

## PROCEEDINGS ARTICLE

# Forming of Types of Volumetric-Spatial Structures in Architecture

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## ABSTRACT

This article is dedicated to the process of the development by people of architectural forms, which is considered to be the result of learning the category of space. The latter is suggested to be the basis for generating space-related views which later on leads to the emergence of the artistic aspect of the process and finally to architecture as a phenomenon. The author, having applied a systematic approach to the problem, shares his hypothesis of the consecutive genesis of architectural forms as an independent category. The so-called volumetric-spatial structures (VSS) are considered to be the lapidary basis for the emergence of architectural forms. It has been determined that despite the countless number of architectural forms, the number of VSS types is only six.

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## 1. INTRODUCTION

Great variety of architectural forms takes place due to the adding of the so-called “architectural excesses” to a purified fundamental form which in our opinion is the basis for the development of certain forms and which we specify as volumetric-spatial structure (VSS). They are several in quantity and actually represent the series of spatial structures which derive chronologically from each other and each of VSS has its own characteristic features to be compared with the previous and subsequent ones. Thus, the VSS are somehow the “quantums” which reproduce certain phases of adopting geometrically arranged space.

## 2. CHARACTERIZATION AND SEQUENCE OF FORMING OF TYPES OF VOLUMETRIC-SPATIAL STRUCTURES IN ARCHITECTURE

Characterizing the VSS we would like to point out that they have clear geometrical outlines, but they are quite generalized (abstract) at the same time as they are contemplative structures. That is why it is not possible to specify exact sizes of VSS, their scale and details of their proportions. The number of VSS is much less compared to the variety of forms. We identify the basic structure and we name it as the “platform” which VSS are based on and which is the basis for development of VSS of the so-called 2nd level – derivative ones – and 3rd level – composite ones.

The “platform” structure represents a parallelepiped (prism, cylinder), which vertical proportions are much less than horizontal ones. Such volumetric-spatial unit can have the gradation from the centric type and up to the one that is “prolonged” as per its

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plan, that is the basic structure. In case a volumetric-spatial unit is excessively stretched along one of its horizontal axes, then it "is moved" from the gradation "platform" and obtains the characters of a hugely elongated volume. In case a volumetric-spatial unit is developed towards the depth (in the direction off the observer, i.e. along the sagittal axis), the so-called "alley" occurs, and if it is "stretched" in the transverse direction, frontal volume appears. Moreover, the structure "platform" can be also developed along the vertical axis until it transforms into the structure "pyramid" ("cone", "hemisphere") and then into "tower". Thus, as it was mentioned above, we identify only conventional proportions of the VSS until one structure exceeds the borders of other (i.e. until one VSS loses the geometric features of a certain "quantum" - "platform", "pyramid" etc.), e.g. the "alley" and "tower" transformations. Three basic VSS - "pyramid", "alley" and "tower" - we determine them as the derivatives of the fundamental VSS "platform".

We suggest that the geometric configuration is important for the VSS. Thereby, the structure "platform" can have such geometric features as the square (rectangular), circle or polygon in their plan. The same is with the VSS "pyramid" which has certain special cases with the circle in plan, which produces the structure "cone". Moreover, rounded outline of the vertical sections leads to the occurrence of the "hemisphere". But nevertheless, all these three types are related to the same volumetric-spatial type (conventionally called the "pyramid"), which space arrangement principle is based on the narrowing of the space that is set up along its vertical axis. All the above are the schemes and they are the VSS and that is why they have clear geometric outlines.

### **3. SPATIAL ARCHETYPES AND THEIR SUGGESTED ORIGINS**

As per our concept, forms that are based on the VSS also have their own beginnings. They are much more "vague" (but not formless) structures which derive from spatial archetypes which underlay within human sub-consciousness and which represent the sense of the spatial categories developed by men during their evolution process. These spatial categories have the so-called axes which direct their evolution, similar to those of crystals' growth [1]. So, in our opinion, the spatial archetypes are a kind of the bundles of intuitive sense of the space, that are arranged along the "lines of force", i.e. certain axes in the three-dimensional space. It is evident that one can imagine them as some reflections of sub-conscious subtle senses which "force" the appearance and generation

of some spatial configurations starting from the archetypes and up to the VSS and the certain forms.

