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PRINCIPLES AND MODES OF NEW MEDIA ARCHITECTURE

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Abstract. *The contemporary age is marked by the rapidly advanced digital revolution, unstoppable rise of computer technologies and omnipresence of technological advancements in all aspects of everyday life. In the information era, computer technologies have become pervasive, ubiquitous and dominant. Their hybridization with previously present media forms resulted in the emergence of a new and exuberant field of new media and technologies. New media is a hybrid field of computer based technological forms, which are used in contemporary practice, not only as tool, but also as an expressive medium. Because of the complex nature of new media, the field is extremely hybrid, positioned at the intersection of art, science and culture. Its emerged cultural paradigm is scientific culture, in which dominant characteristics are technological art and cultural forms, as well as information and techno society. In this overall context, architecture is not an isolated phenomenon. The new media have influenced the field of architecture too, offering new possibilities, features, design methodologies and principles for conceptualizing and developing architectural space. In architectural practice different modalities of the new media are being used. These modalities initiated the emergence of the field of new media architecture. The distinction of these state-of-the-art types of architectural space, together with the principles and concepts they rely on, were the main focus and main contribution of the research presented in this paper.*

Key words: *New media architecture, principles, modes, technologies, digital media*

1. INTRODUCTION

The appereance of new media technologies in the field of architecture resulted in the emergence of a new media architecture, which is not an isolated phenomenon in the era of new media, but is based on the general principles of the epoch which defines it. Certain principles of new media architecture are based on the possibilities of the dominant computer media and digital technologies. Continuous forms, folds and blobs announced the emergence of a new visuality, as well as a new approach to visual architecture (Carpo,

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2011). What is becoming more widespread is the tendency towards analyzing the generative nature of architectural objects, rather than their physical and visual appearances. Generating, changing, processing and behaving are becoming categories for consideration and architectural intervention. Open-end spaces and environments are becoming possible in architecture. Within the structural properties of architectural environments, trends are directed towards the end of the detail as we know it and towards highly customized production. Questions of materiality and virtuality, and also materiality and corporeality, are being in a new way related and reviewed by experimenting with the modalities of new media in practice. Architecture is faced upon rise of new visuality and new realities, in which authorship is redefined (Carpo, 2013). Interactivity and responsiveness, participation and editability become necessary segments of the creative process in architecture, which guarantees improved performance of space, both in terms of conceptualization, as well as structural properties and materialization.

New media architecture, depending on the modalities of the use of new media technologies in the process of conceptualization and implementation, developed its various forms. However, all these new forms of architecture are subject to wider principles and concepts of new media, which have been adopted by architecture. These principles, although general in the field, in some forms of new media architecture are reflected more, in some less, but are latently present in each of them. The technological concepts, which will continue to be reviewed, and on which new media architecture is based, are concepts of computer technologies, as well as concepts of information culture.

Primarily, the properties of computer media determined the properties of architectural space in new media architecture. According to Murray four key characteristics of computer technologies are: procedure, participation, encyclopedic features and space (Murray, 2003). All four characteristics have contributed to the emergence of extensive and explorable spaces in architecture. Procedure as a principle in the design of architectural space has led to the emergence of generic design forms as well as performative architecture and space, which are usually implemented through sets of instructions and procedures (Kolarevic, 2005). The status of participation in new media architecture has become one of the fundamental properties of space, which, paired with the feature of procedurality, are the basis of all interactive and responsive architectural forms. Encyclopaedic features of the computer, as a medium capable of processing and storing massive amounts of data, has opened up the possibility of designing the architecture of the contextually expanded spaces and networked information spaces. These spaces, depending on their form, usually have a visualization of information as their basic conceptual element. Spatial features of the computer, as Murray observes, imply great possibilities of the computer to present itself as a place. The computer has great representational powers and the capacity to envelope tangible dimensionality and become a place both physically, and more importantly, symbolically. Virtual spaces inside the computer media are able to achieve and maintain the illusion of place. The user can easily form a mental map of the symbolically represented territories of the fictional spaces (Murray, 2003). These representational spaces and territories carry within themselves the essential information about values which society considers desirable in space.

