TECHNICAL TRANSACTIONS 8/2019
ARCHITECTURE AND URBAN PLANNING
DOI: 10.4467/2353737XCT.19.078.10857
SUBMISSION OF THE FINAL VERSION: 10/07/2019

Krzysztof Ingarden orcid.org/0000-0001-6330-654X
kingarden@afm.edu.pl
Faculty of Architecture and Fine Arts, Andrzej Frycz Modrzewski Kraków University

From *Architecture Without Architects* to architecture after architects

Od *Architektury bez architektów* do architektury po architektach

Abstract

The ideas presented by Bernard Rudofsky in the exhibition and book entitled *Architecture Without Architects* are being proposed by the author as the starting point of discussion on the condition of the architectural profession. Rudofsky focused the world's attention on architecture formed by the forces of Nature and as a result of natural development processes. The article raises the question of the future of the architectural profession seen from the perspective of the present time, whilst the technological development, in particular automation and computerization of design and construction processes, has gone so far that it is possible in the near future that man might be replaced by machines, which in turn may lead to a deep change in the architectural profession, or to its eventual complete disappearance

Keywords: architecture, artificial intelligence, AI, nature and architecture, BIM

Streszczenie

Autor za punkt wyjścia do dyskusji przyjmuje idee przedstawione przez Bernarda Rudofsky'ego w wystawie i książce zatytułowanej *Architecture Without Architects*, idee architektury formowanej siłami Natury i w wyniku naturalnych procesów rozwojowych. Następnie stawia pytanie o przyszłość architektury widzianej z perspektywy czasu obecnego, w którym rozwój technologiczny, w szczególności automatyzacja i komputeryzacja procesów projektowania i budowy, zaszedł tak daleko, iż możliwe jest w nieodległej przyszłości zastąpienie człowieka przez maszyny, co w konsekwencji doprowadzić może do zmiany charakteru zawodu architekta lub do jego częściowego zaniku.

Słowa kluczowe: architektura, sztuczna inteligencja, AI, natura i architektura, BIM

1. Architecture without architects

In the year1964 Bernard Rudofsky[1] opened his famous exhibition entitled *Architecture Without Architects* [1], accompanied by a book of the same title, at the Museum of Modern Art in New York. The author states that "the history of architecture written and taught at Western universities focuses on a few selected cultural circles" [1, p. 2], and that academic textbooks describe the development of architecture in its late stages, bypassing the early stages, emphasizing mainly the role of eminent architectural stars, or also rulers and patrons and their magnificent residences, tombs, sacred buildings, public buildings, pushing to the background a development history of construction serving the everyday needs of the majority of society, i.e. ordinary people. Rudofsky's goal was to overcome this stereotype and, through the exhibition, pay attention to architecture created anonymously, outside selected culture-forming centres, growing out of experience and local tradition of places, overlooked by such a selectively written history. Rudofsky also draws attention to the fact that man is not the only builder of structures designed to improve everyday functioning in the natural environment, whether it is protection against atmospheric conditions and danger or as constructions helpful in gaining food. Animals behave similarly, for example, chimpanzees are building sleeping platforms suspended on trees, or beavers are constructing dams on the river, etc. Nature itself creates fascinating forms and spaces convenient for human and animal use for shelter – caves, mounds, empty tree trunks, etc. The author of the exhibition wanted to emphasize his willingness to overcome the prejudices existing in developed societies to perceive the authenticity and mastery in the constructions of the so-called primitive, carried out in cultures and regions distant from civilization, not industrialized. To sophisticated forms emerging in a way resulting mainly from the tens of generations of experiences generated by anonymous members of local communities, in accordance with their own technical capabilities and with a specific understanding of the forces and laws of nature. Rudofsky also noticed that many so-called primitive solutions in vernacular architecture apply schemes and technologies to which the modern architecture of highly developed centres was only mature in the twentieth century. He cites "prefabrication, standardization, elastic constructions, natural ventilation, [...], light control" [1, p. 5] etc. As Rudofsky's exhibition and book has been very popular for over half a century, he teaches us to perceive and understand architecture created "without an architect" as a centuries-old building process in conditions of human proximity and dependence on the natural environment and depending on its laws, cyclicality and variability.

