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The Triangulation : From Geodesy to Attempt at Overcoming of Conceptual Limitations in Social Research Methodology

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INTRODUCTION[1]

In empirical social science methodology the term „triangulation" is usually used to denote the combination of two or more sources or methods of observation of a given phenomenon in order to mutually verify obtained information and, at the same time, to extend the means of observing the studied object (Cresswell, 2007, p. 207–208; Denzin, 1978, p. 28; Ritchie, 2003, p. 43). However, this term was introduced to social science methodology from geodesy and cartography as a metaphor for gathering data and establishing their credibility (Berg, 2001, p. 5; Kelle & Erzberger, 2004, p. 174; Rothbauer, 2008, p. 892). It is not difficult to demonstrate that in the field of methodology the understanding generated by this metaphor results form a distorted taking over of triangulation from geodesy. This is probably caused by the cumulating of false notions through successive usage of the metaphor and by the practice of its building without due care for correspondence between its primary and its secondary realm, i.e. between the object used in the metaphor to illustrate and the illustrated object. In other words, if we take a closer look at the idea of triangulation in geodesy, we can see that its metaphorical potential was not used in methodological reflection or perhaps even wasted, for reduced mainly to illustrate the multiplication of observation points and sources of cognition.

That is why I shall begin with presenting the "geodesic" understanding of triangulation, in order to enable the convergence of its connotations with the scope of its metaphoric use in the field of empirical social science methodol-

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1 The article was written on the basis of the following text: S. Pasikowski, *Body – text – space. A Model of Spatial Extension of Methodological Triangulation*, "Czasopismo Pedagogiczne"/"The Journal of Pedagogy" 2015/2016, 1–2, p. 453–467. The current text is an extended version of the primary text and also contains significant changes.

ogy. This will make it possible to conduct a reconstruction of possible tropes of association in the methodology itself. The next step will be to present attempts at improving the methodological notion of triangulation, and the final step will be to present the author's model of multidimensional triangulation extension.

What remains is to justify the discussion on an issue which has already been examined in many publications and frequently applied. Its theoretical and methodological attractiveness stems from the fact that it is rooted in ideas of multidimensionality, diversity and dynamics of phenomena, which can ultimately form part of some entirety. That is why triangulation can appear as an instrument for the implementation of the principle of complementarity and credibility in cognition. This in turn, apart from trends, explains the unabated interest in the issue of triangulation in social studies and humanities, and also explains attempts at improving its models or efforts to replace the very concept with alternative solutions.

THE GEODESIC ORIGINS OF THE TRIANGULATION CONCEPT

In geodesy triangulation is a method of determining distances in a given area by means of angle measurement, in order to map that area. It is one of the oldest methods of horizontal positioning of points in terrain (Smith, 1988). It was invented and published by Dutch mathematician and cartographer Gemm Frisius in 1533, and was later developed to measure the Earth by another Duchtman, also a mathematician, Willebrord Snellius in 1620 (Wójcik, 2011, p. 356–358). It was invented and published by Dutch mathematician and cartographer Gemm Frisius in 1533, and was later developed to measure the globe by another Duchtman, also a mathematician, Willebrord Snellius in 1620 (Wójcik, 2011, p. 356–358).Triangulation consists in determining points in an area (geodesic marks, e.g. in the form of triangulation pillars). These marks are the places of application (points of observation) of theodolite, a geodesic tool used in establishing horizontal and vertical angles[2]. The

[2] Earlier this role was fulfilled by the astrolabe, invented in the antiquity, which was used primarily used in navigation and enabled determining the angle between assumed points. The application of the astrolabe in geodesy and cartography was described in detail by Polish mathematician and geodesist Józef Naronowicz-Naroński, in the mid 17th century (1659/2002). His work *O delineacyjach miejsc różnych i czynieniu map geographice* was the first detailed account of Frisius' and Sinellius' theory in Poland.

points are the apexes of triangles. The apexes are connected by straight lines in such a manner, that the side of one triangle is at the same time the side of another triangle. The effect is a triangular network, which covers the area to be measured. This network is called a wreath or the primary network. The first demarcated line is called the base or baseline. The base is created through the establishment of the coordinates of at least one point and a line led from that point with a properly determined azimuth[3] (Smith, 1988, p. 52). This requires extra precision, for it will determine the accuracy of the next measurements. Determining the length of the segment is possible through the establishment of a second point, through which the line extended from the first point passes. These two points mark the segment endings. Determining the coordinates of the third point is based on this length and the trigonometric calculations using information on the angle values between the lines connecting the three points. Geometry suggests that in order to draw a triangle all you need to know is the length of one of its sides and the value of two f its angles. This enables the establishment of the third apex of that triangle.

