TOPOLOGY VERSUS TIPOLOGY

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Abstract. *Continuity and discontinuity coexist in modern scientific research, from concept to paradigm, from hypothesis to model, from lemma to theorem, from method to methodology, and it is from the integrated opposition of these two apparently distinct approaches that the very trans-, inter- and multidisciplinary nature actually results of an objective investigation with an innovative of original content. Identifying an international school which includes prestigious names of topologists (including several representatives of the Romanian mathematical school) represents a derivative issue of this paper, just as a short journey from the morphological analysis to the multivariate analysis brings into discussion a new method, i.e. Meron – Topological Multidimensional Analysis.*

Keywords: *topology, typology, continuous and discontinuous attitude, multidisciplinary research, multidimensional morpho-typological analysis, Romanian topology school.*

1. INTRODUCTION

"There is nothing that we cannot understand if our spirit examines it closely; all these truths are innate in our spirit, as a king imprints his laws in the hearts of his subjects if he has the power to do so…" – René Descartes to Mersenne, 15 April 1630.

An introductory premiss to this article is that a treatment in the absence of criticism, focusing on the concept maintained by Pangloss, the immortal character that Voltaire ridiculed in *Candide, or the Optimist*, a book published as eearly as 1759, according to whom "in this best of all worlds possible, everything is done to the best effect and purpose" [1], cannot constitute the essence of the specific approach in such a paper devoted to a universe of scientific research, characterized by the opposing tendencies of change and evolution in modern science, emphasizing here only continuity in topology, and discontinuity in typology.

An approach that is specific to trans-, inter- and multidisciplinary scientific research has been, and still is, inetrrogative, involving a limited but well-selected number of questions, from the very onset of its descriptive or investigative approach, such as:

Q1. How can we remain, throughout the course of an analysis, in continuity and discontinuity, simultaneously?

Q2. What does defining mean, and what does using a multidimensional morpho-typological analysis mean?

Q3. What about simultaneously ensuring a topological and typological character to the modern research?

All three of the above questions are given some answers, or else conceptual or paradigmatic delimitations, in this paper. Finally, a number of concluding remarks cannot be omitted, which refer to a fundamental principle of researches that go beyond the border of insulating unidisciplinarity, i.e. the principle of the *equilibrium of the trans-, inter- and multidisciplinary paradigms*, which is otherwise visible in the concept of space-time in modern physics, at first sight topological as space and typological as time, which would require, and expressly explain the acute need for similarities, in parallel with the need for major differences between topology and typology.

2. TOPOLOGY – MEANINGS, BRANCHES AND A BRIEF HISTORY

In the topological vision, mathematics becomes a continuum of change, which thus includes so much more than mere algebraic measuring, geometric drawing, many various mathematical analysis operations defined by signs or letters [2]. Studying elementary or general topology more and more obviously looks like studying a foreign language, involving a continuous process of learning more and more words, rather than looking like learning mathematics, which seems to gather here a huge amount of simple theorems, which tend to take over the role of language norms, governing the use of words. [3] Topological theory, a significant area of modern mathematics, is redefined as the mathematical science of change, applicable to an increasing number of complex phenomena and processes of reality.

The initial meaning of topology is related to studying deformation of space through a continuous transformation (which involves stretching, extension, yet no splits or gluing), or a predominantly regeometrized or spatialized continuity. Etymologically, the term *topology* is derived from ancient Greek (the nouns *topos* and *logos* have become place and study, or the study of the place), which was renamed, Latin-wise, *situs geometry* or *situs analysis*.

In a broader sense, topology brings together a set of rules that describe and explain the relationship between neighbouring points, the more or less intersecting or nearby lines and the adjacent polygons, determining the way all these outline a geometry that manages to keep their space properties when planes or multidimensional objects are subjected to continuous transformations.

Yet topology is clearly different from Euclidean geometry in the manner it considers the equivalences between spaces or objects. In Euclidean geometry, two objects were equivalent when and if they could be transformed into each other through isometrics – transformations that preserve the value of angles, lengths, areas and volumes.

Euclidean geometry does not include any congruence in the sense of stretching or bending spaces, etc. In topology, the study of the qualitative properties of certain objects turns them into topological spaces, which define the concept of invariant placed under some kind of transformation (called a continuous map, and bringing together some properties of transformation – homeomorphism).