Janet Murray's theory refers to the fundamental properties of computer technologies. In addition to this theory, one should take into consideration the more detailed classification presented by Christiana Paul on the basic properties of new media technologies. It states the following features: interactivity, participation, dynamism and flexibility. In addition to these, Paul lists interdisciplinarity, reproducibility, system approach, external contextual information

and coding as essential (Paul, 2003). Lev Manovich highlights programmability above all (Manovich, 2003). All these technological concepts have also become fundamental concepts and principles of new media spaces in architecture.

2. Principles of New Media Architecture

This paper aims at making a contribution to the new and developing field of new media in architecture by trying to assemble a systematic theoretical framework and theory of fragmented emergent forms that happened in architectural practice due to use of new media. New media modalities are used and explored in architectural practice, which resulted in many new types of architectural space. We are witnessing the emergence of new ways of conceptualizing space, production techniques, new types of materials and systems, new realities and new materiality. Due to this, new types of aesthetics emerged. Interaction with space has changed too - its elements became interactive and responsive. The user became an active participant in the realization of space, while the designer became much more a moderator of space. Space started to behave, and designing behavior of the space became more important than designing its visual elements. A shift happened from designing objects to designing and moderating processes and behavior. This research investigated a lot of examples of the application of new media in architectural practice, and identified the main principles and modes of new spaces that emerged. If we agree that new media art is represented by artistic forms and activities that use computer technologies as an expressive, artistic medium, then new media architecture represents all types of architectural spaces and activities that rely on the computer, not only as a tool, but as an expressive medium, as well. For new media architecture technology is as an artistic medium, which allows new types of spaces to develop special aesthetics, functions and forms. The principles on which new media architecture is based have been determined and categorized through this research. Some of them have roots in new media technologies, some in relevant artistic forms, and some in cultural, sociological and technological theories like cybernetics and post-human theories.

- *Interdisciplinarity*

The new media implies interdisciplinary collaboration of experts from different fields in order for the new media space to be realized. The convergence of computer technology and modern art forms led to the hybridization of science, art, technology and culture, which resulted in development of scientific culture and technological art forms, which represent a symbiosis of scientific, engineering and artistic processes (Dewdney & Ride, 2006). Realization of new media architecture, depending on the type, usually requires joint work of architects and experts in the fields of mathematics, programming, mechanical and electrical engineering, biological and medical sciences, as well as visual arts. The necessity of interdisciplinary work with new media technologies, as well as their evolutionary character constantly expands the boundaries of traditional architectural scope and effects.

- *Evolutivness*

The constant evolution of new media technology implies a constant evolutionary development of new media spaces. Thus, the PC (Personal Computing) era has enabled the

development of virtual spaces, the UC (Ubiquitous Computing)[1] era made it possible for computers to go out into the real environment and embed themselves into systems of high-tech spatial units. Physical environments that have computer elements, sensors and microchips embedded, richly and invisibly, in their physical structure, are called *smart.* These smart environments are constantly evolving through the evolution of programmable materials, so in the 21st century we are witnessing an emergence of biological, synthetic, textile spaces, etc, which are opening completely new possibilities and modes for communication between people and space units.

- *Procedurality*

Procedurality as a characteristic of digital media, has enabled the emergence of space in architecture that is substantially oriented towards processes (process-oriented architecture) and not its physical properties. Process-oriented architecture has developed different forms. Therefore in the kinetic and dynamic architecture forms procedures relate to mobile, transformable and kinetic processes in space. In interactive architecture, processes can be determined by the users.

- *Dynamism and variability - a temporality principle*

The dynamic nature of new media inspired the development of architectural spaces with variable properties and ephemeral nature. Some spaces that rely on this principle are based on visualizations of certain variables, data and information flow, for example from internet forums or the stock markets. The origin of these concepts lies in the nature of computer media, which constantly works with turbulent stream and the transmission of data in real time. From the technological point of view, variable media architectural elements made concepts of dynamic surfaces and structures possible in space. With the advent of media facades, the cycle of expected changes in the facade changed from the usual 25 years, to 25 changes per second (Edler, 2010).

- *Information as a principle. External contextual information.*

In the era of new media, in the second half of the 20th century, architecture has gradually made a transition and stepped out of a material space into a digital-virtual-IT space. The digital-computer era was reflected in architecture with the appearance of spaces in which the main concept is the display of information or their visualization. Digital medium in its essence is not visual, and as a basic unit of processing, it possesses data (Wardrip-Fruin & Montfort, 2003). In the architectural context, this technological property has resulted in the development of spaces in which the predominant principle is visualization of information. As time passes, there are more and more modalities in which authors are not concentrated on visualization, but are concerned with the display of raw data, databases or network communication flows.