When creating the wreath it is necessary to establish several bases. They stabilize the triangulation network in a way that enables delimiting the path back to first base, where the measurement began, but they are also control points used in creating the wreath to correct deviations emerging during subsequent measurements initiated in that base. Lack of control results in lower precision of triangulation, which affects the adequacy of the map. As a matter of fact mistakes in measurement are a constant element accompanying the triangulation procedure. Accidental mistakes depending on varying measurement conditions are difficult to avoid, however, a conscious researcher can always implement a suitable correction or rely on the principle that random deviations single each other out. However, the biggest problem are systematic mistakes, resulting from faulty measuring equipment, procedural inaccuracies or personal characteristics of the person conducting the measurement. The

3 The azimuth is the angle between a delineated line and the meridian arc. This line results from drawing a line to the north from triangulation point A, crossed by a given meridian, to point B. Determining the azimuth is meant to stabilize the emerging triangulation network. The azimuth is measured from left to right (clockwise). Understanding the idea of the azimuth facilitates explaining it in the context of geographical latitude and longitude. The former is the angle between the planes of the meridians (planes starting at the Earth's axis and stretching in the direction of its perimeter). The latter is the angle between the plane of the equator and the parallel. The azimuth can be explained as a part of theangle created by the meridian and the parallel.

primary method of reducing systematic mistakes and their later control is the precise establishing of the base.

The process of establishing the base shows that basic significance in the initiation of triangulation is assigned to the external point of reference, in this case the north direction. From the initial point and line the angle value of subsequent points and lines is determined. This is the principle of forming the triangulation network. Coordination of the entire process is performed through trigonometric calculation.

The ultimate purpose of triangulation is to create a map of an area. However, in order toestablish geodesic points a greater concentration of networks is required. This is done by building a network with greater concentration of triangulation points within an existing triangulation network. The resultant sectors are filled with a network of further points. The process of concentration usually involves 4 stages. Each stage results in the creation of primary, secondary, tertiary and quaternary networks respectively. However mapping the details of a given terrain requires further network clustering, which is difficult to continue in the framework of triangulation. For this reason traversing is implemented. This method is based on the same principles as triangulation, the difference being that is does determine the apexes of triangle but of polygon (Smith, 1988, p. 59). The basis for establishing a polygon network are always two neighboring triangulation points. It is between them that we establish points of smaller distance. Owing to the clustering of points the lines delineating the sides of triangles or polygons (usually quadrangles) become shorter in subsequent networks. This facilitates the proportional transfer of terrain dimensions onto maps created in a given scale.

Triangulation and traversing create the framework (as a warp) which serves as a basis to conduct measurements of elements in an area and to map them. The triangulation network is therefore a an object of reference to conducted observation. At the same time it illustrates that measurements in triangulation are conducted from the general perspective to the more detailed one –from macro to micro perspective.

Also of significance are the properties of the object. If the measured terrain is spherical, then the measurements and calculations must be based on a different theoretical basis than in the case of flat terrain. In trigonometry the sum ofangles in a plane triangle equals 180°. However, if the surface is protuberant that sum is larger. The difference between the value of 180° and the value of the sum of angles in a spherical triangle is called the spherical excess.

In order to locate points on a plane and conduct their measurement Euclidean geometry and the idea of two-dimensional space, i.e. space represented by a rectangular coordinate system,are sufficient. However, if the studied terrain is characterized by concavities and protuberances, then non-Euclidean geometry becomes the theoretical basis for measurements and calculations. Spherical geometry belongs to this category. Altitude, as the next dimension alongsidelongitude and latitude, is reconstructed in 2D maps by means of curves connecting points located at the same height. These curves are commonly known as contour lines or isolines. The points delineating them are set as they would be on a plane, with the difference that the vertical angle between the point of observation and the point being established is taken into account.

Two methods have emerged from classical triangulation: traversing and trilateration (Smith, 1988). The latter is similar to triangulation, though it comes from measuring the sides of triangles, not their angles. The former does not require laborious establishing of the initial base coordinates. It is enough to establish the coordinates of points, between which angles are set, which is mentioned earlier. Traversing is sometimes regarded as an element of triangulation.

It should be noted that triangulation is seen as imprecise and archaic in modern geodesy (Blewitt, 2009, p. 354). It was replaced by numerous technologically advanced solutions. However, there is now a more modern version of triangulation, i.e. aerotriangulation, which uses radio wave reflection and photographs from various points in the Earth's atmosphere.

As noted earlier triangulation is used for mapping terrain through establishing points of observation, from which approximations of the properties of that area will be made. Maps are images, simulations or models. This means that triangulation also makes use of the mathematical rule of mapping one set of values onto a different set of values. Thus, in the case of mapping[4] terrainvalidity– meaning adequacy between object and model – plays an important role. Triangulation and traversing are therefore not only methods of creating maps – they also serve as instruments of controlling their accuracy. A key role in map validityis played by the selection of geometrical assumptions, adequate to the properties of the terrain, and accuracy regarding the base and the first angles, on which the precision of subsequent angles relies. Creating broader maps also requires building further wreaths, based on those already built.

[4] In English the term mapping means both creating a map and projecting one set onto another.