But spatial archetypes are not really amorphous constructions, they have quite clear axes as per which the space is arranged, but this space doesn't have any clear geometrical frames. The latter, as we have mentioned above, characterize certain architectural forms. In line with this, a compact ("centric") space-related bundle with the dominating horizontal dimensions over the vertical ones, embodies the archetype "platform". Moreover, as per its basis, as it was pointed out above, the according VSS is developed, it is the structure "platform", and its type will be specified according to its plan by the characteristics of the square, circle (or polygon). Here we should limit to considering the basic planning configurations (circle, square, polygon) used for attributing this VSS because its further detailing (e.g. star-shaped or festoon plans) will have the features of turning to the form considered.

The following three sub-types of VSS ("pyramid", "cone", "hemisphere") are identified by the generalized term "pyramid" as they all belong to the same common archetype, i.e. when the space arrangement is based on the narrowing of the space that is set up along its vertical axis. This archetype can be conventionally specified as "pyramid" or "cone", or "hemisphere", but we have defined it as "pyramid". If this space-related bundle is excessively stretched along its vertical axis, then it will transform into another archetype - "tower" - and each sub-type of VSS that is based on it can be cylindrical, square (or polygon) as related to their plans. So, in this case, the space-related archetypes (unlike VSS) don't have any certain (even generalized) geometric configurations.

The origins of space-related archetypes look quite subtle so far, but in our opinion they represent the "marks" of deep (mental) structures of human sub-consciousness in the kind of the "figure set up on the plane", or vertical and horizontal axes which we have determined as "space-related universals", of course with the certain degree of conditionality.

It is evident that we can define them as the basic archetypes or the ones of the first (and might be of the zero) level because separately they don't have any signs of the space ("figure", vertical and horizontal directions). These exact features differentiate them from the considered archetypes, i.e. space-related archetypes or the so-called archetypes of the second level. But as the "figure on the plane" or the "line" (vertical and horizontal directions or the axes of the same directions) take place in the three-dimensional space and together develop the structure of the space, then a spatial three-dimensional "framework" is created as the result of this "cooperation" of the "two-

dimensional” (the plane) and “one-dimensional” (the lines, axes, directions) components. So, we can surely determine these universals as spatial ones (point V and further on within the text is dedicated to the universals). Thus, all of them together constitute some kind of spatial “matrix” in the rules of which the process of form-development takes place (Fig. 1).

Thus, we suggest the following concept: the archetypes “figure set up on the plane”, “vertical” and “horizontal”, i.e. the basic archetypes of the first or zero level (mental structures or spatial universals) assume the role of the basis for further development of the series of spatial archetypes. They are first of all the “platform”, then “pyramid” (“cone”, “hemisphere”), “alley” and “tower”, which according to VSS are based on, and achieve further on, certain architectural forms. We should point out that the earlier architecture is (as per its stage of development), the higher degree the analogy of the form of the building and the VSS and the latter in its turn represents the archetype (e.g. “purified” forms of the Egyptian pyramids and of the kurgans).

#### 4. INTERACTION OF SPATIAL ARCHETYPES, VSS AND ARCHITECTURAL FORMS

The forming of both the spatial archetypes and VSS accordingly, which are the basis for the development of architectural forms, occurs as per the sequence considered above, i.e.:

- 3) “pyramid” → 5) “tower”
- 1) “figure set up on the plane” → 2) “platform” =
- 4) “alley” (or a frontal configuration)

We should consider further on the suggested origin of the “verticals”, “horizontal” and “figure set up on the plane”, i.e. the basic archetypes or spatial universals. So far we would like to point out the following as related to the considered spatial archetypes, VSS and architectural forms, that the axes, which were the ones for the space arrangement of these configurations, also serve as the directions of the impacts, that unavoidably the spatial archetypes, VSS and architectural forms are affected by, i.e. stretching of them in the space along the vertical axis or along the horizontal one (as per the dominating direction).

