THE APPLICATION MODELS OF THE TOPOLOGICAL PRINCIPLE OF CONTINUOUS DEFORMATION IN THE ARCHITECTURAL DESIGN PROCESS

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Abstract. *Architecture and geometry share a mutual history, and their relationship precedes the introduction of digital and computer technologies in architectural theory and design. Geometry has always been directly related to the modalities of thinking in architecture through the problems of conceptualisation, representation, building, technology. Through the historical overview of these two disciplines, it is possible to perceive direct influences of geometry on the architectural creative concepts, formal characteristics of architectural works, structural aspects, and building methods in architecture. However, the focus of this paper is not on the representation of historical intertwining of these two disciplines, which is indisputable, it is on the attempt to represent one specific bond between topology and architecture, firstly through the explanation of the principle of continuous deformability, and secondly through the representation of the models through which the principle occurs in the architectural design process, as well. The first part of this work will introduce and analyse the transition of concepts of continuity and deformability, from mathematical topology through philosophy to architecture, while the second part of the work will explain two models in detail, formal and systematic, through which the principle of continuous deformation is applied in certain architectural design practices. Overall, this work deals with the interpretation of the principle of continuous deformation in architecture and it shows in which way the architectural discourse changes the meaning of a mathematical-philosophical notion and turns it into a design methodology of its own. The subtlety of the question Bernard Tschumi asks about space illustrates the need to thoroughly investigate interdisciplinary relation between architecture, philosophy, and mathematics: "Is topology a mental construction toward a theory of space?" (Tschumi, 2004, p.49)*

Key words: *architecture, topology, deformation, continuity, space theory*

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1. DEFINITIONS OF THE CONCEPT OF TOPOLOGY

The analysis of the term *topology*, as defined by the Merriam-Webster Dictionary, from the beginning points out the problem of ambiguity, which occurs due to imprecise and frequently loose interpretations of terms which belong to the field of the exact science disciplines. It is explained that topology is a branch of mathematics that deals with the properties of geometric shapes that remain unchanged under elastic deformation such as stretching or twisting. In the wake of this definition others can be found, given by the Oxford English Dictionary, and it links the term to a part of mathematics that deals with the study of geometric shapes and spatial relations which remain unchanged by the constant changing of shape or dimensions of a certain geometric shape. The Cambridge English Dictionary links the noun topology to mathematics and explains that it represents a way the parts of something are organized, as relations and connections between the parts of a whole. It is possible to look for additional reasons for multiple meanings and not quite precise definitions in the genesis of the word which was derived from the Greek words τόπος (place) and λόγος (science, knowledge), which links the meaning of the word to the science of places or the science of place cognition. The key question for the precise interpretation of the concept could be: *What kind of places is this really about?*

The analysis of topology as a contemporary mathematical discipline requires a transition from the term place to the term space because mathematics does not recognize places with their contextual specificities, but examines and describes abstract mathematical spaces and everything they comprise. The relevant literature in the field of mathematical topology explains that, generally speaking, topology studies those properties of geometrical shapes which remain preserved under continuous deformations, such as connectedness or compactness, i.e. mathematical topology makes no distinction between two shapes or two spaces, if it is possible to shift from one to another under continuous deformation. When it comes to this places it is irrelevant whether something is great or small, round or quadrilateral, if it can be changed by, for instance, stretching or bending, and the difference between two spaces is primarily related to those components which remain unchanged when deformation occurs. Some of the typical examples of topological spaces are *Möbius strip, Klein bottle, tori, different knots, etc.*

Overview of the development of topology indicates that the word topology has been in use since 1850, which most likely refers to the title of the book *Vorstunden zur Topologie* (Preliminary Studies of Topology) by German mathematician Johan Benedict Listing, issued in 1847. In the February issue of the English scientific magazine *Nature* from 1883, it was explained that "the term Topology was introduced by Listing to distinguish what may be called qualitative geometry from the ordinary geometry in which quantitative relations chiefly are treated" (P.G.T., 1883, p.316). However, several authors indicate that the first ideas about topology can be found in the works by Gottfried Wilhelm Leibniz, in his book *Characteristica Geometrica* from 1679, in which Leibniz introduced the concept of *Analysis situs* (Analysis of position) to counter size and form, highlighting the lack of adequate language when talking about form (Kline, 1972, pp.370-378). Also, in a letter addressed to Huygens, Leibniz accentuated that we need "another, strictly geometrical analysis which can directly express *situm* /position/ in the way algebra expresses the Latin *magnitude* /magnitude/"[1]. In order to