Iopology meanings have multiplied permanently. In Geographic Information Systems (GIS), topology can be defined as: "*the science and mathematics of the relationships used to validate the geometry of vector entities, as well as a number of operations such as network and neighborhood analysis*". [4].

Topology refers to an imposed structure, or one characterizing a set X, thus generating a topological space, through which it gains important properties in transformation processes, such as convergence, connectedness, compactness, continuity, etc. In this regard there coexist [5]:

1) algebraic topology, as a branch of mathematics which, in order to study topological spaces, puts to use tools taken from abstract algebra (e.g. homotopies, homologies etc.);

2) differential topology takes into account properties and structures (e.g. the smooth structure of a variety to be defined), and is closely related to differential geometry, and with the latter defines the geometric theory of differentiable manifolds;

3) geometric topology focuses primarily on low-dimensional manifolds (i.e. dimensions 2, 3 and 4), as well as their interaction with geometry, without excluding higher-dimensional topology (as part of geometric topology some seemingly distinct theories develop, as the case of theory of knots is deemed, etc.).

Topology was developed as a distinct field of investigation in the theory of geometry, as a result of the careful study of the concepts of space, dimension and transformation. [6] Robert Bruner considers topology as a modern version of classical geometry, defining it as a study of the various types of spaces, a type of modern geometry that is distinct through the kinds of transformations allowed prior to considering the change as permanent. Topology goes beyond projective geometry, or in a Renaissance-type of perspective, and its spiritual father was Gottfried Leibniz, who in the eighteenth century first imagined *situs geometry* (or geometry of place).

It was Leonhard Euler who first formulated and commented an application of modern topology, in 1736, when he published a paper on the solution of the *Königsberg bridge problem* entitled *Solutio problematis ad geometriam situs pertinentis* (The solution of a problem relating to the geometry of position). It was again Euler who initiated the famous formula for a polyhedron:

$$v - e + f = 2 \quad (1)$$

where v is the number of vertices of the polyhedron, e is the number of edges and f is the number of sides.

The real author of the *topological* invariant is Simon Antoine-Jean Lhuilier, who, in 1813, edited a scientific book on solids with holes (where g = the number of holes), where he provided a novel, uniquely innovative solution:

$$v - e + f = 2 - 2g \quad (2)$$

and he generated the first known result for an *invariant* [7].

The term *topology* was first used by Johann Benedict Listing in 1847, without however being fully used before the first decades of the twentieth century (and it was also Listing who described the Möbius strip in 1861 (four years before Möbius).

The authors below, through their major contributions in the field of topology, are listed and thematically organized in relation to studying the following topological concepts:

a) connectivity of surfaces (Johann Benedict Listing, Bernhard Riemann, Camille Jordan, Enrico Betti, Poul Heegaard, Henri Poincaré, etc.);

b) the generalisation of the ideas of convergence (Bernard Bolzano, Georg Cantor, Karl Weierstrass, David Hilbert, Maurice Fréchet, Frigyes Riesz, Felix Hausdorff, etc.);

c) functional analysis (Jacob Bernoulli, Johann Bernoulli, Jacques Hadamard, Erhard Schmidt, Stefan Banach, Henri Poincaré. L. E. J. Brouwer, etc.).

In the mid-twentieth century, topology had already become a major branch of mathematics. The topology of an object became the property "that doesn't change when you bend it or stretch it as long as you don't break anything" [8]. Topological results, seemingly unreal, or closely resembling the *Möbius strip* (the continuum of a strip or band described by the model of a surface with only one side and one edge, having the mathematical property of not being orientable, originally discovered by August Ferdinand Möbius and Johann Benedict Listing in 1858, and later published at long intervals of time), or the *Klein bottle* (the three-dimensional equivalent of the Möbius strip, one-sided and without edges) extended the concept of topological frontier or limit into science trans-, inter- and multidisciplinary realm (the Möbius strip designated an area having a topological border, while Klein's bottle had no border) [9].

The modern meanings of topology are always being extended and amplified, as shown in:

i) network topology (networks which contain only two-terminal devices, and where the circuit topology is an application of graph theory**)** or network topology configurations (depicted physically or logically);

ii) geospatial topology or the study or science of places with applications in earth science, geography, human geography, and geomorphology, etc.