THE CONCEPT OF TRIANGULATION IN SOCIAL SCIENCE METHODOLOGY

In social sciencemethodology triangulation is defined as connecting various data, methods of gathering this data, and theoretical perspectives in the course of conducting research on a given phenomenon or object. It is aimed at providing a wider and more profound perspective,and this has often been compared with mapping (Denzin, 1978, p. 28; Flick, 2008, p. 41; Fontana & Frey 2005). It is hoped that this form of connecting will raise the quality of research, through mutual verification of the credibility of results obtained using various solutions and points of observation (Creswell, 2007, p. 207–208; Flick, 2004; Ritchie, 2003, p. 43).

The method used in geodesy is naturally indicated as the prototype of the triangulation method used in methodology. Attempts at showing their similarities, even if limited to metaphor (Kelle & Erzberger 2004), are usually imprecise or even erroneous. They describe triangulation as a method of locating an unknown point on the basis of two known points and a line drawn from them (Berg, 2001, p. 4–5). It is also limited, in a very simplified and trivial manner, to a method of drawing triangles on a plane (Miles & Huberman 2000, pp. 278, 299; Patton, 2002, p. 555)or delineating their sides (Richardson & St. Pierre 2005, p. 963), and thus mistaken with trilateration. Moreover, in methodology triangulation is brought down to multiplying and connecting various points of observation, while in geodesy it is used to create a framework, i.e. a basisor network which serves as a basis for conducting observation. Therefore, triangulation does not involve simple adding of subsequent points in hopes of the emergence of a more abundant image of the observed phenomenon, or obtaining a verification of recent results of observation. Triangulation requires a plan and its implementation, directed at covering the observed area with a clustered network of points, which will enable conducting observations from various points in the network.

There is also a risk of misunderstanding, due to statements such as the one formulated by Scholz and Tietje (2002, p. 338), that triangulation is achieved when there are no more changes in the image of the phenomenon or when we can see a pattern in the dynamics of this phenomenon (Scholz & Tietje, 2002, p. 338). This way the authors create a basis to associate triangulation with the concept of theoretical saturation. Triangulation, however, occurs through designing a study which includes using various points of observation. The object to which an evoked statement refers is already connected with the effectiveness of triangulation. What is more, in the case of abstract and dynamic notions, it can be postulated that triangulation be maintained for as long as the observation of a given phenomenon is predicted to last (cf. Lewis & Grimes, 1999).

The fact that triangulation is usually mentioned in texts devoted to qualitative methodology can also be misleading, because researchers who prefer-quantitative studies and data analysis are also interested in this method (cf. Morse, 1991). It draws attention mostly of those working in accordance with mixed methodology, in the origin of which the term triangulation played a key role (Teddlie & Tashakkori, 2010, p. 9).In this context it is worth mentioning that one of the first complex triangulation procedures was suggested by Donald Campbell and Donald Fiske, for use in psychometrics (Campbell & Fiske, 1959). It is known as the "multitrait-multimethod matrix". Naturally postulates and applications of triangulation were also presented by other researchers, currently identified with with the qualitative approach, grounded theory methodology or anthropologicalstudies (Flick, 2008, p. 37–40).

The term triangulation in empirical methodology was initially used in the context of verifying information gathered from independent sources (Denzin, 1978; Flick, 2009, p. 444; Miles & Huberman, 1994, p. 266–267) with a clear reference to the work of Campbell and Fiske. That is why triangulation is still identified with procedures of instrument and data validity and associated with the terms validity and reliability (Miles, Huberman, 1994, p. 267; Rothbaue, 2008). However, it is a mistake to restrict triangulation to methods of confirming achieved study results. It significantly narrows its effect and keeps it within the perspective of naïve realism (Bryman, 2012, p. 22; Hornowska et al., 2012, p. 75), facilitating the treatment of cognition in accordance with the "geodesic" establishing of points in an area. This triggers readiness to reduce incoherencies in obtained information about a given object of cognition, whereas this incoherence may shed light on previously unnoticed phenomena. This is because triangulation displays traits not only of confirmatory but also of exploratory approach (e.g. Kelle & Erzberger, 2004, p. 174; Patton, 2002, p. 248). Combining several sources and methods of obtaining information in one project makes it possible to discover those aspects of a given phenomenon, which are not visible from the perspective of single standpoints from which observations or analyses are conducted. As a result triangulation creates conditions for extending and advancing cognition, offering the creation of a multidimensional image of the studied object, while controlling the participation of the qualities of the method, the data format, the researcher and the theoretical standpoint, in the process of cognition and understanding. Awareness of the mentioned qualities of triangulation became at one point the cause of the emergence of two contradicting standpoints. Firstassociated triangulation with data and method validity, and the secondwith supplementation of data and cognitive perspectives, directed at integration (Kelle & Erzberger, 2004, p. 176).

Both classic (Denzin, 1978) and modern approaches (Davey, Davey & Singh 2015; Lewis & Grimes, 1999; Ndanu & Syombua, 2015) assume that triangulation can occur on at least four planes: data from observation (the source and type of empirical material), researchers, methods of gathering and analyzing data, and theory[5]. Its particular advantage lies in the possibility of reducing mistakes and distortion occurring ineach of these plane, and in providing conditions for extending and advancing cognition, through applying more than one source and type of data, method, theory or standpoint, from which observations and analyses are conducted[6].

