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PREFABRICATION – THE EXPRESSION OF RATIONALISM IN ARCHITECTURE

PREFABRYKACJA – WYRAZ RACJONALIZMU W ARCHITEKTURZE

Abstract

At the beginning of the 20th century a rationalistic attitude to architecture together with a new technological idea brought the emergence of prefabrication in the construction industry and a new approach to aesthetic issues. The aim of prefabrication was the elimination of the shortage of dwellings and at the same time it was supposed to solve some social problems. The technology of industrially prefabricated components employed in the building industry became famous in Europe and was a symbol of modern architecture. It had an influence on creation of a new trend, by using rational aspects related to functionality and economics of modernistic aesthetics. Mass production of prefabricated components gave the possibility of constructing houses in a specified typology and functional layout. Prefabrication and typology became characteristics for the beginnings of the 20th century and were to be continued in the future. House and unit production placed the emphasis on social and functional issues until the excessively unified prefabrication subjected the idea of architecture to construction industry and top-down norms. Prefabrication was rational and necessary, but as it was related to large-scale slab technology it gained a very negative context and became a symbol of monotony and anonymity in the 70s. As it was associated with the poor quality of housing developments and low standards of furnishing, it also became socially controversial.

Keywords: prefabrication technology, rationalisation, typology, new architecture, modernism

Streszczenie

Racjonalistyczne podejście do architektury wraz z rodzącą się myślą technologiczną było na początku XX wieku przyczyną rodzącej prefabrykacji w budownictwie i nowego podejścia do zagadnień estetyki. Prefabrykacja miała na celu likwidację niedoboru lokali mieszkalnych, a tym samym rozwiązanie problemów społecznych. Technologia przemysłowych prefabrykatów stosowanych w budownictwie zyskała sławę w Europie i stała się symbolem nowoczesnej architektury. Jej zastosowanie wpłynęło na powstanie nowego kierunku przy użyciu racjonalnych aspektów związanych z funkcjonalnością i ekonomią estetyki modernistycznej. Masowa produkcja prefabrykatów dała możliwość budowy domów w określonej typologii i układzie funkcjonalnym. Prefabrykacja i typologia stały się charakterystyczne dla początków XX wieku i w przyszłości miały być kontynuowane. Produkcja domów i modułów mieszkalnych kładła nacisk na kwestie społeczne i funkcjonalne do momentu, kiedy przesadnie zunifikowana prefabrykacja podporządkowała ideę architektury przemysłowi budowlanemu i ogólnym normatywom. Bardzo potrzebna i racjonalna z jednej strony prefabrykacja, związana z technologią wielkopłytkową, uzyskała w latach 70. silnie negatywny kontekst i stała się symbolem monotonii i anonimowości. Utożsamiana ze złą jakością wykonywanej zabudowy i niskim standardem wyposażenia zyskała miano kontrowersyjnej także społecznie.

Słowa kluczowe: technologia prefabrykacji, racjonalizacja, typologia, nowa architektura, modernizm

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1. Introduction

Rational understanding of architecture connected with an intellectual approach towards the issues of existence and gaining knowledge is often contrasted with sensual intuition and metaphysical sensations. Rationalist epistemology goes back to Descartes¹, who claimed that the real world is the embodiment of rationalistic procedures, which we perceive as certain and what is uncertain is considered to be illusory and unreal.² Rationalism, which emphasises the significance of mind, is a collection of many intellectual trends or philosophical theories, but it is also a sign of the varied and creative activities of human beings, including the creation of architecture. This theory might be a symptom of different times, trends, and styles, also nowadays. It still means searching for rules and universal principles and seeks to obtain rational ‘certainty’³. Developing rationalism in architecture comes from its function and the role which it was supposed to fulfil. Due to achievements in knowledge and willingness to apply them, the architecture has become a method for *dealing with many social misfortunes*⁴, following universal and typical solutions within time.

Rational treatment of the world and a new approach towards architectural issues had its beginnings in the industrial revolution. The fast development of technology and methods of production of material goods at the turn the 20th century, especially the production of iron, contributed to forming a new trend related to presenting constructional and functional possibilities which embraced European architecture. The achievements of the industrial era contributed to changes in social structures and a bigger concentration of people in the cities. The distinct and rational attitude towards creative architectural activities was supposed to solve social problems, which meant building cheap houses for people working in industrial centres and also definitely improving their living conditions. At the beginning of the 20th century traditional constructions were replaced with cheap prefabricated components and experimental building structures. They enabled quicker and more economical solutions and they were supposed to increase the number of residential units, too. Using prefabricated parts set new aesthetics in architecture and became a foundation for many future solutions belonging to a trend of modern architecture, as a clear sign of rationalism and forthcoming modernism.

