A Stratified Space by the Integration of Physical and Digital Spaces

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Abstract. Today’s spatial formations are based on tectonics and forms of physical environments in terms of dealing with the envisioned and finished configurations. However, as a result of media and information technologies, digital space brings out a new interpretation and aspect to the architectural space within the new concepts of space, time and reality. By digital space, users can imagine, produce, share, and store their perception and experiences in a new kind of territory which is based on data and information. The incremental and ever-changing needs of user and inclusively improving environments are the most common impacts of this information age that give rise to the importance of information rather than material. Stratified space is a combination of the physical space and digital space. Within this combination, we suggest a new concept of architectural space which will respond the dynamic, unpredictable and ever-changing needs of its users and environmental conditions.

Keywords. Space-time; reality; surface; physical space; digital space.

INTRODUCTION

In this paper, it is aimed to discuss the impacts of digital media and information technologies in terms of our conception of architectural space to suggest a design proposal for further architectural space investigations. Today’s architectural space is a formation of material constituents, structure and their relation with the program which is comprised according to the current needs of user, social and physical environments. These spatial formations are based on tectonics and forms of physical environments in terms of dealing with the envisioned and finished configurations. However, as a result of media and information technologies, digital space brings out a new interpretation and aspect to the architectural space within the new concepts of space, time and reality. By digital space, users can imagine, produce, share, and store their perception and experiences in a new kind of territory which is based on data and information. The incremental and ever-changing needs of user and inclusively improving environments are the most common impacts of this information age that give rise to the importance of information rather than material.

Taking its departure point from the physical space, this paper will explore the new concept of architectural space within the scope of digital space
which causes a shift to our understanding of the concept of space. We combine digital space and physical space to form a new architectural space which we called as stratified space. This stratified space is a mix-space which responds the dynamic, unpredictable and ever-changing needs of its users and environmental conditions instead of dealing with the principles as finished or concrete facts. It maintains the importance of user participation to decide the program and it adapts itself due to the changing needs and conditions in both physical and digital environments. Therefore, our design proposal is a multi-dimensional space formation that adjusts to its environment according to the current needs and has the ability to change in the process of time.

As an introduction, physical space is introduced within the scope of the new interpretations of space, time and reality. While doing this, we focus on the differentiations on the conception of the new geometries and design techniques to give a general understanding about the other dimensions of space and their effects to the architectural design. Then, digital space is discussed to guide the reader through the consequences of it and to express the basis of our aspect for the architectural space.

**PHYSICAL SPACE**

Physical space is a system which has a specific geometric boundary that is formed by physical and mathematical rules and material constituents. The geometric boundary is constituted by geometric relations that are defined by distances, dimensions and directions between spaces. The discovery of new geometries and the relative understanding of space-time gave rise to a new interpretation for the definition of physical space. These new aspects have led the invention of higher dimensions of space which has caused a shift towards an ideal space with different physical relations and principles.

Euclidean geometry, which is the oldest mathematical system discovered by Euclid around 300 B.C., has been first used to interpret these relations and properties of physical space. Point, line and plane are the early basic resources of Euclid to define geometric properties. According to Euclid’s common definition, plane is formed by line as line is formed by point. It proposes a planer kind of geometry to represent three-dimensional space. It is asserted that each part of geometrical definition is based on the other parts. Euclid’s five postulates have been accepted as the most acceptable geometrical definitions for defining the physical space. The first two postulates argue that a straight line segment can be drawn to join any two points and any straight line segment can be extended to any finite length. The second two postulates propose that a circle can be drawn with any point as its center point and all right angles are congruent. Among Euclid’s five postulates, the fifth postulate called parallel postulate has led to a lot of discussion. Parallel postulate argues that given a line, only one parallel line can be drawn through the point which is not on the line.

A lot of mathematicians tried to prove the parallel postulate by using the other four postulates but they did not achieve a valid statement. At the end, mathematicians like Carl Friedrich Gauss, Janos Bolyai, Nikolai Ivanovich Lobachevsky, and Bernhard Riemann started to questionize other possible geometries by the first half of the 19th century. So the aim of proving parallel postulate gave rise to new geometries that are known as non-Euclidean geometries. They mainly tried to prove an assertion of the contrary to what parallel postulate affirmed. They assumed that the fifth postulate is false and brought out two important statements. The first statement argued that given a line, there are no parallel lines through the point that is not on the line and the second argues that there will be infinitely many parallel lines. The first statement gave rise to elliptical geometries while the second led to the discovery of hyperbolic geometries. Spherical geometry, which is the simplest form of elliptical geometry, is based on the positively curved surface of a sphere instead of a plane and hyperbolic geometry is based on a negatively curved infinite surface. These new mathematical ideas induced the possibility of understanding
and representing the other dimensions of space beyond three dimensions. Based on this situation, the fourth dimension of space has been an impressive debate for proving higher dimensions of space. Albert Einstein's theory of relativity added a time notion as a new fourth dimension to space that changed the interpretation of physical space. Possibility of higher dimensions has altered the geometrical conceptions that led the term of n-dimensional and then hyper dimensional geometries. At the end, physical space has turned into an idealization space which was called hyperspace.