A universal school of topology brings together the names of renowned mathematicians, conceptually structured above, to which we can also add other important names like Hans Freudenthal, Georghe David Birkhoff, Itiro Tamura, Oswald Veblen, Samuel Eilenberg, Vladimir Arnold, Yukio Matsumoto, Shigeyuki Morita, William Browder, Shigefumi Mori, etc. [7; 10].

What seems interesting, as far as Romanian mathematics is concerned, is that there appear the names of several major representatives of national mathematics, most of whom worked abroad (mainly after part of the mathematics school migrated to the US in the 1970s and the 1980s) over the past 50 years. he Romanian school of topology includes, every bit as naturally, the names of great academic mathematicians, from George Vrânceanu to Alexandru Ghika (founder of the Romanian School of functional analysis), up to Valentin Poénaru (since 1962 he has been living in France, and has worked at the University of Paris), to Mitrofan Ciobanu (born in Moldova), or Aristide Deleanu (since 1968 in US, Syracuse University of New York), or the younger Ciprian Manolescu (born in 1978, he is living in US, working with the University of Los Angeles) [10].

Poincaré's conjecture, which was enunciated for the first time by the French mathematician Henri Poincaré in 1904, states that if in a three-dimensional closed and infinite space (immersed in a four – dimensional space) all two - dimensional "circles" can be reduced topographically until they become a point, then this three-dimensional space is tantamount topologically (homeomorphically) to a three-dimensional "sphere". Russian mathematician Grigori Perelman's demonstration in 2002 (when he solved a problem that had preoccupied the specialists for nearly a century) was ranked first among the most important mathematical discoveries, in a ranking made by the prestigious journal *Science* on 22 December 2006, and is one of the most important victories for the science of topology [11].

Topologically means today more than the mutual placement of several items that remain in the same relationship no matter of the change in position, and implies either new significance for continuity, errors, scenario, space-time, and especially new connections like:

I. Topology and social, economical, spatial, or phenomenological interactions;

II. Topology and space continuity and mathematical physics and astronomy;

III. Topology and demography together against errors (e.g.: in 1970, preparing general census, United States Census Bureau used mathematical topology to reduce errors that appear on the map results etc.).

By focusing on ensuring a continuum, topology has extended its impact, and is gaining more and more space-time in almost all trans-, inter- and multidisciplinary fields. Modern topology, or that of the future, can certainly improve the trans-, inter- and multidisciplinary concepts, by means of the continuity of its analyses.

3. TYPOLOGY AS THE PERMANENT ADVERSITY BETWEEN TYPE AND ANTI-TYPE

Typology is the study of types. Typology is a composite measure that involves the classification of observations in terms of their attributes on multiple variables.

Such classification is usually done on a nominal scale in statistics. Typology is, at the same time, synonymous to a classification of the observations resulting from analyzing their attributes. The final result of typology is also called ae taxonomy, and it is embodied in a set of categories or types.

The term etymologically derives also from a Greek word (*typos*) and signifies a matrix, a very simple morphological model, based on several possible combinations, frequently resulting from two or more variables (more rarely through from special methods), each variable being typically defined by a series of discrete values. Typology has a statistical substrate and mathematical dimensions of physical space, as in that most frequently cited example of the Cartesian coordinate system. Typology expresses in the most in-depth manner the discontinuum, or discontinuity in the space-time type of variable. Through a genuine taxonomic excess there coexist several types of typology (in summary, a typology of typologies), a kind of discontinuity in discontinuum, which is the multiplied expression of an adversity of types and anti-types [12; 13; 14]:

a) philosophical typology (grouping based on the similarity of some traits);

b) statistical typology (a purely statistical concept, a complex design of scientific research);

c) anthropological typology (a notion derived from cultural division);

d) archaeological typology (classification of artifacts in relation to their characteristics);

e) linguistic typology (systematization and classification of languages with respect to their structural characteristics);

f) psychological typology (models or types of personality);

g) typology in theology (typology was frequently used in early Christian art, where type and antitype would be depicted in contrasting positions, and typology is also a theory of history, seeing the whole story of the Jewish and Christian peoples as shaped by God, with events within the story acting as symbols for later events) [15];

h) typology at the level of subdomains, or specific populations (examples: classification of farms, the Pavlov typology or the typology of individual differences, sociopolitical typology of political organizations, etc.).