2. The pioneering concept of ‘Dom-Ino’

The beginnings of development of rationalistic ideas were visible in new building concepts. Architecture which presented historic style, proportions and harmony was replaced with modern, industrial aesthetics originating from rationalism and functionalism. Although the search for prefabrication in the building industry was carried out much earlier, the real attempts to use more advanced construction techniques took place in the 1920s. These concepts had an appropriate ideological dimension in the period of modernism. The concept of

¹ Rene Descartes- an outstanding scientist of 17th century, dubbed a father of modern philosophy. The rationalistic theory promoted by Descartes assumed the use of intellect in order to discover knowledge. The knowledge exists in the form of innate ideas.

² R. H. Popkin, A. Stroll, *Philosophy*, Wydawnictwo Zysk i S-ka, Poznań 1994, p. 342.

³ A. Mielnik, *Rationality and rationalism in architecture.*, Space and Form, 19/2013, p. 110

⁴ J. Melvin, *Architecture. Styles. Masters. Masterpieces*, Dom Wydawniczy Elipsa, 2007, p. 106.

the 'Dom-Ino' house of Le Corbusier from 1914 is the prototype of prefabrication. The basic task was the creation of easily reproducible and mass produced 'base components' as the elements for batch production. In this way a system, which was based on a concrete framework consisting of horizontal concrete slabs supported with pillars settled on concrete footings and connected with cantilever stairs was created. The building was called an icon of modernity because it was the first one which separated 'the structure from the envelope'⁵ and offered an open floor plan, devoted to any arrangements of the interior space. The plan was independent of construction. Additionally, the stairway gave a possibility of access to one side of the structure on all levels. It was a prototype of the building which was not fulfilled; however, further concepts and projects of Le Corbusier developed his original idea⁶. One example is the Maison Citrohan from 1920 and other villas from the 30s, for instance, Villa La Roche, Villa Cook and Villa Savoye.

'Dom-Ino' was a diagram which had an influence on the future of architecture⁷, but also on the development of the idea of prefabrication and mass production. Here, connections with the famous Marseille unit- Unité d'Habitation, finished in 1952, are noticed, in which Le Corbusier applied his inventive theories. This unit became in Europe *the biggest factor influencing mass housing construction in the post-war years*⁸ and a widespread production of prefab constructions, which lasted till the first half of the 20th century.

3. The beginnings of industrial prefabricated components – Weissenhof residential estate, Stuttgart

The Weissenhof Estate near Stuttgart revolutionized the approach to affordable housing. It was the first time that struggles with 'technique of industrial prefabricated components' were defined as a symptom of rationalism in the construction industry⁹. The settlement was built in 1927 within an international exhibition entitled 'Die Wohnung'. Seventeen architects¹⁰ took part in it, belonging to the avant garde movement of the time under the guidance of Ludwig Mies van der Rohe. It was a model program, in which twenty-one prototypes¹¹ of single, multi-family and row houses were built. This project was addressed to the representatives of working and middle classes. Despite the fact that different architects were the authors of the projects, the houses displayed formal coherence and unity in arrangement. The common shape of simple, white, geometrical forms and flat roofs were consistent with an applied pattern of standardization and rationalism. Additionally, Gropius implemented an innovative method of prefabrication in his buildings. The architect used a modular system together with prefabricated wall panels fixed to a 'dry construction'. Assembling the prefabricated wall

⁵ <http://www.cidark.com/about-the-prefabrication-concept-le-corbusier/> (access 04.07.18).

⁶ Five rules of Le Corbusier's architecture was defined 10 years later.

⁷ P. Nuttgens, *The History of Architecture*, Wydawnictwo Arkady, Warszawa 1998, p. 268.

⁸ *Ibidem*, p. 269.

⁹ J. Melvin, *Architecture. Styles. Masters. Masterpieces*, Dom Wydawniczy Elipsa, 2007, p. 106.

