

## TOPOGRAPHIC PROJECTION IN AMERICAN DESCRIPTIVE GEOMETRY WORKBOOKS

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**Abstract:** The term ‘topographic projection’ corresponding to Polish ‘rzut cechowany’, Russian ‘проекция с числовой отметкой’, German ‘Kotierte Projektion’, Italian ‘proiezioni quotate’ or French ‘géométrie cotée’ cannot be found in American workbooks. This paper discusses the American proposition of a lecture of the theory and application of the section, which is equivalent to the topographic projection and its application.

**Keywords:** topographic projection, bearing of line, slope of a line, contour lines

The paper is dedicated to the memory of Professor Marian Palej (1923-2001) in his 90th birthday anniversary.

### 1 Introduction

The term *topographic projection* corresponding to Polish *rzut cechowany*, Russian *проекция с числовой отметкой* [1], German *Kotierte Projektion* [7], Italian *proiezioni quotate* [3] or French *géométrie cotée* [2] cannot be found in American workbooks and in the internet. Formally, American authors do not introduce and distinguish the projection in question and its basic terminology. However, it is not completely true. Why? Some differences between American and Polish Descriptive Geometry workbooks was discussed at the article [4], but the author does not explain why American authors do not discuss separately the topographic projection.

### 2 Slope and bearing of line and other determinants of American viewpoint of lecture of Descriptive Geometry

The entity of topographic projection and its application in American workbooks is introduced at the beginning of the orthographic projection onto two projective planes (Monge projection). Luis G. Lamit [6] already introduces the terms *azimuth bearing of a line* and *slope of a line (grade of a line)* on page 113 of his 450-page monograph (cf. Fig. 1a and 1b). Steve M. Slaby [8] makes this reference even earlier, because these terms appear on page 29 of his 350-page workbook. Similarly, F.W. Warner and M. McNeary [9], apart from the basic types of line projection: *horizontal*, *frontal*, *profile*, use the terms: the mapping of *contour lines* of a surface and meaning of *azimuth bearing of a line* on page 20 of their 250-page monograph devoted to the application of Descriptive Geometry. However, the latter book is devoted to the application of Descriptive Geometry, but we do not find there the basic terminology concerning the topographic projection from the traditional European view point.

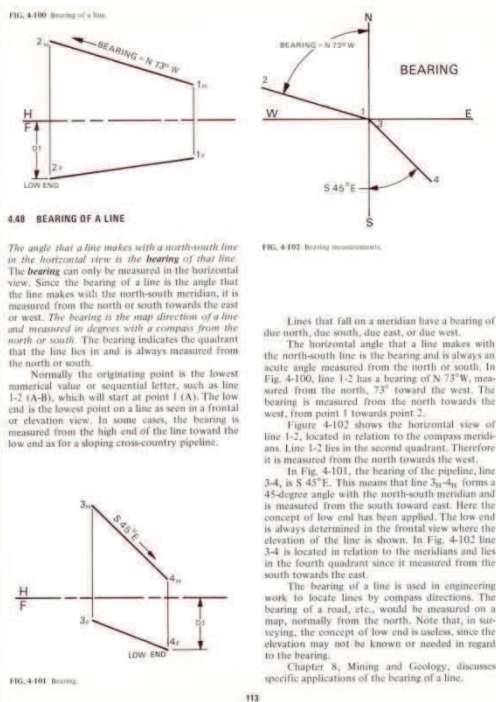


Figure 1a: The azimuth bearing of a line defined by the orthographic projection (two-sheet Monge method) explained on page 113 of the Luis G. Lamit workbook [6]

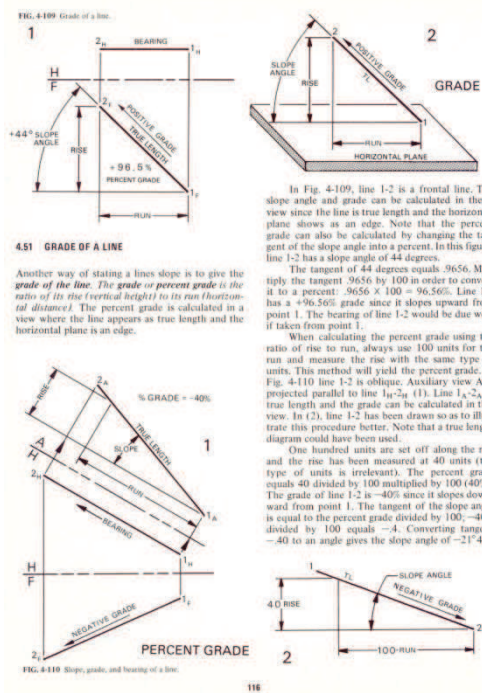


Figure 1b: The slope of a line defined by the orthographic projection (two-sheet Monge method ) explained on page 114 ([6])

