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Architectural education: a reflection of three generations

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ABSTRACT: Changes in the teaching of the basic spatial concept in Slovakia over the past 50 years is the subject of this article. During this time, education was influenced by global architectural trends producing various educational paradigms. These are described by three generations of pedagogues discussing their works. The first generation deals with the process based on typology and functional-programmatic relations according to the *form follows function* principle. The second generation considers the postmodern experimental approaches, applying the opposite idea that *function follows form* and the emergence of the digital turn in architecture. The third generation is inspired by the digital turn, accelerated by data accessibility and artificial intelligence. Each of these is diametrically different but intertwined in education to this day. The new forms of teaching have an impact on the classic profile of a graduate as a universal architect and imply new directions for architectural practice.

Keywords: Architectural education, educational discourses, history of education, pedagogical experiences

INTRODUCTION

The authors of this article introduce the readers to three generations of architecture pedagogues, who registered the changes in the eras 50, 25 and 10 years ago, comparing these periods to contemporary teaching, when new approaches emerged alongside the persistent. Teaching architecture has a long history formed by different schools. Architecture as the mother of arts in the Vitruvian tradition developed in art academies around Europe. A breakthrough arrived in the 19th Century when Jean-Nicolas-Louis Durand founded engineering architecture studies at the École Polytechnique, south of Paris, based on art history, classic tradition and descriptive geometry. This concept expanded quickly and took hold mainly in Central Europe, at the German technical schools. The technical approach to architect education peaked with the establishment of the Bauhaus school in Weimar in 1919. Its strict technical and modernist approach to designing became the model for the Slovak schools. This engineering tradition of architectural education has prevailed in Slovakia to this day.

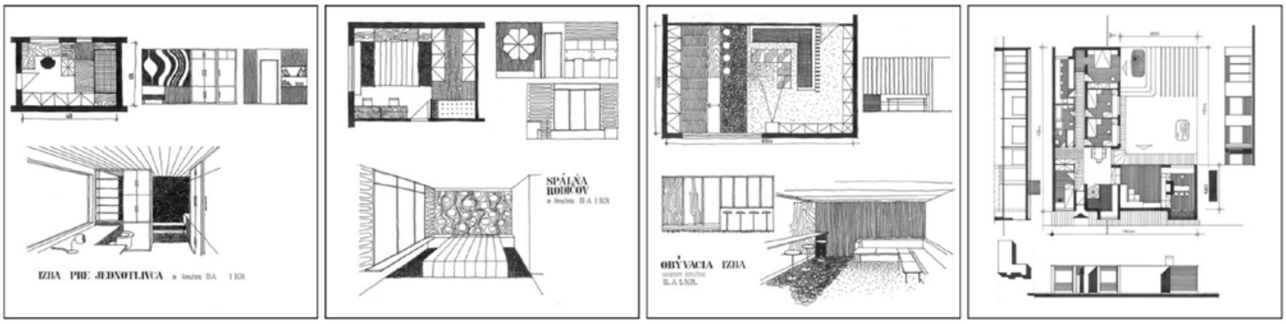
TYPOLOGY: 50 YEARS AGO

Design ground plans and the form will follow was the socialist modified version of the slogan, *form follows function.* This methodological basis resulted in building architecture that was logically if not aesthetically justified. This approach was supported by another concept: *We are not dealing with the architecture of monuments, where the main role is played by the creative, sculptural intention.* These reference experiences in the Department of Architecture at the Faculty of Civil Engineering, Slovak Technical University in the 1970s.

The spatial solution developed back then consisted of a layered floor plan based on brick masonry, which was the basis of structure. Only in the higher years of study did the teaching introduce more modern material superstructures. The typology, standards and memorisation, and practice comprised a significant part of designing. Partial typology leads to creating individual spaces out of context. Students learnt to differentiate between *global* versus *local frameworks*. A family house design often involved co-ordinating partial typologies (see Figure 1).