[1] Bernard Rudofsky, born on 13.04.1905 near Ostrava, he graduated from architecture at Technische Hochschule in Vienna (1928), from 1941 in New York, curator of many architectural exhibitions, author of publications on architecture, lecturer at MIT, Yale, Waseda University in Tokyo [7].

2. Architecture by architects and architecture of information

What is the current state and what might the near future of architecture look like? The conclusion that architects are currently designing buildings may seem trivial, but it may stop to surprise us if we realize that in the near future such a state of affairs may change, and the architect's profession may completely change. The architects of our generation are convinced that they control and create architecture (especially its forms) and control the direction of its future development. They are convinced that the quality of architecture is the result of knowledge, experience and talent, and perhaps also inspiration. Their ambition is to generate individual forms of expression and to send artistic messages of various forms of complexity and randomness, and to apply them into the spaces of our cities and landscape. The archetype of the architect – a modernist demiurge, capable of controlling and shaping architecture and modelling individual and social life on the scale of very complex systems, such as cities and societies, is constantly current and popular. We are still in the era of "architecture created by architects", of course bearing in mind all the external factors limiting architectural omnipotence – that is, the political, legal and economic factors in which the architect functions, and whose influence on the directions of development of our spaces remain dominant. However, we can already observe a strong drift towards a new perspective for architecture and the profession of architect: towards "information architecture". Since the introduction of the first computers to architectural practice in the 1980s, the field of architecture has increasingly been shaped by the imagination and knowhow of the

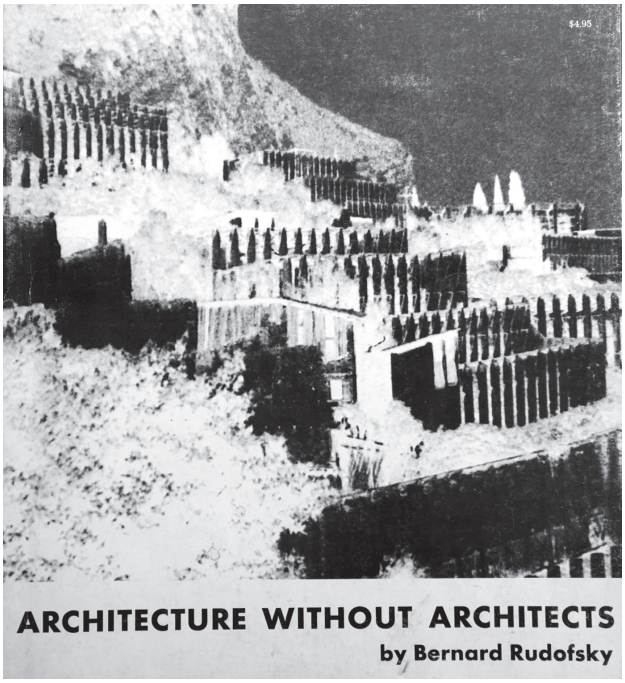

Fig. 1. Book cover – Bernard Rudofsky, Architecture Without Architects [by the author]

information world, software engineers, sociologists, data analysts focused on university and corporate research institutions dealing with urban studies and CAD design technology. Architects quickly understood that computers were becoming an indispensable tool for the proper analysis of the growing quantities of information related to the complex scale of their tasks. The last twenty years of architecture has been a clear and decisive success for digital technologies of urban structure analysis, and sociological research related to the space of architecture, cities, etc., which support the design process.

The influence of computer technology on the design of architectural forms in the period of last twenty years can be called spectacular. It was a definite explosion of the architecture of lines and planes, of computer-generated curves, delight in the possibilities of individualizing architectural forms while maintaining the comparable cost of its production, although this situation may have already passed its climax and is slowly moving towards another change. Mario Carpo [5] described this style of line architecture and curves as "blob style", also known as spline style or digital rationalization. "It became the hallmark of the first digital age of the nineties, [...] With the collapse of the 'digital economy' the wave of digital enthusiasm and technological optimism in the late 1990s suddenly lost its power, and many design professions began to treat digital blobs as the most striking symbol of excess and technological delusions" [5, position 229].