¹⁰ In this project, among others, Le Corbusier, Walter Gropius, Hans Scharoun, Peter Behrens, Mart Stam, Pierre Jeanneret, Josef Frank, Hilbersheimer, Hans Poelzig, Bruno i Max Taut took part.

¹¹ <https://www.open-iba.de/geschichte/1927-weissenhofsiedlung-stuttgart/> (access 01.07.2018).

panels was possible in accordance to the designed grid system¹². The structure of the building promoted modern materials, presented some modifications within the system, which gave an unlimited number of possible arrangements while maintaining a proper quality of production. More importantly, the prototype of the building became a creation indispensable for a 'new' society as it allowed a quick realization. Additionally, it was a finished product, which combined the elements of technological advancement and architecture seen as art. In this way, Gropius underlined the architect's contribution to creating a new 'social'¹³ environment and new aesthetic values of modernism.

The open-air exhibition on the outskirts of Stuttgart showed, apart from a new architectural style and an architectural identity of contemporary creators, a new lifestyle and the huge potential of modern technology in architecture. The designed objects had bright and spacious rooms, were well-lit and opened to surrounding landscapes¹⁴, as might be noticed in Peter Behren's terraced buildings. In his project, Mart Stram applied the concept of rationalisation of the interiors and the way of using them. For him, a minimalistic plan and reduction of domestic chores by using a big number of household appliances¹⁵ became the essence of living. What is more, during the realization of the residential estate the new possibilities of construction of buildings were presented, which employed steel frames in order to explore a flexible plan. One of such examples was Ludwig Mies van der Rohe and Gropius' project, mentioned before, which employed innovative prefabricated parts of the walls.

4. Revolution in prefabrication- New Frankfurt

At the same time a revolutionary method of prefabrication based on concrete slabs was applied by Ernst May in Frankfurt. It may be called an experiment or prototype of individual and collective apartments, for which prefabricated parts industrially produced were used. The idea had its origin in 1928, the time of the housing crisis, which inspired German creators to promote engineering advances in using steel and concrete. The aim of these undertakings was also the idea of rationalisation of the construction industry and using *affordable, flexible, easily-assembled, durable and hygienic housing strategies*¹⁶.

The project included in "Das Neue Frankfurt" presented a new approach not only to material issues but to the plans of the apartments¹⁷ as well. What is more, it shaped the housing blocks as a new type of urban 'code' in the city space. May also proposed a complex social program and urban functions. The residential estate was equipped with playgrounds, schools, theatres and common areas. For the sake of economy and construction speed, the architect used prefabricated forms¹⁸ to build it.

¹² The grid system of 1,06m x1,06 m was used.

¹³ <https://weimararchitecture.weebly.com/weissenhof-siedlung.html> (access 02.07.18).

¹⁴ <http://uk.phaidon.com/agenda/architecture/articles/2012/november/28/buildings-that-changed-the-world-the-weissenhof-settlement-stuttgart/> (access 02.07.18).

¹⁵ <https://weimararchitecture.weebly.com/weissenhof-siedlung.html> (access 02.07.18).

¹⁶ <http://prefabricate.blogspot.com/2014/03/prefabrication-experiments-9-frankfurt.html> (access 03.07.18).

¹⁷ Ernst May used an equal access to solar light, a new functionality of apartments and a prototype of new modernised and rationalised kitchen so called '*Die Frankfurter Küche*'.

¹⁸ <http://architectuul.com/architect/ernst-may> (access 03.07.17).

Practical solutions to the topic of the architecture itself reached further, from functional considerations to aesthetic ones. The corners of the buildings were cut out for better lighting of the flats situated in geometrical housing developments. Additionally, the balconies were added and the height of the corners was raised to obtain urban dominants. Residential estates in Frankfurt were called an ‘unusual experiment in urban planning of the 20th century’¹⁹, which became a success in terms of construction and planning²⁰.

The process of producing apartments was based on the assumptions of ‘rationalisation, standardisation and modularity’, in which precast components were used. In the factory set up by May concrete slabs, panels and beams were produced. These so called ‘sub-assemblies’ were equipped with windows, doors and necessary equipment (hardware). In this condition standardised (one-storey) concrete slabs were transported and assembled on the construction site. The construction system was based on the repetition of dwelling plans and standardised building details. The system of horizontal slab panels for floors and vertical slab panels for walls *employed pre-cast concrete as a fire resistant and soundproof material, two properties required for the success of collective housing*²¹. The system of the industrialised forms turned out to be durable and affordable, which brought the success of produced panels and appeared to be something more than just an experiment of common modular prefab construction industry.