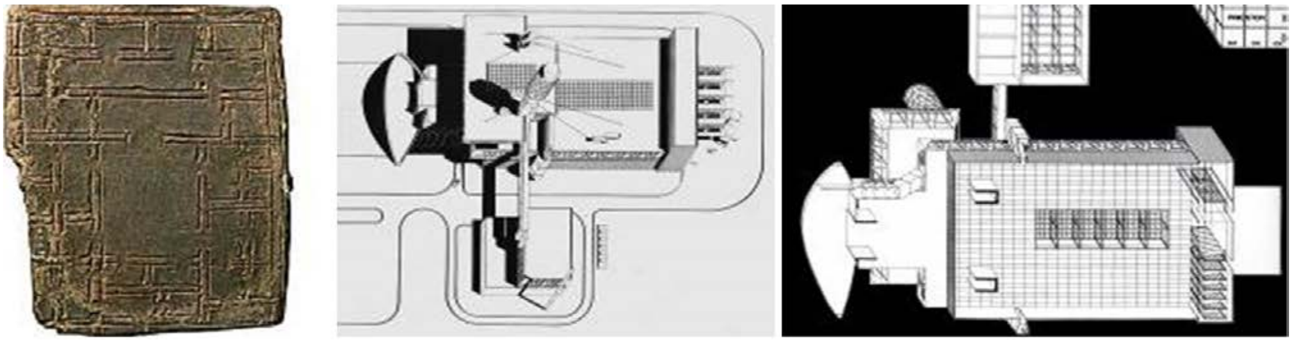
This approach has not changed since the beginning of architectural design (see Figure 2a). Many colleagues, if not most of them, use this approach to this day in their teaching. This is not meant to be a criticism, merely a statement that this technique persisted for millennia. The opinion of Richard Buckminster Fuller needs to be disputed.

One cannot design from the outside in. There can be no character unless we design from the inside out. The surface must express the interior functionalism and life [1].



a) b)

Figure 1: a) Partial typologies of room units; and b) the resulting family house design (R. Špaček, 1971/72).



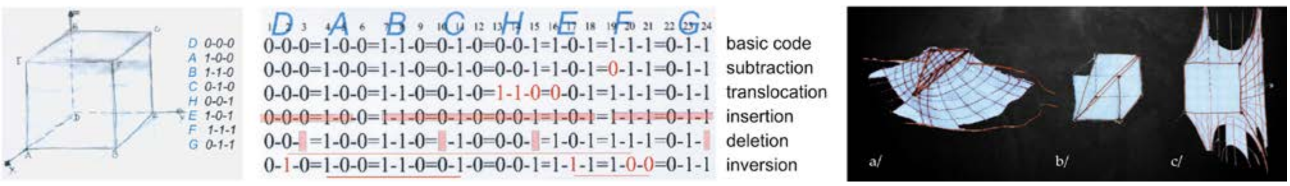
a) b)

Figure 2: a) Earliest known architectural drawing, depicting the ground plan of the palace of Nur Adad in Larsa. Clay tablet engraving; 1865-1850 BC (Gordon Grisinger, www.payette.com); and b) experimentally designed project of a production building proposed as a complex spatial concept with compositional and sculptural substantiation (R. Špaček, 1974/75).

There is often confrontation with the organisation of spaces in a volume determined in advance. This is when the approach from the outside-in unfolds: the function is modified according to the form given by the environment or the compositional intention. Often, prioritisation of the spatial concept was an individual fight against the educational establishment by students and enlightened teachers (see Figure 2b).

POSTMODERN: 25 YEARS AGO

As part of Modernism, A. Durand's raster floor plans were developed into functional-operational diagrams. While another approach was the Modulor anthropometric proportional system by Le Corbusier. Both have in common their static nature, capturing the particular status instead of the process. Therefore, it is more suitable to use the title, *schemes*, for these records. It was the necessity to capture the process parameters, becoming crucial in the critique of modernity that led to the definition of an active architectural *diagram*. The concept is inspired by French post-structuralism, where the work of J. Deleuze about abstract and concrete machines provided the basis for the architectural diagram thought construct. Such a diagram has the ability to capture various external and internal variables of architectural thinking.

