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PREFABRICATION AS CONTEMPORARY RETURN TO TRADITION BASED ON THE EXAMPLE OF MEANINGFUL ARCHITECTURE

PREFABRYKACJA JAKO AKTUALNY POWRÓT DO TRADYCJI NA PRZYKŁADZIE ARCHITEKTURY ZNACZENIOWEJ

Abstract

Prefabrication is a method of creating architectural material. The main idea behind prefabrication at the beginning of the 20th century was to address a Europe-wide housing shortage. The problem of contemporary prefabricated architecture is standardisation, which continues the idea of traditional residential architecture standards. Nowadays the material prefabrication technology is used in meaningful architecture, sacred and monumental structures. Such solutions present a wide range of prefabrication applications, changing the perceptions of the quality of designing the sacred space. Industrial methods of construction are a manifestation of technological progress in construction and allow to create flexible solutions designed to meet individual needs of meaningful structures, whilst maintaining the traditional approach to building an atmosphere of pious concentration when using modern materials.

Keywords: the sacred space, meaningful architecture, contemporary sacred architecture, prefabrication, technology, architecture

Streszczenie

Prefabrykacja jest sposobem kształtowania tworzywa architektonicznego. Główną ideą prefabrykacji była w początkach XX wieku eliminacja niedoboru lokali mieszkalnych w Europie. Problemem współczesnej architektury prefabrykowanej jest standaryzacja, która jest kontynuacją idei tradycyjnych wzorców architektury mieszkaniowej. Obecnie technologia prefabrykacji materiałowej wykorzystywana jest w architekturze znaczeniowej, obiektach sakralnych i monumentalnych. Takie rozwiązania ukazują szerokie możliwości prefabrykacji, zmieniając myślenie o jakości kształtowania przestrzeni sacrum. Metoda uprzemysłowiona wznoszenia obiektów jest przejawem postępu technologicznego w budownictwie oraz umożliwia kreację rozwiązań elastycznych, skierowanych do indywidualnych potrzeb przestrzeni obiektów znaczeniowych, nie zmieniając równocześnie tradycyjnego podejścia do kształtowania atmosfery religijnego skupienia przy zastosowaniu nowoczesnych materiałów.

Słowa kluczowe: sacrum, architektura znaczeniowa, współczesna architektura sakralna, prefabrykacja, technologia, architektura

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1. INTRODUCTION

Material in construction determines technological solutions. In construction of architecture pieces it is a building material, in form construction it determines the essence of spatial expression. A significant part of the modern approach to creation of architectural space is prefabrication, because its applications as material are endless, it is an expression of universality and constant progress in the use of construction technologies.

2. A REVIEW OF THE DEVELOPMENT OF PREFABRICATION

The origins of prefabrication come from the ancient Rome, as Roman builders used material that was technically similar to contemporary concrete in their so-called monolithic structures. It was a mixture of crushed stone aggregate, gypsum, lime and water, as well as volcanic ash that made the Roman concrete waterproof. Roman builders used the concrete to make prefabricates in large-scale moulds and used them to create Roman infrastructure, namely aqueducts, bridges, baths and tunnels, but also as structure elements for the construction of temples of the Ancient Rome³ and the Mediterranean region, where their ruins remain even today. Development of Portland cement in 1824⁴ changed the perception of the production of reinforced concrete prefabricates and their application in construction. Joseph Monier is considered the inventor of reinforced concrete as he used a steel mesh to reinforce concrete and initiated the development of reinforced concrete construction⁵ and, as a result, the first ever reinforced concrete bridge was built in France. However, mass prefabrication of concrete started in the 1920s with the development of rationalism and initial attempts at implementation of more advanced construction techniques. The Maison Dom-Ino designed by Le Corbusier in 1914 was a prototype for the development of later prefabricated buildings. It became the icon of modernity for many generations of architects and the expression of emerging European modernism. The structural system of the building was a reinforced concrete framework consisting of concrete slabs supported by concrete columns and connected with a cantilevered staircase. The open floor plan provided freedom to design any interior configuration and formally separated the structural frame from the building envelope. The design was also ground-breaking for the idea of using the new materials in line with technological progress and for the application of prefabrication, thus introducing mass production. The building components could be easily reproduced in industrial serial production. As a prefabrication pioneer Le Corbusier also experimented with wood and steel. Failure to use prefabrication was mostly a result of technological constraints of that period, and not due to any flaws in the concept. However, there were abstract building designs, such as: *Loucheur Houses*⁶,

³ https://www.inzynierbudownictwa.pl/files/dodatek_4_15_ib.pdf (access 27.07.2019).

