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CONTEMPORARY VISUAL TECHNOLOGY IN ARCHITECTURE

WSPÓŁCZESNA TECHNOLOGIA WIZUALNA W ARCHITEKTURZE

Abstract

With the technological progress of the 21st century, we increasingly refer to the famous words of Arthur C. Clarke, who in 1962 in his book *Profiles of the Future: Exploring the Limits of Possibility* formulated the Three Laws. The most famous and frequently cited is: "Any sufficiently advanced technology is indistinguishable from magic." Modern interactions with artificial intelligence technology often provoke comparisons to magic. A sudden qualitative leap in the ability to communicate, create, or even predict causes many to experience what can be called a "magical effect." This technology can generate literary texts, compose music, or create architectural images that deceive our senses. However, this is not a magical power, but a mathematical optimization. In aspects of contemporary visual culture, British statistician George Box's canonical statement: "All models are wrong, but some are useful" illustrates the misleading aspects of technology but also its multi-faceted role in creating visual representations of architectural ideas.

Keywords: idea of architecture, artificial intelligence, visual technology

Streszczenie

Wraz z postępem technologicznym XXI w., coraz częściej odwołujemy się do słynnych słów Arthura C. Clarke'a, który w 1962 r. w swojej książce *Profile przyszłości: badanie granic możliwości* sformułował Trzy Prawa. Najbardziej znane i najczęściej cytowane to: „Każda wystarczająco zaawansowana technologia jest nieodróżnialna od magii”. Współczesne interakcje z technologią sztucznej inteligencji często prowokują porównania do magii. Nagły skok jakościowy w zakresie możliwości komunikacji, tworzenia, czy nawet przewidywania, sprawia, że wielu doświadcza tego, co można nazwać „efektem magicznym”. Technologia ta może generować teksty literackie, komponować muzykę, czy tworzyć obrazy architektury zwodzące nasze zmysły. Jednakże, nie jest to magiczna siła, lecz matematyczna optymalizacja. W aspektach współczesnej kultury wizualnej kanonicznie stwierdzenie brytyjskiego statystyka Georga Boxa: „Wszystkie modele są błędne, ale niektóre są użyteczne” obrazuje zwodzące aspekty technologii, a także wielopłaszczyznową ich rolę w kreowaniu wizualnych przedstawień idei architektury.

Słowa kluczowe: idea architektury, sztuczna inteligencja, technologia wizualna

1. INTRODUCTION

Modern visual technologies can deceive our senses. In the context of contemporary visual culture, artificial intelligence is a technology that has introduced many changes. Technology that is designed to think and act like a human being in many dimensions, by many perceived as a magical, indescribable black box. However, at the beginning, it would be necessary to define the framework of the taxonomy of this black box, the concept of *artificial intelligence*.¹ A technology that has recently changed many aspects of our lives and will most likely change the nature of many professions. The concept itself has a large degree of interpretability in terms of its meaning. The word *artificial* can be applied to products that are not produced by nature. However, for many it will be synonymous with the words pretended, pompous, theatrical or even extraterrestrial. So in this aspect, the term artificial is a carrier of the myth of the autonomy of technology, it even points to caricatured “non-human minds.” The ideological status of this slogan is enormous.

Then the word *intelligence* is also a very broad term with many connotations. We can distinguish many types of intelligence and for many people this word means something completely different. There is mathematical, logical and spatial intelligence, but also emotional intelligence. Professor Gardner distinguished eight types of intelligence: mathematical-linguistic, natural, musical, spatial, bodily-kinesthetic, interpersonal and intrapersonal.² These theories are based on cognitive science and neuroscience, they assume very different styles of cognition and many ways to understand the world. What was emphasized by Gartner is the fact that we have all types of intelligence, but they are developed to different degrees. Appropriate exercises and curiosity about the world can develop individual intelligence. In the world of modern technologies, the word intelligence also becomes more multi-faceted. Memorization does not become the most important quality. Intelligent people can connect certain facts and find appropriate conclusions.

