

# Interaction of Architecture with the Culture of Digital Civilization

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**Abstract** To this moment, several studies have been conducted on the specifics of the use of digital methods in architecture, however, researchers have yet to evaluate the continuously changing digital formation in architecture and the problems arising in the process of its evolution. The main purpose of this article is to identify and analyze topical issues of digital culture in nonlinear formation. Modern problems of digital shaping arising in the context of digital architecture are analyzed. The concepts of architectural theorists in the field of nonlinear architecture development based on the topic under study are presented. Contradictory aspects of modern design related to the limitations of new technologies and the difficulties of their integration into architectural processes are also presented. The issues of the absence of holism in modern architecture are investigated. In this regard, the problem with lack of integral design approach that would combine existing techniques into a common structure has been analyzed. The aspects of changing the perception of the role of the architect and urban space in the digital age are considered. Identification and analysis of the described problems of introducing digital tools into the structure of architectural shaping is an important step in the further development of the architectural discipline. This is necessary for timely identification of existing difficulties in the design and further evolution of shaping methods.

**Keywords** Digital Culture, Generation of Nonlinearity, Digital Formation in Architecture, Parametric Shaping,

Digital Civilization

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## I. Introduction

The shaping process is the architect's main tool for solving creative tasks. The study of architecture issues in digital culture is becoming extremely relevant due to the nonlinearity and specificity of processes. This topic crosses the areas of socio-cultural development of modern society, where changing aesthetic images form new requirements for both material and spiritual culture. In creating a cultural and aesthetic environment that meets these requirements, an important role is played by the study of the processes of shaping and stylization of objects of the spatial environment within the framework of the problems of digital architecture [1,2].

Rapid progress in the field of computer technology implies the global introduction of innovative methods and tools in the processes of architectural shaping. Global computerization brings a new methodology based on an engineering approach to professional education and architectural design. There are more and more different computer programs that allow you to speed up and facilitate the design processes. Aesthetic and functional requirements for architecture are changing. However, even though digital technologies solve several problems of traditional design, as new computer tools are introduced,

architects face new challenges that need to be overcome soon. The purpose of this study is to consider the main

problematic aspects of the introduction of digital tools in the processes of architectural shaping.



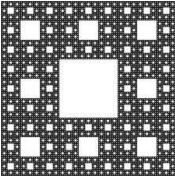

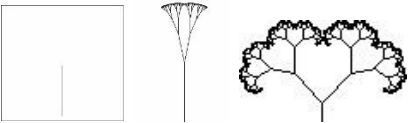

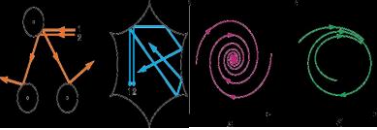

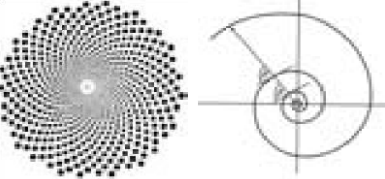



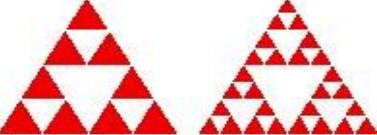

<p>1</p>	 <p>Sierpinski napkin</p>	 <p>TPAC - Taipei Performing Arts Center Image by NL Architects</p>
<p>2</p>	 <p>Sierpinski napkin</p>	 <p>Fuji TV headquarters building on Odaiba Island, arch. Kenzo Tange, Japan</p>
<p>3</p>	 <p>Nonlinear axes in natural fractals</p>	 <p>Research Center, King Abdullah</p>
<p>4</p>	 <p>Dynamic chaos</p>	 <p>The center of Melbourne</p>
<p>5</p>	 <p>A computer model of phyllotaxis and a logarithmic spiral</p>	 <p>Skyscraper of the main office of the Swiss insurance company, arch. Norman Foster, London</p>
<p>x</p>	 <p>An example of a natural fractal</p>	 <p>Residential apartment building, project Daniel Libeskind, Sacramento, USA</p>
<p>7</p>	 <p>The Sierpinski triangle</p>	 <p>Hearst Tower - designed by Norman Foster</p>

Figure 1. Application of fractal structures in architectural design [3]

## 2. Methodology

During the study, the experience of using computer programming tools in the structure of architectural shaping was studied. The analysis of projects on the application of digital architecture in modern realities is carried out. Examples of parametric shaping projects were considered, based on which the main problems of this style were identified. The cause-and-effect relationships of the problems of digital shaping in the processes of urban planning are revealed.