⁴ Portland cement was invented by an English cement manufacturer, Joseph Aspdin.

⁵ In the years 1867–1883 Monier (gardener of Paris and inventor) patented his reinforced concrete structures, i.e.: a tub, a panel, a bridge, stairs and railway sleepers.

⁶ A concept from 1929.

Murondins Houses, that have never been built. The designs constituted the attempt to apply prefabrication to other materials. The vision of industrialisation and its implementation in architecture was very close to the heart of the French designer and ahead of its time, and the willingness to use the technology development was aimed at renovation of architecture and the revolution of the whole society.⁷

An excellent showcase of experiments with prefabrication is the Weissenhofseidlung near Stuttgart, a housing estate built for an international exhibition under the name “Die Wohnung” in 1927. Seventeen avant-garde architects under the direction of Ludwig Mies van der Rohe participated in the project, the result of which were twenty one prototypes of detached houses, terraced houses and apartment buildings in varying technologies. It was an expression of rationalism and the struggle with the industrial prefabricate technology. Despite being designed by different architects, the buildings constituted a formal unit of simple geometric forms with flat roofs and with uniform interior design. They were intended for the urban middle-class. For example, Walter Gropius implemented the prefabrication system where walls were a part of a module system. Wall panels were dry-mounted in the workshop according to the designed internal grid system and brought to the construction site. Modifications within the system endless possibilities of arranging the individual parts, according to the needs of any commission and customer’s wishes. The system of modular prefabrication was however not limitless, as the walls could only be arranged in accordance with the designed grid system and connections between the panels.⁸ It was different in the case of the structure of buildings proposed by Ludwig Mies van der Rohe with steel framework that allowed the use of the flexible plan and application of artistic freedom. The works of Ernest May in *Das Neue Frankfurt* in 1928 were another struggle with building prefabrication, significant to the history of this technology. The housing crisis and austerity measures implemented in financing construction investments made German designers develop a prefabrication method utilizing steel and concrete. Mass produced prefabricates were used in the construction of prototypical houses and apartment buildings demonstrating a new approach to materials, construction technology, room layout and even to the urban space arrangement. The factory set up by May became a benchmark for the manufacture of housing prefabricates. The factory manufactured all sub-assemblies – windows, doors, slabs and beams – that were then assembled on site. The construction system was based on repetitive flat layouts and building structure components, constituting a successful and durable application of industrialized housing.⁹ There was a boom in prefabricated construction after the World War II, when due to the war losses, significant shortage of housing and emerging mechanisation of construction works related to industrialization there were efforts to increase the quantities of housing for the middle-classes of the society.

When discussing the history of development of revolutionary construction technologies one must mention the origins of wood prefabrication. The so called *balloon frame*¹⁰ developed in the 19th century is the benchmark; the frame was made of long continuous framing members allowing entire façades and even parts of the building structure to be pre-assembled in a factory and transported to the construction site. Walls were manufactured whole, from

⁷ <http://www.cidark.com/about-the-prefabrication-concept-le-corbusier/> (access 28.06.2019).

⁸ <https://weimararchitecture.weebly.com/weissenhof-siedlung.html> (access 30.06.2019).

⁹ <http://prefabricate.blogspot.com/2014/03/prefabrication-experiments-9-frankfurt.html> (access 30.06.2019).