Artificial intelligence technology is a breakthrough in understanding the world thanks to the amount of data these systems are able to take into account in their algorithms. Large Language Models use giant artificial neural networks to output the probabilities of given text sequences. Due to the incredible amount of data, algorithms are able to predict which word is most likely to appear next to which. This raises the question of how the artificial intelligence system perceives or understands the text. Predicting word positions is not synonymous with reasoning similar to how a human perceives a literary text. However, during our lifetime we are unable to read even a small part of the data that is uploaded to artificial intelligence systems.

Then we also have a technology for creating graphics by technically denoising random images. Finding a new visual language in the noise of visual data is possible due to databases containing large amounts of images. Millions of graphics available on the Internet have been powered by artificial intelligence algorithms. It should be mentioned that the images used by artificial intelligence are a product of visual social culture. One could say that these are all the images that man has created so far. Therefore, these are not impartial data sets, but subjective in the semiotic sense. Currently, the next phase is taking place, in which artificial

¹ J. Schuett, *Defining the scope of AI regulations*. “Law, Innovation and Technology” 2023, no. 15(1), pp. 60–82. DOI: 10.1080/17579961.2023.2184135.

² H. Gardner, *Multiple intelligences: The theory in practice*, Basic Books, New York 2011, pp. 77–251.

intelligence algorithms are also based on images created by the algorithms themselves. There are already systems that learn from the data they create.

At this stage, it is difficult to predict where such rapid technological development will lead. There are two different theories. One of them is that artificial intelligence algorithms are a kind of stochastic parrot that repeats certain patterns without actually creating anything new. The second is that it is a technology that will change every aspect of our lives. In many aspects, technological development and the impact on the architect's work will depend on how we introduce these tools into the design process and how much we understand them.

2. AI ASSEMBLY LINE

When creating new images of architectural ideas, semiotics is a key technological and process aspect. In contemporary visual culture, artificial intelligence has a broad aspect of social impact. For a long time, most people have been familiarizing themselves only with idealized visualizations or altered photographs of architecture. However, the experience of a real object itself is something that we actually design as architects. We design the experience of space. Algorithms can create realistic images that can be used in architecture. Modern visual technologies are based on entering prompts,³ functioning as keywords. Therefore, creating an image of architecture is based on a huge field of semiotic interpretation of the word in relation to the image. For example, terms such as: spatial, rhythmic architecture can be interpreted in many ways. Just like searching for the meaning of artificial intelligence as a term that each of us can interpret a little differently. The same applies to the production of images using AI. This is precisely where, in terms of process and ideology, we encounter a discrepancy with the multi-threaded architectural process. The design process is not only about searching for words that we transform into architecture. Creating design visions is a multi-threaded process, often of a very individual and complex nature, of making decisions based on analytical and spatial data. The nature of this process is completely different from creating images using artificial intelligence. Therefore, it is not possible to obtain and practice such a process by creating graphics. Possibility to obtain realistic images that should be the final element of the process can deceive our senses. Technological development does not change the priorities of an architect's work, where empathy, understanding the user's needs and searching for ideas based on design processes are invariably the key to design.

In many ways, a key aspect is understanding technology and its limited capabilities from a semiotic perspective. The most important aspect here is how we control the creation of images. The first phase in the AI assembly line is *data*. Recently, large language models have become groundbreaking technology. Designed to generate and process human-like natural language. Chat GPT is one example of such a technology. Large language models are functioning because they are trained on huge amounts of data. The texts come from the Internet, books, articles. Only by processing such a large amount of data is it possible for the algorithm to predict new elements. So, the right data will be the key in the future. By having appropriately sorted data from a selected sector, scientists are able to use it to precisely predict responses. For example, if we train AI algorithms based on a set of data regarding

³ E. Yildirim, *Text-to-image generation A.I. in architecture* [in:] K. Hale (ed.), *Art and architecture: Theory, practice and experience*, Livre de Lyon, Lyon 2022, pp. 97–121.

legal solutions in a given area, we are able to obtain good patterns for algorithms that will successfully replace a given part of a lawyer's work. Large corporations that provide their services for free actually do it to obtain data. In architecture, we could imagine that by having appropriate data on architectural competitions or data on a plot of land, AI algorithms in future would be able to come up with some specific conclusions and design suggestions. The quality of collected data is becoming a key element of the development of modern artificial intelligence technologies.