In particular, the American authors in their workbooks do not mention the so called interval of a line and a plane. Such a term cannot be found. Searching for any equivalent of the interval we can find the term *run* (*horizontal distance*). Therefore the *grade* or *percent grade* of the line is the ratio of its *rise* (*vertical height*) to its *run*. The percent grade is calculated in a view where the line appears as true length and the horizontal plane is an edge (Fig. 1, p. 116, top, left side – third angle projection). If the line is in another position (not frontal), then the author [6] uses transformation into primary auxiliary view (Fig. 1, p. 116, bottom, left side – third angle projection).

This paper discusses the American proposition of a lecture of the theory and application of the section, which is equivalent to the topographic projection and its application. This is all preparation for the implementation of the topographic projection, which is the realization of an explicit begin when discussing the problems of mining and geology. So let's look at the introduction to the chapter devoted to this question.

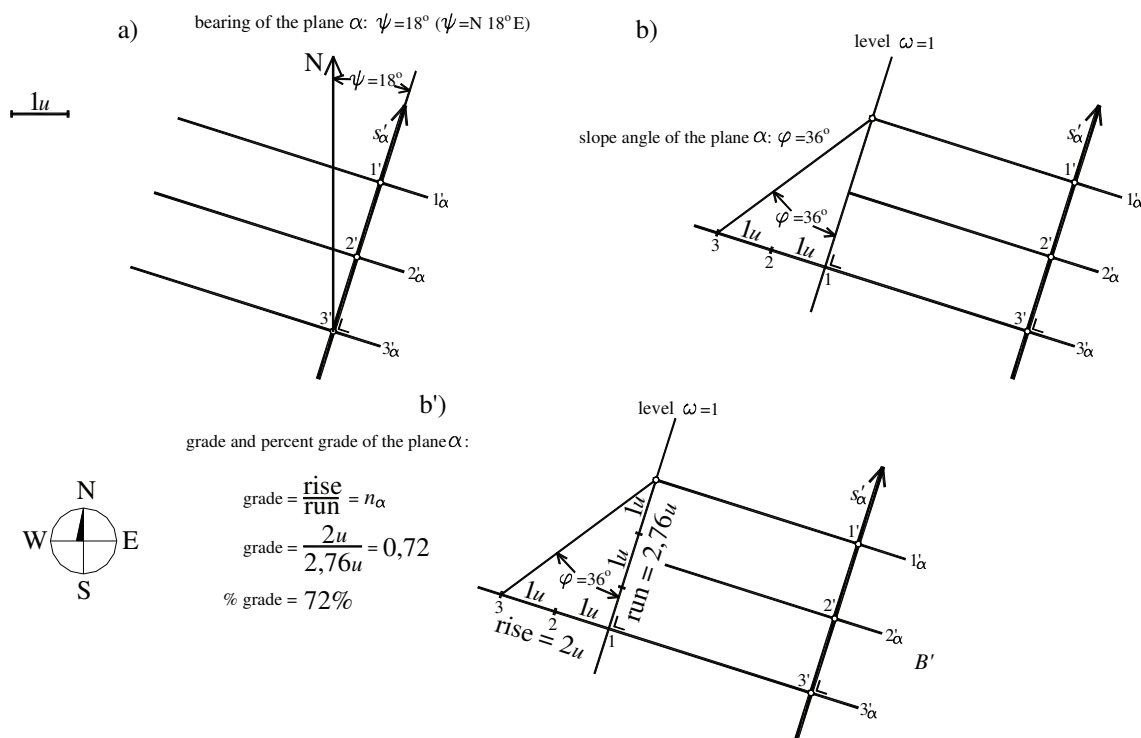


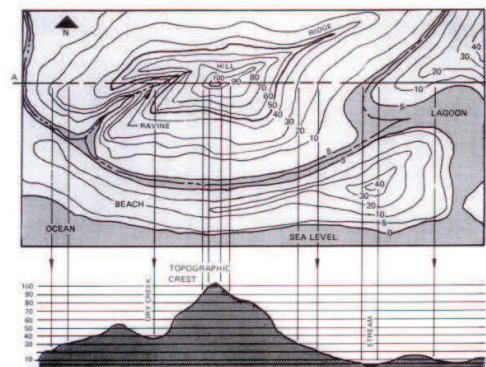
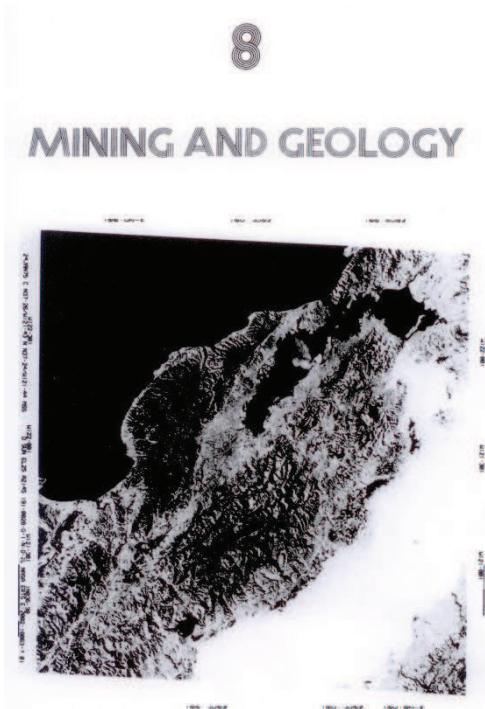
Figure 2: The description of the azimuth bearing and slope of a line defined in the author’s lecture for the ERASMUS students [5]

On page 354, at the beginning of section 8 *Mining and geology*, in the subsection titled *Mining and topographic applications*, G. Lamit writes „The principles of orthographic projection are used continually in the real world of engineering construction and mining. Topographical and mining problems involving land contours, surface and subsurface earthwork and their specific applications in construction technologies utilize a variety of descriptive geometry principals, practices, and procedures in their solutions... [6]“ and publishes the drawing represented in Figure 3. So in this section the first realizations of topographic projection disappear. Author introduces two notions: contour maps and plan-profiles based on a topographic map (obtained from a surveyor’s topographical notes and calculations or an aerial photo survey) using the Monge’s method. Contours are curves of intersection of a series of evenly spaced horizontal cutting planes and the ground surface (earth’s