There is justification to consider triangulation also in the paradigm plane. A development of this idea was presented in the concept of metatriangulation (Lewis & Grimes 1999). It mentions building a theory across paradigmatic divisions. Such an approach is aimed at using similarities and differences which the juxtaposed paradigms provide, in order to create conditions for a creative, complementary and complex development of theories. These theories would be less burdened by the risk of dogmatism on the one hand, and relativism on the other (Lewis & Grimes, 1999, p. 672). In this perspective the purpose of triangulation is to raise validityand to play the role of explorative strategy. The explorative character of triangulation would be expressed, among others, in discovering divisions and conditions within a given theory, that would allow integration, and that may not be visible in a single-paradigm perspective.

Connecting various points of observation and various levels shows that triangulation is based on the principle of providing variety, which is to increase credibility and serves to gather complementary data and perspectives

[5] Stanisław Palka (2011), when writing about studies on the didactic-uprbringing process, broadens this classification, highlighting triangulation of the types of research, triangulation of research approaches and triangulation of interdisciplinary approaches. These additional forms can most likely be derived from the method triangulation term.

[6] Further in the text, regardless of the type of plane, each of the adherent elements will be referred to as a point of observation. I do this in order to avoid having to signal each time, that I am referring to specific data, researchers, methods and theories.

(Kelle & Erzberger 2004, p. 174). It is worth emphasizing that this principle ties triangulation to the idea of contextual cognition or at least cognition aware of the context in which it occurs (Hornowska et al., 2012, p. 76; Konecki 2000, pp. 20, 36; Lewis & Grimes, 1999, pp. 675, 686). This context is created by various factors which can be classified in reference to the four planesmentioned earlier. That is why the triangulation model, which accounts for the multidimensionality of its characteristics, could serve as an illustration of constructing knowledge, which takes into account the indexicality of cognition results, obtained in separate research projects and their specific parts.

Today in methodology we underline that triangulation possesses the properties of: a) validationstrategy, b) data supplementation strategy, bent on the complementary character of cognition, and c) an approach which generalizes research results, consisting in confirming the obtained effects through discovering their presence in various contexts, in which the studied phenomenon is present(Flick, 2004; Patton, 2002). These three qualities of triangulation are raised in methodological literature, however, within the theory of methodological triangulation itself it is difficult to find a model which would provide a complex illustration of them (cf. Flick, 2008; 2009). Thus, our ideas concerning the essence of "methodological" triangulation are still based on the "geodetic"concept, which is usually unrecognized. It imposes associations connected with procedures of verifying effects of observation using successively obtained results and reducing information which stand out, which situates triangulation in the context of actions aimed at eliminating mistakes in cognition. Moreover, in methodology the emphasis, which in geodesy is placed on planned and gradual clustering (or thickening) of points and triangulation networks, and multiplying wreaths[7], is usually weakened. This marginalizes the valor ofsequent approximations, realized in accordance with the principle "from a general rule to more and more detailed images",already have in empirical research methodology. The same is applicable to the valor of replicating this process. In geodesy triangulation tends to move in the direction of broadening microperspective, but it also allows us to broaden the view in order to uncover further fragments of the whole. The aim is to approach the ideal of a complete map.

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7 It needs to be noted that A.L. Strauss and J.M. Corbin, (1998, p. 33) assumed that triangulation makes it possible to thicken theories.

GOING BEYOND THE LIMITATIONS OF THE METHODOLOGICAL CONCEPT OF TRIANGULATION

There are attempts at going beyond the idea of triangulation in the direction of developing all that cannot be included in its geodesic notion. An example in this respect is the conception of methodological crystallization and the kaleidoscope concept which is based on it.

Laurel Richardson (Richardson & St. Pierre, 2005) suggests replacing triangulation with methodological crystallization , which according to the author is better suited to the deconstructionist attitude of postmodern and post-structurally oriented ethnographic research. Her concept is based on the metaphor of cognition as a crystal, in which material is organized according to the rules of symmetry and in a multidimensional fashion. According to the author the crystal treated as a prism allows us to perceive the diversity of quality, emerging as a result of changes in the configuration of the angle of view, the light and structure of the crystal itself. The author attempts to show the superiority of crystallization over triangulation, indicating that the latter is focused establishing the accuracy of the view of the world from three directions, while crystallization does not impose limitations in the scope of possible observation perspectives, developing the knowledge of the object of cognition in a multidimensional system (Richardson & St. Pierre, 2005, p. 963). However, this perspective demonstrates a basic lack of understanding of the idea of triangulation, stemming from its trivialized identification with the sides of a triangle, and reducing it a method of verifying the accuracy of cognition. The very conception of methodological crystallization, apart fromreferring to the structure of a crystal, based on a multidimensionality and symmetry, is not elaborated on, thus remaining an obscured metaphor. Additionally limited to the issue of accuracy. However, we should take note of how the crystallization concept was used by Laura Ellingson (2011) to build a model of a qualitative method continuum, in response to the persistent tradition of dichotomization and polarization in the area of cognition and the implementation of research practice. The author treats crystallization as a metaphor, which makes it possible to perceive and to illustrate an unlimited number of configurations of methodological procedures, based on blending approaches, genres, perspectives and methods. Ellingston's model presents the process of creating credibleknowledge, free from pretensions to being the only right perspective, as a complex established by the vast number of observation points in a multidimensional zone, between which there are no clear boundaries.