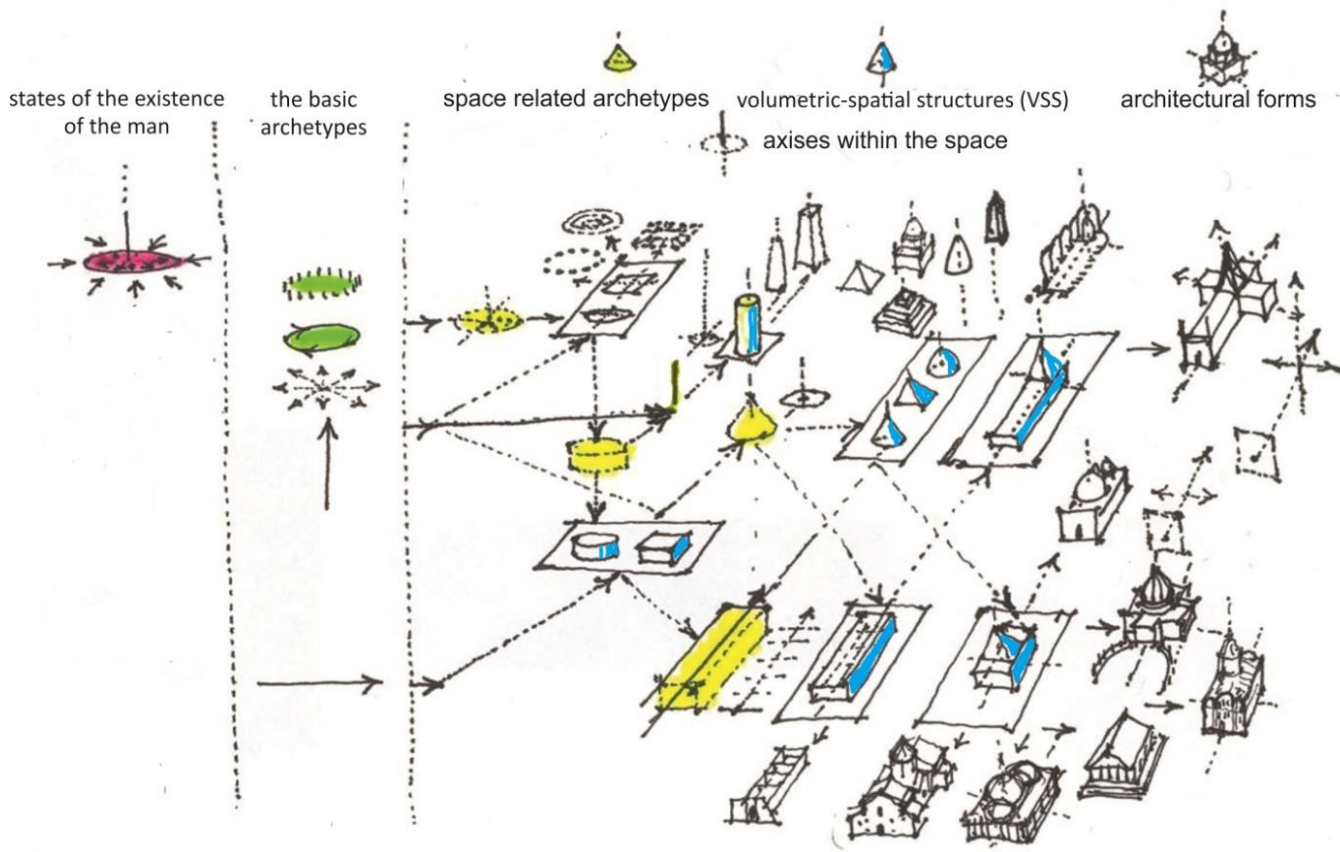


Figure 1. Forming of the archetypes, VSS and architectural forms.

The “chronology” of all components of the specified chain of volumetric-spatial “quantums” (“prism”, “pyramid”, “alley” etc.) occurs due to the consistent transformation of spatial configurations. Thus, the archetype “platform” – “parallelepiped” (“prism” or “cylinder” with its base diameter that is more than the cylinder element) is created by the influence of the first level “vertical” archetype (i.e. elementary stretching as per the vertical axis) on the according figure that is set up on the plane (circle, square).

