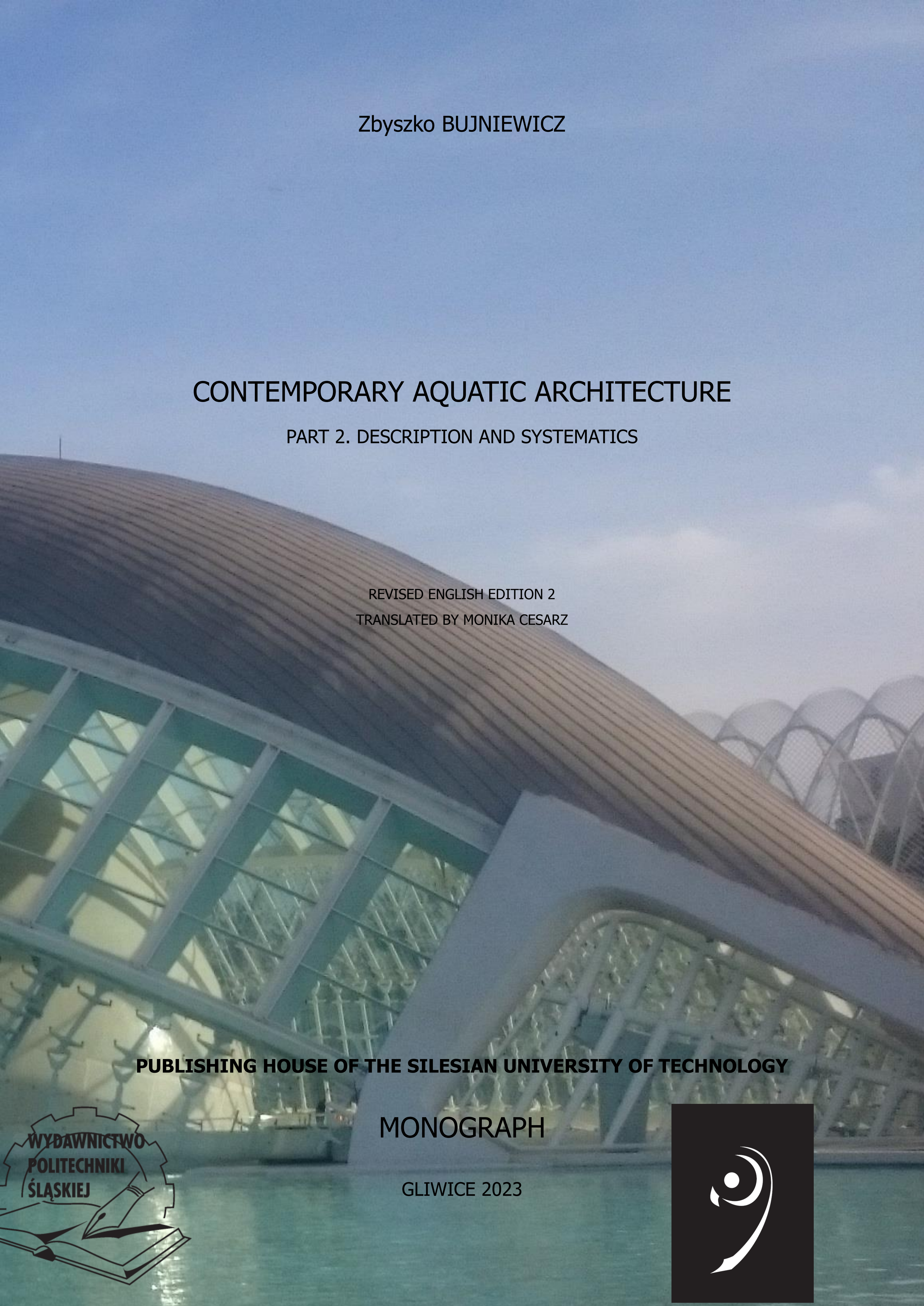

Zbyszko BUJNIEWICZ

CONTEMPORARY AQUATIC ARCHITECTURE

PART 2. DESCRIPTION AND SYSTEMATICS

REVISED ENGLISH EDITION 2

TRANSLATED BY MONIKA CESARZ

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CONTENTS

SPIS TREŚCI

PRELUDE TO THE SECOND EDITION

The original monograph on Contemporary Aquatic Architecture (the title of the Polish original: Współczesna Architektura Akwatyczna), which was published in 2015, became a little bit outdated after just a few years. The scope of aquatic architecture is international, so the first edition in Polish had a small range of influence. That is the reason for the preparation of the English edition. Additionally, the monographs will be published in the digital network, which can make them more accessible to readers.

A general aim is to prepare a completely revised part about development possibilities as well as a new scope and area of implementation. In order to serve this purpose, the scheme of the work has been changed in such a way as to better fit the established goal. The publication has been divided into three parts in separate monographs.

PART 1. STUDY AND INVESTIGATIONS
PART 2. DESCRIPTION AND SYSTEMATICS
PART 3. A NEW SCOPE OF IMPLEMENTATION, CONDITIONS OF DEVELOPMENT

The first part was published in 2019. It is read very often through the electronic access. The current monograph constitutes the second part and focues on new current studies. Some projects and designs in the second part of the study have been changed, so that they could present the current stage of their implementation.

In the monograph the author describes and analises the data included in the first part entitled STUDY AND INVESTIGATIONS. It is advisable to read the first part before.

Chapter 1. FUNCTIONS OF WATER IN DEVELOPING CONTEMPORARY AQUATIC ARCHITECTURE

In this Chapter, functions of water in the aquatic architecture facilities are linked with certain implementations. The purpose is to document the way water is used in buildings and aquatic facilities as well as to provide systematics of water functions in contemporary aquatic architecture.

1.1. Architectural structures in the water environment

Water as the natural environment has influenced the shape of architectural development since time immemorial. There are as many spatial solutions in the relations with water as there are meanings of water for the civilization. First of all, there are implementations serving the purpose of overcoming water obstacles. Another type is the location of an architectural object on the borderline of land by a natural water reservoir – due to practical reasons or attractiveness of the site. Space occupied by water in the natural environment is sometimes also a place of implementation of building development. Such building development takes different forms in the water environment, from the setting on the stilts, through floating structures, to the objects hidden in the depths of water (**Fischer J.** 2008). Contemporary solutions offer new possibilities of the expansion of architecture into the water environment, therefore the following areas of research on the relation of water and architecture have been defined:

– water as a natural obstacle and technical challenge,
– objects located on the borderline of land and water,
– objects located in the water.

Water as a natural obstacle and technical challenge

Facing and overcoming technical challenges are characteristic of our civilization. A scale of solutions depends on the level of technology, a given issue and the competence of the creator. Aquatic architecture includes several subsets where technical challenges constitute their inherent part. Transport requirements enforce the undertaking of more and more daring challenges to overcome water obstacles. Architectural objects set above the surface of water or in the water are an example of expansion into the natural environment or confrontation treating the water environment as a technical challenge. These issues include bridge crossings, which overcome water obstacles and are naturally associated with technical challenges. Water can be also perceived as a natural element and its unrestrained nature may be associated with a challenge.

The struggle with water as an element of nature is an objective of some actions. Not always a technical challenge is a consequence of necessary spatial solutions, it happens that an undertaking aims to tackle a problem and push the boundary even further (**Nyka L.** 2013). In order to combat water, many actions are taken. The very fact of tackling water environment conditions constitutes a challenge in itself. There are designs of underwater structures and floating structures whose objective is a sole existence in the alien environment. Such ideas create technical challenges not necessarily providing solutions how to meet them. These are manifestations of efforts or rather aspirations to address technical challenges related to living in alien surroundings, for instance, an attempt to move people onto floating mega-structures or even underwater structures: *Lilypad* by Vincent Callebaut, *AZ Island* by Jean Philippe Zoppini, *Freedom Shi*p by Norman Nixon and others.