The discovery of hyperspace has caused a shift to the perception of the physical space and architectural representation techniques. Visualizing these dimensions has been an important attempt over the years and with the beginning of the computer age, it has become possible. Computers have led designers to perceive and represent the architectural space with the interaction of the users, temporal and environmental factors. Designers have used computers not only to design and manufacture special forms, but also to control the design process until reaching a satisfied design solution.

However, although the possibility of visualizing higher dimensions have played an important role for extending the possibilities of designing and representing the physical space, architecture still gets more benefit from the Euclidean geometry to constitute a physical space for people who experience and use the space pursuant to their needs. Like Euclid's planer geometry, the substantial space formations are composed by planes that are detailed within material and structural features. The space formations are mainly based on tectonics and forms of physical in terms of dealing with the envisioned and finished configurations. In a physical space, the planes are designed and constructed as surfaces like walls and floors, which can be chosen as the most common boundaries for architectural space. The position and features of the surfaces are determined by the usage of space as usage determines the dimensions of space. So the scale and characteristics of the physical space are the results of the usage and the composition of different surfaces. Since the usage is the basic determiner of space formations, physical space with finished and concrete material constituents and permanent dimensions brings out a limitation to deal with the changing needs. Moreover, media and information technologies have increased this rate of change and a new way of architecture is crucially required to satisfy the unexpected and unpredictable needs of user.

DIGITAL SPACE

Today, architecture can be considered as a cross-section of different disciplines. Some of those can be assumed as architecture, engineering, information technology managing, digital painting and designing. Architecture in this new age is much more interactive and it allows users to cooperate during the design process. The new contemporary architectural discourse is introducing a new understanding of space, reality and experience. This is mostly noticeable in digital space which still waits for further explorations. This new territory's possibilities are not fully understood or explored. Developments in computer technologies caused to come out new approaches with new frontiers in the architectural process and in discourse. The term interactivity is the main idea behind the digital age of architecture. The new contemporary architectural discourse celebrates this new term while introducing a new understanding of space, reality and experience.

Digital space can be defined as a total interconnectedness of human beings through computers and telecommunication without regard to physical geography. While we create identities in digital space, we must get aware that these identities exist. We are creating not only a virtual reality in digital space, but a reality separate and distinct from our own reality which can be called as an alternate dimension and this alternate dimension allows us to explore new forms of art, entertainment, performance and culture. According to Milgram (1994), there has been a growing interest in techniques
for combining real and virtual environments to create mixed realities and spatial environments where participants can interact with physical and digital information in an integrated way. As a result, mixed reality is generally concerned with integrating of virtual spaces into real, physical space. By doing this, it aims to create an environment that enables the users in shared and remote physical spaces to interact and communicate through their natural senses. The computers and digital space are not only electronic tools anymore but spaces that are to be entered in. They become a physical space filled with data where we can navigate through the furniture of data. The visitor’s navigation and exploration of this digital space is connected to real space and to other participants. Therefore, data is organized spatially and revealed as the user navigates the space (Milgram, 1994).

Digital space looks for answers to some questions. It is questioning the info-communication space and suppressing the mediating role of the computer into background awareness. Digital space refers to environments that are able to combine real and virtual objects with visual representation of real and virtual space. This can be imagined as the interconnection of the real and the virtual that produces a new framework for communication and interaction possibilities. The components of digital and physical information are merged in different degrees in digital space. This creates a situation that connects the users with each other.