Nevertheless, it is not so important for the spatial archetype “platform” (unlike the VSS) if the circle or square are the base of it – i.e. as we have mentioned above some kind of a compact “bundle” of the space whose core demand is – horizontal dimensions have to be more than vertical ones. With regard to the generalized VSS that has appeared on this basis, the configuration has principal importance because the resulting forms appearing do depend on it. It might be a low height cylinder (shape of a medical tablet), or a parallelepiped, or even a polygon prism. All of them represent the “platform” where their horizontal proportions dominate over the vertical ones.

In case we take the architectural form that is developed on the basis of this VSS, we should point out that the geometrical configuration is of great importance for it, as it exactly determines the special features of the architectural form. It is the form, that derives from the spheres of sub-consciousness (within which the VSS exists) and develops into the real image, and takes place at the edge of the ideal and material world, proceeds to the outer world, i.e. occurs assuming certain features, aspects and details.

The archetype “pyramid” is created as the result of the trend to further “stretch” along the vertical axis (with the subsequent narrowing) of VSS “platform”, which is the basis of the VSS of “cone”, “pyramid”, “hemisphere” types, or even a stepped structure (compare: mastaba → pyramid). So, it is evident, that despite some certain specifics of diverse types of VSS (circle, square etc. by their plans) and in case this series of “platforms” develops further in the vertical direction, it turns into some generalized image: a spatial archetype in the kind of space, narrowing along its vertical axis, whose geometrical characters are correlated with the according VSS and finally specified in the architectural forms. Thus, relatively speaking, the VSS “platforms” (prevailing at the stage of “figures on the plane”) that were round in their base plans might be changed later on by the square or pyramid like forms (e.g. square in its base plan and pyramid like Salbyk kurgan in Khakassia (RF) which was erected on the basis of the fencing of the Bronze Epoch, which might not have been exactly square but might have also been round or oval).

On the whole, the logical change of the space arrangement type “platform” for the according space arrangement type “pyramid” took place many times within the history of architecture evolution (famous example is mastaba, then it is the basis for the stepped pyramid of Djoser and later on the development of classic square pyramids). In case the VSS “platform” is under domination of the trends to “stretch” it along the horizontal axis (basic archetype “horizontal”), the archetype “alley” occurs, i.e. deep-spatial composition or a frontal configuration having the according VSS.

Archetype “tower” occurs as a result of the excessive development of the archetype “platform” along the vertical axis (passing through the stage “pyramid”)¹.

These basic types of archetypes specified above actually represent all of them.

Further on some kind of “mixed” (combined) VSS appearing based on the considered limited number of archetypes. This process takes place in our opinion as the result of further impact of “stretching” of the volume along the vertical or horizontal axes within the frames of the formed VSS with the following specifics: when during the process of form-development not only “vertical” or “horizontal” axes “participate” in it, but also the archetypes themselves affect the VSS, trying to change them “according to their standards”.

However according to the above, longitudinal center line (axial) structures are characterized by prevailing of the centric, most often domed space which is arranged over the building frame that is restrictedly “stretched” into depth (temple Aja Sofia, mausoleum of khoja Ahmed Yassavi, cathedral of Saint Peter), or on the contrary, excessive spatial depth arrangement of the building frames that has the “secondary” tower, that is installed over the crossing of the cathedral (Romanesque, gothic cathedrals). In the first case the trend to “stretch” the space into the depth (deep-spatial archetype “alley”) impacted the formed centric domed structure, which resulted in “stretching” it to some extent along its longitudinal axis. In the second case, the centric spatial archetype (“cone”, “pyramid”) impacted also the formed “basilica like” (deep-spatial) structure, that resulted in the development of the tower (vertical axis) installed over the crossing only (mentioned above) in the Romanesque and gothic

1. However, the archetype “tower” might have been generated in line with other “adjacent” ways: (a) “cloning” of the basic element (one floor pavilion → multilevel pagoda); and (b) “sudden” (one moment or explosive) emergence of the vertical volume due to urgent critical demand (Nuraghi of Sardinia, signal towers of Central Asia, etc.). But even these ways of occurring of the tower volume can be assigned in any way to the generalized principle of excessive development of geometric volume along its vertical axis.

cathedrals. It might be possible that towers of the Romanesque and gothic cathedrals might have affected the development of the crossings in them.