The idea of moving the civilization onto a floating platform or underwater development constitute rather remote and challenging tasks. However, the concept of construction of a linear city between Osaka and Kiusiu designed by Kiyonori Kikutake seems to be more probable, especially if this idea is treated as an alternative solution to difficulties of land building development on Japanese islands. The challenge to implement some facilities over the surface of the sea does not seem to be so remote. Additionally, attention should be drawn to the existence of similar but not so elaborate housing and industrial structures, such as *Neft Dashlari* on the Caspian Sea, called the city on the sea, which can be treated as an experiment, or the implementation of an ideal radiant city in *Luchao Harbour City*[1] in Shanghai designed by Von Gerkan, Marg Und Partner. This is a successful example of the creation of a uniform structure in the relationship with the water environments. A similarly successful implementation of some technical challenges can be seen at the airport *Kansai* in Osaka, which was built on an artificial island [Example 17] as well as the harbour terminal in Jokohama designed by Foreign Office Architects.

The set of implemented objects of aquatic architecture includes many cases in which technical challenges were the aim of the investment or the consequence of implementation. Aquatic objects built both on the land and waterfront do not constitute such a big technical challenge as objects implemented in the water environment. This relation indicates the interest of designers in eccentric locations for contemporary architecture. Such visionaries perceive water as an area where technical capabilities can be manifested.

Natural water reservoirs and flows in the environment are perceived as obstacles to transport and circulation or are considered to be an element of variety in the scenery. An engineering approach to this issue leads to the perception of water as a challenge. Bridges are the structures which have been inseparably connected with water and have been created practically in each culture and environmental conditions. Overcoming of the so-called water obstacle has been the subject of many elaborations produced by both engineers and architects. That resulted in important spatial solutions. Taming of the element of water has been reflected in gigantic structures built using the knowledge and expertise of hydrotechnical engineering. Natural expression and impact of such objects on the environment do not generally result from the sole activities of architects. Facilities of this kind are designed by experts on hydrology, geology, building engineering and assessed by the engineers of environmental engineering. However, the simplicity of formal solutions subjected to the function of crossing an obstacle creates solutions characterized by elegance and lightness, like the bridge designed by Mira Riveira in Texas, which juxtaposed with water reveal individual expression (**Finkel P**. 2006).

The bridge belongs to one of the most expressive contemporary structures and constitutes both an architectural and engineering challenge (**Lewandowski M**. 2006). It is a common ground of engineering, architecture and natural environment. Water as an obstacle becomes the reason for building these massive monuments of contemporary engineering. It also involves various emotions (**Krzechowicz G**. 2007). Not only the overcoming of space in terms of length is important. Designers of bridge structures often seek innovative solutions to overcome the issue of the bridge span. The application of various innovative shapes leads to the creation of bridges having individual and unique forms. Designers apply different innovative elements in order to address the challenge of creating an uncommon and exceptional way of crossing a water obstacle, such as *Erasmus Bridge* by Ben van Berkel in Rotterdam[2], *Gateshead Millennium Footbridge*

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[1] https://static.kunstelo.nl/ckv2/ckv3/utopia/luchao/UrbanPlanet_org%20%20The%20Luchao%20Harbour%20City.htm 22.10.2022

[2] http://broer.no/bro/b/b4_2.jpg 22.10.2022

by Wilkinson Eyre and Gifford & Partners [Example 13], *Millennium Bridge* by Norman Foster[3] and bridges designed by Nicholas Grimshaw[4], Santiago Calatrava[5] and many others.

In spite of typical technical engineering problems, the participation of architects in the creation of such structures is considerable. The most renowned contemporary architects, such as Norman Foster, Santiago Calatrava, Nicholas Grimshaw, take pride in designing bridge crossings. This fact is also confirmed by the example of *Webb Bridge* in Melbourne designed by an international designing office Denton Corker Marshall[6].

Bridges are as old as mankind. The most basic water crossings of primitive people were of a solely functional character. Static diagrams of such crossings are still relevant although their form underwent evolution. From the period of antiquity to the time of industrial revolution, bridges were built in an arch or beam form, as a wooden truss or a suspension footbridge. Architects of the previous epochs almost competed in decorating the constructions and providing them with artistic expression (**Niemczyk E.** 2002a). One can mention here the following bridges: Ponte Milvio in Rome, Ponte Sant'Angelo in Rome and Pont Neuf in Paris. Venice built the bridge Ponte Rialto, which was determined by other utility functions, whereas Florence constructed Ponte Vecchio[7]. There are also other famous historic bridges, such as Anji Bridge in Zhandzou, Pont St. Martin in Aosta or Alcantara Bridge in Spain as well as Pont St. Benezet in Avignon[8] , which have a simpler, solely functionalistic form and are thus more appealing to contemporary aesthetics. The importance of bridge structures to civilization is visible in their noble names and decorations. These structures have always been a manifestation of technical and artistic capabilities (**Perino A.S., Farragiana G.** 2004).

The use of steel in the construction of bridges, which began in the 18th century and lasted till the end of the 19th, led to the construction of bridge crossings of extensive parameters over water obstacles. The most significant bridge structures of those days are: suspended Menai Bridges in Great Britain, Pont de la Caille in Haute Savoie in France, Szechenyi Bridge in Budapest, Brooklyn Bridge with stone-iron structure and chain curve suspension, arch-string bridges such as Britania Bridge in Wales, Eads Bridge in St. Louis in the USA, Viaduct de Garbait in Saint-Flour, Cantal in France. Iron bridges of mixed structure, such as Tower Bridge in London, Forth Rail Bridge in Edinburgh or the bridge of Alexander III in Paris. All of them present technical capabilities which were put into practice at the implementation of the bridges on the site of crossing water obstacles, which had been an inspiration to build the above-mentioned structures (**Perino A.S., Farragiana G.** 2004).

The 20th century continued overcoming obstacles connected with water by means of steel arch structures and suspension structures, however, new challenges arose due to the application of concrete. The developing technology of reinforced concrete contributed to the construction of concrete arch bridges, such as Salignatobel in Graubunden in Switzerland. A characteristic feature of contemporary times is undertaking challenges of building the longest possible bridge crossings.

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[3] https://farm3.staticflickr.com/2551/5717252013_54c1d02e02.jpg 22.10.2022
[4] http://upload.wikimedia.org/wikipedia/commons/d/dd/Enneus-heermabrug.jpg 22.10.2022
[5] http://upload.wikimedia.org/wikipedia/commons/6/67/Puente_de_lusitania.jpg 22.10.2022
[6] http://www.dentoncorkermarshall.com/projects/webb-bridge/ 22.10.2022
[7] The foregoing historic bridges were mentioned in Study but were not included in the computations concerning contemporary architecture. Their sheets are not shown among sheets in Annex 1 at part 1.
[8] Ibidem.

The development of building engineering techniques as well as application of mixed materials create favourable conditions for that. Such solutions make use of the best technological properties in places which require that. Structures using compressed concrete were developed. The first half of the 20th century witnessed the construction of: *Harbour Bridge* in Sydney and *Golden Gate Bridge* in San Francisco. These bridges were not situated on the site of the narrowest water crossing, but in places crucial to the circulation and transport, including the sea bays. In this way water became the challenge undertaken by the creators of these structures (**Perino A.S., Farragiana G.** 2004).

The second half of the 20th century met the challenges connected with the length of the crossing as well as attempts to show the beauty of the sheer structure of bridges. Architects undertook the interpretation of the structure of water crossing. The length of bridges is impressive, such structures as the Maracaibo Bridge in Venezuela and the Verrazano-Narrows Bridge in the USA were constructed.