## 3. Results

The emergence of new technical capabilities, as well as the rapid introduction of information tools into the structure of the urban environment, encourages architects to search for completely new architectural forms that reflect modern trends. Digital shaping is extracted from a dynamic computing process. One of the sources of inspiration is "fractal geometry", which reveals aspects of the most complex problem of the synthesis of architecture and the natural environment [3, p. 84] (Fig. 1). This method of searching and interpreting architectural solutions requires the use of software focused on determining the design algorithm implemented in natural objects using computer analysis.

Digital capabilities of nonlinear architecture are improving, which is becoming a revolutionary foundation for the latest design industry, but at the same time there is a threat to traditional architecture. "The design process can easily lead to a number of different spatial solutions by swapping parameters." In modern architecture, the use of the concept of nonlinear dynamics within the framework of digital methods reveals the prospects of architectural shaping for the development of our civilization [4]. The current trend of the introduction of digital technologies has expanded. This situation significantly changes and promotes a person's perception of the environment and space.

Along with the increasing level of technological development, in particular the directions of parametric and generative architecture, one can observe radical changes in the presentation of existing design methods, especially in their creative component. The problem of the full implementation of computer programs in the processes of synthesis of architectural objects lies in the lack of understanding by computers of specific compositional nuances and in their lack of thinking as such. It is believed that large, multi-level project tasks cannot be implemented without the direct participation of a person, his creative skills, continuous aesthetic evaluation, and subsequent adjustment. Usually, the use of artificial intelligence in architecture is not characterized by the creation of fundamentally new forms, and the tasks solved by this approach are strictly limited to a certain set of rules. Thus,

today architects face a global task: the search for new architectural forms and methods of their implementation, applying and adapting continuously developing technological means.

### The Need to Revise the Usual Idea of the Form

The synthesis of architecture influences the image and uniqueness of compositions. The current trend towards the expansion and rapid development of cities leads to the complication of the created forms. The improvement of technical capabilities has made it possible to create fundamentally new architectural forms that depart from traditional ideas. The design becomes more flexible, striving for continuous changes in appearance. The introduction of innovative IT technologies today is observed in the form of a wide variety of types of architectural synthesis: digital art, media art, light design, etc. [5] Such a variety of tools that create an architectural form leads to the expansion of the subject range of urban design objects. In addition, there are significant changes in the traditional view of the architectural facade, its style and composition. All this creates the need to revise the usual idea of the material concept of form.

### Problems in Shaping Parametric Architecture

Parametric architecture has been successfully developing within the framework of avant-garde design for more than a decade, but only recently has this direction begun to claim the role of the leading style of the "digital" era. Parametricism, which is a response to the protracted crisis of modernism, creates a multilevel, continuously, and smoothly developing urban environment.



Figure 2. Metropole Parasol, Spain

However, despite the seemingly limitless potential, there are several important problems of parametric shaping in modern architecture. In relation to this style today there is a clear problem of the relationship of function, form, and interaction with the environment [6]. Parametric projects are often characterized by the primacy of form over the functionality of structures. Most of the buildings resemble an abstract art object, they do not feel oriented to a person,

to his physical and psychological comfort. In addition, being in some way experiments with the shape of a building in the parametric style, they are often designed with disregard for ergonomic standards, as well as irrational use of space and materials. As an example of the poor functionality of the structure, we can refer to the construction of the Parastole Metropole (Fig. 2), the location and cost overruns in the construction of which were the subject of public criticism. Another example is the Sunrise Tower in Kuala Lumpur (Fig. 3), the construction of which sacrifices part of the squares in favor of a sculptural form. Also, most often parametric buildings do not seem to be tied to the environment and its context. Parametric forms have a certain conceptual aggressiveness, attracting all attention to themselves and not being part of the architectural composition.