Once the data is collected, the next step in the AI assembly line is the *algorithm*. The first way AI algorithms work is through supervised learning. In this method, AI algorithms are controlled by uploaded images, thus teaching it to recognize people, things or places. This method is time-consuming in terms of describing and uploading data, but it is the best method in terms of the quality of the output data. In an ideal system, through appropriate data selection, we achieve better final results. Another method is unsupervised learning, in which the data is not marked with labels. This is a type of raw data in which the algorithm is responsible to search for connections between individual elements. Unsupervised learning is one of the methods used in machine learning. Another machine learning model is reinforcement learning. This is the third main trend in which the idea is to collect data from the environment. So it is a methodology that is closest to our perception of the world. In this respect, we also live in the environment of architectural and urban space. The data we obtain through the sense of sight, touch and smell causes interaction with space. This technology is currently at a breakthrough moment. When we imagine that in the future, robots with built-in artificial intelligence will perceive our world through receptors and see data in them. Just like it is in the case of people's perception of space. We are at the threshold of questions about historical changes in the adaptation of such machines and how they will actually participate and create the future world. So far, there have been known robots that played football and performed many complex activities, but these were always programmed elements. Research is currently being carried out to enable robots to perform sequences of tasks without prior programming of these activities. Already in 2022, scientist Fei Xia from Google Research presented a demonstration of a robot that understood what to do in response to command.⁴ The physical actions that the robot performed in response to commands were not pre-programmed. The experiment was conducted at Google in Mountain View, California. The researcher told the robot that he was hungry, the robot came to the counter and handed the scientist a bag of chips and offered a snack. This marks a huge breakthrough in the design of future virtual assistants. For the first time, we are dealing with technology that begins to perceive the world as data and provide answers and physically participate in space without prior programming. Certainly, in the near future, this technology will become even more accurate and virtual assistants will be multi-tasking robots that perceive and understand the world just like humans.

The third and final step in the AI assembly line is the *statistical model*. An appropriate example of how a statistical model could be useful is climate science. Analyzing global temperature data, algorithms have indicated certain trends. Global warming was somehow predicted and calculated as a statistical model. The collected temperature data from each day determined the temperature variability curve projected into the future. This model is

⁴ W. Knight, *Google's new robot learned to take orders by scraping the web* [in:] Wired, 16.08.2022, <https://www.wired.com/story/google-robot-learned-to-take-orders-by-scraping-the-web/> (access: 1.06.2024).

certainly incorrect in some aspects, but it is useful because it shows certain tendencies and directions of development of data patterns. When Greta Thunberg warns to save the climate, she actually says listen to the statistical models of climate science. Text produced as a result of the operation of algorithms in the case of large language models, is also a model of statistical data processing. Realistic images that captivate our senses are also a statistical model of processed data. And the resulting processing is a static element from the provided data set.⁵ And this is where technology brings us full circle. We return to data that are a social product with many determinants.

2.1. LABOR MARKET AND AI

The iconic slogan from Silicon Valley: *move fast and break things* is reflected in the world of artificial intelligence. Artist Agnieszka Pilat became famous for using Boston Dynamics robots in one of her projects. She says she developed relationships with them in terms of working and creating together. As she emphasizes: “I really like working with the robot. This is a very rational and planned work. It intellectually fascinates me. The robot is emotionless, so every problem can be solved – if you have enough patience. I didn’t feel any frustration or disappointment working with the robot – I like this relationship”.⁶

Her unique concept of “technological art” is a comprehensive example of a new approach to creation and technology. Teaching a robot to paint became an idea for her on how to use technology in a creative way. She taught how to paint a robot from Boston Dynamics called Spot, which is one of the most efficient robots in the world. This is one example of how the nature of work can change due to the influence of technology.

The labor market is changing under the influence of artificial intelligence. The structure of the architectural profession will also evolve under the influence of technology. As artificial intelligence advances, there is a growing need for new competencies, such as analytical and programming skills, the ability to interpret data and creative problem solving. Architects will also be forced to constantly improve their skills and adapt to dynamic market conditions. The introduction of artificial intelligence into the labor market brings both challenges and threats, such as ethical issues. It is crucial to effectively manage these challenges by developing appropriate strategies and adopting the right approach. New professions will certainly appear in the near future. Perhaps these will be professions such as AI systems architect, chatbot trainer, prompt engineer. The example of teaching a robot to paint is exactly that. So this kind of revolution and the creation of new professions has already taken place. In 2023, there was a five-month screenwriters strike in Hollywood regarding the functioning of artificial intelligence in the film industry and the level of staff in offices. Writers, screenwriters, IT workers, the music industry, the profile of all these professions is changing.