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[1] The letter Leibniz adressed to Huygens has been mentioned by two sources. The first is Prof. Dr. Rade Živaljević at the lecture "Topology - Understanding the Space" held on 18.02.2010. as a part of the lecture

understand Leibniz's idea about analysis of position, i.e. the idea that through position some different properties of geometric shapes can be explained in relation to the properties we learn through measuring, it is important to take into consideration the fact that in the same period Leibniz worked on inventing the Calculus, or the tool through which it is possible to define the graphical curve of a function using local information at the infinitesimal area of each point.[2] It is considered that the first precise setting of topological spaces was conducted by Leonard Euler in the period around 1735. In attempt to solve the problem *The Seven Bridges of Köninsberg* he made the first topological diagram and established a base for the mathematical graph theory. What is essential for understanding the problem which Euler reduced to the diagram is the cognition that no matter of the quantitative characteristics of the diagram, the shown topological structures, as well as a solution to the problem given remains the same. By changing the approach Euler has predominantly pointed out to the nature of the problem, placing it in the field of autonomous, qualitative properties of geometric shape, ones that remain unchanged under certain conditions. Euler explains this as follows: "The branch of geometry that deals with magnitudes has been zealously studied throughout the past, but there is another branch that has been almost unknown up to now; Leibniz spoke of it first, calling it the "geometry of position" (*geometria situs*). This branch of geometry deals with relations dependent on position alone, and investigates the properties of position; it does not take magnitudes into consideration, nor does it involve calculation with quantities." (Euler, 1956, p.573). Reducing mathematical and philosophical ideas of the two mathematicians, the essence of their reasoning could be also contained in the question: *What can we say about the comprehensive organisation of a certain space, if we don't know its dimensions?*

2. TOPOLOGICAL THINKING IN ARCHITECTURE

The beginning of the 1990s was still marked by the issues of Deconstructivism, which had many followers, all of which based their belonging to deconstruction on what Greg Lynn would define as *contradictory logic* by Jacque Derrida (Di Christina, 2001, p.7). The shift of dominant philosophical figures in architectural discourse, where Derrida was dominating in the 1980s and Gilles Deleuze and Felix Guattari in the 1990s (Hagan, 2001, p.137), for architectural theory and design meant to remain within the limits of their own discipline, because through the previous period of relation with Derrida position of classic philosophy in the field of architecture developed to the level of architectural design strategy. Moving from Derrida's discourse to Deleuze's was partially formed as a reaction to the deconstructive glorification of fractures, fissures and similar theoretical concepts. Concept of diversity was still there, as one of the main topics in architecture, with attempts to find appropriate spatial systems and formal terms by which different variations would be incorporated in architectural projects, whose merging would seem more natural and inclusive.

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seried "Mathematical Theory of Space" in Kolarac Foundation. The second source is Jean-Michael Kantor, "A Tale of Bridges: Topology and Architecture", Nexus Network Journal, vol. 7, no. 2, 2005, 13.

[2] The complete Leibniz's mathematical and philosophical work is possible to interpret as searching for holistic principles. It was his thesis from 1663 which contained the concept of *Monades,* unique, undividable entities which were supposed to be the constituents of spiritual and material world. In 1684 he publishes the first work dealing with differential calculus, and in 1686 the work in which he explains calculus with integrals. For more detailed explanation of Leibniz's work and the importance in the history of mathematics, one should examine Dr. Milan Božić, *Pregled istorije i filozofije matematike*, Zavod za udžbenike, Beograd, 2010, pp.185-197.