The classical view of classification generates the common typology based on fundamental categories or types. Thus, in his *Dialogues*, Plato is the man who first introduced the philosophical approach centred on grouping objects based on their similar properties. Aristotle continued Plato's approach by analyzing differences through types, classes and variety (adversity and complementarity by type – the antitype is essential), drawing on a taxonomy that was subsequently applied in classifying living beings (by successive investigative techniques for shared properties, thus founding the distinction type – the antitype, and eventually generating the taxonomies in natural sciences).

The classical (or Aristotelian) view maintained that all the categories are distinct entities (type, class, variety), characterized by a set of common properties that define the necessary and sufficient conditions for membership, are clearly defined and mutually exclusive (type –antitype adversity) and define, in an aggregative and exhaustive manner, higher or superordinate categories.

There are multiple coexisting modern versions of the classical approach to typology, which emphasize certain aspects:

i) conceptual clustering (deriving from an attempt to explain how the distinctive type (cluster or entity) is generated by the formulating of the first conceptual description, and subsequently ensures classification according to descriptions resulting from scientific understanding and knowledge);

ii) prototype theory is based on the concept of prototype, although it essentially (though the necessary context and appropriate conditioning almost never occur in the real world, as in the logic and rationality of this theory) constitutes a basic element for human development, learning and research rely on learning about the research world and the reality via embodiment;

(iii) new urbanism theory of typology underlines that individual characteristics generate patterns or specific models, and relate elements hierarchically across physical scales (from small details or sub-systems to large systems);

(iv) modern statistical typology is based on ascending/ descending classification and use the following ten steps and many different statistical instruments [16; 17] and logical tools [18; 19; 20]:

- step 1: defining types of variables used (type – antitype for quantitative variables and dichotomized or binary variables, and qualitative levels and status for other variables);
- step 2: specific types and anti-types (defining case profile);
- step 3: aggregated types and anti-types (defining group profile);
- step 4: Euclidean (3) or chi-square distances (4) between types and anti-types (distances used between cases or groups):

$$dx,y = \sqrt{\sum_{j=1}^{n}(x_j - y_j)^2} \quad (3)$$

$$dx,y = \sqrt{\sum_{j=1}^{n}\frac{1}{(sj)^2}(x_j - y_j)^2} \quad (4)$$

- step 5: predefined typology (defining the initial typology);
- step 6:statistical specificity derived from the characteristics of distances by groups;
- step 7: descriptive statistics for quantitative variables and summary statistics for qualitative active variables;
- step 8: final typology (description of resulting typology;
- step 9: statistical variance explained (summary of the amount of variance explained by the final typology);
- step 10: useful or applied hierarchical ascending/ descending taxonomy or classification.

In the last quarter of a century [12], Velleman, Paul Wilkinson Leland heightened the in-depth critique of statistical typologization, which appeared as early as three quarters of a century ago, more precisely after 1945, when researcher and psychologist Stanley Smith Stevens basically invented the terms of scaling or nominal, ordinal, interval, and ratio typologies, in order to describe and rank the measurement scales used in taxonomies, in keeping with traditional statistical procedures [21; 22].

Through its impact on textbooks and the literature, Stevens's taxonomy influenced the statistical taxonomic reasoning of at least two successive generations. And, despite all the criticism of other statisticians, it still persists in some statistical manuals which naturally include typology or taxonomy. The major criticism levelled at the Stevens type of categorizations is based on the finding that the use of Nominal, Ordinal, Interval, and Ratio Typologies in the selection and recommendation of methods of statistical analysis is not appropriate because they do not describe the attributes of actual data that are essential for proper statistical analysis, and they can often be completely erroneous. Stevens's typologizations fail to provide a classification scheme suitable for modern methods of data analysis. So the following aspects represent real complex issues that are solved incorrectly, even in practical situations, through the Stevens scalings and categorizations – aspects that shape the following classical tuype of criticism, which is actually valid to the present [23; 24]:

1) the issue of limiting the choice of the statistical methods that provide suitable invariances for the kind of scale practiced is particularly serious, or dangerous for the analysis of the data of the pre-typology;
2) the issue of an excessively strict approach to allow the application of the Stevens typologizations on the actual data;
3) the issue of the specific prohibitions from one scale to another for Stevens categorization leads to the degradation of data, especially the hierarchies and rankings, which ultimately contributes to unnecessarily resorting to non-parametric methods. The modern arguments challenging statistical typologization extend to other aspects found recently [25; 26]:
4) the need for multiplying the alternative taxonomies based on the diversification of the real data types;
5) the need to develop new procedures for multidimensional scaling to be used in the conversion of actual measurements;
6) the *a priori* lack of databases without errors by definition, parallel to capitalizing on the packages of specialized programs focused on clusters and clustering, etc.