[1] Weiser identified three stages (or trends) in the development of computing: 1) *Mainframe Era* (many people share a computer), 2) *Personal Computing* (one computer, one person) and 3) *Ubiquitous Computing* (one person, many computers). Weiser predicted that the third stage of computing (UC) will overlap with the second stage (PC) around 2005-2020. „Computers in the UC era will be embedded in walls, chairs, clothing, light switches, cars – everything. UC era is fundamentally characterized by the connection of things in the world of computation (Weiser & Brown, 1996, p.4)".

- *Coding and trans-coding. The concept of code.*

The visual material can be conceived and produced in new media art and architecture through coding. Through the processes of bitmapping and binary operations, coding and trans-coding, visual information is coded into numbers, in order to be recontextualised again, through a different set of instructions, and finally converted into a different visual result. In spaces based on the concept of procedural coding, a coding process itself becomes an architectural intervention. In spaces that are realized on such principles, architectural intervention is included in the process of defining and writing the code, which determines the final outcome of the space.

- *Mathematical and numerical representations. Parametricism, automation, modularity and variability. Complex geometric forms.*

The mathematical capacity of the computer medium has led to the emergence of concepts in architecture which are based on numerical principles. In new media architecture, principles of representation between numerical apparatus and visual forms are vast. Due to the variability of parameters, parametric architecture is distinguished for the outstanding ability of the creator to control variability of form, at the unimaginable level of precision. Ultimately, 3D printed modules appeared as unit elements of the architectural systems - elements which combined can create the whole structure, causing the death of the above-mentioned architectural detail as we know it (Carpo, 2015).

- *Illusions and simulations. Augmented and composite reality.*

The ability of a computer to represent a strong illusion of a three-dimensional space has enabled the creation of effects previously unimaginable in contemporary architecture. Forms of new media architecture that can be called illusory are those based on either representations or augmentation of physical space. These forms vary from completely immersive types of virtual environments and video games in which the user is fully immersed in the spatial representations, to forms of spaces which consist of augmented and composite reality, in which, as Paul observed, the point is not to make absurd alternative reality, but to cause a collision of reality and perceptual illusion (Paul, 2003).

- *Networking. Remote Presence - Telepresence.*

The origin of the concept of networked space and remote presence in architecture, can be found in the technological concepts of the Internet, which provide users with access to hyperspace of information flows and data on a global level that transcends geographical limitations. In architecture, this concept has resulted in the development of networked spaces in which the user can physically reside at one place, while, through networking and remote access, can be telepresent at another. The spaces, which operate on the concept of networking in architecture have various forms. Some ideas use the concept of networking to create composite spaces, in which physical premises are connected to the networked virtual environments, and/or remote physical spaces.

- *Participation. Interactivity. Space as an open system. Space as an interface.*

Interactivity as a new media technological concept in contemporary architectural practice has resulted in the emergence of interactive architectural spaces, in which the participation of users is necessary for the development and realization of spatial narratives (Bullivant, 2006). The concepts of interactive spaces in contemporary architectural practice vary from interactive facade systems, walls and floors, through responsive video mapping and interactive light

installations, to smart materials and mobile technologies. The development of interactive and responsive environments leads to futuristic visions of highly personalized and customized spaces. This idea basically embodies McLuhan's concept of the symbiosis of man and technology, which in the architectural context means the symbiosis of man and space. In this symbiosis, space becomes an open system, the user becomes an active participant, while the architect becomes a moderator of the spatial experience.

- *Real-time design. Communication and control in real time.*

As the two fundamental characteristics of new media, on which the information society of today is based, Manovich identifies network communication and control in real time (Manovich, 2003). Real time control carries exciting potential for architecture, enabling new technologies like information-technology systems, to be installed as building systems which collect data on user habits or energy consumption on a daily basis, regulate energy performance, climatic conditions, the effects of light, or even some elements of visualization of interior spaces. This way, real-time control implicates the future of architecture as the future of continuous open-ended environmental and building systems.