Philosopher of mathematic Arkady Plotinsky explains the difference between these two theoretical aspects with Derrida's *algebra*, which referred to writing, characters, and form dislocated in negation, and Deleuze's topology through which he insists on the continuity of folding[3]. Deleuze introduces the concept of *Le Pli*, as a spatial concept *par excellence*, and elaborates it starting from the basic concept of Leibniz's Monads, which serves him to inwardly introduce the matter, as an infinitely folded matter (Deleuze, 1993, p.6). Technical construction is not covered under the aforementioned, but a multitude, diversity, and differentiation which rely on continuity. Certain concepts such as *Manifold*, for instance, Deleuze even takes over terminology from the area of topology, referring to Riemann's work on defining the measurement of the curvature of space (Božić, 2010, p.212). Manifold, presented in detail in 1980 in *A Thousand Plateaus: Capitalism and Schizophrenia*, served Deleuze to develop an idea about complex relations between several concepts related to the curvature such as smoothness, folding, immeasurability, decenter, etc. John Rajchman, an architectural theoretic, explains that Deleuze's shift from idealism to scientific materialism in architectural discourse marked the abandonment of the idea of building forms through expression in favour of the idea about its genesis and generating process (Rajchman, 1998, p.18), so that in the mid-nineties the form itself began to mark a static category, as opposed to the dynamic process of creation (Oxman, 2006, p.252).

The aforementioned shift of the philosophical framework was followed by two significant influences. The possibility of description and explanation of the architectural design process through writing, not only by architectural theorists and historians but also architects who were actively building, meant that the theoretical interpretation of design process could deepen their understanding. Integrating writing with the design discourse, especially in conditions of the strong intertwining of architecture and philosophy has already been present in the architecture of the 20th century and relied on the search for adequate geometry which already begun at the beginning of the 1990s. Even though he mentions that geometry resists writing more than any other language, Lynn accentuates that it was writing that has the ability to explain different elements, without reducing them to the idealised form (Lynn, 1998, p.42).

Simultaneously with the shift of the philosophical framework, the beginning of the 1990s was marked by the emergence of digital tools used in the process of architectural design, which are more suitable for extensive research on contemporary mathematical theories of space in the architectural creative work. The use of personal computers was rapidly increasing, which was also related to the software development of image processing software. The use of digital tools has drastically altered the ways of presenting architectural projects, but besides improving the graphic possibilities it also influenced on the graphic ability of architects, so that the software use altered the design approach itself in the process of architectural design. Most architects in the early 1990s used software for modelling, in which the two points could connect with a curved line, with the help of simple operations that segmented the curve into sections of straight lines. The evolution of Autodesk software

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[3] Arkady Plotnitsky, „Algebras, geometries, and topologies of the fold: Deleuze, Derrida, and quasi-mathematical thinking (with Leibniz and Mallarmé)", *Between Deleuze and Derrida,* Paul Patton & John Protevi, ed.(London, New York: Continuum, 2003), 100. Plotnitsky additionally explains the difference between geometry and topology, which, even though both branches deal with the issues of space, mathematical background makes them different. He explains geometry through the space measuring, as geo-metry, whereas topology disregards sizes and deals exclusively with the structure of space *(topos)* and the essence of a shape.

AutoCAD (Computer Added Design) and *3d Max*[4] with the significant improvement of the speed of processing which increased the development of processing components, has soon led to the ability to connect two points easily with the continuous curved line, which was defined with a mathematical function. At that point, using computers enabled visualising an infinite number of the families of curves that were created using the same algorithm, and whose parameters altered depending on the need or the will of the designer. Thanks to the new technology it has become possible to make a smooth, curvilinear surface with specific topological characteristics. Even in the mid-nineties, the developed personal computers equipped with software for modelling the desired curvature have become widely available.

There is no doubt that the appearance of Deleuze's philosophy in architectural theory occurred at the time when digital technology has already been significantly developed, which today represents a basis for the debate on whether Deleuze's philosophical platform within digital tools has found the way for its own realisation, or whether it would have such influence on architecture had there been not for technological conditions for its visualisation. In any case, the relation between Deleuze's philosophical theory and digital technology in the field of architecture is undeniable.