The crystallization concept became an inspiration for Dariusz Kubinowski (2013, pp. 59, 65), who introduced the term kaleidoscope in order to enhance the crystal metaphor through emphasis on multidimensionality, diversity, complexity and the dynamics of the scientific cognition process. Aside from the traits of the crystallization concept, which require that we treat itwith suspicion as an alternative to triangulation, the attempt to introduce the notion of the kaleidoscope to the discussion requires taking into account the properties which the author does not mention. The idea of a methodological "kaleidoscope" has inherent limitations resulting from the specificity of the construction and functioning of the kaleidoscope as a device. First of all, this devicedelivers diversity in the scope of image, but its functioning is based on polarization. This means that light is reflected in the mirrors from the object in such a way, that each image resulting from the reflection has its own inverse counterpart. What emerges is a total image which is the result of a configuration of a finite number of particular reflections and reflections of reflections. Moreover, the changeability of total images is also limited by the number of elements, i.e. glass and mirrors inside the kaleidoscope. The complexity of the image depends on the fixed angle of the mirrors in the kaleidoscope. This is an unquestionable invariant. In the case of three mirrors (a triangle kaleidoscope) the angle between them is structurally invariable, because the sides of the flat mirrors must converge at an angle of 60°, in order to create a triangular tube. These are the most popular kaleidoscopes today. In the case of two mirrors (a dihedral kaleidoscope) we have one of the 4 standard angle values, which include 22,5°, 30°, 45° or 60°. The smaller the angle the bigger the number of images, which in the case of dihedral kaleidoscopes, and in the case of angles being o multiplicity of the round angle (360°) can even be calculated using this formula: $N = \frac{360° - \alpha}{\alpha}$, where N stands for the number of images and α is the angle between the mirrors (Derfel, 2015).

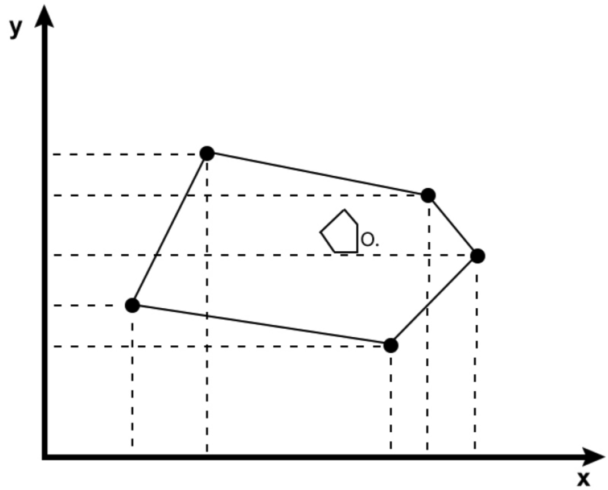
The image in a kaleidoscope is not a constant function of the rotation of kaleidoscope itself. Image changeability is thus discrete in character and is not continuous, which means that it stepwise. To put it in simple terms, the change in the image occurs after a several degree shift in the angle of rotation of the body of the kaleidoscope. This usually results from the irregularity of elements (e.g. colored glass) found between the mirrors. What is more, the total image provided by the kaleidoscope is always symmetrical.

All this means that the kaleidoscope metaphor imposes limitations which hinder the modeling of diversity and multiplicity of cognitive perspectivesand its possible results. The adaptation which the author mentions (Kubinowski, 2011, p. 59) takes place within boundaries determined by the elements of the kaleidoscope, with a clearly restricted number of possible configurations. While the concept of crystallization and the kaleidoscope can constitute alternative instruments, which can even enrich modeling of credible cognition, they do not do away with difficulties which also occur in the case of the triangulation concept, which is prevalent in social science methodology.

A MODEL OF A MULTIDIMENSIONAL EXTENSION OF TRIANGULATION

The origin of the methodological concept of triangulation is connected with geodesy and cartography. However, if we return to the meanings of this concept invented earlier in geometry, the scope of possible associations clearly gains several elements. This particularly applies to the multidimensionality of the cognition of the object of research (observation). The geodesic term triangulation refers to the plane, on which new positions are identified based on already known positions or points. This enables us to create a map of the terrain along with the localization and description of its particular elements. In the case of methodological triangulation the terrain could by our object of observation, however, based on definitions and descriptions by the authors mentioned earlier, we cannot exclude the possibility that the terrain also includes an entirety created by the investigatedphenomenon, along with the points of observation and the whole inventory at its disposal. This metaphor additionally limits modeling in a two-dimensional system (cf. Blewitt, 2009, p. 353). A view from a two-dimensional plane of many points, regardless of how many there are, does not allow us to accurately model objects with more than two dimensions. We can say that we see an object from more than one angle, but even a polygon (a plane figure with many angles) still provides a view in two-dimensional space, i.e. where every point of observation is determined using two coordinates (Picture 1.). Owing to advances in technology the later developmentof new mapping methods in geodesy made it possible to move on from two-dimensional triangulation measurement, even if it involved using contour lines, to three-dimensional measurement. However, this does not constitute the analogy which is at the base of the methodological concept of triangulation, which in turn refers directly to the classical theory of measurement by Frisius and Snellius.