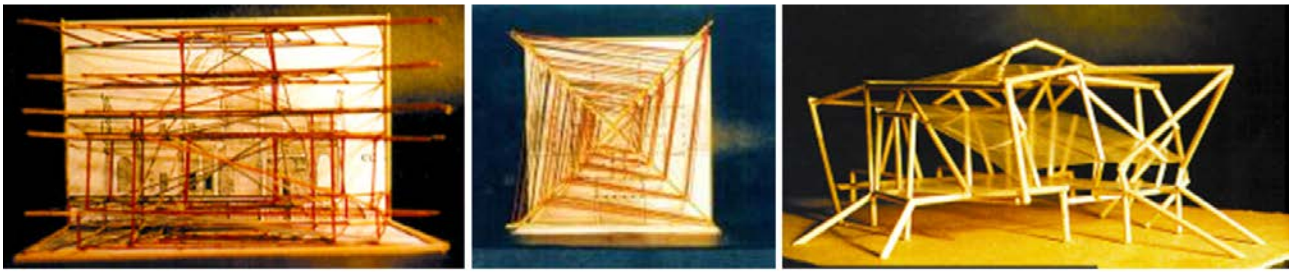


a) b)

Figure 3: Cube mutation; a) binary DNA record and possible cube mutations; b) reconstructed cube sequences: insertion, inversion, deletion (M. Uhrík, 1996).

The Palladio Deconstructed is the student work of Martin Uhrík. It was implemented in the LabArch studio under Imrich Vaško at the Academy of Fine Arts and Design (AFAD), Bratislava, Slovakia, in 1996. Since 1991, LabArch has been exploring experimental architectural procedures. The direction was influenced by the Archfest '96 conference and workshop, which included Greg Lynn, noted for work on digital architecture, and the American representatives of critical theory, Jennifer Bloomer, Catherine Ingraham and Sylvia Lavin. The event was organised in co-operation with Imrich Vaško from AFAD, and Marian Zervan, Dana Čupková and Monika Mitášová from the Faculty of Architecture at Slovak University of Technology (FA-STU). The approach at this time was fluid, reflecting different poles of architectural theory and deconstructivism. Palladio's classic Villa La Rotonda was recoded into a binary record interpreted as the Villa's DNA. Pictured in Figure 3 is the procedure tested on a cube.

After transcribing the cube points into a sequence of numbers reminiscent of DNA, mutation processes known from biology are applied to the chain. The sequence was further reconstructed to form a 3D object. In the case of La Rotonda, the same procedure required creating a specific geometric recording method using a spiral co-ordinate grid, which was subsequently mutated. After selecting viable mutations, it was reconstructed into its spatial form (Figure 4).



a) b)

Figure 4: a) Spiral geometric grid describing the mass of Villa La Rotonda; and b) reconstruction of the mutated Villa's DNA (M. Uhrík, 1996).

The project draws on the critical theory of architecture defined by the semiotic approach to designing. As well, there are influences of the emerging digital architecture techniques: rigid notations, clearly defined procedures and inspiration from biological processes. There is no longer the form and function as the basis of architectural design, but rather a search for internal relations in architecture characterised neither by functional nor aesthetic paradigms. The approach based on process research became characteristic of the postmodern period. Its basic tool comprises a diagrammatic record of architectural thinking and form.

DIGITAL ARCHITECTURE: 10 YEARS AGO

A new type of diagram is crucial for digital age architecture. Architectural thinking moved into the digital era and designing a diagram using the programming language became one of the basic skills. Lynn identifies two recent decisive shifts in architecture. The first: abandoning architectural theory based on semiology or philosophy and instead focusing on computer-simulated processes. The second: using topological geometry which has produced an architecture of smoothness for architecture (Figure 5).

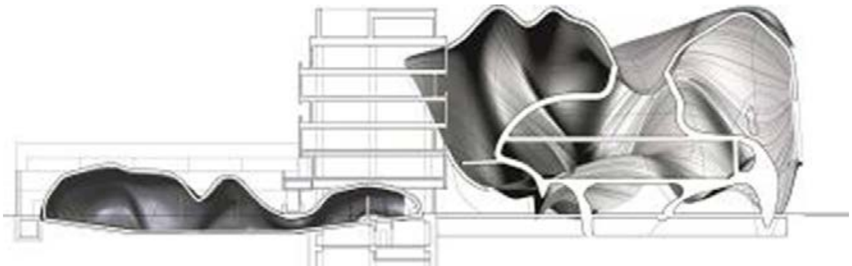


Figure 5: Competition design for the reconstruction of the Slovak National Gallery (SNG) (Vaško, Uhrík et al, 2003).