Digital space can be seen as a threshold. It changed our understanding of spatial perception. It is the next step of evolution. Via it, we evert virtuality, we conceive algorithmically (morphogenesis); we model numerically, we build robotically, we inhabit interactively, we telecommunicate instantly, we are informed immersively, we socialize without locally. Through the use of the computer and its ability to completely ignore the laws of physics, new forms can be created (Spiller, 2000). This new type of architecture does not hold to the rules of Euclidean geometries, and from the expectations of logic, perspective, and the laws of gravity. Novak views this as an expression of the “4th dimension” that incorporates time alongside space among its primary elements. Novak’s digital architecture bends, rotates, and mutates in interaction with its visitors. In digital architecture, “science and art, the worldly and the spiritual, the contingent and the permanent” converge in a poetics of space (Novak, 1991). Digital space is not static. It always changes. As Maude-Laure Ryan mentioned, the multidimensional exploration of a virtual text can never be complete because its fluid architecture rebuilds itself continually (Ryan, 1999). It is the same for digital space as well. Its dynamic state allows growing itself continually.

As a result we can emphasize 3 elements of digital space. These elements are (1) to be inclusive, (2) to be interactive and (3) to interact in real time. Digital space is a combination of emerging computer mediated communications and virtual reality communications. In some way digital space changes our traditional ideas on mass communication, transforms the way we produce and exchange knowledge.

STRATIFIED SPACE

Stratified space is a combination of the physical space and digital space. Since digital space has been accepted as an important extension of architectural space, a new debate has occurred to find a relation and combination between physical and digital. Although a lot of disciplines have tried to constitute the possible communications, transitions and interactions for these different spaces, a strong relation still needs to be inquired and investigated. From this argue, we suggest a new concept of architectural space which will respond the dynamic, unpredictable and ever-changing needs of its users and environmental conditions instead of dealing with the principles as finished or concrete facts.

Within the information age, communication, availability, processing, accessing and representing information have become the most fundamental needs of users. These unpredicted, incremental and ever-changing needs have called for a new way of architecture that has to extend its scope into an
interactive and dynamic character to cope with the new material information. In this new age, digital space has been a significant extension of physical space in terms of leading the users to experience different realities. By digital space, users can imagine, produce, share, and store their perception and experiences in a new kind of territory which is based on data and information.

Digital media and information technologies have altered not only the aspects of everyday life, but also architectural design, fabrication and manufacturing process. Since the information is more important than the materiality of the things, relations between real-virtual and form-function have been the most important discussions of today’s architectural space. The digital space has been offering a different reality due to the possibility of representing multi-dimensional spaces and temporal variable. Baudrillard brought out a new approach to this new reality by coming up with the notion of hyper-reality. According to Baudrillard the reality has collapsed today and emerged a new kind of reality. He argues that reality is an image, illusion and simulation in today’s world and hyper reality is a regeneration of this reality (Baudrillard, 2006). From this statement, we can assert that if there are separated realities and hyper-real is a stratified real of different realities, the new space should be a stratified reality space.

In recent years, the new technologies and discoveries like computers, geometrical evolutions, higher dimension, and space-time intersection have led the transformation of a new paradigm for architecture. Today, architects are confronted with interactive, generative and performative processes and systems in terms of dealing with the new tools of media and information technologies. The discovery of multidimensional space and the possibility of visualizing these dimensions have led designers to perceive and represent the architectural space with the interaction of the users, algorithmic and parametric design tools. Relation of form and function gained a different meaning by algorithmic and parametric design techniques which are the integral parts of computer aided design technologies. In recent years, these techniques have come into prominence by undertaking unpredictable and emergent notion to the architectural space. Rather than designing a finished and concrete object, architectural endeavor has turned into dealing with the parameters and variables of social and physical environmental conditions. Marcos Novak describes this new way of architecture as “liquid architecture”. According to Novak, in a liquid architecture the form is contingent on the interests of the beholder. It is an architecture that opens to welcome you and closes to defend you, it is an architecture without doors and hallways, where the next room is always where it needs to be and what it needs to be (Novak, 1991). Marcos Novak informs a flexible and adaptive space formation that adjusts itself to the changing needs over time. By using algorithmic techniques, he tries to achieve liquid space formations by breaking up the physical starkness. However, it is still a question that how physical space will have this adaptive formation and changes in terms of dealing with the manufacturing process. Although in design process, designers get much benefit from algorithmic and parametric design techniques, at the manufacturing process, they have to choose a final form among all other possibilities. Therefore, multi-dimensional space, which has the temporal and other parameters by the advantage of algorithmic design techniques, will be lost with the decision of physical final form. Also this final form will not satisfy the changing needs of users in a long term. This is the most critical argument that we want to focus with our design proposal for trying to bring out a new aspect for further studies.