Thus, in our opinion, these new (“combined”) VSS, centric-deep and depth-centric structures, were created under influence of the according archetype, applied on the already formed VSS (centric or depth-centric one). That is why they are resistant to impacts and not vice versa and also not by the affecting of the “structures” on each other. Moreover, features that appeared to be prevailing, were the ones of the same already formed VSS but not of those of archetypes that happened to be “too late”. Thus, it was the VSS that actually dominated the process of form-development and not the newly occurred trends which slightly “stretched” the basic structure as per “their” order. So, it was only some slight “concession” of the VSS to the archetype that appeared to be too late.

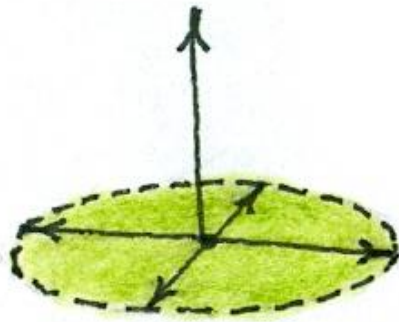
Thus, the undoubted “centricity” of such monuments as temple Aja Sofia (Turkey) and mausoleum of Khoja Ahmed Yassavi (Kazakhstan), that is arranged in the kind of the domed space development which dominates in their architectural compositions and which have small development of the longitudinal axes of their building frames; one-volume temples of the orthodox Christianity (without added bell towers). All of them justify the primacy of the domed centric structure which was affected by the trend to expand the depth of the insight space. At the same time, the dominating vertical axis is apparent in the domed and centric yard compositions which were created during the far early period of the medieval architecture on the vast area covering the Middle East and up to the Central Asia, and which hindered the development of distinctive depth-spatial structures. We should point out that the centric yard compositions also “stretched” slightly along the longitudinal axes (mosque Bibi-Khanum in Samarkand (Uzbekistan)).

On the contrary, historically formed “basilica like” structures of the Western Europe that are associated to some extent with the according antique temples of Greece and Rome (“peripteroses”), have developed into unprecedented domination of depth-spatial compositions of the gothic temples but with some features of the centricity that is expressed by the appearance of the crossings and towers over them. Nevertheless, the centric compositions also were developed simultaneously (type of rotunda) in the architecture of the Western Europe.

## 5. TWO-DIMENSIONAL AND THREE-DIMENSIONAL WORLDVIEW

As we have suggested before, the spatial archetypes are constructed on the axes: vertical and horizontal ones. Thus, the horizontal axes (at least two in number) establish the horizontal plane which is “pierced” by the vertical axis, this exact area of the plane is limited by the “figure set up on the plane” that is arranged around the vertical axis. But it took quite a long period of time for people to learn the space as a phenomenon, this process derives from the period of even the “animal” state of them, i.e. to achieve such differentiation of the space and to develop the awareness of these axes (albeit sub-conscious). As “... the basis of toponymy which is the three-dimensional system of coordination of the humanized space, is not adopted by the human sub-consciousness immediately but in some certain process”, the two-dimensional toponymical space view of a child is changed for the three-dimensional space view during the maturation process [2].

It is apparent that in this case, the ontogenesis repeats phylogenetic development of the spatial ideas. The myths, fairy-tails and the other cultural expressions (e.g. the shaman practice of the human souls seeing off), surely have marks of the human ancient views on the world in the kind of “plane” (two-dimensional) topological surface (and might have been even the universe). They are the source of such relict expressions, “the edge of the world”, “three-ninth kingdom” (the world of dead) etc., the places that locate very far but nevertheless somewhere on the surface of the earth. The world of the times of Dante was imagined as of absolutely different kind (the Bottom, Middle and Upper worlds), the world was developed as per the vertical axis, that was the world with new spatial paradigm. The samples, we have mentioned covering the history of architecture in our article, also justify this idea. Conditionally speaking, the basic archetypes should have been formed in the sub-consciousness of the people: “vertical”, “horizontal” and later on, due to the crossing of horizontal axes, “figure set up on the plane”. All of them were united into one whole unit in the kind of the “figure set up on the plane” (having horizontal axes) which was “pierced” by the vertical axis. Moreover, the vertical and horizontal axes crossed at one (“initial”) point (Fig. 2).