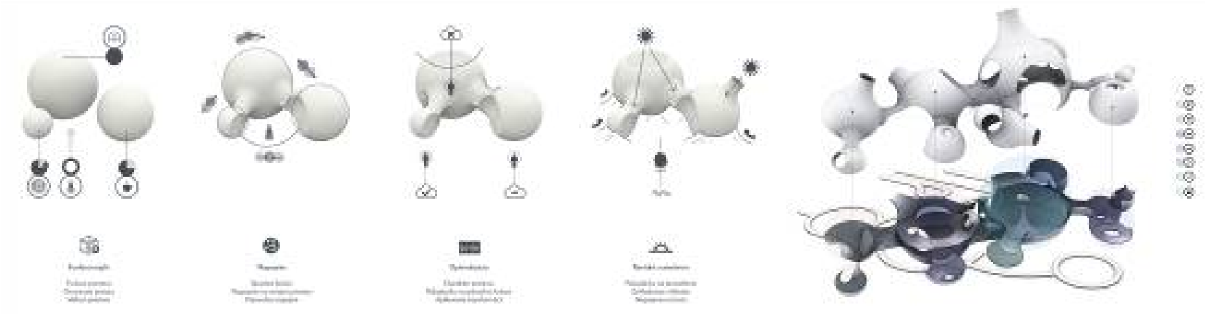


Figure 6: Catalogue of possible space aggregations and the resulting museum building (J. Novacká, 2017).

The A7 Studio and Experimental Studio of the FA-STU worked with the topic of smoothness and the search of new aesthetics, using the tools of digital architecture. Students created families of objects to understand the variability of the virtual world and mass-customisation. An example is the museum project of student J. Novacká of STU, who was primarily inspired by the propagation and reflection of sound in space. Her initial formal studies were based on modifications of a sphere using sound propagation. She modified the geometry, exploring other architectural features, such as openness, connection and illumination. Thus, families of possible spaces evolved. Combining their features provided options for functional content, connections, illumination and noise (see Figure 6).

SECOND DIGITAL TURN: TODAY

Design tools have changed architecture and its education. Compared to the elegant and legible smooth curves of the digital paradigm in architecture, leading to parametricism [2], a seeming chaos of exaggerated form is emerging. The situation was explained by Carpo in 2016, calling it the second digital turn [3]. He compares it to the *first turn* (or wave) of 1990, with the new computing machines at the core of this paradigm. However, the new machines were applied to the previous methods used in architecture.

Since then, these machines have not changed, but the method of working with them are new [3]. The computing technology is used to record and search big data and offer immediate results. Carpo described this as the onset of search mechanisms: *Search, don't sort!* [3]. By processing big data, more accurate virtual models can be produced creating virtual results faster than doing so physically. Nowadays, the designers use computing power and available data to record reality with errors and imperfections at any resolution. Thus, the second digital turn in architecture is manifest with new aesthetics. Instead of the streamlined curves, there is discontinuity of form, glitch aesthetics and excessive resolution.

Retsin demonstrated the second digital turn using the three curves (see Figure 7). The first is modernist - composed of several prefabricated components. The second is Lynn's curve, which does not connect separate parts, only using the smoothness of functions and representing the first digital turn. The last one is the curve of the second digital turn, defined by similar discrete elements and its level of detail only depends on the resolution, each of the elements being the holder of particular information, such as a 90° rotation [4].

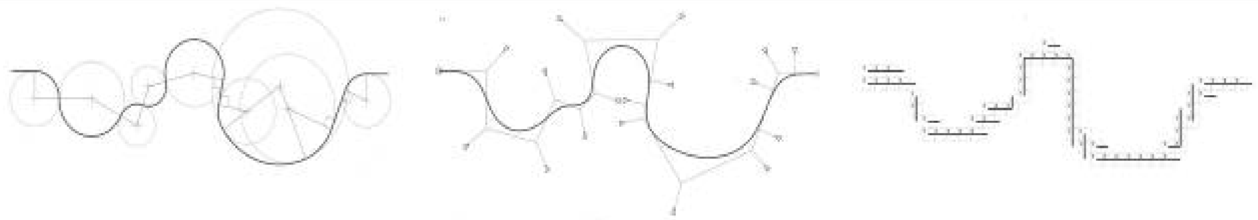


Figure 7: From left to right: Modernist, Lynn's and Retsin's curve (G. Retsin, 2019) [4].

The curve is the continuation of the mathematical expression of geometric shapes, starting from Descartes, and thus the continuation of the architectural procedures of the previous generations. How to represent objects in the space in a new way? The answer is by accepting the computer. Ultimately, any shape in the digital world is interpreted as a cluster of spatial points - the voxels [5].