3. THE PRINCIPLE OF CONTINUOUS DEFORMATION

The first attempts to record and analyse the topological principle of continuous deformation in the architectural design process appear in the historical and theoretical overviews of contemporary architecture using the most general term *topological architecture*. Mario Carpo explains the new architectural avant-garde at the beginning of the new millennium, known as *topological* which was considered to be an architectural response to the new digital technologies that were flourishing at the time. "Topological" architecture, as it was called then, was seen for a while "as the quintessential embodiment of the new computer age - and we all remember the excitement and exuberance that surrounded all that was digital between 1996 and 2001" (Carpo, 2011, p.84). Branko Kolarević uses the same term while classifying digital architecture: "This new fluidity of connectivity is manifested through folding, a design strategy that departs from Euclidean geometry of discrete volumes represented in Cartesian space, and employs topological, "rubber-sheet" geometry of continuous curves and surfaces." (Kolarević, 2000, p.251). The similar term *topological tendencies* in architecture was introduced by Guiseppa Di Christina, where topological tendencies represent "the topologising of architectural form according to dynamic and complex configurations leads architectural design to a renewed and often spectacular plasticity, in the wake of the baroque and of organic expressionism" (Di Christina, 2001, pp.6-13). It is noticed that in the first analysis of the principle of continuous deformation was considered as a specific formal construction above all and that only with a certain time shift more comprehensive interpretations of the topological principles in the architectural design process will appear. In attempt to fully realise the potential of topology, the architectural theory is significantly turning to the original mathematical definition, leaving philosophical, especially Deleuze's interpretations aside. Starting from this point of view, one can analyse the data that Felix Klein has even in his opening speech from 1872 while becoming a university

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[4] The first version of commercial graphic software AutoCad appeared in 1982, while the first version of the graphic program 3d Max for three-dimensional modelling was introduced in 1990. http://usa.autodesk.com/company/

professor, described geometry as a science dealing with the properties of geometric figures which have variable character depending on the group of transformations applied on it (Božić, 2010, p.214). Thus, the Euclidean geometry deals with the study of properties of geometric shapes that remain unchanged in relation to the group of rigid transformations, such as translation and rotation. Klein has made a classification of diverse geometries through the groups of transformations in them, so as to theoretically ground results and observations, which remain relevant up to this day (Emmer, 2004, p.10). Relying on this definition, the principle of deformability could be interpreted as a possible type of deformation, whose greater significance for the design process reflects in the fact that it is possible to equate two metrically different spatial entities through deformation, than in the result of deformation conducted in a certain space. The grounding of the importance of this characteristic can also be found in the fact that the mathematical study of topological spaces is based on defining arbitrary sets of elements and their selected collections, whose subsets can be copied from one to another by continuous deformation, on condition that there is a part of properties that remain unchanged in that way. In this process, deformability, i.e. ability to deform[5] indicates to the possibility that two sets of arbitrary elements can be equated by deformation. In order for the principle to be within the limits of topological, it is necessary to take the example of the shape that we arbitrarily deform, but in a way that there is no possibility of its subsequent merging or cutting, which actually defines the principle of continuity. The basic characteristic of the principle of continuous deformation provides the unity of disintegrated structure, especially within the arbitrary group form. One of the most significant definitions of the application of the principle has been given by Kostas Terzidis, introducing the concept of *topological operations*, which involve folding, stretching, and compressing, but not tearing and cutting. Each type of operation which deforms the form by hollowing creates two topologically distinct entities, which leads to the conclusion that "topology may be regarded as the unifying force that preserves the integrity of an indefinitely changing geometry" (Terzidis, 2003, p. 24). By this he means that certain formal properties remain unchanged even when geometrical shape endures intensive distortions, so that it loses its metrical and projective properties. The importance of Terzidis's definition lies in a clear distancing from the traditional architectural design methodologies that were based on addition and substitution of the form, by which widens the range of possible transformations that can be used in architectural design, making it closer to Klein's classification.

Although the principle of continuous deformation can be used to create spaces of different formal characteristics, for the architectural design process the analysis and the study of the possibility to transform space becomes more significant. The potential for the transformation of the basic form, which is known to us and metrically defined, is recognised as the most important characteristic and becomes the basis for the defining two models of implementation of the principle of continuous deformation: formal and systematic.

4. THE FORMAL MODEL

The analysis of the formal model relies on the definition given by Rivka Oxman, and thus classifying digital design models. She introduces the topological formal model, which implements topology and non-Euclidean geometry in the study of architectural forms in

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[5] Oxford English Dictionary states that the word *deform* was derived from the words *de* and *form*, i.e. *de* (prefix for change) and *form* (form, shape)

the architectural design process through digital tools. This allows the introduction of complex, non-linear logic in the design process which contradicts static and typologically determined logic of the previous design methodologies. Oxman highlights that this model can be considered as the first model since the use of digital technologies began, typical for the second half of the 1990s (Oxman, 2006, pp. 251-252). Most explanations regarding the principle of continuous deformation of the formal topological model testify about the shift from Cartesian geometrical model in architecture to more spatially complex logic, through which it is possible to express flexibility and continuity of an infinite number of variations. Essentially, the formal model is based on establishing formal similarities between certain topological models and architectural form, by which the lack of precise mathematical definitions is meant. The examples of the topological spaces, which have their own prominent visualisations or philosophical interpretations of the topological concepts, are being used.