The profile of the architect’s profession will also change, the only question is how and whether these changes have not already happened and it is simply technology that tricks our senses and we become trapped in it. Artificial intelligence technologies are developing at

⁵ Enjellina, E.V.P. Beyan, A.G.C. Rossy, *A review of AI image generator: influences, challenges, and future prospects for architectural field*, “Journal of Artificial Intelligence in Architecture” 2023, no. 2(1), pp. 53–65. DOI: 10.24002/jarina.v2i1.6662.

⁶ N. Przybylska, “*Roboty to dzieci ludzkości*”. *Rozmowa z Polką, która robi karierę za oceanem* [in:] Business Insider, 2.10.2021, <https://businessinsider.com.pl/technologie/digital-poland/digital-festival-2021-rozmowa-z-agnieszka-pilat-z-boston-dynamics/84qsp12> (access: 1.06.2024).

such a rapid speed that its impact on architecture is inevitable. In the future, we can expect greater involvement of AI in design processes, building management, urban planning and education.⁷ Algorithms will be able to analyze huge amounts of data about users, the environment, materials and trends, allowing the creation of more optimal and sustainable solutions. One potential application of AI in architecture is to generate architectural designs based on specific parameters and preferences. The developed methodologies illustrate the multi-faceted role of modern technologies in creating visual representations of architectural ideas in terms of possible creations and the key role of hand-drawing as a base element for further transformations using artificial intelligence. Due to the development of modern technologies, the original ideological sketch, a clear and understandable presentation of the idea in the drawing is an important element of the architect's work, starting from the early design phase. Through good drawing, the dynamics of contemporary visual processes become effective and multi-threaded (Ill. 1, Ill. 2). Architects will be able to use tools that, based on data analysis, will propose various design variants, tailored to the client's requirements and local conditions. These types of technologies can significantly reduce the time it takes to develop a concept, allowing architects to focus on the more creative aspects of their work.

Another area where AI can play a key role is building management. Smart building systems, equipped with sensors and algorithms analyzing data, can optimize energy consumption, manage safety and ensure user comfort. Such systems can automatically adjust building parameters to changing conditions, allowing for more efficient resource management and minimizing environmental impact.

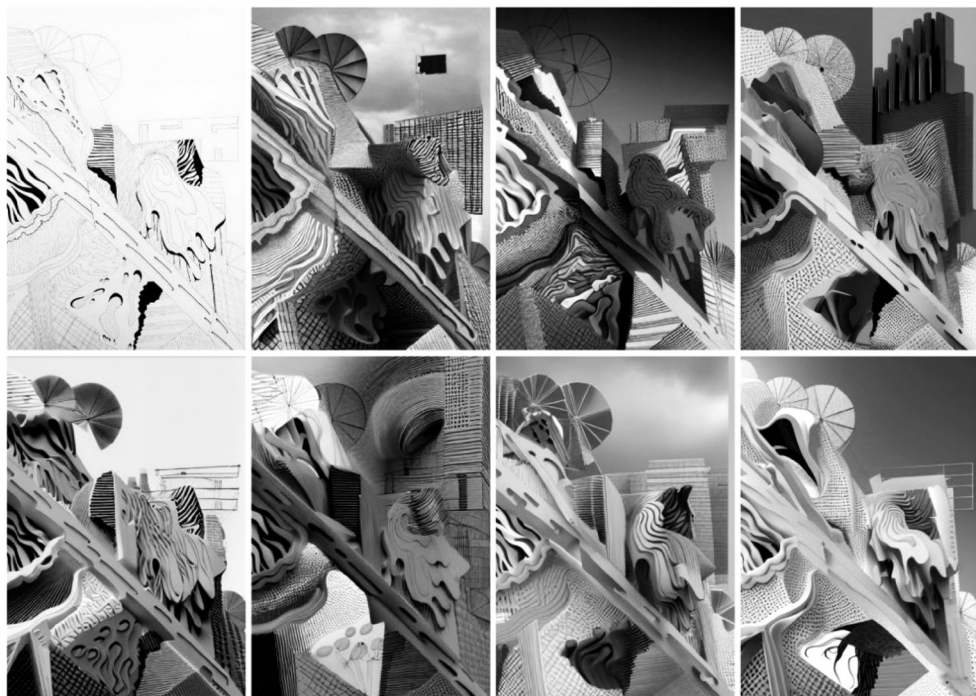
Urban planning can also benefit from the development of artificial intelligence technologies. The analysis of spatial, demographic and economic data will allow for better planning and management of urban spaces. Perhaps algorithms will be able to identify areas requiring revitalization and help optimize urban infrastructure.