The bridges of Santiago Calatrava in Merida, Spain, over the river Guardiana as well as La Mujer Footbridge in Buenos Aires[9] present how the architectural staffage may make a simple structural form more attractive. This approach is continued by the bridge Puente de la Barqueta in Sevilla[10] or Pont de Normandie in Le Havre. A pragmatic form of the bridge structure, which is simplified to a minimum, is visible in and characteristic of the Millau Viaduct in France designed by Norman Foster, the Rion Antirion Bridge in Greece[11] and the Tsing Ma Bridge in Hongkong[12]. Expression of structural forces on the borderline of technical capabilities is a unique spatial value and a strong point of these implementations.

An aesthetic, formal and plastic approach to bridge structures can be found in the works by Cezary Bednarski (**Schwab D.H.** 2002). He treats the river crossing as an opportunity to develop a spatial culture of a place, for instance the bridge of *Lansisatama Katu* in Helsinki[13] or a symbol or even a gesture of cultures or religions, such as 'inhabited bridge-garden' in Rome (**Bednarski C.** 2002b). In the creator's opinion, a bridge may be an element of urban-planning intervention healing the tissue of the city (**Bednarski** 2002a).

An approach to the water crossing as a place of possibilities of shaping a new architectural form can be noticed in the structure designed by Nicholas Grimshaw in Amsterdam - Enneus Hermabrug (**Bukowy C.** 2002) or in the bridges of Cracow (Kraków) – the *Kotlarski Bridge* and the *Zwierzyniecki Bridge* (**Motak M.** 2002) as well as in the bridges of Warsaw (Warszawa) – the *Świętokrzyski Bridge* and the *Siekierkowski Bridge* (**Kaczorowska M.** 2002, **Pulkkinen P**. 2001). The designing of a bridge which precisely satisfies local circulation needs as well as spatial and crossing conditions is the main objective in the design-decision-making process (**Gadomska B**. 2001).

A number of bridges built in the late 20th century makes it possible to ascertain that those days witnessed easiness in overcoming water obstacles. Japan constructed a dozen or so bridges

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[9] https://en.wikipedia.org/wiki/Puente_de_la_Mujer#/media/File:Puente_de_la_Mujer_by_night_(7565437534).jpg 22.10.2022

[10] https://structurae.net/en/structures/barqueta-bridge 22.10.2022

[11] https://greekreporter.com/2017/08/13/rio-antirrio-bridge-13-years-since-the-engineering-marvel-transformed-western-greece/ 22.10.2022

[12] https://thewondrous.com/wp-content/uploads/2010/07/Jiangyin-Suspension-Bridge.jpg 22.10.2022

[13] http://studio-bednarski.com/images/HELSI/01_Helsinki.jpg 22.10.2022

joining the islands of Honsiu and Sikoku in the form of three crossings. The sea and close economic relations between Scandinavian countries resulted in the construction of the bridge over the Great Belt strait, the Oresund Bridge between Denmark and Sweden[14]. The aesthetic use of shrouds or cables created the forms of the Lerez Bridges in Ponteverda in Spain, the Erasmus Bridge in Rotterdam and the Vasco da Gama Bridge in Lisbon. A modern architectural approach to the river crossing can be seen in the Millennium Bridge designed by Norman Foster in London, the Solferino Bridge over the Seine in Paris[15] or in the 'Blinking Eye' bridge – the Gateshead Millennium Footbridge in Newcastle (**Perino A.S., Farragiana G**. 2004). In London, the Thames Barrier was built on a reinforced construction in the Thames' river bed designed by Rendel, Palmer and Tritton[16]. Apart from a crucial hydrotechnical role, this structure plays a role of a spatial landmark thanks to its unique architectural form. It is also an example of taming a water obstacle and the regulation of its impact on the human living environment.

The foregoing implementations show how a challenge such as a water obstacle may generate the creation of imposing spatial forms. The structures created by constructors, who were aided by a growing number of architects, decide on the image of our civilization and constitute symbols of contemporary technology and engineering. These works make up a set of contemporary architectural objects which came into existence due to meeting the challenge of overcoming water obstacles.

Location on the waterfront

The very location on the edge of a water basin provides architectural objects with aquatic features. A bank, shore, strand, beach, *waterfront* are terms which describe an important location for a group of architectural objects of an aquatic character. Waterfront and architecture located there is a subject that has been extensively described. It specifies building development in such places. (**Januchta-Szostak A**. 2009 to 2011), (**Dudzic-Gyurkovich K., Gyurkovich M**. 2008). Spatial and functional relations of the facilities located on the *waterfront* provide them with prestige and make it easier to achieve individual spatial effects. The buildings implemented in such a place, irrespective of the quality of their architectural solutions, are attractive thanks to a close visual contact with the natural environment represented by a water basin (**McGuire P.** 1998). The values and uniqueness of the location on the waterfront was used by the design office Behnisch and Partner in the architectural contest for a concert hall in Bristol. Instead of presenting a ready-made and closed spatial concept, the designers decided to present only capabilities of such facilities and remained open to investor's suggestions in the spatial context of a place and function. This strategy, which highlighted solely the attractiveness of location, was crowned by success and the building was implemented by this design office (**Jones P.B.** 1998).

A strong impact of the sea *waterfront* has been an inspiration in designing residential, holiday and hotel buildings with the sea view. The single-family building Haus H. designed by Ernst Bender is located on the embankment of Lake Aussee. Its internal space was shaped in such a way as to make the surface of the water be the continuation of the rooms. Swimming pools which are implemented in such facilities are shaped in such a way as to visually extend the sheet of water in the pool by the surface of the sea water. A building constructed on the river Spree,

[14] http://tenspeedhero.com/wp-content/uploads/Bridge_3.jpg 22.10.2022
[15] https://en.wikipedia.org/wiki/Passerelle_L%C3%A9opold-S%C3%A9dar-Senghor#/media/File:France_Paris_Passerelle_Solferino_02.JPG 22.10.2022
[16] http://en.wikipedia.org/wiki/ Thames_Barrier 22.10.2022

in the river bend, namely Paul Lobe Haus designed by Stephan Braunfels[17], is one of many examples of the architecture of the so-called *waterfront*. The architecture of the Guggenheim Museum in Bilbao designed by Frank Gehry also takes into consideration close relationships with the neighbouring water basin.

On the shore of a natural island, there is a resort Soneva Fushi in the Maldives designed by Sonu and Eva Shivdasani[18]. The purpose of this object was combined with the exposition of the qualities of a close relationship of water and architecture.

Architectural objects implemented on the waterfront attempt to draw community activities close to the water. An example of such implementations may be the building of the Copernicus Science Centre[19], whose aim was a symbolic 'turning' of Warsaw towards the river. The development of the *waterfront* and turning the city towards the river or another water basin constitutes an essential urban-planning issue included in this design. Waterfront areas in many cities witness the implementation of exceptional and unique objects having stately and cultural functions. Such an example is the Royal Opera House in Copenhagen[20], whose characteristic silhouette is a perfect match for the waterfront development, or the Hyogo Prefectural Museum of Modern Art designed by Tadao Ando. The river banks in the city centre constitute an attractive place for residential and commercial purposes as well as recreational ones. In the case of the Copenhagen Harbour Baths (*Havnebadet Islands Brygge)*, designed by BIG + JDS Architects[21], a symbiosis may be observed between the developed waterfront and the space on and over the water. Easiness of establishing spatial relations between the developed urban space and the water basin results in the creation of architecture set in the water. This issue is separately analyzed in this monograph. The development of sea shores and river banks often takes a form of complex systems combining architecture and environmental conservation, as can be seen in a new strategy of the riverside development of the Thames.