Carpo notes that new trends in the design world will be associated with the so-called era of Web 2.0, which he describes as a "participatory network" – "When the dust settled, the new spirit and some new technologies led to the so-called Web 2.0, which means a participatory network, based on collaboration, interactivity, crowdsourcing and the end user – for which individual content will be generated" [5, position 238]. However, he adds that the transition to the mass network collaboration phase has not yet occurred – with one exception – "Except avant-garde experiments and, more importantly, except the technology family known as Building Information Modeling, or BIM – unanimously adopted by the construction industry, though reluctantly accepted by academic and design-related professions that strongly rejected the direction of technological and cultural development that would weaken (or in fact transform) some of their traditional copyright privileges" [5, position 238].

These opinions indicate that we are now witnessing the clash of two tendencies: one aiming at further technologicalisation of the design process supported by artificial intelligence, and the second "participatory" trend, arising in opposition, expressing anxiety about the loss of subjectivity in the author's creative process. The future of architecture will depend on which of these trends dominates the market.

3. Architecture after architects

It becomes justifiable to ask about the future of our profession at the moment when the first in the above tendencies will be able to dominate the architectural design market as well as the investment process, and will affect the methods of selling the final product,

i.e. buildings, flats, etc. Further technological development, in particular the automation of design and construction processes, may go so far that it will be possible in the near future to replace man by machines, both at the design and construction stage, and interestingly – also when it comes to the use of buildings! It should be mentioned that in terms of building function, a new type of facility has already been identified. The architecture of technology has emerged in addition to residential, public, industrial and other known types of architecture. New architectural objects appeared in our landscape in which the main user is not directly man, but machines. It is the architecture of powerful automated warehouses, server rooms, logistic centres, packing rooms, and other industrial facilities in which the production process is robotic and digitally controlled. This topic is the leading subject of the issue 01/2019 of Architectural Design, edited by Liam Young [6]. In the introductory article, he writes about the phenomenon of the emergence of gigantic data centres of such companies as Facebook, Google, Apple or Amazon built in Oregon: "These flickering buildings are more than just computational infrastructures, they are becoming the defining cultural constructions of our age. At a time when our collective history is digital, these blank forms are our generation's great library, our cathedral, our cultural legacy. Every era has had its own iconic architectural typology. The dream commission was once the church, Modernism had the factory and then the house; in the past decade we celebrated the decadent museum and the gallery. Now we have the data centre" [6, p. 10].

The construction of these objects is based on the new logic and measure, man is not a reference point in this case: "Ancient craftsmen once measured using parts of the human body: the cubit is based on the length of a forearm; the inch, the length of a thumb. Le Corbusier designed his buildings based around the Modulor, a scale he derived from the proportions of the human body. We once understood our world through systems that positioned ourselves, human scale, vision and patterns of occupation at the centre of the structures that we design. In the age of the network, however, the body is no longer

Fig. 2. Examples of buildings printed using 3D printing technology – carried out in Shanghai by Shanghai WinSun Decoration Design Engineering Co. [10]

the dominant measure of space; instead it is the machines that occupy the spaces that now define the parameters of the architecture that contains them – an architecture whose form and materiality is configured to anticipate the logics of machine perception and comfort rather than our own" [6, p. 11].

This type of building is still designed by an architect, but the jump towards the automation of the design process is small in this case. It involves formalizing the technological process and adapting to it the appropriate form and construction technology, laws of physics, etc. Architecture will always be the product of a special kind of skill related to the efficient use of these laws for utilitarian purposes to be achieved through the physical form of the building. In the near future, these skills will be implemented not necessarily by an architect or structural engineer, but by means of computers and appropriately programmed design algorithms combined with large databases.

Technological progresses, which take place in the production of building materials and methods of computer building design, both its construction and the entire set of installations necessary for the proper functioning of the building, allow for increasingly precise control of the functioning of the whole object as a real and functionally-oriented object. That is, adapting it to external natural conditions – geographical, topographical, climatic conditions, as well as controlling the assumed internal thermal, moisture, acoustic parameters of the object. As a result of this process, buildings become more and more energy-efficient and adapted to individual ergonomic and functional needs, and they are also cost-optimized in terms of implementation and operation.