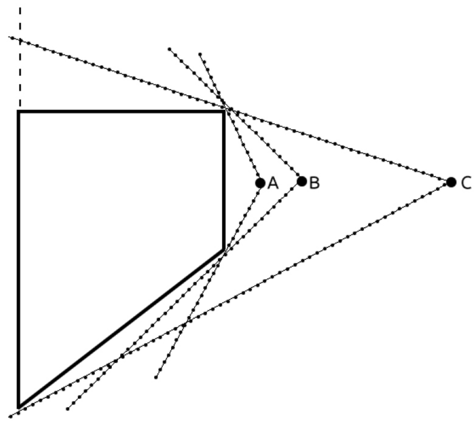
Picture 1. A poligon created by connecting the observation points of object O. in two-dimensional space



Source: the author's study.

If we discard for a moment the "geodesic" version of triangulation, while remaining interested in determining the angle of vision towards a given object, we gain an additional perspective on the notion of methodological concept of triangulation. If the object is big enough the system it creates together with the observer can be described using 3 angles: 1) the angle of vision, 2) the angle between the object and the point of observation on the left side of the angle of vision, and 3) the same angle on the right side. The size of the angles will differ depending on the distance between the object and the observer, though the sum of angles will remain constant, and the angle value on the left and the right side of the angle of vision will remain equal. This of course implies that the object is situated with its front to the point of observation. The researcher will obtain different information when he/she is very close to the object, and different when he/she is very far. The angle of vision will become smaller as the point of observation departs further. This issue is shown in picture 2, where points A, B and C symbolize the position of the observer, while the dotted lines determine the scope of the field of vision of the figure which is the object of observation.

Picture 2. The object – observer system, with a shift in position in one dimension

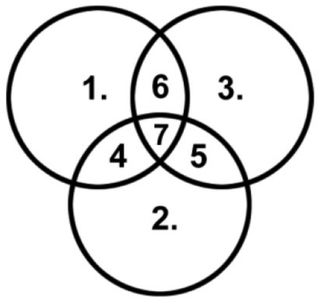


Source: the author's study.

If we continue in this manner, by adding another dimension (as in picture 1) we can model looking around the object – as it is in the case of two-dimensional triangulation. If the distance between the object and observer remains the same, the points of observation can be marked on a circle, one next to the other respectively. Hence, the number of observation points, and at the same time the number of images of the object, will become multiplied if we also take into consideration the dimension created by the distance. Thus the number of circles will be equal to the number of distance points between observer and object. However, in order to make the issue of the number of images of the object more clear, I will refer to the example of the number of observation points and leave out, for now, the issue of dimensions.

If we observe an object from two observation points, we get three results. The image from point 1 (O_1), point 2 (O_2), and the sum of these images (ΣO_{12}). When observation occurs from three points, the number of possible images rises to 7 (O_1, O_2, O_3, ΣO_{12}, ΣO_{13}, ΣO_{23}, ΣO_{123}). Adding another observation point increases this number to 15, and a total of five would result in 31 images. Therefore, each image would have to be viewed as 1-element, 2-element, 3-element, 4 element and finally 5-element sets. It is easy to calculate the number of images for a set of 6 observation points. We would have to use a formula for a combination without repetition for every possible number of elements in a given set of 6 observation points, and add the results. This way we will obtain the values 7, 15 and 31, as mentioned above. The multiplication of the number of images, depending on the number of observation points, is easier to show using illustrations of sets and their common elements. The common elements are products, not sums of sets. However, for the illustration to be clear, the common elements are highlighted, and the number of observation points is limited to 3. The numbers 1, 2, 3 we can see in picture 3 signify sets of information which constitute separate images of the object. It is highlighted by the dot next to the number. The numbers 5, 6 and 7 signify products of these sets.

Picture 3. Images of the object as relationships between sets of information



Source: the author's study.