surface). Therefore each contour line represents the horizontal projection of a line (usually curvilinear) on the earth’s surface at a particular level. Note that this is the slice-based approach to the representation of the geometric solid (cf. [6]). This particular level is defined by height relative to sea level, and here is where the *cote* of a point (however, the author does not introduce the name “cote”). The frontal view is called a profile since it shows the „profile” of the ground’s surface.

### 3 Why is there no topographic projection in American handbooks?

The answer comes as a result of the analysis of the approach discussing orthogonal projections (with two or more projection planes) based on continuous use of auxiliary projection planes, i.e. practicing geometry position relative to the projection planes (Fig. 4).





8.2 CONTOUR MAPS AND PLAN PROFILES

The *plan-profile* drawing is based on a topographic map of a portion of the earth's surface. This map is drawn from a surveyor's topographical notes and calculations and/or an aerial photo survey. Therefore a topographic map is a horizontal view (plan view) of the earth's surface. Variations in the surface of the earth within the limits of the survey are represented by *contour lines*. Contours are lines of intersection of a series of evenly spaced horizontal cutting planes and the irregularities of the ground surface. Therefore a contour line represents a line on the earth's surface at a particular elevation level. Normally contour lines are established with vertical divisions (intervals) of 10 ft or 100 ft, depending on the size of the area being drawn.

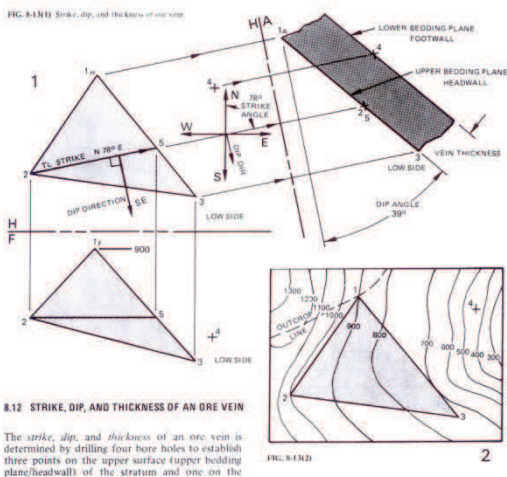
The frontal view of a topographical map will show the actual *profile* of the ground's surface and each horizontal cutting plane (representing the elevation view of the contour lines) as an edge view. Contour spacing (contour intervals) can be seen here. Contours are established from a designated or standard starting elevation, usually sea level (0 ft).

The frontal view is called a *profile*, since it shows the "profile" of the ground's surface. In most cases, the profile view is actually a projection of a vertical cutting plane passed through the plan view at a specified location in order to determine the outline/profile of the ground along a particular line of interest.