**Figure 2.** Figure set up on the plane, “pierced” by the vertical axis.

Actually, the human awareness of such syncretic space should have been developed almost simultaneously with the numerous living situations and diverse living experience. For people, such mental adopting of the space was necessary for the further sharing of the impressions they had experienced, i.e. for establishing on its basis the activity, dedicated to the development of the artificial space, which led them later on to the foundation of architecture.

As compared with the static spatial archetypes, the basic archetypes “vertical”, “horizontal”, “figure set up on the plane” (spatial universals) express almost “directly” sub-conscious awareness of the movement (and more general: activity), which is connected with their origin. To some extent they are the intermediary component between the improving of human mental structures towards the living management activity and the spatial categories adopting, i.e. between “the meaning” and “the form”.

“Vertical”, “horizontal” axes and their active interaction on some plot of the horizontal plane are marks of the process of adopting the space in human mental structures. The movement as in its general meaning is the “chase – escape”; or “the man-owner”, who occupies the center of his own space” etc.<sup>2</sup>

As the inner ideal activity of people should have been arranged as per the model of the outside one, that was subjective, then “both the inner and the outside activities have common structure” [3]. The latter actually has become eventually the basis for creating the vertical and horizontal axes in the “spatial chaos”, similar to that of a musician who is aware of the melody’s clear structure when listens to a melody that seems monotone. Horizontal axes locating on the plane create this plane, on which the interaction of all the axes takes place on the limited area of the plane,

2. These “marks” might have been improved also during the cases of “empathy” that took place during the watching of similar processes around the people.

within the surface of the “figure set up on the plane” (in its center, i.e. in the initial point). However, the mechanism of form-development with its deep origins needs further compelling interdisciplinary study.

## 6. AUTOPOIESIS AS BASIS FOR THE GENESIS OF SPATIAL AWARENESS

First of all, due to human mental adopting of the space, the fenced “figures set up on the plane” were formed, i.e. fences, corrals, pens etc. that were round or square in their plans, also funeral stone fences (which enclosed and safeguarded the inner sacral places of them). Such spatial structures were the point where the “figure set up on the plane” and the vertical axis in its center “met” with each other. Exactly they were either the round or square fence, protecting the offspring of people and animals with the master of all of them who occupied the center of it. (Demiurge, the First man – vertical). It is evident that those evolutionary formed and emotionally charged spatial impressions that were encouraged by the “states of the existence”, made it possible for the mankind to survive. Exactly that is why they (evolutionary formed spatial impressions) stayed in the deep structures of human sub-consciousness<sup>3</sup> and people might have remembered them (in the kind they had been memorized) not only each time when it was necessary to increase the offspring and to supply it by the resources, but also they became the starting point for the further development of the space and generating the artificially created forms. The term autopoiesis which was introduced by Humberto Maturana and Francisco J. Varela is applicable in our opinion to the specified “spatial state” which means self-forming, self-manufacturing [5]. Actually, the most ancient stage of the human mental evolution was reproduced in the myths, e.g. Avestan Varus, and the biblical cattle pen, and even the Noah’s ark.

The specified myths reflect those initial “states of spatial impressions” but with the already formed crossing axes, one vertical axis and at least two horizontal ones which took place on the horizontal plane also. The latter, as we mentioned above, appeared to be the initial point for further development of VSS that happened as the result of the gradual impact of the multidirectional “stretching” efforts (vertical and horizontal ones) to expand the

3. “Endless reiteration marked those experiences within our psychological constitution, but it wasn’t in the form of the meaningful images, it was in the kind of forms without contents only that give the possibility to some kind of perception and action. ... We are not considering innate ideas but the inherent structures of mentality, thought-patterns.” [4]

space. The basic condition of the existence of the spatial composition is its constant evolution, i.e. the "movement". If the latter doesn't happen then the spatial composition "dies off", i.e. actually turns into a monument. As it was specified above, as the result of such development, firstly there were formed archaic, i.e. somehow "intermediary" VSS that were reflected in such diverse forms as of the Egyptian mastaba, the earliest kurgans as Arjan ("platform"), then the Egyptian pyramids, the Sacks kurgans of the middle of the first millennium BC ("pyramid", "cone", "hemisphere") and the so-called "top class", i.e. the combined VSS. The latter, as me mentioned before, happened to be the basis for gorgeous architectural structures having the centric-deep spatial compositions (temple Aja Sofia, the mausoleum of Khoja Ahmed Yassavi, churches designed as per the Byzantine tradition) and depth-centric ones (Romanesque and Gothic temples). These VSS, assigned to the "top class", that had already emerged in the Middle Ages, became the crowning point of the architectural development. Nothing principally new has not been created yet.