¹⁰ Also known as “Chicago construction”.

the sill plate to the top plate, without division into individual floors. The system, perceived as the origin of wood prefabrication, was used in colonising and populating uninhabited areas.¹¹ The technology used smaller than before cross-section beams, therefore buildings were cheaper and easier to manufacture. In addition, smaller cross-section beams were more easily available and lighter, which meant lower costs of transport and less labour intensive construction, as well as no need for highly skilled workers. The *balloon frame* technology was used not only for housing, but also warehouses, public buildings and sacred structures. One of the first was St. Mary's Catholic Church in Chicago built in 1833.¹² This type of wood structure was one of the most popular in the United States and Canada up until the mid-1950s, also becoming the most common in the Scandinavia¹³ and other European countries. Wood prefabrication is also valid today and is often used in construction of residential structures of various types and other, more complicated construction systems, fitting in with modern and energy efficient construction, as well as responding to the needs of modern design trends splendidly.

Prefabrication also owes its existence to the nineteenth-century greenhouses and temporary conservatories. First structures of cast iron and glass prefabricates were built at the same time as the ones made of concrete and wood. The work on the design of a conservatory in partly prefabricated lightweight structure of Joseph Paxton, who built the *Lily House* (a conservatory more than 30 metres high) and the *Great Stove*, are regarded as the origins of this technology. His *Crystal Palace* from 1851 was an innovative achievement due to the method of cast iron and glass prefabrication. The building was impressive due to its size (it was 549 metres long and 40 metres high), sophisticated workmanship, quality of materials and extraordinary appearance. In order to complete the design Paxton developed a machine for window frames that were technologically very advanced, having special condensation grooves and drains. The project was successful due to close cooperation with Robert Chance, the manufacturer of the thinnest and largest glass sheets of that time. The building, first in the world made entirely of prefabricated elements, was shown during the Great Exhibition in London as a technological novelty and the evidence of the need to develop the production systems of prefabricates and their use in architectural objects.

With time prefabrication technology became more and more popular, taking over ever greater areas of construction, industry, infrastructure and affecting the range of manufactured products. Even though at the beginning of the 20th century the main idea behind prefabrication was to address the problem of housing shortage and solve European social issues, it gained renown and became the symbol of modern architecture. The direction in the production of prefabricated elements based on functionality and rationale introduced a range of improvements that changed the perception of the elementary space of human existence, becoming a breakthrough. The physical structures of buildings demonstrated the concepts of prefabrication in an honest and comprehensible way and the quest for universal principles of construction resulted in the diversity of the architectural form.¹⁴

¹¹ <http://www.cidark.com/industrialization-and-architecture/> (access 28.06.2019).

¹² The church designed by Augustine Taylor.

¹³ https://archirama.muratorplus.pl/encyklopedia-architektury/balloon-frame,62_491.html?cat= (access 30.06.2019).

¹⁴ Orchowska A., *Prefabrication – the expression of rationalism in architecture* [in:] T. Kozłowski (ed.), *Defining the architectural space: rationalistic or intuitive way to architecture*, Vol. 7, Kraków 2018, pp. 23–31.

The persistent problem of modern prefabricated architecture are the measures toward unlocking the potential of prefabricated components to reduce production costs, increase the quantities of manufactured elements and making prefabricates more readily available, and therefore more common in housing. Nowadays, on the other hand, the technology of prefabrication of concrete, wood and other materials is shaking off the yoke of typical solutions and evolving into customized ones, thus challenging the practised and recorded architectural solutions.

The prefabrication method changes the current approach to the quality of architectural space design and is not only driven by the technological progress in construction, but the creation of flexible solutions intended for the individual needs of meaningful structures and spaces.

3. PREFABRICATION IN SACRED STRUCTURES

Contemporary architecture, just like the other fields of modern art, escapes the simple categories of fundamental research. Architectural structures are interconnected due to their function, investor and the technical capacity of the time of their creation. Trends and tendencies in secular architecture filter through to the design of sacred buildings. Meaningful architecture, apart from its function, structure and form also has a significant layer of meaning.¹⁵ Marks and symbols make a space sacred.¹⁶ However the use of new technologies does not contradict the semantic layer. Nevertheless, when designing sacred structures it is difficult to distance oneself from tradition and the perception of the sacred space. On the other hand, searching for new solutions in sacred structures is driven by the need to break the boundaries of creative intuition and human performance.