The discrete nature of such data enables processing them by machine learning, a set of algorithms capable of learning the relations between the input and output. This is apposite because space has too many variables for a human, which makes it difficult to evaluate their relevance and mutual relations [6]. These days, the most developed groups in this area use artificial neural networks (ANN), the mathematical model inspired by neurons in our brain. The ANN mimic the human brain in two aspects: information is collected during learning and neural connections are used to store the information [7]. A learned model can be used to predict new data based on the previous learning. Therefore, experimentation in the virtual has the same accuracy as the physical.

Second Digital Turn at FA-STU

The second digital turn also has its effect at the FA-STU, where an educational and research platform titled Data[LAB] was established in the winter term of 2019. This originated from the previous A7 Studio, including the subjects of Digital Architecture. The focus of the curriculum in this studio is on defining the issue, finding the relations and proving the solution by experiment. The projects are focused on the near future and are speculative and provocative.

Defining the issue and finding the relations teaches the students to think critically, to analyse, abstract and search for data sources. The students are inspired by these contexts and express them with experimental proto-spaces sorted in catalogues, whereby they learn different types of data records and classification. Digital Architecture enables students to explore the properties of elements from their environment and build abstract structures [8].

The experimental proto-spaces are aggregated to explore combinations of relations and properties. The students learn to control and use the interactions, and to understand the spatial and functional concepts. By finding the suitable aggregations, the students create their own architectural language. Subsequently this is applied in the case study. The inspiration, methodical examination of the geometry and data available results in original spatial concepts. However, it is not the result itself that is important, but the creative process. Similar to the education of parametric design, only such an experience can show students the potential behind algorithmic design tools [2]. Such a record offers an option to promptly identify incorrect decisions and revisit them later. During three years of studies, students learn to automate this process and control it through algorithmisation, whereby they gradually achieve greater complexity of solutions and expression.

The diploma thesis of the Studio is a good example. Student A. Nemeš recorded information from the environment into vector fields, which modified the curve geometry. This way, he created a catalogue of spaces, through aggregation. Thus, the developed generative algorithm can create new spaces based on input data from the environment. The student had learned to create tools for processing data from the environment and to use them in generative design, which is an advantage in trying out many solutions (Figure 8).

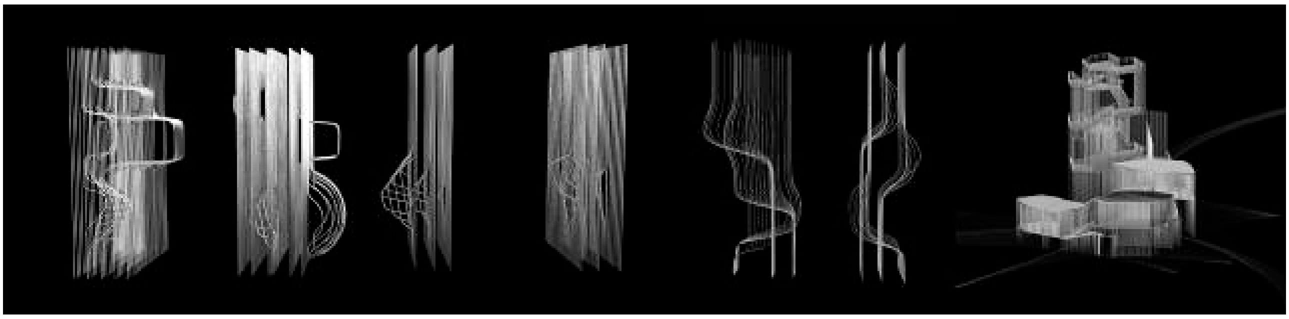


Figure 8: Deformation of curves by recorded data and the resulting building (A. Nemeš, 2019).

The link to research is an important aspect and students on the course explore possible applications. An example is the diploma thesis of student P. Čičkán, which dealt with the application of machine learning. The work focused on the predicted heatmaps from tracked user movements [6], from which the Museum of Time structures were 3D printed using algorithms. Thus, the building became the inscription both of the future and the past. The student speculatively described the scenario for applying artificial neural networks and building industry robotisation with two contrasting types of space: the smooth human legible ones and the discrete voxelised one (Figure 9).