Until the beginning of the 20th century, further seeking of new forms in line with the process of form-development as related to the VSS, appeared to be concentrated around these spatial structures with the diverse variants of their combining. However, in terms of its artistic imagery and spiritualizing basis the architecture had the perspective of achieving great discoveries.

## 7. CONCLUSION

So, there actually have been two "architectural revolutions" within the process of its evolution: initially the mastering of the geometrical "form set up on the horizontal plane" (the first one) was expressed by the planning of circles, squares etc. Later on, it appeared to be the only basis for the development of the volume of the construction with its further subsequent artistic interpretation by means of the spatial composition ("the second architectural revolution"). The process of forming of the volume occurred in line with the strict sequence of changes, both during the certain stage of the form-development (archetype – VSS – architectural form) and the phase of generating of its geometric components ("figure set up on the plane" which was the basis for the fundamental "platform", then the "pyramid", "alley", "tower" etc.).

The origin of the specified "Generative grammar" (in line with A.N. Chomsky) as related to the process of architectural form-development arises from the

necessity to survive, i.e. the autopoiesis. Subsequent experiments with the architectural form and applying technological aspects to it are fraught with the destruction of the phenomenon "Architecture" in its classic interpretation.

We should point out that on the whole, the sequence of actions, i.e. the development initially of the "horizontal plane", and on this basis the "vertical" break through ("activation" of the vertical axis), and further as the result, the learning of the space that surrounded this "vertical".

This sequence of the space development actions is apparently the universal one. Anyway, the land surface reclamation ("horizontal plane") and the subsequent first human flights ("vertical" axis) resulted in the exploration of the atmosphere (actually the "space around the vertical") and further on the penetration into the nearest cosmos through the atmosphere (in fact through the new "horizontal plane") led to the learning of the near-the-Earth space (again, the space around the vertical).

Nowadays, the flights of sputniks to the depth of the Galactic and even the observing it with the help of telescopes actually embody the "vertical axis" which is "supported" by the "horizontal plane" of the familiar near-the-Earth cosmos and fosters us to develop our view on the nearest cosmos and also on the "volumetric" arrangement of the distant cosmos, but that is around the according "vertical axis" which is directed to remote depths of the Universe. Thus, the existence of the horizontal plane itself with its initial point on it, is the basis for the emergence of the "vertical axis", around which the surrounding space is actively developed. Then this exact expanded space, having developed all the possible horizontal directions around this "vertical axis", becomes in turn the new level "horizontal plane" which will be the basis for the further "breakthrough to the unknown spheres", i.e. the development of the principally different specific "environment" etc.

"Having scrutinized the possible nature of the environment, we can expand our views on its directly perceived specifics and are able to predict the features which accompany them" [6]. We have already suggested our outlook for the architecture evolution in the aspect of its content change [7]. As related to the considered context, the principles of form-development process, identified above, can be applied to the specific content in any sphere. Applying of this scheme of cognition to the process of abstracting from the certain content of the space-related categories, i.e. in the re-considered kind, could be useful for the study of any phenomenon. It is apparent that there

are many “keys” to solve the variety of world-wide problems which are impossible to handle at all without global development of the New, which embodies theoretical studies in the according spheres. It is necessary that newly obtained results in any research sphere should be recoded, for them to be a universal (as similar to tectology, cybernetics etc.) methodological instrument. Only after assuming such invariant “core” it will be able to “join the ranks” of the so-called “the fund of algorithms” to learn the new. Being an integral part of the universal model of cognition [8], they will be able to foster the development of new paradigms in line with theory of Tomas Kun. Probably the theory of architecture also, which is re-considered on the philosophic level, can become not just one of the specified “keys”.

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