There were a number of reasons for the move away from the interpretation of the sacred space as a mere historical imitation. The invention of reinforced concrete and using it in mass production of architecture of that time¹⁷ and the emergence, at the same time, of the Liturgical Movement in Europe, which initiated the considerations concerning the sacred liturgy in the Catholic Church. The considerations of that time concerning the way the sacred space should be shaped in Catholic Church were concluded with the records of a Decree of the Second Vatican Council.¹⁸ Liberalisation of art and the post-modernist lack of aesthetic categories of beauty, truth and good undoubtedly affected the designers of that era. The introduction of prefabrication in sacred structures was closely connected to the use of reinforced concrete in construction. Such structures, at first only used in secular architecture, soon found many enthusiasts as they provided open floor plans and long spans. It is notable in contemporary architecture, in particular the one related to the sacred space, that none of the materials is reserved for one function. Konrad Kucza-Kuczyński, when sharing the example of the construction of the Higher Theological Seminary of the Resurrectionist Congregation in Kraków, used the term “sacralisation of concrete” in the meaningful archi-

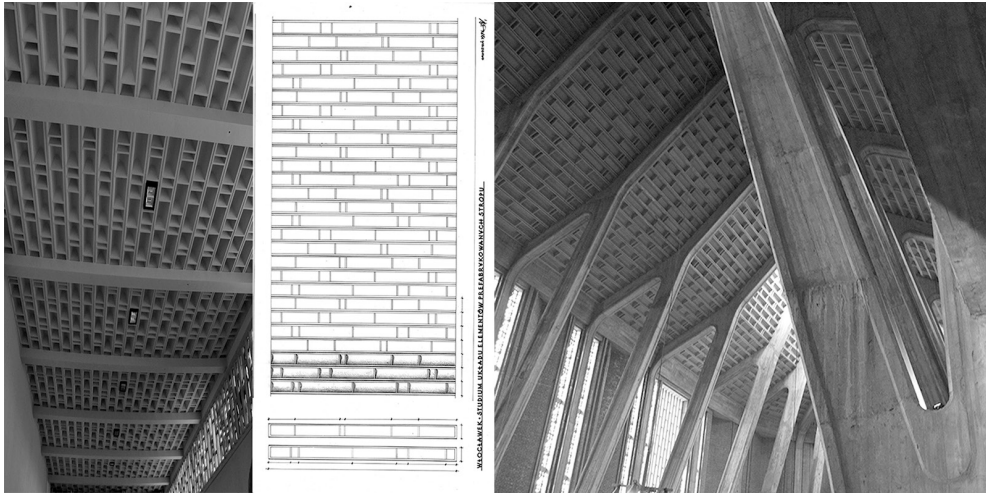
¹⁵ Biegański P., *U źródeł architektury współczesnej [Sources of contemporary architecture]*, Warszawa 1972, p. 118.

¹⁶ Wierzbicka A. M., *Architektura jako narracja znaczeniowa [Architecture as a meaningful narrative]*, Warszawa 2013.

¹⁷ Documents of the Second Vatican Council, Ch. VII *Sacred Art and Sacred Furnishings*, KL 123.

¹⁸ *Ibidem*.

ecture.¹⁹ Designation of material as “sacralised” shows a certain phenomenon of sanctification of the profane matter. The use of reinforced concrete in secular construction is closely connected to the prefabrication of individual elements and architectural details. As early as in 1930s we can find the use of prefabrication in sacred structures as a sustained design trend. The first reinforced concrete sacred structures of Europe of that time are an excellent example of the implementation of projects that use prefabrication.²⁰



- Ill. 1. Prefabricated elements in the Church of the Sacred Heart of Jesus in Biadolino in Poland, arch. W. Pieńkowski, ceiling drawing
 Ill. 2. Drawing of prefabricated beams for the church of St. Dominic in Warsaw, arch. W. Pieńkowski