But whatever may be said about statistical typologies, they retain their usefulness when those who use them do so with statistical discerning wisdom, and in appropriate trans-, inter- and multidisciplinary approaches, without considering them *old-fashioned* and *unsophisticated* [27].

As a consequence of the need for balance in typological analysis, there also appear General Morphological Analysis (GMA) and Multidimensional Morpho – Typological Analysis (MMTA). General Morphological Analysis (GMA) is simply "an ordered way of looking at things, within the final and true world image everything is related to everything, and nothing can be discarded a priori as being unimportant." [28].

The most relevant example is Morphological Analysis (MA), which defines in architecture a complex discipline. MA studies the outer form and inner structure of organisms, entities (home, community, city), bring an approach to understand the studied objects and studying parts of a whole, the sub-systems of a system… MA is simultaneously topological and typological as follows: a) topological as availability between several elements that remain in the relationship regardless of changing position; b) typological whent it refers to configuring the house (form).

In statistics, econometrics, financial econometrics, data mining, any multidimensional analysis defines a data analysis process, which groups the data into two categories: data dimensions and measurements.

A. Data that provide a longitudinal cross-section:

The turnover or profits of a corporation for several years (a one-dimensional analysis defined by a data set)

B. Data that provide a cross-sectional dimension:

The turnover or profits of several corporations in one year (a one-unidimensional analysis defined by another data set).

C. Data that provide both a cross-section and a longitudinal section:

The turnover or profit of several corporations over several years (a two-dimensional analysis defined by a growing data set, or a data panel)

D. Let's try to imagine a data set of predictions (or forecasts) conducted a population of forecasters, and really get into the multidimensionality of the analysis, which is also the only really outset of big data).

MMTA operates with big data, and the chances to realize an objective analysis are increased significantly. Whether it is morphological or multi-dimensional, statistical analysis cannot however merge topology and typology, out of considerations of an insulating one-disciplinary nature.

Typology is also a study of object forms, but time destroys the form because the form is changing. Thus, the historical approach in the field of science (especially in biology) was always considered as an alternative to typology. Sergey Meyen (1987) proposed a general idea, i.e. that the typological and the historical approaches are mutually compatible if the form of an object is considered as a dynamic aspect. Then, the form is not destroyed, but rather created time [29]. This is an example of inter-, trans- and multi-disciplinarity, which enables a topology that connects topology to and typology (in a manner specific to understanding hyperspatial future, where the space–time variable is essential). The example does not however stop here, it rather extends to another method of classification, called meronomy or the study of common essence of united objects (designated as an archetype). Meyen proposed this new term *meron* for a class of similar parts, and thus meronomy becomes the classification of object or type parts. Objects or types are considered similar if they have common merons and thus Meyen generates the idea that typological and historical approaches are compatible if the form of an object is considered in dynamic aspect, the form being not destroyed, but created by time [29]. Temporal structure of an organism or a type is not less important than its spatial structure.

Better adequate to the reality than MMTA could be a new method based also on scenarios but using the new space – time concept, topological as space and typological as time, but still remain a multidimensional analysis method. Life scenarios in space – time could have a new type of analysis (global and even universal analysis) entitled as an awaited method [30]: Meron – Topological Multidimensional Analysis (M-TMA), as result of a multi-paradigm combining space continuity from topology with time discontinuity from meron typology.

Modern typology can be defined not only as the permanent adversity between type and anti-type. Modern typology essentially and analytically contributes to forming new concepts, beyond type and anti-type, and also goes to non-types, in keeping with a neutrosophic type of approach [31]. In other words, non-types will virtually influence the major extension of modern typology, and also, and to a similar extent, modern topology of the future… They both have an equal contribution, providing the ever more rapid multiplication of inter-, trans- and multidisciplinary research.