In our proposal, we aimed to reach a mix-space that we called as stratified space which uses the advantages of digital space by altering the physical to provide a multidimensional space. Today’s physical environment is static in terms of dealing with the envisioned and finished configurations. However, due to the information technologies and digital media, it is accepted that architecture should give importance to the information rather than material. At this point,
we suggest a stratified space for gathering, transforming, evaluating and transmitting information. Therefore, our proposal is a dynamic urban memory (dum) that will position to a location and take on a local character according to environmental information and adaptation process.

Dum creates dynamic spaces which constantly improve and change depending on time and meet the unpredictable and incremental needs of its users (figure 1). It maintains the importance of user participation to decide the program that will need a space afterwards. So, instead of a stable space that is waiting for its users, a space that will be organized by the need of users is suggested.

Dum stores the memory of physical and social environment according to its location, and uses this memory for creating new hybrid memories. So it improves in two phases. The first phase starts with gathering information from current environmental conditions. Then, this information is stored and transformed for later use. It is the learning phase to become localized as a result of the adaptation to the environment while the second phase is about responsive behaviors due to the acquired information. Since environmental data and interpretation are nonlinear, the outcome of the process is open-ended and unpredictable.

As an introduction, the first phase is explained to understand the localization process and its direct relation with the dynamic urban memory. Then, the second phase is detailed within the scope of spatial constituents, structure and program.

**PHASE 1: LOCALIZATION**

The substantial urban formations are the result of the usage according to a given program, material constituents and their integration to the local environment with geometrical relations like dimensions, distances and directions. Space occupancy proportion is the consequence of the form, function and their integration with the temporal dimension (Figure 2). The map of the urban compound changes in the course of time and the memory is regenerated according to these changes. However, the finished and concrete architectural components become contradictory and bring out a limitation to this dynamic process.

Dum suggests a dynamic mapping system that is formed by stratified maps of the different programs and functions which are changeable according to user’s decision and physical environment. Figure 3 shows the formation of the multidimensional mapping system of dynamic urban memory. The first map (3a) represents the functional storage that includes the storable areas and spaces for the movement

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**Figure 1**
Dynamic urban memory

**Figure 2**
Maps of different urban formations
that are called activation areas. The middle map (3b) shows the relation with the local site and functional lines. This is the starting point for localization process of the urban memory. The right map (3c) is the superposition of two maps and it is tentative depending on changeable and expanding physical and social information. The stratified mapping system is first studied as two dimensional but it will have more dimensions while adapting itself according to the different levels of the local environment. By temporal changes and the adaptation process, it becomes a multi-dimensional space formation (figure 4).

The storage map brings out the first limitation to the programmable organization by its systematic rules. Since dum adapts itself to the changing needs over time, a coding system is required to avoid confusion and to control the programmable spaces due to the unpredictable and changing programs. Coding system controls the constitution of the new spaces and provides spaces for the other possible programs. While the local data changes constantly, the overlapped map adapts to these changes at different levels. Therefore, every function is separated into different categories and designated by different subjects. The colors are used to indicate these programmable differentiations to guide the reader. Figure 5 shows the memory-storage working process. Dum records the information by coding, then stores to use it by transforming according to the needs at that time.
To reach a dynamic organization and programmable functions, a planer system, which consists of surfaces, is suggested. The position and features of the surfaces are determined by the program as program determines the dimensions of the spaces. So the scale and characteristics of the spaces are the result of the usage and the composition of different surfaces. Surfaces are stored as units for the future organizations in terms of dealing with the current program (figure 6).

PHASE 2: PROGRAMMING

Dum behaves like a living organism that captures and interprets the current information and creates new information. The coding system becomes more detailed as a result of the incremental functions. Figure 7 shows the variable density of the program and behavioral structuring due to the different spatial and temporal changes. The structure and changing quantity of the programmable units bring out other limitations to the system. The behavioral structure has a growth limitation as well as the quantity of the different programmable units. After reaching a certain level of program density, the structure rises up to a certain level. The velocity of change depends on the unstable needs and environmental conditions while the system tries to equilibrate its space occupancy proportion by the systematic rules.
CONCLUSION

As a conclusion, the new concept of architectural space is suggested as a stratified space according to the combination of physical and digital under the influence of the new requirements of the new information age. It is an intention to rearticulate a possible way for architecture rather than proving an architectural assertion. Dynamic urban memory suggests a new framework for the integration of spatial constituents, structure and their direct relation with the program. It behaves like a living organism that captures and interprets the current information and creates new information. It has a dynamic mapping and structural system with programmable units that are formed by systematic rules. The rule system can be altered and redefined according to the different physical and social environments and time.

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