taken up to establish a set of technical rules for the design and construction works which would replace the national standards in the Member States. Polish standardization body **PKN** (Polski

Komitet Normalizacyjny) was bound to implement the European standards into Polish market since the time Poland joined the EU. Standard PN-EN ISO 5456-4 (2006) has set up the rules for construction of a perspective projection. As far as the methods described in the standard are well known from the Polish descriptive geometry textbooks, yet the notions used for particular terms seem to be inappropriately used as they are direct translations from English language instead of being adopted from the Polish geometrical books. Although there exists the need for harmonization of the European with the national standards, the question arises why the "old" terms and notions have not been utilized in the newly introduced laws? Numerous examples of the new terms implemented in the standard PN-EN ISO 5456 (2006) have been compared to those that were traditionally used by descriptive geometry (Table 1). It should be also emphasized that the drawings (Figures 1÷ 19) do not illustrate in an adequate way the construction of perspective drawing and not always are correctly constructed (e.g. Figure 4, p. 9). Finally, let us make a remark that a comparison of the terms and notions used in German literature for perspective projection has been provided in order to emphasize the fairness of the judgment. Polish and German descriptive geometry books use analogous terminology and symbols for particular elements of perspective construction.

Table 1: **Letter symbols** used in a central projection the notions **bold typed** according to PN-EN ISO (2006; p.5)

	Term	PN-EN ISO 5456 – 4 and ISO 5456 - 4	Symbol used in Polish DG textbooks
1.	**płaszczyzna rzutu** – projection/picture plane - Bildebene	**T**	**τ** or **π**
2.	**płaszczyzna bazowa** - płaszczyzna podstawy (Bartel 1958) – basic plane (ISO 1996) - ground plane (Bertoline 2006) – Standebene/ Hauptebene	**G**	**α**
3.	**linia bazowa** - linia podstawy (Bartel 1958) – basic line (ISO 1996) - ground line (Bertoline 2006) - Standlinie	**X**	**p** or **s**
4.	**płaszczyzna horyzontu** - płaszczyzna zbiegu (Bartel 1958)- horizon plane - horizontale Ebene durch das Auge	**HT**	**ζ** or **χ**
5.	**linia horyzontu** - horizon line - Horizont	**h**	**h**
6.	**środek rzutowania** - środek rzutu/ oko (Bartel 1958) – center of projection - Projektionszentrum	**O**	**O** or **S**
7.	**punkt główny** - center of interest – Hauptpunkt der Perspektive	**C**	$\mathbf{O^{\tau}}$
8.	**główna linia rzutowania** – promień główny (Bartel 1958) - central projection line - Bickachse	**pL**	
9.	**stożek widzenia** – cone of vision - Sehkegel	**K**	
10.	**krąg widzenia** - koło widzenia obrazu (Bartel 1958) – circle of vision - Sehkreis	**Ks**	$\mathbf{k_w}$
11.	**linia rzutowania** – promień widzenia (Bartel 1958) – projector – Sehgerade	**Pl**	
12.	**punkt oddalenia** – głębokość tłowa (Bartel 1958) – distance point - Augdistanz	**DP**	**ρ**
13.	**punkt pomiarowy** – punkt mierzenia (Bartel 1958) – scale point (ISO 1996) – measuring point (Bertoline 2006) -	**MP**	**M**

[1)] die Flucht = means the "escape"; flüchten = to escape

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LINGWISTYCZNA I TECHNICZNA ANALIZA PORÓWNAWCZA TERMINÓW NAUKOWYCH STOSOWANYCH W ZAKRESIE RZUTU ŚRODKOWEGO

Przystąpienie Polski do Unii Europejskiej wymusiło proces unifikacji przepisów normatywnych w niemal każdej z dziedzin aktywności człowieka, a zatem również w dziedzinie projektowania. W szczególności, tematem rozważań które poświęcono w niniejszej publikacji, są treści zawarte w normie PN-EN ISO 5456- Część 4 (2006): *Rysunek techniczny – Metody rzutowania – Część 4: rzutowanie środkowe*. W normie podano definicję rzutu środkowego, zawarto tabele z normatywnymi oznaczeniami poszczególnych elementów rzutowania środkowego, podano klasyfikację różnych metod odwzorowania oraz wymieniono pewne szczególne własności obrazów perspektywicznych konstruowanych za pomocą opisanych metod. W pracy podano analizę terminów i symboli stosowanych w polskojęzycznej normie do opisu obrazu perspektywicznego, a także porównano zastosowane oznaczenia do tradycyjnie używanych w teorii perspektywy w Polsce. Analizie krytycznej poddano terminologię i symbolikę, która jest wprost przeniesiona z literatury anglosaskiej, podczas gdy tradycyjnie nie jest stosowana w typowym kursie *Geometrii wykreślnej* wykładanej w każdej polskiej uczelni technicznej.