Fig. 3. Example of a building printed using 3D printing technology – by Shanghai WinSun Decoration Design Engineering Co., Shanghai, China [10]

Fig. 4. A printed building completed in 2018 in Denmark by the COBOD company [11]

All types of design issues are now controlled and coordinated in constantly improving BIM (Building Information Modeling) which is becoming one of the key aspects of the construction and architectural design process. BIM software allows you to accurately coordinate the form of the building with installation projects, with the construction, with the selection of the appropriate architectural elements, such as walls, stairs, windows, doors, etc., and in effect gives you complete control of the whole, as well as individual subsystems of the building. The future BIM building remains a fully-controlled system during all phases of design, construction and operation. To paraphrase Le Corbusier, it becomes a new kind of "machine for living in" in this process.

It is easy to imagine the automated production of such "machines" using contemporary BIM design machines supported by the achievements of artificial intelligence (AI). The first step to creating an automated production process is to create databases containing legal regulations in the field of local urban planning and construction law, then regarding social, health and neighbourhood conditions (the task of psychology and sociology of architecture), further – the system of local administration and the procedure for obtaining approval of the documentation project. The next step is the databases of individual fields of construction technology, from calculation methods to construction and finishing details related to all construction sectors, as well as databases defining ergonomic minima of individual functions. Such work is being carried out in many scientific institutes, e.g. in the French CSTB (French Scientific and Technical Centre for Building) [3].

Fig. 5–6. The next phases of building printing – by Cobod [11]

Of course, all data containing examples of historical architecture should also be found in databases in order to be able to use and develop the best proven solutions in each type of building and to relate it to specific local cultural and climatic needs, etc. The next step is to create expert systems that help to organize information hierarchically. This information in turn will feed the next stage of the system, which is the simulation of the design process. Its creation must be based on a thorough analysis of the process of making subtle design decisions that assume the possibility of considering new data during the design process, as well as the possibility of changing it (fragmentation, decomposition and self-modification), that is, considering the opportunity to learn [2, p. 167].

Probably in the near future self-learning architectural software of the new generation AI-BIM (Artificial Intelligence – Building Information Modeling), will be able to develop to the point that it will be able to replace architects, structural engineers, and HVAC engineers in design work. What's more, every entrepreneur, equipped with the appropriate AIBIM software, will be able to "do it yourself" design and construction. He will simply enter the coordinates of the property boundaries, and further – the parameters of the desired building – that is, the appropriate number of apartments, rooms, number of floors, expected construction cost per square metre, and the machine will analyze this data and suggest a solution to the task, taking into account the laws of physics, building regulations, formal guidelines from the local master plan, local climate, and the spatial conditions of the neighbourhood, as well as financial feasibility, etc. More advanced versions of the program will be able to offer additional variants with individualized features of the building form, generated on the basis of algorithms taken from analyzes of historical objects. Eventually, if the developer's ambitions are aimed at further individualization of the architectural form, the generating process of forms can be based on other types of algorithms, e.g. researching the demand for specific forms in a given location among local community, based on conclusions resulting, for example, from big data analysis[2]. If, however, the formal result aims to surprise all connoisseurs of architecture with a certain manneristic unpredictability and uniqueness, the generation of architectural forms could be generated, for example, based on algorithms drawn from the theory of catastrophes[3].

In the next stage, i.e. after preparation the construction documentation, the AI-BIM software will send the project data to the appropriate computer in the Department of Architecture of the City Office, where the computer will instantly check compliance with local law, and then automatically send a building permit, the finality of which will be confirmed in time real-life computers by all parties and will not be subject to endless further discussions, interpretations, cancellations, etc. The client will continue to press the next

[2] "Big Data" is a trend to look for, collect and process available data. It is a method of legally collecting information from various sources, and then analyzing and using it for your own purposes. As a result, a consumer profile is created, which is later used, for example, to increase sales. The most important is the practical use of the conclusions flowing from them, and not the mere collection of data [8].