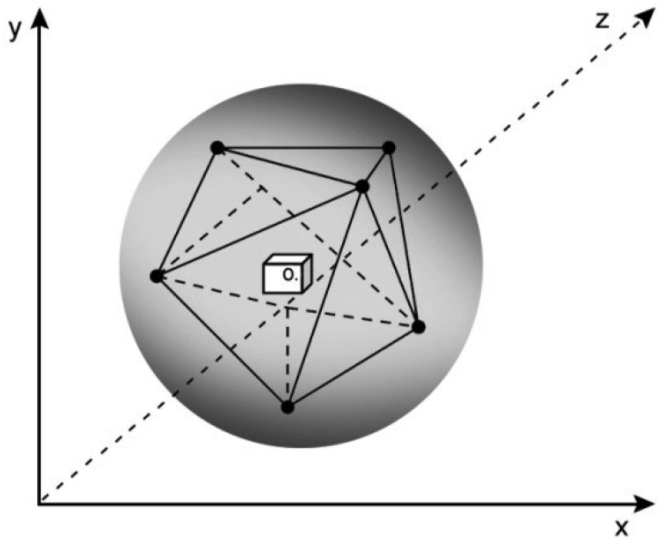
It is worth bearing in mind that the weight of the images is not equal. Sums usually have more information value than images obtained from particular observation points. There is also the synergic effect. Although knowledge concerning individual objects, in accordance with the idea of possible observation points, can be modeled well enough using a circle (a two-dimensional sphere), at least two issues cannot be excluded. Firstly, images from close observation points can overlap or even double. Secondly, not all observation points within this two-dimensional sphere can be reached. While the first issue can be of value from the point of view of data and research method validity, the second one is connected with restricted cognition. It may be necessary in this case to use approximations and idealizations, with a readiness to permanently change the position from which we conduct our observation. A ready concept of these approximations, leaving the possibility of making changes in the object image, in the course of establishing new observation points, is suggested in the idealizational theory of science by Lech Nowak (1977). However, detailing the model of the observed object does not have to occur, when the next observation point does not bring changes to the image of the object. It is nevertheless desirable to move between observation points. Remaining in one position can be considered what Gaston Bachelard (2000) called an epistemological obstacle. Lack of movement limits vision to one perspective.

The recent extension of the methodological notion of triangulation still uses the idea of only two dimensions. The three-dimensional model (Picture 4) creates a space in which knowledge concerning an object, depending on the number of observation points, can be presented not only using a curveor a plane, but also as a geometric body within a three dimensional sphere. The sphere symbolizes an ideal set of all possible observation points, where the boundaries of the sphere are delineated by the farthest points from object O[8]. From the every point of the set can be carried a countless number of straight lines (secants, diameters, chords). Each of the lines is inclined at a different angle. In this way, a countless number of possible cross-sections of the observed phenomenon could be reached.Depending on the distribution points the figure can take a symmetrical or amorphous shape. It is also possible to imagine a distribution of observation points which would produce a sphere that is smaller than the model sphere. This can bring to mind an association with the metaphoric notion of methodologicalcrystallization, which seems to approach knowledge spatially as a geometric body that emerges as a result of acquiring further images of some phenomenon. The main differencelies in the fact that conception of methodological crystallization excludes amorphous forms (Richardson & St. Pierre, 2005, p. 963) therefore it is worse at modeling knowledge, which does not have to assume regular shapes. Particular observation points can be found at various distances from object O, but on the same plane. The model also shows that points located at the same distance from object O can be on different planes. It allows us to predict that within the space of vision there can occur "white spots", positions and their clusters, from which the object has not yet been observed. It is worth to emphasize

[8] Modeling complete knowledge with the use of the sphere is rooted in ancient ideas (Mizińska, 1998, p. 21–25). The idealization of wholeness does not require using the notion of the sphere. In principle it is not the shape that matters, but the rule of convergence of form and substance. The idea of complete knowledge on modeling in a three-dimensional coordinate system can thus use a random geometrical shape. Completeness in a model occurs when the substance assumes the shape of the form, fills it perfectly, or uses the potential which the form supplies. This understanding also seems to be easier to reconcile with possibilities which the modeled reality can create. The metaphoric distance of observation points lying farthest from the object does not have to be the same for each point.

that the object in this model does not have to be given or known. Only further cognitive operations can disclose its form and, consequently, reveal its complexity or even show that what is presented in a given perspective can be a part of some entirety in a different perspective. The triangulation model in the multidimensional extension takes into account that with its help cognition can disclose and reveal, not just deepen, verify or confirm knowledge and the instruments for creating it. Although these characteristics are raised in modern developments of the triangulation concept, including meta-triangulation, they remain on the level of postulates and have no reference in illustrations.

Picture 4. The three-dimensional model of triangulation space



Source: the author's study.

This model is not perfect, for it does not provide an answer to the question how we can determine the similitude in the distance of points found on different planes. Furthermore, it becomes less clear when the number of dimensions is more than 3. However, this is not a substantial disadvantage. With 4 dimensions the model of knowledge concerning an object (images, their sums, products) takes the form of a hyperspehre. It is easy to imagine that an object will yield to observation in a multidimensional space created by many variables which determine that observation. Among them special attention should be devoted to time, which determines the dynamics of cognition and of the object under observation. Another issue is the fact that not all variables determining the image of the object can be successfully modeled using dimensions. This could be the case with paradigms, demanded by the authors of the meta-triangulation concept.