- *The virtual space. The narrative spaces and video games.*

The ability for the computer to present itself as a place, in its purest form is demonstrated by the example of virtual environments. The word virtual was first defined in the dictionary in 1903 (Baldwin, 1903). The first definition is based on the explanation by Charles Pierce: "A virtual X (where X is a common noun) is something, not an X, which has the efficiency (virtus) of an X." In modern language, the term virtual space usually means space attainable only through the use of computers, although, the term is much older, and renaissance paintings, for example, presented virtual space too. This clearly demonstrates how nowadays the new media is seen as the most convenient technology for representing virtual space. The virtual space is the most radical form of user interaction with the virtual environment, since it implies a complete abandonment of its real environment. From the perceptive point of view the user is becoming unaware of its real surrounding, with his conscience completely immersed in virtual sensations. The ways for the virtual sensations to be translated into physical ones are considered the most problematic topics in the field of new media, still requiring experimental research. Video games are a special phenomenon of virtual space, which at an early stage of development presented a paradigm, that much later became common in interactive art. Interactive computer graphics, 3D modelling and animation have become the dominant methods for the representation of space and the construction of virtual environments.

- *Cybernetics. Cyber space. The symbiosis of biological and artificial systems. Artificial organisms and life. Bioarchitecture.*

The principles of cybernetics, processes of communication and control between artificial and biological systems, machinery and the living world, are at the root of many studies in modern science, new media art and architecture. In contemporary architectural practice the concept of cybernetics has encouraged the development of architectural research in several directions, from research of biological systems through biomimetic and morphogenetic design, to more complex neoplasmatic architectural design, protocell systems and plectic architecture (Spiller, 2009). It may be noted that in contemporary architecture, the concept of cyberspace eventually made the transition from a virtual-computer to a computer-biological realm. In the initial studies of biomimetic systems the aim was to achieve sustainability by mimicking biological systems,

models and processes. In morphogenetic design the research focus shifted to the possibilities of self-organization and regeneration of space. In even more complicated bioarchitectural research special attention is paid to the study of cellular systems, their organization and functioning. In developing such protocell and neoplasmatic systems, mankind could gradually get to the point where it could essentially and irrevocably change the way of communication between man and space. Man would be communicating with a space that is alive.

- *Cybernetics. The symbiosis of man and machine. Augmentation of the human body. Mediators of spatial experience.*

The concepts of cybernetics influence the design of space in contemporary architecture in two ways. The first way is the previously described concept of creating symbiosis between artificial and biological systems into cybernetic spaces (Wiener, 1954). The second way is more indirect and concerned with the impact machines have on man's perception of space, not the actual space itself, and the creation of cyborg – half man, half machine systems. The cybernetic concept of fusing artificial and biological systems, for both types of systems means advancement through the qualities of the other one.

- *The ubiquitous technologies. Smart architecture.*

The ubiquitous presence of the computer (Weiser, 1991) modalities in the physical environment of contemporary society, from the micro to the ecological scale, resulted in radical changes in the materialization of space. Calm technologies (Weiser, 1996) have enabled the development of smart technologies and materials in architecture. They enabled within architectural materials and systems new radical properties such as responsiveness, adaptability, evolvability, recombination, mobility, etc. The use of smart technologies and materials in contemporary architectural practice is still in its early stage of development, but is considered the most perspective and exuberant field of architectural development in the 21st century.

3. Initial Practical Research and the Development of New Media Architecture

In practice, new media architecture implies different new media application modes. Similar to new media art, it can be defined as computer-based, in which computer technologies play the role of expression media. In the beginning, new media architecture appeared in the form of digital screen spaces and interactive space installations. With the development of the Internet, in the age of personal computers, architectural space developed its virtual forms and moved from the real domain to cyber space. In the computer age, the reverse process happened. Computers broadened their effect from the virtual field to real space, in which they became the generally present support. Through its uprising, new media architecture developed from digital screen spaces to high technology, post-digital and plectic spaces in which science and art work together in a complex way, and digital fabrication and smart technologies are generally present in space.

The starting point of perceiving the theoretical and practical research in the field dates back to 1960s, when the field of new media architecture was not yet clearly profiled, but had its roots in experimental projects based on research in arts and technologies. The first institutional frame of these efforts was created by Billy Clüver in 1966, who founded the Experiments in Art and Technology (EAT) organization with the aim to develop effective

cooperation between engineers and artists. The EAT disseminated direct collaboration between artists, engineers, software developers and scientists in emerging technologies. The mutual projects developed through the decades gathered names like Andy Warhol, John Cage, Jasper Johns and others.