On one hand, there is the formal model whose continuous deformation is conducted as an architectural theoretical interpretation of those examples of topological spaces which had their special appearances (Möbius strip, Klein bottle, tori, different knots, etc.) As these examples mostly had properties of smooth mathematical manifolds, which primarily dealt with surface curving, it is no wonder that the appearance of topological formal model in architectural theory started to equate with the ideal of creating curvilinear geometrical objects. In the first half of mid-nineties, which was marked by "the fascination exerted on architects by topological entities" (Picon, 2011, p.33), the project for Guggenheim Museum Bilbao from 1997 was referred to as a typical example of deformability use which was allowed by flexible topological geometry although the "forms of bending, twisting or folding" (Lynn, 2004, p.28) were the example of architectural interpretation of the topological principle of continuous deformation. Even while Giuseppa Di Christina argues that the use of topology goes beyond the questions of form, she remains primarily focused on the formal vocabulary.

On the other hand, the analysis of theoretical architectural texts which followed the use of the formal model indicates to the dominant use of philosophical interpretations, especially through Deleuze's philosophical concepts. Even in 1991, the Peter Eisenman's winning project at the competition for Rebstockpark in Frankfurt was followed by several significant essays in which the altered relation to the predominant philosophical thought can be recognized. There are no references to mathematics or new geometry in them, but only to the philosophical interpretations of its properties through the concepts of Gilles Deleuze's. This is the period in which topology is not known and thus is not taken into further consideration, but formal similarities between the text of architectural theory and philosophical text has been established. The essay by John Rajchman *Perplications: On the Space and Time of Rebstockpark*[6] contained more Deleuze's terms and concepts of folding, multiplication, complexity, and informality are presented as key concepts. The notion of *Le Pli* makes constant appearance mostly to explain Eisenman's design strategy, but also in order to distinguish it from Robert Venturi and Colin Rowe. Eisenman himself used terms bending, twisting, and unfolding around 1991 so as to explain his conceptual diagrams, as in the case of Alteca Office Building Project in Tokyo (Eisenman, 2004). He develops the ideas of continuity and deformable variations through context, explaining a different relation towards the city that the project is trying to establish. He explains that the buildings should no

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[6] John Rajchman, "Perplications: On the Space and Time of Rebstockpark", *Unfolding Frankfurt*, Peter Eisenman and John Rajchman, ed., (Berlin: Ernst&Sohn, 1991), 18-77. Only for the second publication of the essay in the book *Constructions* (Cambridge: MIT Press, 1998) Rajchman changed the original title to "Folding"

longer be defined by the form established by the principles of standardisation and whose appearance impresses with its universal laws, but they should be replaced with the principles arising from the current situation in which fluctuations are substituted with stability, and the building is positioned in infinite number of variations (Eisenman, 2004). In Eisenman's reading of Deleuze's notion *Le Pli* the idea of the form which can be modified, reformatted, even moved, under the laws of continuous variations is accentuated, but the recognition of the characteristics of topological spaces behind this concepts does not exist. The issues of the changes of architectural form are enhanced and the forms capable of continuous variations are insisted on, i.e. the forms which are capable of changing over time, but in spite of emphasising these and similar formal strategies, the process of folding for Eisenman remains completely conceptual.

At the same time, architectural critique brings up the issues of form idealising. The concern about architecture returning to the world of idealised objects could be found in critique texts which followed published project at that period, with their authors expressing doubt in the existence of deeply considered attitude in comparison to pure experimental interest in mathematics and digital media (Robinson, 2004). According to them, *topological architecture* demanded a shift from becoming only a formal gesture, a socio-political aspect of what is supposed to allow it to escape from the emptiness of the objects. They suggested that there were no isolated parametrically generated forms, nor that the complexity is self-sufficient, but that the complexity should be sought in complex relations that are producing architecture.