4. SOME FINAL REMARKS

Topology and typology express the two fundamental aspects of the research [32], i.e. continuum and discontinuum, respectively, and it is only in conjunction that they allow getting analytic and synthetic knowledge, both overall and in-depth, of the of phenomena subject to any investigation of reality.

There is a proven necessity for multidisciplinary scientific knowledge of an increasingly unstable equilibrium, visibly defining for the progress of the complex systems of the social and economic type of. The two transdisciplinary approaches of the physical and mathematical type (focusing on topology, as an expression of the continuum), as well as statistical and biological type (with biological or meronic accents of taxonomization, and statistically typological ones, defining the discontinuum in a discrete manner) are a solution, by the complex paradigm that they can construct as a result of the simultaneity of their application, or the ambivalence of their interpretations based on their intrinsic logic of a continuum – discontinuum type.

A natural principle of economic and social equilibrium gradually developed arguments to demonstrate the possibility for topology, discretely combined with typology, even with major similarities and differences of vision, to bridge the gap between the transdisciplines of a physical–mathematic and statistic–biologic type, not only in biological and social systems, but also in the universe, and even the multiverse of scientific knowledge.

These final remarks lead to the idea of the necessity for new multidisciplinary methods in keeping with the new inter-, trans- and multidisciplinary concepts or paradigms, such as space-time, or even methods like M-TMA capable of ensuring both the continuity and the discontinuity of phenomena, populations, etc, and of forecasting scenarios that are closer to reality and the coexistence of the species…

Maintaining a perpetual investigation-directed status remains essential for knowledge of the topology–typology antinomy, and the researcher's questions and critical spirit remain the solutions of modern academic training of an inter-, trans- and multi-disciplinary nature, in the context of the constantly valid and topical verse in *Gaudeamus igitur*: *Vivat membrum quodlibet;/ Vivant membra quaelibet; / Semper sint in flore!*

5. REFERENCES

[1]. Voltaire, J.J. (1969). *Candid sau optimismul*, traducere a ediției din 1759, de Al. Philippide, Ed. Literaturii Universale (E.L.U.), București, p.14.

[2]. Lemke, J. L. (2002). Mathematics in the Middle: Measure, Picture, Gesture, Sign, and Word, In Anderson, M., Saenz-Ludlow, A., Zellweger, S. & Cifarelli, V., (Eds.). *Educational Perspectives on Mathematics as Semiosis: From Thinking to Interpreting to Knowing.* pp. 215-234. Ottawa: Legas Publishing. 2002.

[3]. Viro O.Ya., Ivanov O.A., Netsvetaev N.Yu., Kharlamov V.M., (2008). Elementary topology: problem textbook, AMS, [on-line], available at: http://www. pdmi.ras.ru/~olegviro/topoman/eng-book-nopfs.pdf, accessed May, 26, 2016.

[4]. SDSU GEOG 104. *Geographic Information Science and Spatial Reasoning (GEOG 104) (A General Educatin [GE] Course)* Spring 2012, available on line at: http://map .sdsu.edu/geog104/unit-4.html, accessed May, 25, 2016.

[5]. Petrov, P. *Euler – A New Branch of Mathematics: Topology*, part II, [on-line], available at: https://www.math 10.com/en/maths-history/math-topology /topology.html, accessed May, 20, 2016.

[6]. Bruner, R. (2000). *What is Topology? A short and idiosyncratic answer*, [on-line], available at: http://www.math.wayne.edu/~rrb/topology.html, accessed May, 23, 2016.

[7]. O'Connor, J. J., Robertson, E.F., (1998). *A history of Topology*, [on-line], available at: http://www-groups.dcs.st -and.ac.uk/history/HistTopics/Topology_in_mathematics. html, accessed May, 25, 2016.

[8]. Pickover, C.A. (2007). *Banda lui Möbius*, traducere D. Constantinescu, Editura Humanitas, Bucureşti.

[9]. Edward Witten, Viewpoints on String Theory, http://www.pbs.org/wgbh/nova/elegant/view-witten.html, accessed

[10]. Deac, I., (2001). *Dicţionar Enciclopedic al matematicienilor,* [on-line], available at: https://www.scribd.com/document/33584895/Dictionar-Enciclopedic-Al-Matematicienilor, accessed May, 20, 2016.