The advantages of the location in the vicinity of water are used in the regeneration of deserted areas. The alteration of the purpose of post-harbour areas may result in the creation and implementation of new spatial structures, such as *Port Vell* in Barcelona[22]. Innovative waterfront structures have not only a formal dimension but often play an important role in creating the community centres. They become a space that creates an image of the city, as it is in the case of the above-mentioned Opera House in Copenhagen or in the so-called Hafencity in Hamburg. Seaside promenades are one of the most attractive places in the cities. Creating a unique image of the city starts from the *waterfront*.

Due to a changeable level of water, the buildings and facilities existing both in the water environment as well as on land are called amphibious architecture. The term 'amphibious' comes from Biology and defines organisms which lead 'double lives' (amphi from Greek means 'both', whereas bios means 'life') in water or on land. It means an organism or a vehicle that can move on land and in water (**Kopaliński W**. 2007). Such objects combine the features of typical land

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[17] http://www.braunfels-architekten.de/#/projekte/auswahl/ausgewaehlte-projekte/paul-loebe-haus-berlin/ 22.10.2022

[18] http://www.soneva.com/soneva-fushi/ 20.09.2022

[19] https://www.warbud.pl/pl/realizacje/d-152-centrum-nauki-kopernik, Authors J. Kubec, M. Gilner, M. Tomanek, Z. Bujniewicz. 20.09.2022

[20] https://en.wikipedia.org/wiki/Copenhagen_Opera_House 29.10.2022

[21] https://www.archdaily.com/11216/copenhagen-harbour-bath-plot 29.10.2022

[22] https://pl.wikipedia.org/wiki/Port_Vell#/media/Plik:Port_Vell,_Barcelona,_Spain_-_Jan_2007.jpg 29.10.2022

implementations with the qualities of floating structures or structures set in the bed of water flows or basins. Several types of construction of amphibious architecture may be distinguished on the basis of methods ensuring proper functioning. In the first type, a foundation is made which has such a cubic volume as to ensure that a rising level of water hydrostatically pushes upward the weight of the building, as in the Archimedes' principle. Such buildings are secured on vertical guideposts allowing the building to slide up and down. The posts are driven into the bottom or set by means of a solution called 'a pool in a pool'. They rise and fall onto the same place. A building by BACA Architects implemented on the river Thames can serve as an example[23]. Another method makes use of mechanical equipment to raise and lower the object in case of rising waters in the surroundings[24]. A behavioural solution consists in the migration of users onto higher floors in case of rising water levels. This type of a building is set high enough to function without the contact with the ground in case of flooding.

Amphibious architecture is one of the solutions to the issue of reducing the aftermath of floods or freshets. The feature of being amphibious is not always exhibited by means of special architectural forms. It is achieved solely thanks to the applied technical solutions which enable the object to function at a changeable water level of the neighbouring water basin.

Location in the water space

Water takes such a place in space which is usually perceived as an element of the natural environment. This particular space is defined by means of the borders of a water basin and naturally extends above and below the surface of water. The construction of facilities at the bottom of water, on stilts, near the shore or in the shallows is a way of entering the water space. There are places in the world where the expansion into water is the only possible direction of development. Building in water has had a long tradition in regions where the location on land is not possible. For instance, in the mangrove forests of Indonesia, buildings are set on stilts in the sea. Such structures are easier to make and provide better living conditions. In other cases, the reason for the location of buildings in water is the necessity of developing urban structures. Sometimes, it is the desire to make an artistic installation, a manifesto or to increase the attractiveness of the work. Buildings are often situated in the area of waters due to functional reasons. Such locations serve well the purpose of transport and circulation facilities, recreational facilities, objects specializing in mining raw materials, such as the *Troll* platform off the coast of Norway and others. In this way, implementations typical of land development are transposed over water and therefore the space above the surface of water becomes a part of the built environment.

Construction in or on the water, irrespective of the causes of such a decision, has an element of originality in its character. Buildings in such locations are distinctively noticeable in the spatial structure. The expansion of buildings towards water, such as Dutch building development towards the sea, initially consisted in drying the sea by building dams and reclaiming the area on the sea bed. Many places, however, are not suitable for this kind of expansion into the water environment. That is why it is attempted to build facilities over the water, situated on artificial islands set in the bed of shallow water basins or on stilts fixed in the sea bed. This type of construction has a lesser impact on the environment than draining. It has ecological values.

[23] https://www.construction21.org/belgique/case-studies/i/the-thames-amphibious-house.html 29.10.2022
[24] https://www.engineeringforchange.org/solutions/product/lift-house/ 29.10.2022

The Museum of Art in Groningen, designed by Coop Himmelb(l)au[25], constitutes an example of an implementation built on stilts. This group includes also buildings being art objects, such as *Aqua extrema* prepared for the World Exhibition in 2002 in Neuchatel in Switzerland, designed by Gruppe Mulipack[26] as well as the Museum and Art Centre *NORVEG* in Rorvik in Norway by Gudmundur Jonsson. The so-called *Blur Building* designed by Elisabeth Diller and Ricardo Scofidio [Example 2] was constructed as a temporary building during World Exhibition 2002 in Switzerland in the city of Yverdon les Bains. It was also built over the water surface of a lake like Katrup Sea Bath in Denmark, situated in water, designed by White Architectur AB[27]

The Hotel in Neuchatel designed by Kurt Hofmann[28], the Medienhafen office building in Düsseldorf by the JSK Architekten as well as the Universum Science Center by Thomas Klumpp are examples of architectural objects constructed above the surface of water on stilts fixed in the bed. Similarly, the *San Carlino* implementation by Mario Botta[29] is deprived of aquatic features except for the location. The building situated in the water near the shore, set in the bottom, could have easily been built in a different place not necessarily in the vicinity of water. An attractive and provocative location is the only way water influences the spatial form of this object.

Setting of the building on stilts fixed in the sea bed is the most popular method in recreational resorts. The facilities of the highest class, which are built on islands and atolls, feature must-have structures on stilts in the shallows close to the best luxury suites. This type of housing development, designed by Richard Hywel Evans, can be seen in *Zil Pasyon Spa Resort* in the Seychelles[30]. In such places, the setting of the structure over the water on stilts fixed in the sea bed seems only natural and constitutes a specific entrance of the architectural space into the natural environment. Apart from considerably big attractiveness of such solutions, they do not interfere with the natural environment on a big scale in comparison with other methods.

Artificial islands shaping the surface of the sea, such as *The Palm Islands* in Dubai[31] designed by Al Nakheel Properties, are covered with residences that have no other features connected with water than water proximity. These objects could also exist in the landscape deprived of water. All buildings have swimming pools, however, that makes a standard in this region. The housing estate of *Water Villas* in the Netherlands, designed by UNStudio[32], is an establishment revealing some aquatic features solely thanks to its location. Leaving out certain attributes, such as a pier for mooring motor boats, these buildings could exist in other unrelated-to-water locations. The *Terminal Kansai International Airport* on the waters of the Osaka Bay in Japan, designed by Renzo Piano, as well as *International Port Terminal* in Jokohama, implemented according to the design of Foreign Office Architects[33], are objects constructed on artificial islands and have functions transposed from land over water. A common feature of

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[25] https://coop-himmelblau.at/projects/groninger-museum-the-east-pavilion/ 29.10.2022
[26] http://en.wikipedia.org/wiki/Expo.02#mediaviewer/File:SwissExpo02-Neuchatel.png 29.10.2022
[27] https://www.archdaily.com/2899/kastrup-sea-bath-white-arkitekter-ab 29.10.2022
[28] http://www.palafitte.ch/en/home.html 29.10.2022
[29] https://www.archdaily.com/917254/san-carlino-mario-botta-architetti 29.10.2022
[30] http://six-senses-zil-pasyon-mahe-island.seychelleshotel24.com/pl/ 29.10.2022
[31] https://adventure.howstuffworks.com/dubai-palm.htm 29.10.2022
[32] https://www.unstudio.com/en/page/11809/water-villas 29.10.2022
[33] http://www.archdaily.com/554132/ad-classics-yokohama-international-passenger-terminal-foreign-office-architects-foa/ 29.10.2022

buildings located in the water environment without the subjugation to water is the confirmation and presentation of the possibility of transferring the qualities of typical architectural objects into the water environment.