5. THE SYSTEMATIC MODEL

In the period after 2000 until today it is possible to notice the development of the systematic model which is primarily based on the study and translation of systematic characteristics of the principle of continuous deformation and their integration into mechanisms of the architectural design process. What was necessary for developing the systematic model was a deeper knowledge of not only philosophical concepts but mathematical notions of continuity and deformation, so as to translate widely acquired knowledge from other disciplines which would later be translated to architectural methodologies. The systematic analysis of the characteristics of mathematical models which were possible to apply on the architectural design certainly possessed the biggest potential, but also pointed out that this interdisciplinary approach meant new techniques, research methodologies, and visualisation, i.e. the new forms of producing and implementation of knowledge empirically based on experiments. As long as geometric shapes are visible, clear forms that define points, planes or surfaces, topology is immense to a certain extent and can be understood primarily through spatial relations. It could be said that geometry deals with the geometric shape itself, while topology explains relations within the shape and the system in which parts influence one another. As the ideas about the wider influence of topology in architectural discourse grew, explanations of how topological spaces ultimately deal with relations could be found more often, relationships with the given spatial context and not the specific form, which makes clear that a certain topological construction can be manifested through numerous forms. In other words, topology has become less of a spatial determination, but more of a spatial relation. The accent has shifted from the "making the form" to the "finding the form" (Kolarević, 2003, p.17). Finding the form is essentially a generic process, which means an analysis of the system which lies within the basis of the topological principles.

A significant contribution to the use of the principle of continuous deformation, especially the systematic model, can be noticed in Ben van Berkel and Caroline Bos's architectural design process. Although they have tried to distance themselves from both Deleuze's philosophy and the mathematical topological principles of used models, it is evident that the essence of their approach to architecture is deeply rooted in these two platforms. They have developed the attitude towards the use of the term topology as their own concept *Inclusion*, in which they counter *blob* and *box*, through the hybrid figure that will merge the representatives of the two different geometries and different logics about space in general (Van Berkel, Bos, 1999, p.220). In attempt not to favour any, getting closer to mathematical definitions established by Beltrami and Klein, explaining that the complex geometry and the Euclidian geometry are the parts of the same system and that a straight line is nothing but a cross-section of a big curve (van Berkel, Bos, 1999, p.222). The issue of the relation towards the formal characteristics of architectural objects seems to have been set on an equal footing in relation to the two geometries, i.e. the principle of *Inclusion* is far more than a relationship towards geometry. However, when the model of the principle of *Inclusion* in design gains features of non-hierarchical complex generative systems, which are *topologically generated* (van Berkel, Bos, 1999, p.225), it is clear that the Euclidean geometry becomes suppressed. More important than this is the idea that geometry is interpreted as a possibility of including all relevant aspects in architectural design, i.e. the systems for collecting various types of information which can influence the design process. This interpretation inevitably refers to Deleuze's aspects of manifold, where local points cannot be compared, but they become a part of the heterogeneous global image.

A significant influence on the architectural design methodology was made when the use of diagram started to get involved in design process, which gets a central role in controlling the process of design the complex systems (Eisenman, 1999, p.34). Also, it began to be used as an external element for collecting different databases (van Berkel, Bos, 2002, p.8). Clarifying the role of the diagram Jeffrey Kipnis highlights that actually diagram was helped "to avoid the pitfalls of Expressionist processes" (Kipnis, 2004, p.63). At the moment when the issue of curvature was put aside, with the complex network of aforementioned influences on the architectural discourse, continuous deformation shifts from being a principle of shaping forms to an integral part of the theory of architectural design. Development of the systematic model has meant for the topological principle of continuous deformation to be perceived as a comprehensive spatial system, where topology is understood as a flexible structure formed by specific and clear relations, unchanged by transformations and deformations. To design in a topological manner started to mean accentuating specific relations or certain *states* (Stojanović, 2013, p.10) crucial for the logic of organisation, by which geometry in relation to dimensions, distances, or form remains flexible. Today in the architectural theory topology is no longer interpreted as geometry of building nor its prototype but as a demonstration of certain geometric principles. The attitude that topological spaces do not deal with specific form, but relations, authors explain with the fact that topological principles can be manifested through numerous forms where "the concept of continuity is only gained through the application of the algorithmic logic" (Zellner, 1999, p.52). Michael Hensel accentuates that for the use of the topological method "shifting the focus from a mere metric conception of the geometric relationships that define the system's morphology and behaviour towards an understanding that includes non-metric and topological aspects, provides the base for computational morphogenesis of material systems that enables the unfolding of differentiation which