Figure 9: Floor plan from a heatmap and demonstration of the structure growth in 3D printing (P. Čičkán, 2019).

Discrete geometry in architecture brings the connection of data and form. The discrete architecture creates new forms and alters aesthetics. In the words of Imrich Vaško:

> *We are losing the Cartesian geometry chopped by the multiplication tools and transformations of nature* [9].

The forms are fragmented. The basic unit - voxel - can take various formal and character forms. A cube is the simplest and most intuitive voxel form. It may be simply compiled into aggregations. However, the design of the basic units is crucial for creating a larger whole. This process of architectural form design differs considerably from previous procedures. What is substantial is the necessity to process big data, which is only possible using computers.

CONCLUSIONS

Big data, non-anthropocentrism, robotic and additive production systems, and discrete capturing of reality define contemporary architecture, i.e. post-digitalism. Post-digitalism addresses the contemporary direction of society.

The term defines a breakthrough in the present understanding of reality. The founder of architectural computing Nicolas Negroponte in the text called Beyond Digital, wrote:

> *Is digital destined for the same banality? Certainly. Its literal form, the technology, is already beginning to be taken for granted, and its connotation will become tomorrow's commercial and cultural compost for new ideas* [10].

More than 20 years later, the process he described is becoming a mainstream description.

Humanity is in a post-digital age. Superficially, society often rejects digital technologies. In the post-digital language, an image of a person sitting on a park bench typing on a mechanical typewriter became the symbol, a meme [11]. Similar images occur in architecture. Several well-known architects, including protagonists of the computational design, refrained from presenting their works via digital media. Collages are the latest trend: not made with scissors and water-colours, but in Photoshop. Rejecting technology is apparent in architecture and in architectural education.

The trend in schools to create a universal architect using the modernist, postmodernist and computational procedures leads to mediocrity. Each of the methodologies requires mastering of their unique theoretical and practical tools. There is no need to know what it will be like in 20 years. What is required at universities is to deal with the here and now, not trying to satisfy society with post-digital collages. Foundations are required for more pluralistic and democratic education. Otherwise, the profession could face the threat that architecture will start to be defined outside the profession.

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BIOGRAPHIES

Robert Špaček finished his study of architecture in Slovak University of Technology in Bratislava (STU), Slovakia, in 1976. In 1981-1982, he was a postgraduate student at the University of Hannover. He is a member of the Institute of Ecological and Experimental Architecture of the Faculty of Architecture at the STU, which he founded in 1990 with Professor Julián Keppl. In his research, teaching and publication work, he focuses on sustainability, urban democracy and ethics, as well as architectural theory and review work. He is an author, co-author or editor of dozens of scientific and popularisation texts, including the books, *Efficient Housing*, *Manual of Sustainable Architecture* and *Solar Cities*. He is a member of scientific and publication boards, as well as other associations. Between 2010 and 2018, he was the Vice-Dean of the Faculty of Architecture at the STU for Research, PhD Study and PR.

Martin Uhrík graduated from the Academy of Fine Arts in Bratislava in 2001. He studied in the Faculty of Architecture at Slovak University of Technology in Bratislava (FA-STU) and also received his PhD from this Institution in 2006. Most recently, he was a visiting scholar in the School of Architecture and Conservation at Columbia University in the USA, and has been working with several internationally acclaimed institutions. He is the author of the book entitled *Digital Architecture*. Presently, he is a teacher in the Institute of Ecological and Experimental Architecture at the FA-STU conducting classes in Digital Studio - Data[LAB]. His professional practice is based on research in architecture that bridges the boundaries of other fields of study. The scope of his academic work is broad and consists of lecturing, research, publishing, architectural design, industrial design and computational form of computer driven design.

Roman Hajtmanek graduated from the Faculty of Architecture at Slovak University of Technology in Bratislava (FA-STU) in 2016, and from the University of Applied Arts in Vienna, Austria, in 2018, gaining his Master’s degrees in architecture. He completed his doctoral studies in the FA-STU in 2019. His research work focused on experimental applications of virtual reality and machine learning in architecture. During his studies, he won numerous competitions, and his work was presented in several group exhibitions, as well as published in several architectural magazines. Currently, he is a postdoctoral researcher and member of the Institute of Ecological and Experimental Architecture in the FA-STU. He teaches in the design studio Data[LAB], and his focus is on the experimental and computational approach to architecture.