Mamoru Mimura, *The Japanese School of Topology*, in History of Topology (1999), 1st Ed. by I.M. James Amsterdam; New York : Elsevier Science B.V.

[11]. O'Shea, Donal (2007). *The Poincaré Conjecture*. USA: Walker Publishing Company.

[12]. Velleman, P. F., Wilkinson, L., (1993). Nominal, Ordinal, Interval, and Ratio Typologies are Misleading. *American Statistician,* vol. 47, pp. 65-72. Available on line at https://www.cs.uic.edu/~wilkinson/Publications/stevens.pdf accessed May, 20, 2016.

[13]. Cohen, H., & Lefebvre, C. (Eds.). (2005). *Handbook of categorization in cognitive science,* New York: Elsevier.

[14]. Frey, T., Gelhausen, M., & Saake (2011). *Categorization of concerns – A categorical program comprehension model. In proceedings of the workshop on evaluation and usability of programming languages and tools (PLATEAU) at the ACM onward! And SPLASH conferences. October, 2011. Portland, Oregon, USA*

[15]. Campbell, D.M., *Puritan typology*, [on-line], available at: http://public.wsu.edu/~campbelld/amlit/typology.htm Accessed May, 19, 2016.

[16]. Săvoiu, G., Čudanov, M., Vladu, M., (2012). Profile Method – An Example of Multidisciplinary Applied Method, *ESMSJ*, Vol. 2(2): pp. 36-44.

[17]. Săvoiu, G., Burtescu, E., Ţaicu, M. (2014). Statistical Delimitation of the Profile of Local Elections Candidate – An Applied Statistics Research, *Romanian Statistical Review – Supplement* no. 7, pp. 115-123.

[18]. *Typology and Ascending Classification (statistics) – UNESCO*, [on-line], available at: http://www.unesco.org/webworld/portal/idams/html/english/E2typol.htm. accessed May, 19, 2016.

[19]. Ball, G.H. and Hall, D.J. (1967). A clustering technique for summarizing multivariate data, *Behavioral Sciences*, vol. 12, (2), pp. 153-155.

[20]. Cormack, R.M. (1971). A review of classification. *J. Roy. Statist. Soc.* Serie A, 134:321–367.

[21].Stevens, S.S. (1946). On the theory of scales of measurement. *Science,* 103, pp. 677-680.

[22]. Stevens, S.S. (1951). Mathematics, measurement, and psychophysics. In S.S. Stevens (Ed.), *Handbook of experimental psychology*. New York: John Wiley.

[23].Lord, F. (1946). On the statistical treatment of football numbers. *American Psychologist*, vol. 8, pp. 750-751.

[24].Savage, I.R. (1957), Nonparametric statistics, *Journal of the American Statistical Associatio*n, vol. 52 pp. 331-334.

[25]. Gaito, J. (1980), Measurement Scales and Statistics: Resurgence of an Old Misconception, Psychological Bulletin, vol. 87(3), pp. 564-567.

[26]. Tukey, J.W. (1977), Exploratory Data Analysis, Boston, Addison-Wesley

[27]. Collier D, LaPorte J., Seawright J., (2012). Putting typologies to work: Concept formation, measurement, and analytic rigor. *Political Research Quarterly* vol. 65(1), pp. 217–232.

[28]. Zwicky, F., (1969). *Discovery, Invention, Research: Through the Morphological Approach*, London: Macmillan.

[29]. Smarandache, F., (2005). Matter, antimatter, and unmatter. Infinite Energy, vol. 11 (62), pp. 50–51.

[30]. Săvoiu, G., Jaško, O., Dulanović, Ž.,Čudanov, M., Craciuneanu, V., *The value of general methods, quantitative techniques and management models in professionalizing management*, Management, vol. 49 (50), pp. 7-11.

[31]. Meyen, S., (1987). *Fundamentals of Palaeobotany*, New York and London: Chapman and Hal.

[32]. Lemke, J. L. (1996). *Typological and Topological Meaning Discourse Processes*, New York. Springfield, [on-line], available at: http://static1.1.sqspcdn.com/static/f/694454/12422434/1306510778573/TypoTopo Meaning. Accessed May, 27, 2016.