Through the 1970s, as was noticed by Lev Manovich, although annual festivals like SIGGRAPH-a (Special Interest Group on Computer GRAPHics and Interactive Techniques) (1974) and Ars Electronica-e (1979) were established as places for gathering researchers in the field of new media, this field was still far from the mainstream cultural events (Manovich, 2003). Even today, both festivals and their institutions are among the most progressive ones devoted to the development of new media theory and practice.

It was not until 1980s that new media became part of the mainstream culture. Primarily in Europe, at this time there is enough interest and financial support for institutions devoted only to the development and production of new media technologies and art forms. Among the first of such institutions was the Center for Art and Media Karlsruhe (ZKM Karlsruhe) in Germany, founded in 1989. ZKM Karlsruhe remained one of the leading institutions in the area of developing new media.

Through the 1990s, in Europe, the uprising of institutions which support new media culture and arts continues to grow. Thus simultaneously in 1990 the New Media Institute in Frankfurt, the Inter-Society for Electronic Art (ISEA) in the Netherlands, and also the Intercommunication Centar Tokio (ICT) appear, the last of which introduces Japan as one of the leading new media culture destinations.

At the end of the 1990s the readiness for developing the area of new media and new media architecture in America maturates and its rapid dissemination begins.

The beginning of the 21st century is distinguished by a quick development of the field, due to a silent revolution of the generally present computers and the constant growth and popularity of computer technologies. In contemporary architectural practice, new media architecture is implemented as a separate area, distinct by an extremely interdisciplinary character and a broad research domain.

Besides the established institutions for new media culture, at the end of the first decade of the 21st century more and more online platforms devoted to new media discourses appear uniting arts, sciences and technologies.

In the second decade of the 21st century, besides the institutions and platforms, as significant places of the technological discourses, numerous annual festivals and conferences were established, focused on different aspects within the field of new media. The Transmediale in Berlin, the KIKK festival in Belgium, the Rob/Arch -Robotic Fabrication in Architecture, Art and Design in Vienna, the Moving Buildings Festival in Amstelveen, the Netherlands, the Mapping Festival in Geneva, the Japan Media Arts Festival in Japan, the Festival of Light in Berlin, as the Light festival in Lyon, France, are some of the festivals presenting state-of-the-art achievements.

4. TYPES OF SPACE IN NEW MEDIA ARCHITECTURE

Different modes of applying new media in modern architectural practice require a typology of new media spaces, which differ according to their conceptual, functional and aesthetic characteristics, technological and structural performance, as well as their

relationship with the users. Common for all types of new media architecture is that they succumb to general rules and principles in the field of new media and the dynamically responsive technological paradigm.

In such a context, the technological and functional classification of space in new media architecture is based on the mutual effect of the two main criteria:

- The technological foundation of the type – new media mode on the basis of which the type is conceptually and technologically based;
- The functional performance – functional aspect, which, similar to smart materials, takes into account the physical (the type of processes happening in space) and phenomenal (what are the consequences and effects of those processes) performance of space.

The first criterion covers the aspect of determining new media spaces in architecture as physical or virtual environments with specific material, structural or information features, while the other is focused on space, not as an ambience, but as a process.

In accordance with the above mentioned criteria, the technological and functional classification of new media architecture was done as follows:

1. *Screen and media architecture*, representing the initial form of new media architecture (screens, media spaces, facades, etc.).
2. *Static light and dynamic light architecture*, promoting light as a material in architecture, static and dynamic lighting systems as generators of space narrative, light installations, projections and video mapping.
3. *Interactive architecture*, as architecture of interactive, responsive, adaptable and dynamic systems.
4. *Kinetic and transformable architecture*, in the form of kinetic systems in architecture, autonomous kinetic structures and elements, and mobile, portable and transformable architecture.
5. *Digital architecture*, generative, parametric design, blob architecture, wave and fluid forms, performative architecture, 3D and 4D print[2] and digital materialization.
6. *Virtual and cyber architecture*, consisting of enlarged, composite, virtual and network spaces and video games, as well as data visualization.
7. *Bioarchitecture*, through biomimetic, morphogenetic design, neoplasmatic and protocell systems, plectic architecture, neo-nature, energy spaces, meteorological [3] and morphoecologic architecture.
8. *Textile architecture*, represented by architextile spaces, techno textiles in architecture and their supporting components.
9. *Experimental architecture***,** which is, presently represented by protoarchitecture, robotic, space and transgressive architecture.