The functional floor plan of the constructed flats was a very essential element of prefabrication. The plan was strictly related to the size of the family which was supposed to live there. Rationalisation of technology of producing houses and apartments also meant applying any facilities connected with the interiors, equipment, furnishing and mechanization of daily activities. The process of daily activities was compared to factory or office work, where *greater production is the result of a reduced waste of energy*.

One of the examples is mentioned before the ‘new’ Frankfurt Kitchen showing the savings in time and work, where the fixed units and equipment played an integral part of the room. Bigger spaces were replaced with a smaller square footage, showing well-thought organisational details of the interiors and functional simplifications, which fulfil the daily needs of users and provide the dwellers with a better comfort and life hygiene²².

5. The way to mass production

Many contemporary architects conducted experiments with prefabrication of the construction elements with the aim of taking advantage of well-understood rationalisation in building apartments and employing new industrial products. Between 1926 and 1928 Walter Gropius together with the Bauhaus group built 316 low-budget system houses in Dessau-Torten. The terraced houses had floor spaces of up to 75 square metres and promoted various prefabrication technologies. Load bearing walls made of concrete hollow blocks and rein-

¹⁹ *Ibidem*.

²⁰ In 5 years 15 thousand building units were built.

²¹ <http://prefabricate.blogspot.com/2014/03/prefabrication-experiments-9-frankfurt.html> (access 03.07.18).

²² <http://www.planum.net/neues-bauen-in-frankfurt-am-main-a-new-way-of-building-in-frankfurt> (access 04.07.18).

forced concrete beams were produced on the site for optimal rationalisation of production²³ and the process of assembling prefabricated components.

The construction site was a production line and during work a few buildings were assembled at the same time. The economy of solutions involved using a mirror reflection of the detached houses built in groups of four to twelve units. The facades had a horizontal character with strip windows and horizontal subdivisions²⁴ of housing units.

Walter Gropius, the founder of the Bauhaus school, after many years implemented the idea of mass housing again in the 'Packaged House' with the cooperation of Conrad Wachsmann in 1942. Gropius, as an enthusiast of prefabrication, understood that the essence is *the greatest possible standardization with the greatest possible variation in form*. He proposed a system of nine types of panels which had cut-outs for windows, some could be used as doors, others as floors, walls and ceilings. Applying panels, possibilities of their adaptation and flexibility depended on a metal Y-shaped 'wedge connector'. Thanks to this, the elements could be assembled side-by-side or at right angles to each other on either the short or long side, depending on the invention of the designer, eliminating the need for another construction system in the building. Panels were made from steel, copper, and wood. Manufacturing took place in the factory and prefabricated parts were assembled on the site. The originators were convinced of the uniqueness of the panel system and its relatively large formal variability. Gropius claimed that it overcame 'the monotonization of form' that had made previous prefabrication schemes²⁵ fail. Panels and repetition of the elements, which created the architecture, built the tectonics of modernist stylization. This system, however, required some improvements to be completely autonomic and could not be connected with any standardized elements of other systems existing on the technological market, due to their lack of compatibility.

Further development of prefabrication was connected with improvements in technology, but also with unifying architectural and aesthetic patterns. The mass character of the phenomenon became a pretext for withdrawing from social issues, which were the essence of the rationalistic architecture of modernism.

6. Contemporary prefabricated construction industry

Industrialised technology of the housing construction reached its apex after the Second World War due to the destruction of the war and the significant demographical increase in European countries. The development of mechanical building equipment, such as cranes, caused the mechanization of the building industry and that was connected with the industrialisation of the economy. On the other hand, there was a decrease in qualified workers participating in realizations of construction projects and the cost of the workforce increased significantly. Prefabricated large-panel building was employed, which allowed to

²³ U. Knaack, S. Chung-Klatte, R. Hasselbach, *Prefabricated Systems. Principles of Construction*, Birkhauser, 2012, pp. 20,21.

²⁴ <https://www.bauhaus-dessau.de/en/architecture/bauhaus-buildings-in-dessau/dessau-toerten-housing-estate.html> (access 05.07.19).