As early as at the beginning of the 20th century there were attempts to use reinforced concrete in earlier sacred structures, but the first building completed entirely in the new technology was the Notre-Dame Church at Le Raincy near Paris built in the years 1922–1923, designed by the French architect, August Perret.²¹ The use of the new technology of reinforced concrete in architecture was related to the method of shaping individual architectural elements. Prefabrication used in the mass house production quickly found application in the sacred architecture of the modernist era. New tendencies in architecture coincided in time with the beginning of renewal of the Catholic Church that became more open to new trends in the art and architecture. However, searching for new solutions in sacred architecture was gradual.

¹⁹ Kucza-Kuczyński K., *Sakralizacja Betonu – Dariusz Kozłowski, Waclaw Stefanski, Maria Misiągiewicz Droga Czterech Bram – Wyższe Seminarium Duchowne Zgromadzenia Księży Zmartwychwstańców w Krakowie* [in:] D. Kozłowski (ed.), *Architektura betonowa*, Kraków 2006.

²⁰ Woycechowski P., Adamczewski G., *Prefabrykacja w XXI wieku [Prefabrication in the 21st century]*, Inżynier Budownictwa, 13.04.2015, http://www.inzynierbudownictwa.pl/dodatki_specjalne,prefabrykaty,artykul,prefabrykacja_w_xxi_wieku,8157.

²¹ Malacarne G., *Construction and character; the architecture of Auguste Perret* [in:] M. Misiągiewicz (ed.), *Defining the architectural space. Transmutations of concrete*, Vol. 1, Kraków 2017, <https://repozytorium.biblos.pk.edu.pl/resources/25488/iso-69>.

Solutions applied in the first sacred buildings of reinforced concrete structure stand between the quest for new trends in architecture and the traditional approach to designing sacred buildings. The traditional elongated floor plan of the first church was similar to a basilica and the soaring towers brought to mind the image of Gothic cathedrals. The inside of the building was designed with prefabricated lightweight openwork elements. The repeatability and precision of detail was achieved solely with the use of the new technology. The openwork, light-flooded interior makes the heavy reinforced concrete structure seem lighter.²² The Paris design soon became a part of the contemporary canon of sacred buildings as an example of modernist trends filtering through to the sacred architecture. The publication on the contemporary French sacred architecture titled: *Patrimoine sacré XXe et XXIe siècle* by Paul-Louis Rinu²³ gives numerous examples of contemporary places of religious worship built in the years 1905 – 1980, where prefabricated elements are widely used.

Implementation of the new prefabrication technology in mass construction coincided with changes within the Catholic Church, which undoubtedly affected the designs of sacred buildings. The Decree of the Second Vatican Council proclaimed during the emergence of the modernist tendency in architecture.²⁴ Asemantic nature, a purposeful break from the tradition, therefore from marks and symbols, was contradictory to the design of meaningful structures. The lack of a traditional narrative made designers include the new trends in designing churches. The use of prefabricated openwork elements is clearly visible in contemporary sacred buildings. The church in Audincourt, Doubs, built in 1949–1951 by Maurice Novarina with a traditional design, uses prefabricated elements filled with stained glass. This method of designing detail allows to design a uniform façade. A prime example of prefabrication applied in a place of religious worship is the St. Joseph's Church, Le Havre – Saint Martin, also designed by Perret, built in the years 1951–1955.²⁵ The architect with maturity applies prefabrication filling the walls, thus obtaining an interior of a simple modernist form. An exquisite prefabrication and design craftsmanship was also applied at the Saint-Rémy church designed by Nicolas Kazis in the years 1955–1957. The wall elements manufactured by industrial means create an integrated whole merging into an openwork wall. The lighting was obtained by perforation of upper wall elements, which reinforces the impression of the church being lighted by multi-paned windows.²⁶ A similar trend in designing sacred buildings of that time can be noticed in the method of filling the wall spaces between structural elements. The use of repetitive elements is evident in the Saint-Julien church designed in 1954 by Henry Bernard or the much smaller Chapel of St. Thérèse of the Child Jesus and the Holy Face designed by Hermann Bauer. In this building the openwork prefabricates were covered with glazing on the outside. The trends in façade design are evident in European examples of sacred architecture using reinforced concrete structure. Due to the time of their creation the spatial forms derive from the traditional systems and shapes, but are made of new materials. Buildings of that time demonstrate a strong influence of traditional perceptions of the sacred space. New technologies, in particular prefabrication allowed to manufacture the