Water Houses designed by TANGRAM Architekten make up a housing estate on the Danish coast, which consists of nine double-family houses set on stilts in the water. The buildings of *the Sphinxes* in Huizen near Amsterdam, designed by Neustelings Riedijk Architects[34], are residential buildings set on stilts driven into the lake bed, similarly to the implementation of *Silodam* by MVRDV Group [Example 15][35], therefore their aquatic character results solely from the location of the buildings. Residential housing built in the spatial area of water is popular in the Netherlands due to geographical conditions and a tendency to select the most attractive locations like water and *waterfront* for living (**Gronostajska B.E.** 2008).

The location on the waterfront and the internal function of the oceanarium in Lisbon, designed by Peter Chemayeff and Cambridge Seven Associated[36] are the only aquatic features of this building. Similarly, the spatial solutions of the Naval Museum in Karlskrona in Sweden, designed by Henderus Malmstrom, do not have any associations with water, except for the building's location and a tunnel for visitors, which is situated under the building and is one of the tourist attractions (**Miles H.** 1998).

An object which is situated in the river is the Mur Island (Murinsel) on the river Mur in Graz in Austria, implemented on the basis of the design by Vito Acconci. Building on and in the water has become a current trend and direction of architecture. Water has become a significant element shaping architectural space (**Fischer J.** 2008). An object which is built also on an artificial island is the hotel Burj al Arab in Dubai, designed by Tom Wright, [Example 04]. Apart from a water basin proximity, this building has additional aesthetic features causing associations with nautical forms. The form of the building reminds of the elements of sails (canvas), masts and a yard - typical of the structure of vessels. Architectural implementations bringing associations with nautical building engineering may be successfully classified into the set of aquatic architecture as one of the most remarkable and expressive examples.

Due to the fact that land development takes up more and more new sites and approaches water, the necessity arises for people to build on the surface of water. To serve this purpose, floating buildings were applied, which turned out to be an effective solution. Housing development of water spaces in the cities may prove profitable for their spatial and economic growth. The sites of construction of such architectural objects are rivers and lakes, initially free of any buildings. New places of architectural implementations come into being (**Bujniewicz Z., Kołodziej A**. 2011, **Graovac** 2007, **Haduch B**. 2002a, b).

A characteristic feature which distinguishes floating houses from houseboats (barges) or cruiser boats is the application of architectural means of expression and the building structure similar to facilities built on land (**Fischer J.** 2008, s. 110). Many examples of modern architecture have been built as floating housing development. Such implementations feature the foundations constructed in a form of chambers made of watertight concrete having such cubature that allows

[34] https://neutelings-riedijk.com/lakeshore-housing-the-sphinxes/ 29.10.2022
[35] Square brackets include references to the cases analyzed in detail in Chapter 2.
[36] https://commons.wikimedia.org/wiki/File:Lisbon_Oceanarium_(39808601264).jpg 29.10.2022

the building to float on water. The roof coverings are made analogically to the roof slopes made on land. The same applies to walls, which are constructed using technologies typical of land building engineering. One of the examples of floating architecture is *Floating House* designed by MOS Architects in Canada, on Lake Huron [Example 01], mass-produced facilities in Cologne, Germany, designed by Friedrich Schiffswerft, or a floating single-family house, designed by Forster Trabitzsch on water in Hamburg due to the lack of free space on the shore. Herman Herzberger designed a floating house in Middelburg in the Netherlands[37], X-Architects and Leen Vandaele built a floating house in Dubai[38].

The term SPA is derived from a saying used in ancient Rome: Sanus Per Aquam, which means 'healthy through water' (Latin-Polish or Latin English dictionary). Nowadays, it functions with relation to the architecture including recreational functions connected with water and warmth. The word SPA itself, especially in daily speech, is also extended over beauty treatments and other cosmetic services. Derivation of this word from the name of a Belgian city Spa under Roman protectorate seems rather improbable. In Wolfsburg in Autostadt, a recreational centre, the so-called SPA, was built according to the design by Max Wehberg[39]. The spatial structure of the spa is based on the floating foundations. A swimming pool in New York, in Brooklyn, designed by Jonathan Kirschenfeld Associates and *Badeshiff*, bathing facilities on the river Spree in Berlin, designed by Gilbert Wilk and Susanne Lorenz[40] as well as a swimming pool designed by Robert de Busni on the river Seine are well-known examples of swimming pools floating on the surface of water.

Another example of a swimming pool on water is a Paris implementation by the architect Robert de Busni. A seemingly ordinary floating swimming pool conveys additional meaning – the fulfilment of the Parisians' dream of all-year-round bathing in the Seine (**Place J.M.** 2005a). The pool water is drawn directly from the river and then purified to the state of cleanliness of drinking water. Also in London, a concept of bathing facilities on the river Thames was implemented according to the design by Lifschutz Davidson. The location of the swimming pool on the water seems to be the best combination of an artificial utility space with the natural environment (**Slessor C.** 1998).

Concepts of floating commercial and service facilities are becoming more and more popular. They include the design of the stadium by Peter Knoebel, called Offshore Stadium – the Vision of Football World Championship FIFA 2022 as well as *Big Foot* – a floating stadium of American football in Santa Monica, designed by Heneghan Pen Architects. Football pitches, which were implemented on a smaller scale, are located in the harbour bay in Singapore and on the river Danube in Vienna.

The concepts of floating facilities containing residential and multifunctional architecture take a form of mega-structures. This phenomenon can be observed on the examples, such as a floating building of Hydrahouse designed by the Office of Mobile Design from Los Angeles and Physalia – a floating island[41]. Some of these concepts, like the Adriatic Hotel designed by

[37] https://www.architecturalrecord.com/articles/12262-watervilla 29.10.2022
[38] http://www.archdaily.com/13699/houseboat-x-architects/ 29.10.2022
[39] https://www.studio-wehberg.de/de/details/spa-volkswagen-autostadt-gmbh.html 29.10.2022
[40] https://arquitecturaviva.com/works/piscina-flotante-en-el-rio-spree-6 29.10.2022
[41] https://pl.pinterest.com/pin/an-amphibious-floating-garden-that-purifies-the-water-the-physalia-if-its-hip-its-here--661677370222667555/ 30.10.2022

Ivan Filipovic[42], have a greater chance of implementation than others. Objects of an experimental scale, such as *Spaceframe* designed by N55 , have been implemented so far.

Among architectural objects floating on water there is also: a prison on the river Rikers in New Orleans, an office building in Houthavens in Amsterdam, a football stadium in Gandsfjord in Norway, designed in a conceptual phase by Snøhetta & Sandnes, and Monolith by Jean Nouvel[43] – the only aquatic feature of these objects is their location.

The developed concepts and attempts of implementation of architectural objects in the water space show a great potential which is concealed in aquatic architecture. The facilities designed on water may perform a function of a supplement of urban tissue; they may also be movable objects providing sports services at changeable venues during cyclical events.

Legal issues constitute a serious problem in the case of implementations of designed objects in the area of water (**Kazimierczak I., Zaremba K.** 2013). Construction on the surface of water of a floating object is subject to the law of navigation and the law of water resources, not to the building law[44]. Taking into account the foregoing, some architectural solutions are impossible, therefore there is a necessity for the adaptation of the conceptual layer of the design to the regulations concerning navigational vessels. Architectural forms of floating buildings and facilities are sometimes a response to the environment of their future implementation, they are full of nautical associations or adopt the style of land-based objects but are only located on water.