[3] Catastrophe theory – mat. theory describing abrupt changes in the state of various systems. Particular attention is paid to models showing resistance to small disturbances (structural stability). The author of the disaster theory is Rene Thom (*Stabilité structurelle et morphogenèse*, 1972), and the prominent propagator of it – E.C. Zeeman. The theory is used in physics and technology, as well as in sociology, economics, linguistics and others [9].

Fig. 7. 3D house in Chattanooga, Tennessee, USA, 2017, architect: WATG's Urban Architecture Studio and Branch Technology [12]

button on the keyboard, which will send the project to construction companies offering 3D printing construction. The building will be printed in a short time, basically without the need for human supervision.

The 3D printing technology for residential buildings is already up-to-date and applied in practice. The first such residential buildings in the USA, in China and in Europe have already been constructed. Refining this technology and fully automating the design process is a matter of a short time, maybe one generation, and probably our current students will in a decade or so treat these current novelties as everyday practice.

Marketing and sale of offices spaces or apartments will be individualized – the offers will be immediately sent to selected potential buyers. These will probably be precisely targeted sales offers, suitably selected in terms of personality traits for users of Google, Facebook, Instagram and other social media, or similar tools generating information about users, referred to as "Big Data". Proper analysis and ordering of these data in terms of adequately selected psychological personality theory (e.g. OCEAN[4] type or other, more extensive and precise) [4] will allow screening of recipients and reaching a targeted sales offer to those whose psychological profile guarantees acceptance of a given project. As a result, a quick purchase will be not a surprise.

It is quite probable that the future of architecture will be such a pragmatic, albeit highly sophisticated and individualized architecture of intelligent machines – devoid of the traditionally understood artistic vision, intentions, individuality of the creator and emotions deliberately caused by artistic play with form and material – architecture that is a post humanist

[4] O.C.E.A.N. – one of the psychological personality theory, created by Paul Costa and Robert McCrae, developed among others by prof. Lewis Goldberg (University of Oregon). Theory assumes that human personality can be described through a combination of five features of The Big Five, these are: Openness (openness to experience), Conscientiousness (conscientiousness), Conscientiousness (extraversion), Agreeableness (agreeableness) and Neuroticism (neuroticism).

incarnation of the contemporary Zeitgeist. This architecture will be able to adapt perfectly to the natural environment, will implement the principles of sustainability in all possible aspects and, very importantly, will be perfectly adapted to the needs of each end user, because it can be perfectly anchored in its individual personality profile. It will probably guarantee the full satisfaction of the user as well as local communities.

It is difficult to predict whether the above perspective of the development of architecture--related technology and the architectural profession will gain an advantage over tendencies which contest this direction, but AI technology is progressing and its further development seems inevitable.

References

[1] Rudofsky B., *Architecture Without Architects. A Short Introduction to Non-Pedigreed Architecture*, Doubleday & Co. Inc., New York 1964.

[2] Brown D.C., *Artificial Intelligence for Design Process Improvement*, [pdf] http://www.academia.edu.

[3] Poyet P., Delcambre B., *Artificial Intelligence and Building Engineering*, Building Research and Information, 09/1990.

[4] Johnson J.A., *Big-Five model*, [in:] V. Zeigler-Hill, T.K. Shackelford (eds.), *Encyclopedia of Personality and Individual Differences*, New York, Springer 2017, DOI: 10.1007/978-3-319-28099-8_1212-1 2017.

[5] Carpo M., *The Second Digital Turn. Design Beyond Intelligence*, MIT Press, 2017.

[6] Young L., *Neo-Machine Architecture Without People*, Architectural Design, 01–02/2019, *Machine Landscapes. Architectures of the Post – Antropocene*, John Willey and Sons, 2019, DOI: 10.1002/ad.2379.

[7] The J. Paul Getty Trust, *Bernard Rudofsky Papers*, ca. 1910–1987, [online] http://archives2.getty.edu:8082/xtf/view?docId=ead/920004/920004.xml;chunk.id=ref8;brand=default.

[8] https://poradnikprzedsiebiorcy.pl/-czym-jest-big-data

[9] https://encyklopedia.pwn.pl

[10] https://www.3ders.org/

[11] https://cobod.com/

[12] https://all3dp.com/1/3d-printed-house-homes-buildings-3d-printing-construction/