In Fig. 8.3, the profile view is a vertical section taken along cutting plane A-A. The vertical and horizontal scales are the same (though they need not be if one wishes to exaggerate the profile configuration). The profile view is drawn by projecting points of intersection of contour lines and section line A-A in the plan view to the edge view of the contour lines in the frontal profile view. In the plan (horizontal) view, changes in the slope of the terrain are represented by the irregular contour lines. Steep surfaces appear as contour lines close to one another and mildly sloping areas are shown by wide spacing. The high point of elevation is called the topographic crest. Crowded contour lines extending out from a hill or mountain represent ridges. Contour lines that extend in toward the higher elevation are ravines or canyons. Stream bed lines are drawn as shown.

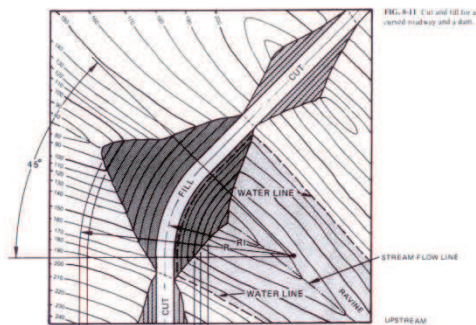
Figure 3: The beginning of the mining and geology section explained on pages 353 and 355 of the Luis G. Lamit workbook [6]

And that is the essence of topographic projection. In handbooks there is no concept of a revolved section, and all tasks are solved by the transformation of projection planes, and the problems in the context of topographic projection are related to the use of projections on the two projection planes. This point of view is not surprising if we accept the fact that the topographic projection is really a plan view of the two projection planes, where the elevation of a point is highlighted instead of the vertical projection (hence the distance from the horizontal projection plane), expressed as a measurement in the accepted unit.



8.12 STRIKE, DIP, AND THICKNESS OF AN ORE VEIN

The *strike*, *dip*, and *thickness* of an ore vein is determined by drilling four bore holes to establish three points on the upper surface (upper bedding plane/headwall) of the stratum and one on the



8.9 CUT AND FILL FOR A CURVED ROADWAY AND A DAM

shown. The profile is the same scale as the plan view. The points of intersection of the cut or fill lines with the existing contours establish the cut and fill areas in the plan. The 45 degree angle and arcs swung from the center point of the curve (as R1 and R2) are used to draw the fill contour lines and to establish the cut area in the upper right corner of the plan. The cut contours are straight lines, parallel to the road. The fill contours are arcs parallel to the road. Draw the water level in the plane between the

Figure 4: Strike, dip, and thickness of an ore vein is determined using auxiliary elevation views (transformation of projection planes methods in Polish terminology) ([6], p. 369)

Figure 5: Cut and fill for a curved roadway and a dam ([6], p. 364) is realized by the orthographic projection (the two-sheet Monge method)

#### 4 Conclusions

The entity of topographic projection and its application in American workbooks is introduced at the beginning of the orthographic projection onto two projective planes (Monge projection) and this concept is included in the whole lecture of the orthogonal projection method. The tasks are solved by the transformation of projection planes, and the problems related to the topographic projection appear as examples of orthogonal projection (onto two projection planes) in the technique.

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## RZUT CECHOWANY W AMERYKAŃSKICH PODRĘCZNIKACH Z GEOMETRII WYKREŚLNEJ

Próżno poszukiwać w amerykańskich podręcznikach geometrii, na stronach internetowych, terminu odpowiadającego naszemu ‘rzut cechowany’, rosyjskiemu ‘проекция с числовой отметкой’ niemieckiemu ‘Kotierte Projektion’, włoskiemu ‘proiezioni quotate’ czy francuskiemu ‘géométrie cotée’. Amerykanie formalnie nie wprowadzają rzutu cechowanego i jego podstawowej terminologii jako oddzielnej klasy rzutowania, ale tylko pozornie nie mówią na ten temat. Dlaczego? Odpowiedź przychodzi w następstwie analizy przyjętej koncepcji omawiania rzutów prostokątnych na dwie (i więcej rzutni) polegającej na ciągłym posługiwaniu się rzutniami pomocniczymi, czyli uprawiania geometrii położenia w stosunku do rzutni. W podręcznikach nie występuje bowiem pojęcie kładu, a wszystkie zadania rozwiązywane są metodą transformacji, zaś problemy w rozumieniu rzutu cechowanego pojawiają się jako przykłady zastosowania rzutów na dwie rzutnie w technice.