The analysis of architectural implementations in which water performs a function of environment resulted in the formation of a separate subject matter of underwater housing development. The concepts and implementation attempts of underwater constructions create a new area for architectural facilities. The conditions of novel implementations in the unknown underwater built environment constitute the subject of deliberations presented in Chapter 4 and are one of the objectives of this monograph.

[42] http://www.archdaily.com/148154/navigating-adriatic-hotel-ivan-filipovic/ 30.10.2022
[43] https://www.a-n.co.uk/media/52475473/ 30.10.2022
[44] The lack of valid legal regulations described in detail by I. Kazimierczak and K. Zaręba (2013) as well as the lack of typical technical solutions are factors which have been introduced as weaknesses into the SWOT analysis in the further part of this monograph.

1.2. Determinant of the object's purpose

There is a group of buildings and facilities which were constructed with the purpose of using water and the water itself forms their chief functional element. These are objects whose existence would make no sense if they were deprived of the attraction such as water (**Adamczak. M.** 2007). In this architecture several subsets may be identified: swimming pools, water parks, aquaria or oceanaria, yacht marinas and the like. Due to the ways of using water and its properties, the following objects have been distinguished:
– sports and recreation,
– transportation,
– scientific,
– therapeutic,
as the most characteristic in order to present a determinant function of water in architecture.

Sports and recreational facilities

Sports and recreational functions are performed by objects such as the simplest outdoor swimming pools, through more complex indoor swimming pools, and then the most complex recreational facilities called water parks (aqua parks).

Natural swimming pools

Architects weave water into various designs and they do it in many different ways, most often these are artificial water reservoirs. Natural swimming pools are constructed due to various reasons (**Feierabend P**. 2003), however, the most important is the desire to imitate nature.

Natural swimming pools are a manifesto of ecological and holistic perception of nature and such a message is sent by these implementations. They encompass forms similar to natural ones which can be observed in the natural environment, such as: grottos, mini bays, rocks and waterfront greenery. A natural swimming pool designed by K. Norton in Indian Wells in California may be a good example of such an implementation[45]. Apart from a decorative function and the manifesto of an ecological approach, the natural swimming pool most often performs recreational functions. Natural swimming pools should be differentiated from small lakes, ponds and small garden ponds.

The constructed swimming pools are natural. They imitate the realities of the natural environment and their aesthetics, however, they make use of the technologies maintaining cleanliness of the water and insulating it from the ground. Such natural swimming pools are located next to residential buildings and garden pavilions. They are somehow interwoven into the natural fabric of landscape.

Another subset of swimming pools includes objects which are closely connected with a form of the building and their character can be described as 'swimming pools of architectural type'. Their unity with the building structure is revealed in their direct formal impact on the architectural space. Water reservoirs in these solutions often constitute the main compositional element and their edges are made from materials analogical to the ones used in the building's structure, for

[45] Baldon C., Melchior I. & Levick, M. (1997) Reflections on the pool. California designs for swimming. Rizzoli, New York, pp. 38-41

instance a swimming pool in San Diego designed by J. Lautner[46]. The water is confined and shaped by means of forms or solids bringing unambiguous associations with the built environment. Water becomes a continuation of the sphere of buildings and an additional material shaping the character of architectural space, as in the case of a swimming pool designed by Kengo Kuma in Atami in Japan[47]. A different type of 'architectural swimming pools' are ornamented swimming pools (**Baldon C., Melchior I.** 1997). A solution of this type can be seen in a swimming pool in a five-star smart skyscraper the Central Plaza in Kuala Lumpur in Malaysia, designed by T.R. Hamzah & Yeang. The water has been shifted to the background due to aggressive competition of patterns and architectural forms. Ornament of the bottom of the swimming pool dominates the expression of water.

Irrespective of a natural or architectural type, such swimming pools (located close to the house) often play a role of training facilities. The performance of swimming activities requires the application of an elongated form of the water reservoir of around two metres in width and from approximately ten to a dozen or so metres in length. A form determined by its recreational function becomes a distinctive element of space.

Swimming pools of an *infinity* type (**Kuc S.** 2013, **Canizares A**. 2006), constructed in residential and commercial buildings, are characterized by the application of view openings onto the surrounding scenery. Apart from usual provision of attractive views, a technical trick is used, namely the lowering of one of the edges of the swimming pool. The main rule is that the lowering which makes the overflow of the tank should simultaneously be the opening to the view stretching over the surface of the swimming pool water in the direction of a natural water reservoir, like in Ponta del Sol on Madeira in Portugal, designed by Tiago Oliveira[48]. The optical combination of the pool water with the natural water has impact on the swimmers' perception creating an optical illusion of bathing in a much bigger and natural reservoir (**Baldon C.**, **Melchior I**. 1997).

Various needs and requirements of swimming pool users make designers create new types of such facilities. There are swimming pools adapted to diving, jumping and plunging or passive recreation. The construction and implementation of swimming pools should be carried out in compliance with the planned way of use. Pools for passive recreation or therapeutic pools should have a safe depth, adequate facilitation of the entry and a proper shape of the edge line or shoreline. Pools suitable for jumps must have a proper depth and size of the water surface enabling safe and efficient use. Particularly the depth of the diving pools should be adequate to the planned activities (**Bujniewicz Z.** 2015). Recreational functions of swimming pools are enriched with specialist equipment of water attractions, such as water slides, bowls, cascades, etc., where the users look for extreme sensations.

Swimming pools

Water in swimming pools which meet certain cubature requirements serves the purpose of sports training and recreation, and thus determines the functioning of the pool. Swimming pools being the facilities of sports disciplines and recreation are defined in the regulations of the Polish Swimming Association (PZP)[49] as well as in the guidelines of the Ministry of Sport and Tourism.

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[46] Baldon C.,Melchior I. & Levick, M. (1997) Reflections on the pool. California designs for swimming. Rizzoli, New York. pp.150-153.

[47] http://kkaa.co.jp/works/ architecture/water-glass/ 30.10.2022

[48] https://sayyestomadeira.com/hotel-estalalagem-da-ponta-do-sol/ 30.10.2022

[49] PZP – Polish Swimming Association - Polski Związek Pływacki; Source: http://www.polswim.pl/ as of 24.07.2015.

The required parameters make it possible to hold competitions in accordance with international regulations as well as do active recreation.

Basic types of swimming pools serving the purpose of practising swimming sports in association with the FINA[50] are as follows:

1. training and recreational swimming pools of the dimensions of the pool 16.67 x 8.5 m for training, learning how to swim and recreation;
2. swimming pools[51] of the dimensions of the pool 25.0 x 12.5 m for national competitions and possibly a higher rank by consent of the Polish Swimming Association (PZP);
3. sports swimming pools of the dimensions of the pool 25.0 x 160 m for national and international competitions as well as training, recreational swimming and learning how to swim;
4. olympic swimming pools[52] of the dimensions of the pool 50.0 x 25.0 m serving the purpose of world olympic games and championships, sports training and recreational swimming;
5. swimming pools for jumps, water ball and synchronic swimming.

Precise regulations define the dimensions of swimming pools and swim lanes as well as the equipment (such as start-posts, turn ropes, pool elevators for the disabled, etc.). Moreover, methods of marking the swimming pool bottom and walls are also specified. An additional functional requirement in the swimming pool facilities is the auditorium, which is used during sports competitions. A number of places depends on the expected level of competitions. The olympic games auditorium is the biggest, however, it is often partly dismantled after the olympic competitions. Swimming pools constitute simple recreational facilities, including indoor and outdoor objects. However, maintaining the right temperature and the quality of water requires the application of complex water treatment systems in all cases.