An important aspect in integrating AI with architecture is ethics and responsibility. When presenting ideas, architects must be aware of the possibilities and limitations of technology, as well as the potential consequences of its use. Transparency of visual design processes and consideration of various social and environmental needs will be crucial for sustainable development in the context of contemporary visual technologies in architecture.

3. CONCLUSIONS

Modern visual technologies and artificial intelligence are introducing significant changes in the field of architecture. From generating images for design to building management and urban planning, the potential of these technologies is enormous. However, like any advanced technology, it requires a responsible approach and understanding of its limitations. Architects must be prepared to integrate AI in their work, while ensuring that humanistic and ethical values are preserved in design processes. The future of architecture depends on the ability to combine technological innovations with traditional design principles to create spaces that

⁷ M. Fareed, A. Bou Nassif, E. Nofal, *Exploring the potentials of artificial intelligence image generators for educating the history of architecture*, "Heritage" 2024, no. 7(3), pp. 1727–1753. DOI: 10.3390/heritage7030081.



III. 1. Transforming freehand sketches into 3D design options using artificial intelligence, Stable Diffusion, author: Natalia Pitala – student of the Faculty of Architecture, Cracow University of Technology.



III. 2. Transforming sketches into realistic design options using artificial intelligence, Stable Diffusion, author: Jakub Golec – student of the Faculty of Architecture, Cracow University of Technology.

References

- [1] Enjellina, Beyan E.V.P., Rossy A.G.C., *A review of AI image generator: influences, challenges, and future prospects for architectural field*, “Journal of Artificial Intelligence in Architecture” 2023, no. 2(1), pp. 53–65. DOI: 10.24002/jarina.v2i1.6662.
- [2] Fareed M., Bou Nassif A., Nofal E., *Exploring the potentials of artificial intelligence image generators for educating the history of architecture*, “Heritage” 2024, no. 7(3), pp. 1727–1753. DOI: 10.3390/heritage7030081.
- [3] Gardner H., *Multiple intelligences: The theory in practice*, Basic Books, New York 2011.
- [4] Imdat A.S., Prithwish B. (eds.) *The Routledge Companion to Artificial Intelligence in Architecture*, Routledge, London 2021.
- [5] Knight W., *Google’s new robot learned to take orders by scraping the web* [in:] Wired, 16.08.2022, <https://www.wired.com/story/google-robot-learned-to-take-orders-by-scraping-the-web/> (access: 1.06.2024).
- [6] Leach, N., *Architecture in the age of artificial intelligence*, Bloomsbury Publishing, London 2021.
- [7] Przybylska N., *“Roboty to dzieci ludzkości”*. *Rozmowa z Polką, która robi karierę za oceanem* [in:] Business Insider, 2.10.2021, <https://businessinsider.com.pl/technologie/digital-poland/digital-festival-2021-rozmowa-z-agnieszka-pilat-z-boston-dynamics/84qsp12> (access: 1.06.2024).
- [8] Schuett J., *Defining the scope of AI regulations*. “Law, Innovation and Technology” 2023, no. 15(1), pp. 60–82. DOI: 10.1080/17579961.2023.2184135.
- [9] Yildirim E., *Text-to-image generation A.I. in architecture* [in:] Hale K. (ed.), *Art and architecture: Theory, practice and experience*, Livre de Lyon, Lyon 2022, pp. 97–121.

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