Figure 3. Sunrise Tower in Kuala Lumpur, Malaysia

### Changing the Place of Manual Modeling in Creating an Architectural Form

Undoubtedly, with the advent of the latest digital methods of shaping, traditional manual modeling has become less and less used. The advantages of the digital method include the realism and convenience of working with complex multilayer models. In addition, digital

graphics can more accurately convey the mood of an architectural object and simulate the presence of an observer, thanks to the ability to recreate the environment, weather conditions and lighting features. Creating a model of an architectural object pursues the goal of immersing the architect or the customer in a possible scenario of the real perception of the object. Even though both manual and digital modeling perform the same task of embodying and visualizing the model, the objects created with their help have significant differences. These modeling methods can reveal the artistic quality of the same form in completely different ways. Also, in the process of creating a model in one of the described ways, the architect experiences various experiences. In the process of manual development of the search layout, the author experiences, in addition to visual, also bodily experience, and the transformation and build-up of the form become like the growth of biological objects [7]. Due to the peculiarities of the materials used, as well as the duration of the process, manual modeling disposes the author to artistic improvisation and modification of the initial idea.

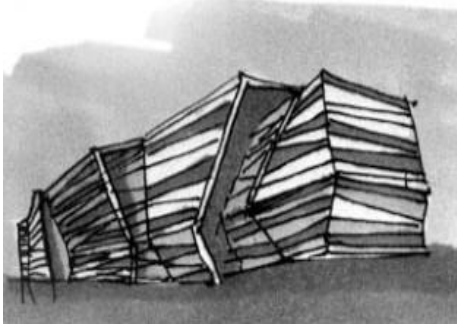
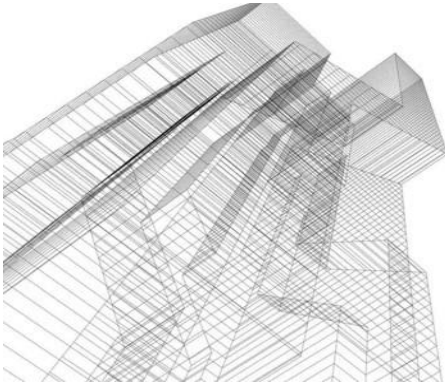





Another common type of manual design is the creation of graphic sketches. This method is indispensable when performing work with the priority of form over function and is usually used in conjunction with computer modeling. The combined modeling method has obvious advantages. A manually created model can be the result of improvisation and quickly presents the model, while a digital model provides a detailed and accurate representation of the form.

The main disadvantage of the manual production of architectural layouts is the high labor intensity, therefore, today about half of the architectural companies in the world use three-dimensional modeling (BIM). The next logical step in using this technology is 3D printing of architectural layouts, which has several advantages: the best presentation of the project in a form understandable to the customer, eliminating the risk of errors and misinterpretation of the designed form by the customer, saving, speed, accessibility and increasing the efficiency of the entire architectural process as a whole [8].

Table 1 shows the types of manual and digital presentation of the projected form. With the advent of digital methods of project presentation, several issues have emerged concerning the place of manual modeling in modern design. How will manual and digital design interact with each other? Will these methods be used in combination, or will digital design and 3D printing completely replace manual modeling? And finally, how it will affect the creative processes, originality, and diversity of the form.



**Table 1.** Types of manual and digital presentation of the projected form

	Manual	Digital		
Sketch	 <p>Hand sketch</p>	 <p>Digital sketch</p>		
Model	 <p>Manual layout</p>	<th>Virtual</th> <td>  <p>BIM model</p> </td>	Virtual	 <p>BIM model</p>
		<th>Physical</th> <td>  <p>3D printing</p> </td>	Physical	 <p>3D printing</p>

**Rethinking the Role of the Architect**

In the first half of the XX century, the role of the architect in the design processes was quite clearly defined. Depending on one or another educational concept, a specialist in the field of architecture was perceived either as a humanist with a technical education, or as an experienced builder with an aesthetic education [9]. Practically the same perception of the architect is used to this day, however, a significant discrepancy between the current state of the educational system and the degree of development of digital technologies, as well as related social changes, becomes apparent. Hence, there is a sharp

need to reconsider the role of the architect in the working processes of shaping and designing and, at the same time, to identify new areas of knowledge in which the architect's specific mindset and competencies could be applied. Thus, the task of a fundamental reassessment of the fundamentals of the architect's profession arises. It is necessary to re-evaluate the relationship between the visible, creatively created architectural form and its computational basis.