Water parks

Groups of swimming pools providing recreational services constitute **water parks**. They contain various types of water attractions. Water space becomes the object of commercial exchange as the users pay fees for using water. In water parks around the water, there are many recreational facilities and services providing biological renewal (**Bujniewicz Z.** 2005a, **Bujniewicz Z., Bujniewicz-Adamczyk H.** 2007). Spatial solutions in water parks are of various character. Water as an environment has numerous meanings and this facilitates the creation of associations connected with the water environment. This results in the formation of synthetic recreational spaces such as thematic water parks (**Bujniewicz Z.** 2005b).

European Waterpark Association (EWA)[53] defined which object should be deemed a water park and which functional conditions it should satisfy. Water parks are extensive leisure machines, which offer far more than conventional indoor or outdoor swimming pools[54]. Apart from numerous

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[50] FINA Federation Internationale de Natation; Source: http://www.fina.org/H2O/ as of 24.07.2015.

[51] http://www.jeannouvel.com/en/projects/aquatic-complex-les-bains-des-docks/ 30.10.2022

[52] https://pl.wikipedia.org/wiki/Aquatics_Centre_w_Londynie#/media/File:London_Aquatics_Centre_interior_-_1.jpg 30.10.2022

[53] EWA (European Waterpark Association) is the biggest and the most active organization associating water parks in Europe. The membership is held by water parks from Germany, Austria, Slovakia, Sweden, Poland, Norway and Cyprus. 'EWA is an association of European outdoor and indoor water parks, therapeutic thermal baths, sauna complexes which guarantees the quality of such facilities' (**Melas S.** 2005). The experience and scope of activities of this association justifies the fact of using its classification as a frame of reference.

[54] https://aquapark.wroc.pl/pl 30.10.2022, Wrocław water park designed by Architekturbüro Horst Haag, Stuttgart

swimming facilities, water parks offer such attractions as water slides, rapid rivers, pools with waves, whirlpools and sparkling baths, etc. Usually, such objects also include sauna facilities, outside pools and restaurants. Also thermal baths, which specialize in biological renewal, have been qualified as water parks. Water parks may exist in the form of seasonal attractions or may be open all year round. Their character can be best defined by taking into consideration their purpose and facilities. There are four categories:

- sport. This category includes objects equipped with swimming pools not necessarily for professional sport training ,
- entertainment and attractions. These objects have an extensive programme of water attractions, such as slides, dedicated to play and active leisure, other than sport[55],
- therapy. A therapeutic character is ascribed to objects which provide the users with an extensive programme of biological renewal or in the case when such a complex constitutes the basis of the object functioning,
- relaxation and sauna. This category includes objects which have an extensive complex of saunas and other elements enhancing passive recreation.

Aesthetic values of water parks are achieved by means of decorative and architectural solutions. The character of the decorations and equipment influences users' mood, brings associations and stimulates their imagination. The applied artistic solutions of a unanimously defined concept of architecture and interior design, including decoration, may create an atmosphere of certain scenery[56]. There are different decorations referring to: civilization symbols, natural environment or geographical regions. In some cases, the decoration is limited to interesting artistic, visual and plastic solutions, the so-called designer's solutions, which do not imply any symbolic meaning.

Transportation facilities

A natural meeting point of water and land, the so-called waterfront, is often occupied by transportation facilities. On the borderline of these environments, boats are moored. Architectural objects built in such places serve the purpose of loading and unloading goods as well as the transport of passengers, whereas water plays a function of a circulation route. To provide services in the scope of water traffic, the facilities of water ports are constructed.

Water port (from Latin portus) is a place for a temporary stay of vessels, where the following activities take place: loading/unloading of goods, reception of passengers, supplementation of necessary supplies and products, servicing of vessels. Ports are equipped with a set of devices allowing vessels to moor as well as enabling the exchange of people and goods, execution of typical activities connected with the operation of vessels (technical maintenance, supplementation of supplies, removal of sewage and waste, refuelling, etc.). Ports may be adapted to the storage and transport of goods mainland. There are natural ports located at the mouth of a river, in a fiord, bay or lagoon, as well as artificial ports created by digging port pools, docks and constructing piers, breakwaters, etc. The construction of a port is done using caissons filled with stones, rocks, sand and cement and then fixed in the sea or river bed' (**Czajewski J.** 1996).

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[55] https://waterworldwaterpark.com/ 30.10.2022
[56] https://www.mayamare.de/ 30.10.2022

They include piers, jetties, marinas, river and sea harbours. The rules of the development of harbour areas in Poland are regulated by the *Law on the Marine Areas of the Republic of Poland and Marine Administration*[57]. Marina, a yacht port is 'a small or medium harbour (or a designated part of the port, i.e. a yacht basin) suitable for reaching the shore, mooring and stop-over of yachts and other small vessels. The area of port is sheltered from the open water with a breakwater, in a natural or artificial way'. Sea port is a 'type of water port located on the shore of an ocean, sea or marine internal waters of a given state. Such a port consists of water reservoirs and the adjacent land area as well as related infrastructure. It is a basic point enabling sailing, marine transport of goods and passengers' (**Mazurkiewicz B.** 2004).

The designated mooring space for vessels plays a significant role in the functioning of the city and its architectural structure. In many cases, such places initiate the process of creation of harbour towns, therefore the functions of transport and circulation of the water being in contact with land becomes a factor contributing to urban development. In the existing cities, port facilities are expanded or new harbours and marinas are created. In Hamburg, in the 'HafenCity', the newly rebuilt port quays, designed by the EMBT and called the Magellan's Terraces, constitute a new attractive part of the city. The function of water transport and circulation becomes an impulse for the formation of new urban spaces (**Bachman W., Bartels O.** 2005).

The conducted research took into consideration harbour facilities of various sizes, including: the port terminal in Jokohama, designed by Foreign Office Architects or Port Vell in Barcelona, designed by Pere Mateu, Joan Romero and Joseph Maria Serra. Among smaller havens one can enumerate *La Maddalena* – the facilities implemented on Sardinia, on the basis of Stefano Boeri Architetti's design[58] or *Nordwesthaus* – a marina with the seat of a yacht club in Port Rohner Fussach in Austria, designed by Baumschlager Eberle[59], or a port haven in Thessaloniki, designed by Giannikis SHOP[60].

The development of transportation and circulation functions often results in the creation of additional facilities (**Śmiechowski D.** 2004), for instance the Hotel *Marina Diana* in Białobrzegi by the artificial lake Zalew Zegrzyński, designed by APA Wojciechowski, Witold Dudek, Izabela Pietraszek-Kubicka, Michał Sadowski, Szymon Wojciechowski. BAR Architects, the authors of the Opera House in Copenhagen, took advantage of the location in an excellent way. Not only did they apply formal means to emphasize the spatial relations of the building with the water, but also provided access to the entrance from the water by water bus, using thus a transportation and circulation function of water (**Pastuszka Ł.** 2005).

Therapeutic resorts

A style of the contemporary living is characterized by rush leading to the exhaustion of the reserves of physical and mental strength (**Dawidowicz A.** 1978, **Gieremek K.** 2000).

[57] *of 21 March 1991* (Journal of Laws DzU of 2003, no 153, item 1502).
[58] http://www.archdaily.com/27417/ex-arsenal-at-maddalena-conversion-stefano-boeri-architetti/ 30.10.2022
[59] http://www.dezeen.com/2008/12/07/nordwesthaus-by-baumschlager-eberle/ 30.10.2022
[60] http://www.archdaily.com/186899/thessaloniki-water-transport-piers-proposal-giannikis-shop/ 30.10.2022

The surrounding conditions cause stress[61], which originally was a psycho-physical reaction preparing a human organism to escape or attack (**Alix K.** 1996). Nowadays, the growing burden of strain may be compensated using treatments of biological renewal[62]. An essential role is played by hydrotherapy. Elements of hydrotherapeutic treatments may be carried out in specially selected groups of devices and specially designed architectural complexes. Hydrotherapy requires the creation of proper forms, such as special buildings, equipment and furnishings. Water reservoirs dedicated to hydrotherapy and biological renewal should have carefully thought-out dimensions of the water surface and depth. The treatments should be performed in specially shaped rooms enhancing psychological effects of the therapy.