The model requires further work, though it presently allows the combination of the properties of triangulation as a validity strategy, a method extending cognition regarding a given phenomenon, a generalizing approach, and which even allows the construction of the object of cognition. In its present form it should be treated as a suggestion to extend the notion of triangulation, based on an idea taken from geodesy. However, it can create conditions where we can find an alternative to remaining with the trivialized, geodesic understanding,which limits the modeling of knowledge concerning the object of study to a map regarded, at best, as a plane with a possible substitute for a third-dimension in the form of contour lines.Such a limited perspective, in accordance with the standpoint by Bachelard, reduces opening the sphere of cognition onto other dimensions of the object of study, which makes it impossible to perceive its other qualities. What is more, it does not correspond with the number of dimensions to which the theory of methodological triangulation refers in its classic form. Triangulation of data, researchers, methods and theory can be seen as independent dimensions, and the areas themselves as separate sets of dimensions. We can imagine that each of these areas is subject to multidimensional modeling according to the traits which will be selected for their characteristics. Perceiving areas of triangulation as separate dimensions, though capable of being used together seems a lot more promising than adhering to their intuitive perception as types of triangulation (cf. Denzin, 1978; Flick, 2008). That last approach makes it difficult to notice, that in the course of triangulation we obtain cognitive positions determined by the coordinates of observation (data, methods, researcher, theories, time, etc.), not isolated modes of vision. Cognition, most of all scientific, undertaken by specific people or groups, has more chances of succeeding, when it is done in accordance with a holistic model.

CONCLUSION

The suggested model of multidimensional extension was suggested with the intention of constructing an alternative to the "geodesic" perception of triangulation in social science methodology, but at the same time without renouncing valuable elements supplied by the metaphor of triangulation used in geodesy, and the effects achieved so far in the area of methodological conception. From the point of view of this model triangulation clearly presents itself as a strategy of displaying what is common but also as a complementary element, which fills the image with data unavailable from one specific point of observation. The suggested model reflects the idea of thickening points of observation and networks of vision, and creating a multidimensional image in macro and micro-perspective, which is present in the geodesic method. It is a separate matter that the model can decrease or even remove tension between viewpoints, e.g. that various methods provide insight into different aspects of the observed object, and that various methods provide data of varying quality, which is not identical or even approximate (Rothbauer, 2008). Various aspects and various data are elements of a multidimensional space of cognition towards a given object which, according to the notion of spherical excess, requires effort increasing the adequacy of applied research methods and the model of that object. The principle of connecting various points of observation and as well as types of triangulation seems to respond to this. This situation is also expressed in the approach to research of such complex processes as, for instance, education (cf. Palka, 2011, p. 123). The idea of integrated dimensions also facilitates modeling triangulation in connection with the contextual character of cognition. This in turn inclines us to maintain distance towards the object – observer dichotomy, moreover a position supported by theoretical standpoints which deem it unwarranted to maintain that the image retained in cognition can only be a realistic representation of the observed object. Attention should also be drawn to the primary difference between the "geodesic" understanding of triangulation in methodology, and its notion which stems from the multidimensional model. The former refers to the reconstruction of mapped terrain. The latter, to the multidimensional reconstruction of thevision space. In the first case points are established on the object, and in the second case, mainly in the virtual space surrounding the object. What remains unused from the concept of geodesic triangulation by the multidimensional extension model,is the idea of establishing further points of observation, matching and control. This is expressed in the trigonometric calculation on which the triangulation network is based. However, the model does not exclude the possibility of discovering further observation points on the basis of the ones already established, and of stabilizing the "system-network" of knowledge built in this manner. What is more it is a system which, similarly to the triangulation network, will enable conducting further discoveries in the scope of those elements of empirical reality which demonstrate stability, as well as those characterized by dynamics.

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SUMMARY

The article is devoted to the issue of triangulation in the field of the methodology of social studies as well as humanities. First the focus is on the source of this concept and the presentation of its prototype, expressed in geodesy and cartography. Next, the modern understanding of triangulation in the realm of methodology was presented, along with an attempt to present its weaknesses, which was the reason for seeking alternative solutions in the scope of creating complementary knowledge concerning the subject of study. As a result a basis was created for the presentation of the idea of triangulation in a multidimensional expansion model, which makes it possible to combine the functions ascribed to triangulation: validation, generalization of research results, broadening of knowledge.

Key words: triangulation, multidimensionality, social science methodology, cognition.

TRIANGULACJA. OD GEODEZJI DO PRÓB PRZEKRACZANIA OGRANICZEŃ KONCEPTUALNYCH W METODOLOGII BADAŃ SPOŁECZNYCH

STRESZCZENIE

Artykuł poświęcony jest zagadnieniu triangulacji w obszarze metodologii badań społecznych, jak też humanistycznych. W pierwszym rzędzie uwaga skoncentrowana została na genezie tego pojęcia oraz prezentacji jego pierwowzoru, który wyrażony został w geodezji i kartografii. Następnie zaprezentowane zostało współczesne pojmowanie triangulacji w obszarze metodologii wraz z próbą ukazania słabych jego miejsc, które stały się podstawą poszukiwania alternatywnych rozwiązań w zakresie tworzenia komplementarnej wiedzy o przedmiocie badań. W rezultacie przygotowana została podstawa do przedstawienia idei triangulacji w modelu wielowymiarowego rozszerzenia, który pozwala łączyć przypisywane triangulacji funkcje: walidacji, generalizacji rezultatów badawczych, pogłębiania i poszerzania poznania.

Słowa kluczowe: triangulacja, wielowymiarowość, metodologia badań społecznych, poznanie.