Today, the architect must change his attitude to computer technology to a large extent. A global rethinking of the role of a human architect in the processes of construction and design of artificial environment objects is required.

### **The Problem of the Lack of Holism in Modern Architecture**

Breakthroughs in the field of knowledge, acceleration in the development of technology, as well as an increase in the level of cultural exchange through globalization gradually led to the overcoming of the traditions of modernism and minimalism. The innovations of deconstructivism also seemed rather limited to architects. A breakthrough was needed that could prompt the emergence of new directions and expand the creative possibilities of the artist. The answer seemed to be the transformation of architecture into a discipline that would follow the needs of people and could also conduct a dialogue in the languages of various natural-ecological and historical-cultural environments. As a result, radical trends (conceptual art, contextualism, etc.) and virtual ones (parametric and generative architecture) have reached the forefront. Within the framework of the mentioned architectural approaches, art is intertwined with several social, natural, and exact sciences. Interdisciplinarity is a new evolutionary stage of architecture, which today is driven by many factors and is not subject to trends in art alone. The use of new technologies and modern materials in construction, the introduction of parametric and algorithmic – all this variety of methods and tools is designed to solve specific problems of our time. However, an attempt to effectively use technology has led to several difficulties arising in the work of an architect with new tools.

The creation of an architectural form involves several key processes: the study of the design task, the transformation of the task into a structure corresponding to the architectural form, and, finally, the synthesis of the final object. During the execution of these processes, the problem arises of developing the necessary languages for the transformation of the architectural space. Since the latest architecture implies the use of combined methods of modeling complex elements, an architect, in addition to understanding the algorithm of action and presenting the result, requires a certain level of competence and experience in the field of computer technology.

In addition, the variety of existing approaches to date may introduce some confusion in the architect's understanding of the order of his actions and complicate the course of his work. Now, there is no integral design approach that would combine existing techniques into a common structure. Such a task seems extremely difficult, and it has yet to be solved by specialists in the future.

### **The Problem of the Lack of Identity of Cities**

Architectural style in the history of art has always represented something large-scale, holistic and, as a rule, ubiquitous. For dozens or even hundreds of years, the style of the past could prevail in the forms of urban space, evolving very slowly. Looking at the preserved

architectural structures of the past centuries, it is possible to trace the characteristic signs and features inherent in society at a particular time and place. Of course, historically not all architectural styles have developed consistently, some, for example, Baroque and classicism, nevertheless coexisted and interacted with each other simultaneously [10]. However, in no epoch of the past has society encountered such a variety of completely dissimilar structures.

The emergence of new technological design tools expands the range of available architectural forms and materials. All this leads to coordinate changes in the appearance of buildings, how they fit into the environment and what impression they create for a person. Due to these changes, modern architecture can more accurately reflect the state of society and influence social thinking and culture. Digital architecture strives for a variety of structures, their uniqueness and dissimilarity to the destruction of several conservative views on the architectural aesthetics of the form. A remarkable characteristic of the latest architecture is precisely its excessive diversity, due to the development of many different technological methods and shaping tools. With such a huge number of styles, there is a certain sense of loss and uncertainty in architecture. A large volume of various design solutions can give rise to the development of people's taste and aesthetic preferences that differ from each other, which can lead to some disunity of society.

The described can be interpreted as a problem of finding mechanisms and means that endow urban space with an identity that gives it some meaning. The emergence of the latest architectural forms leads to the appearance of compositional uncertainty in the combination of the old and the new. Building elements of different times do not interact with each other and do not form an integral ensemble. There is a disintegration of architectural unity associated with the gradual weakening of urban planning and compositional requirements, as well as the collision of old and new building principles.