²⁵ <http://www.aiacc.org/2017/01/16/walter-gropius-and-prefab/> (access 05.07.18).

move a part of construction works to the production plant²⁶ and increase the number of produced flats for middle social class. The first buildings appeared in the 50s of the last century in France, Finland, Sweden, and also in other European countries. Mass prefabricated construction spread across the whole Europe. In the countries of Eastern Europe, including Poland, the dominance of large-panel technology started in the middle of the 50s. In the 60s, regional systems of the industrial construction were common but also central systems appeared, offering typical units and whole buildings. The 70s were subject to political decisions on the maximum use of large-panel technology in housing construction. At the time the centrally governed manufacturing plants of prefabricated components, known as 'Factories of Houses'²⁷ were realized. It is estimated that between 1979 and 89 in Poland twenty-four large-panel systems were used in housing construction in their basic modified forms. The concepts of constructing system buildings turned out to be faulty due to manufacturing and material defects, problems with exploitation, and also unfavourable spatial-functional solutions.²⁸ The prefabricate industry led to a cultural degradation, it did not meet the needs of contemporary society and did not present a suitable standard of living. Prefabrication, despite its aim of solving social issues, soon became a social problem. A mistaken understanding of rationalism became the road to the failure of the prefabricated industry.

Developing building technology of large-scale panels and then mass production of prefabricated slabs led to production of poor quality elements, disorganisation during the construction process and the creation of visually unattractive architectural objects. Prefabrication was placed in the negative chapter of achievements in the housing construction also due to typical and complicated plans of the apartments, the norms of floor space and mass employed and monotonous looking housing units. Architecture as a product of rationalistic ideas was subject to a formal execution of typical projects. In the 60s the architectural studios were obliged to make agreements on the designed plans of the buildings with manufacturing companies, taking into consideration their production capacity²⁹. The attention was paid to 'lack of balance between undertaken tasks resulting from social needs and the possibility of their realization'³⁰. Prefabrication was to be a 'remedy for everything', and because of its defects it multiplied the negative phenomena and devaluation of the properties of the housing construction³¹.

Nowadays the future of prefabrication is moving towards the economic solutions but also it requires considering ecological issues in terms of material solutions. A clear rule and limitation of principles or perhaps a more functional view on spatial solutions are characteristic for rational architecture. Such an attitude should be a sign of modern architectural solutions

²⁶ S. M. Wierzbicki, *Problems of modernisation of large-scale buildings. Technical possibilities of modernisation of large-scale buildings in Poland and their current conditions*, Conference materials, Instytut Techniki Budowlanej, Mra̧gowo 1999 p. 9.

²⁷ *Ibidem*, p. 12,13.

²⁸ W. Baranowski, *Economic aspects of maintaining and modernisation of large-scale panel buildings. Technical possibilities of modernisation of large-scale buildings in Poland and their current conditions*, Conference materials, Instytut Techniki Budowlanej 1999, p. 29.

²⁹ A. Basista, *Concrete Heritage*, Wydawnictwo Naukowe PWN, Warszawa 2001, p. 82.

³⁰ Such a record was included in the ZG SARP Act of 1967.

³¹ *Ibidem*, p. 85.

based on prefabrication technologies, the rule of typological solutions and strong appeal to social issues.

7. Conclusions

The development of prefabrication systems was connected with a rationalistic view on the shape of housing construction and focused on economical, functional and aesthetic norms. The functionality of the objects as a basic trend in the prefabrication systems introduced many improvements, changing the way of thinking about the basic space of a man, house or apartment. Functional solutions became the breakthrough phenomena and had influence on the daily lifestyle. Architectural patterns of forms originating from rationalism were built on a clear and reliable prefabrication technique employing modernistic stylization. Aesthetic patterns of rationalism had a strong connection with practical solutions related to function. New architecture and the pioneering ideas of Le Corbusier, Gropius and other modernists became revolutionary for future generations, bringing irreversible spatial, social and ideological consequences. The rational ideas of prefabrication of the beginnings of the 20th century influenced the future of housing construction. Physical structures of architecture in an honest and understandable way demonstrated the ideas of prefabrication and good or bad technologies had one thing in common, namely the idea of rational thinking and searching for universal rules. More complicated and advanced technological systems allowed constructional elements to be connected in diversified ways leading to more variations of forms. Less advanced technologies and inflexible ones presented too big simplifications and at the same time they led to complications in the functions of the apartments, monotony and banality of aesthetic solutions.

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