[2] *4D Printing* is a new scientific term for 3D printed materials that can transform over time in a pre-programmed way, in response to a stimulus.

[3] Meteorological architecture is a term coined to describe emerging types of spaces in which the invisible takes precedence over the visible, and the atmospheric (conduction of heat, perspiration and shifting weather and climate) conditions are foregrounded (Rahm, 2009).

5. CONCLUSIONS

Application modes in new media architecture are characterized by pronounced interdisciplinarity which results in hybrid forms, which is why particular practical examples can be categorized as different types. Due to the nature of computers and new media, features of interactivity and responsivity became widely present, and can be found in many practical examples.

The application of new media in architecture unfolded new opportunities for determining concepts and materializing spaces, which is why the very idea of space (and what it may be) broadened. Evidently, architecture at the beginning of the 21st century needs to be redefined, as a profession and practice, together with its theoretical discourse. Contemporary architectural practice, slowly but certainly, widens the traditional territories of architectural creativity. If architecture is to flourish again, after being pressed by standardization and economic profitability through the second half of the 20th century, architects need to accept all spatial possibilities offered by new media technologies. As well as space, architects need to redefine their position and improve creative thinking in order to prevent being outdated and redundant. New media architecture requires a new set of skills for understanding and creating expanded new media spaces: real, augmented, virtual spaces of data and smart environments. The architect in the 21st century may not design space through drawings, but use a variety of different types of media presentations as spatial structures or for designing different space elements, possibilities or behavior (Clear, 2013). From the appearance of digital media, a number of possibilities emerged for the development of spatial concepts and their communication with the surroundings and users. Today, architects design spaces through CAD, BIM technologies, 3D modeling and rendering, software algorithms, manipulation of digital content, or animation techniques. Architectural theory and practice needs to accept the fact that the idea of space and function in architecture is being broadened. Form becomes a space medium and an expanded area of information design, virtual and enlarged reality, time-based narrative, as well as programmed intelligent ambience. These new spaces expand the traditional and common architectural ideas regarding the meaning of space and the role of the architect in its creation (Clear, 2009). When creating hybrid spaces we should be searching for an innovative use of new media modalities, in order to investigate and exploit their great powers of representation. We should not be using them only as an advanced tool for achieving the already known and usual goals, but as a new, powerful and creative medium, that can provide completely new qualities for the architecture of the 21st century.

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PRINCIPI I MODALITETI PRIMENE NOVIH MEDIJA U ARHITEKTURI

Savremeno doba obeleženo je digitalnom revolucijom, rapidnim usponom računarskih tehnologija, kao i opštom tehnologizacijom svakodnevice. U informatičkoj eri, računarske tehnologije postale su dominantne, a uparene sa ranije prisutnim medijskim formama, oformile su bujno polje novih medija i tehnologija. Novi mediji predstavljaju hibridnu oblast računarski zasnovanih tehnoloških formi u kojima se tehnologije pojavljuju i u ulozi ekspresivnog medija. Zbog kompleksne prirode novih medija oblast predstavlja izrazito interdisciplinarno polje na preseku umetnosti, nauke i kulture, a kulturološka paradigma koju je ovo polje ustanovilo odlikuju izrazito naučna kultura, tehnologizovana umetnost i informaciono društvo. U ovakvoj situaciji, ni arhitektura nije izolovan fenomen, pa je prodor novih medija ustanovio nove pojave, postupke, kao i principe za konceptualizaciju i realizaciju prostora u arhitekturi. Pojava novih medija u arhitekturi podrazumeva njihove različite modalitete primene, koji su uslovili razvoj novih i specifičnih tipova prostora. Specificiranje tipova ovakvih prostora, zajedno sa principima i konceptima na kojima se zasnivaju, predmet je istraživanja koje je predstavljeno u radu koji sledi.

Ključne reči: *novomedijska arhitektura, principi, modaliteti, tehnologije, digitalni mediji*