Throughout the history of the world, the city has somehow broadcast a message that allows citizens to identify themselves with their place of residence. In cities, most often in their central parts, there were important symbols characterizing a certain general idea, values, or the main activity of residents. There were various temples, markets, squares, and statues everywhere. Today, architecture often looks disjointed, superficial and represents chaotic information flows. Centralization is extremely rare in modern cities, and architectural compositions do not have obvious distinctive accents and can be said to be impersonal. At the same time, multiculturalism is inherent in the main style of the digital era – parametrisation. Therefore, looking at the current cities, it is difficult to identify the goals pursued by the society living in them. Architecture should define the identity of the region and embody in its forms and images the cultural and landscape features of specific territories. Today, to

assign a certain identity to the same type of urban space, various decorative designs and facade paintings are mainly used, while the main forms of buildings remain low-lying.







**What Should A Modern City Look Like**

Modern IT technologies play an important role in the design of urban space. Today, any large city has an information technology structure of varying degrees of development and influence on socio-social processes. Along with the evolution of urban space and the continuous introduction of innovative technologies into its structure, there is an increasing need to rethink the existing concept of the city. Urban space, previously perceived simply as a living space or as a kind of decoration, today acquires a more animated meaning. The city becomes flexible, begins to respond to human actions, and its computational processes become more and more like the processes of human thinking. At the same time, the idea of a modern metropolis is increasingly associated with the term "smart city", implying an urban environment focused on the following aspects: achieving the greatest efficiency in the use of resources, reducing economic spending, improving the quality of life, as well as reducing the negative impact of human activity on the environment [11]. The pursuit of these goals in the process of designing a city unambiguously translates the common values and

aspirations of society, which can to some extent endow the city with its own identity. To date, several authors have noted the advantages of the urban environment arrangement system. However, on the way of implementation and subsequent development of this "smart system" designers face serious difficulties. The main one seems to be the need to determine which of the scenarios for the emergence of a "smart" city (table 1) will be the most effective: the introduction of IT technologies into the structure of existing cities or the construction of a smart city from scratch. Table 2 shows a comparison of possible scenarios for designing a smart city.

To identify the method of shaping a smart city with the greatest potential for sustainable development, it is necessary to investigate existing examples of implemented projects, as well as analyze a large array of complex data. This seems to be an extremely difficult task, since now it is difficult to fully analyze such experimental cities due to the youth of this concept, which has been developed relatively recently. In addition, researchers have several other questions. How will the introduction of various information technologies affect living conditions? What combinations of technological means are most advantageous to use in various situations? And many other questions, the opportunity to answer which will present itself only in the future.

**Table 2.** Comparison of smart city design methods

	<b>Traditional city</b>	<b>A smart city based on an existing one</b>	<b>A smart city from scratch</b>
<b>Features</b>	Local and chaotic implementation of IT technologies	Structured implementation of IT technologies based on the highest efficiency	Dense high-rise buildings with landscaped spaces. The crystal structure of the city
<b>Schematic illustration</b>			
<b>Examples of cities</b>	 Sao Paulo, Brazil	 Singapore	 Songdo, South Korea

## 4. Discussion

Summarizing the above, we can conclude that at this stage the architecture is not able to change as quickly as structural transformations occur in programming itself. Despite the huge advantages of non-standard objects of modern architecture, many architects face difficulties in implementing their projects. Now, there is no general opinion on what a modern city should look like and what methods should be used to design it. In further research, it is necessary to identify existing methods of overcoming the problems of digital shaping and outline trends in the development of architecture.

## 5. Conclusions

At the moment, architecture is rapidly developing, transforming almost all the methods and tools that it consists of. In these conditions, it is extremely important for architects to be aware of the existing problems of shaping, which are relevant today. This is necessary for timely identification of existing difficulties in the design and further development of ways to solve them. The emergence and introduction of new computer technologies into architectural processes not only facilitated the work of designers, but also surpassed the new challenges that the scientific community had to face for the first time. The fact of such changes, which are a natural phenomenon, marks the onset of a certain crisis moment, which can significantly change the existing architectural paradigms. It remains only to observe the course of history and what direction architecture will take in the future. One thing is for sure: this discipline will continue to develop under the influence of a changing society and its needs, and in response it will also influence a person and his feelings about being in the space of the city.

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