²² P. Biegański, *op. cit.*, p. 123.

²³ Malacarne G., *op. cit.*

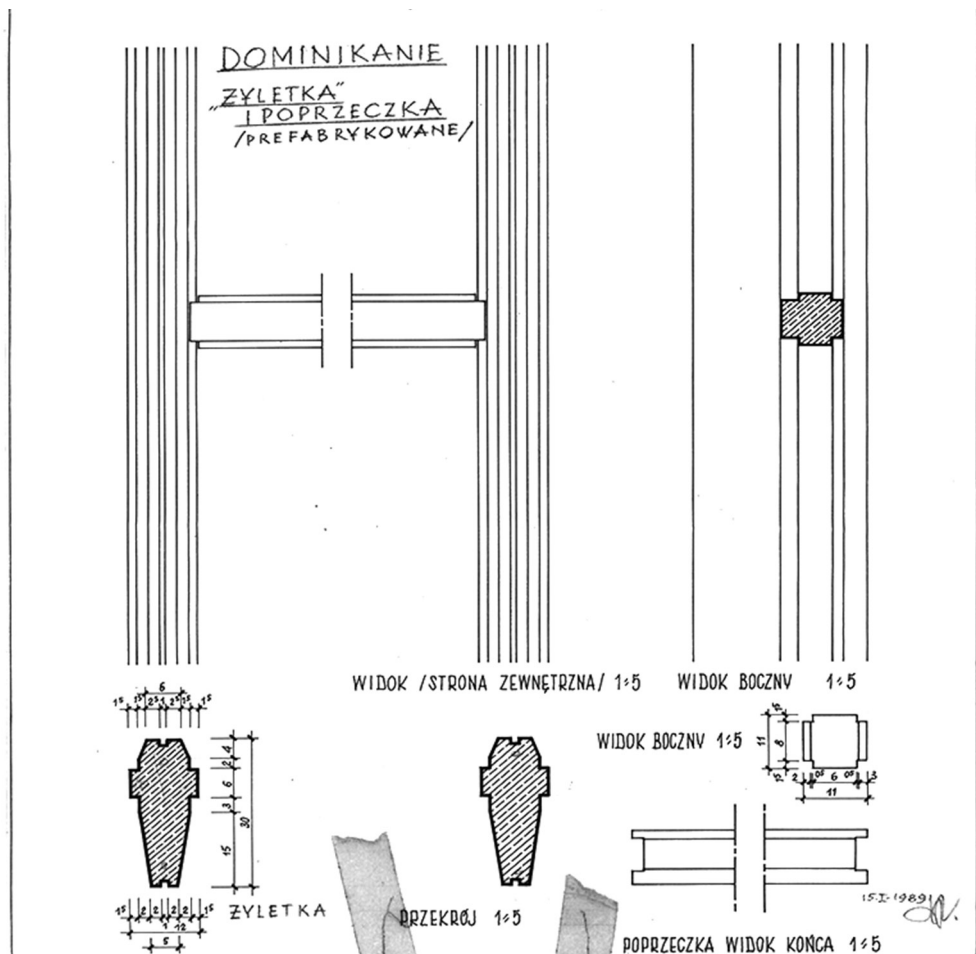
²⁴ Schwarz R., *The Church Incarnate*, USA 1958, pp. 8–9, I publication *vom Baum det Krich*, Heidelberg Germany 1938 [in:] E. Heathcote, L. Moffatt, *Contemporary Church Architecture*, Great Britain 2007.