remains coherent with materialisation and fabrication logics" (Hensel, Menges, 2013, p.43). The width of the interpretation of the principle of continuous deformation primarily through architectural theory leads to the study of digitally-generated models of *quasi* topological forms, in which "architects freely appropriate specific methodologies from other disciplines" (Imperiale, 2000, p. 38). Relying on the need for the comprehensive understanding of topological spatial system through potentials that possesses, topological form in architectural design methodology starts to be treated as something that happens when it is filled with the elements full of potential to happen, due to stretching, folding etc. (De Landa, 2002). The importance of the systematic model lies within the illustrated change related to breaking mathematically-topological shapes of digitally generated forms so that mathematical-philosophical logic becomes a way of thinking in architecture. As the notion goes beyond the architectural text in the direction of the architectural design process, the application becomes more direct, and therefore the possibility of a mathematical-philosophical notion becomes a constitutive part of the process in which a society, community or an individual create their own reality.

6. CONCLUSION

The illustrated transition of a topological principle towards the field of architectural design, primarily through the examples of texts of the architectural theory and critique, showed the process through which the productive relations between mathematics, philosophy, and architecture are being established. Tracing a certain mathematical-philosophical concept points out the possibilities of exchanging knowledge between these areas, as well as the influence topology has had in the last three decades on forming new theoretical concepts in architecture. In the interest of this paper is to point out the diffusion of data networks, which provide adequate results only when systematically used. However, focusing on the mechanisms placed outside of the observed disciplinary framework, it appears that architecture is not a separate artistic discipline, but it becomes a constitutive part of the process of imposing certain social values. As many of the authors from the 1990s argued that the new digital tools "finally liberate creative forces that technology and society had long constrained, enabling the expression of nonstandard individualities, differences and variations that older technologies could not support, and older societies would not tolerate" (Carpo, 2011, p.111). Even if these observations were related to the fact that topological spatial models were only used because it became technically possible, the tendency to impose new social relations with the contribution of the characteristics of topological spaces separated from the real perceptual world was shown. Openness, deformability, and the relation between local elements in the global system were observed as the instruments through which it is insisted on adopting individuality in architecture. This paper is above all an attempt to point out the subtle ways through which architecture refines our sensibility to differences and strengthens our ability to accept and tolerate unknown realities.

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MODELI UPOTREBE TOPOLOŠKOG PRINCIPA KONTINUALNE DEFORMACIJE U ARHITEKTONSKOM PROJEKTANTSKOM PROCESU

Arhitektura i geometrija dele zajedničku istoriju, a njihov odnos prethodi pojavi digitalnih i kompjuterskih tehnologija u arhitektonskoj teoriji i stvaralaštvu. Geometrija je oduvek bila u direktnoj vezi sa modalitetima promišljanja u arhitekturi, kroz pitanja konceptualizacije, prikazivanja, građenja, tehnologije. Istorijskim pregledom odnosa ovih disciplina moguće je sagledati direktne uticaje geometrije na arhitektonske stvaralačke koncepte, formalne karakteristike arhitektonskih dela, konstruktivne aspekte, uticaj na metode građenja u arhitekturi. Međutim, fokus ovog rada nije na prikazu istorijskog prepleta ovih disciplina, koji je neosporan, već je pokušaj da se prikaže jedna specifična veza između topologije i arhitekture, najpre kroz objašnjenje principa kontinuirane deformabilnosti, a zatim i prikazom modela pomoću kojih se princip pojavljuje u projektantskom procesu. U prvom delu rada će se prikazati i analizirati tranzicija pojmova kontinuiteta i deformabilnosti od matematičke topologije, preko filozofije do arhitekture, dok će se u drugom delu detaljnije objasniti dva modela, formalni i sistemski, pomoću kojih se principi kontinualne deformacije apliciraju u pojedinim projektantskim praksama. Uopšteno, rad se bavi tumačenjem principa kontinualne deformacije u arhitekturi i prikazuje na koji način arhitektonski diskurs menja značenje jednog matematičko-filozofskog pojma i pretvara ga u spostvenu projektantsku metodologiju. Suptilnost pitanja o prostoru koje postavlja Bernard Tschumi najbolje govori o potrebi da se detaljno istraži interdisciplinarni odnos između arhitekture, filozofije i matematike:"Da li je topologija samo mentalna konstrukcija bliska teoriji prostora?"(Tschumi, 2004, p.49)

Ključne reči: *arhitektura, topologija, deformacija, kontinualnost, teorija prostora*