²⁵ Rinuy P.-L., Lemaître P., *Patrimoine sacré XXe et XXIe siècle*, Paris 2014.

²⁶ Malacarne G., *op. cit.*, p. 55.

precisely structured elements more quickly. Many of the contemporary structures became the designing canon of the sacred buildings.

Prefabricated wood elements used in housing construction: both detached houses and apartment buildings, are applied in smaller structures of the sacred architecture. Detached houses are an excellent example of the use of solid walls in the CLT timber panel system. Prefabrication of solid walls offers a lot of freedom in designing the interior, where there are no redundant structural members and supports. Solid walls are load-bearing, which allows to freely shape the interior space. An example of the application of such a solution in sacred architecture is the minimalist chapel in Andelsbuch. The chapel, designed by the Cukrowicz – Nachbaur studio in 2008, constitutes an interesting example of a traditional form with a modern look. Light filters in through a slot into the minimalist interior, highlighting the solid wooden wall.



III. 3. St. Dominican Church in Warsaw, arch. W. Pieńkowski

Modern sacred buildings show clearly that there is a tendency to move away from the cold and detail-free modernism. In many cases the ambience of the interior is created by the laminated timber. There are also examples where the prefabricated laminated timber is used not exactly according to its properties. An example of such use is the college chapel in Oxford (Bishop Edward King Chapel) designed by Niall McLaughlin. The laminated timber structure is not load-bearing. Material continuity of the structural elements is broken, which is inconsistent with structural properties of the timber. Visually the structure evokes the image of traditional Gothic vaulted ceilings. This example shows how widely used the prefabricated elements are in sacred architecture. The use of materials, even with the new prefabrication technology, is not always governed by the logic of construction and materials. Wood used in the interiors of sacred buildings always creates ambience, whether used in a traditional way, or in the form of prefabricates. Prefabrication has not changed the approach to the traditional design of sacred buildings, as demonstrated by numerous examples of the use of prefabricated wood elements.

4. CONCLUSION

Early projects implementing prefabrication technology had a significant impact on designs of the contemporary sacred architecture in Europe. There are some projects that are their continuation in an altered form, translated into the modern conceptions of design. Meaningful structures of today, completed with the use of modern materials and industrial construction methods, utilise known patterns of spatial narrative and sacred elements. A modern approach to sacred architecture is translated to other fields of artistic creation.

Sacred buildings play an essential role in the urban tissue, as they stem from the universal need to sacralise space. The search for new solutions, materials and construction methods derives from the time of the structure construction. Due to the ever growing production costs prefabrication is the future of modern construction. The use of typical standardised prefabricated elements considerably reduces the costs of construction. Using prefabricated elements makes construction works easier, minimising the number of failures resulting from the low quality of the contractors' work.

Prefabrication of the structure, walls and details is a consequence of the technical progress and allows to transfer a part of the construction process to a factory. The use of prefabrication does not restrict designers in creating sacred buildings, as demonstrated by examples of contemporary places of religious worship. Designers of sacred buildings are always faced with a dilemma how to express the sacred and the atmosphere of the place using modern materials. Although the standardisation contradicts the primary concept of the sacred, prefabrication does not entail just a single design. Prefabrication is slowly becoming the future of modern construction and in the age of globalisation it also filters into the sacred architecture, which, as rightly emphasised by Rudolf Schwarz *We cannot return to the architecture of cathedrals of the early Christianity and draw from the patterns of that time. This was the failure of historicism. And our modern technologies would fail us. Obviously, it would be possible to reconstruct Roman or Gothic architecture. Would it be true, though? For us architecture is something different. [...] Architecture has to correspond to the condition and the meaning of our time. It is only from the sacred that the architecture of a church can derive. Sacred architecture does*

not derive from the world but from faith and is the answer to our times. [...] Sacred matter, from which church architecture is to be created, should be a living response to the needs of our generation.²⁷

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²⁷ Schwarz R., *op. cit.*, pp. 8–9.

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