Water is the environment where both bathing and physical exercises may take place. These types of activities require the application of certain spatial solutions and the maintenance of particular thermal parameters. Pools for physical exercises should have a depth of approximately 80–120 cm. Water of different temperatures has impact on all systems of the human body. That is why therapeutic exercises should be done in the water having a temperature between 29–32ºC, whereas swimming pools should have a water temperature between 25–29ºC. Showers and sprays may use a whole range of temperatures and be applied to different segments of the body depending on the purpose.

Hydrotherapy takes advantage of the following properties of water:

– dissolution of therapeutic substances in water (elements of balneotherapy[63]),
– thermal properties, thermal conduction and accumulation,
– mechanical – connected with hydrostatic lift (buoyancy), static and dynamic pressure.

Chemical substances solved in the water may be absorbed by the skin, penetrate into the blood, be deposited in the epidermis tissue and directly on the epidermis surface. Gaseous additives into baths may be absorbed by the skin or mechanically work on the skin (**Straburzyński G.** 1997).

The fundamental task of water is a thermal regulation of the organism. It causes local reactions such as narrowing or expanding of blood vessels and it may cause a general reaction on a bigger area of the body which depends on the stimulus temperature (**Gieremek K.** 2000). Baths are one of the hydrotherapeutic treatments[64]. They are carried out in specially built basins of various sizes, from bathtubs to pools, with temperatures from cold water to hot one.

[61] It was already in 1964 that the research financed by the World Health Organization proved the following: if a stress reaction of the organism does not lead to physical activity, the organism is subjected to growing strain and psycho-physical overburden. It increases the strain of blood vessels and heart as well as long-term changes in the blood composition, breathing disorders and muscular tension.

[62] The most cited studies treat biological renewal as a process of comeback to physical efficiency at the starting level after considerable physical and mental stress as well as counterbalancing them with means and environmental conditions which actively enhance and accelerate the process of organism regeneration (**Jethon Z.** 1987).

[63] From Latin *balneum* – bath and *therapeja* from Greek – it is one of the most ancient branches of medicine. It uses water of different particular chemical properties for therapeutic treatments. It was discovered that the therapeutic application of water took place as long ago as several thousand years in India, Egypt and Mesopotamia as well as in ancient Greece and Rome. Contemporary balneotherapy was developed in the 18th and 19th centuries thanks to the first authors of scientific elaborations on hydrotherapy (including Vincent Priessnitz (1821) a precursor and supporter of hydrotherapy, phytotherapy and rational nutrition). The most famous figure is Sebastian Kneipp (1821-1879), who after 30 years of self-education in the scope of water therapy, published a book *My Water Cure*. In Poland, Jan Żniniewicz (1872-1952) was the pioneer of balneotherapy and the founder of a hydrotherapeutic establishment in the city of Poznań (**Drozd I.** 2014, **Korczak M.** 2014, **Straburzyński G**. 1997, **Adamczyk H., Bujniewicz Z.** 2015).

[64] Water treatments have a positive influence on the level of resistance of the organism and its metabolism (**Gieremek K.** 2000, **Podgórski T.** 1996, **Straburzyński G.** 1997).

Hydrotherapy acts also through mechanical stimuli. Water buoyancy is a significant factor in the rehabilitation of motor organs – it provides weightless environment for joints and ligaments enabling at the same time the application of load to muscles. Hydrostatic pressure is a special kind of therapy applied while bathing[65]. The movements of the body are counteracted by the forces of water cohesion and viscosity. While moving in the water, the body must overcome the resistance of water. This phenomenon has its application during the activity of swimming and therapeutic gymnastics.

Hydrostatic pressure acts on the user when the water is put into motion. Such solutions are often applied in public facilities by means of specially designed architectural elements. The therapeutic function of water is played very well by small pools with the so-called hydromassage, as for instance in the hotel *Watermark* in Brisbane, designer Bagot Woods.

A therapeutic role of water requires proper technical solutions in order to apply its mechanical, thermal, physiological and chemical properties. Such technical solutions are often implemented in the form of multi-functional complexes of facilities. Specially selected functional programmes enable the realization of therapeutic goals even in commonly accessible objects (**Adamczyk-Bujniewicz H.** 2015). Such multifunctional complexes are often called 'thermae' or thermal baths, especially if they are built on and take advantage of geological thermal waters, or water parks, etc. In order to provide extended therapeutical treatments in such multifunctional facilities, the so-called wellness[66] zones are created. Especially in hotel buildings and the like, the combination of sports, recreational and decorative functions with therapeutic functions often is the standard, as for instance in the hotel *Four Seasons* in Maui in Hawai, designed by Wimberly Allison Tong & Goo. In these cases, the application of water as decoration in the entrance space is just an invitation to using the object's therapeutic properties in specially designed zones located further on.

Objects with a well-developed therapeutical function are often located in spa resorts which thanks to the local climate create favourable conditions for health. Such objects may also have modern architectural appearance and contemporary spatial solutions, as for instance the Hydrotherapy Centre in Nałęczów, designed by Bolesław Stelmach and partners. The authors applied many contemporary artistic and plastic arts means to emphasize a therapeutic role of water and show hydrotherapy as a kind of ritual (**Kusztra M**. 2005). Similar modern means of architectural expression are used by Mateo Thun along with Baumann Zillich Architekten in Thermal Baths in Meran. The designers' interdisciplinary knowledge encompassing not only the fundamentals of building engineering but also physiotherapy constitutes the basis for the creation of therapeutic architectural facilities.

[65] In total immersion, the mechanical impact of water on the human body causes the following: decrease of the chest circumference, compression of soft tissues, increase in intra-abdominal pressure, facilitation of exhalation, difficulty in inhalation, shift of blood to the heart, increase in venous pressure, compression of peripheral venous vessels and lymphatic vessels, increase in the heart volume (**Podgórski T.** 1996).

[66] A new term 'wellnes zone' and the rules of its formation constituted the subject of the conference of European Waterpark Association in Berlin, in 2003. Participants of the conference included operators and designers of the facilities providing publically accessible facilities of biological renewal. The discussions aimed to give the direction to the development of this type of services as well as their standards and premisses. On the basis of observations of the contemporary state of wellness services in publically accessible objects one can notice the accuracy of the prognosis and observations made twelve years ago. Pilzer (2007) states that *wellnes* is a synthesis of *wellbeing* and *fitness*. The activities focus on the prophylaxis of physical ailments and the creation of wellbeing in emotional and mental spheres.

Research facilities

Contemporary oceanaria create artificial water environments. Particular spaces of water tanks imitate various climatic conditions and environments characteristic of natural wildlife habitats. Modern spatial structures contain the presentation of the life-giving and ecological role of water in the environment as well as its importance for the life on Earth. Scientific exploration of the world and pursuit of knowledge give an impulse to the creation of buildings specially dedicated to the exposition of water properties and specialized research. An immense investment effort is directed at the construction of facilities where the artificial water environment is created. Oceanaria and museums of rivers are prestigious investments having stately and representation functions. They emphasize the role of water as an extraordinary environment and miraculous substance and thus change its perception. Such objects are a proof of openness to nature and manifest tendencies to protect water. Water is highlighted there as the heritage of our planet which is integrally related to the survival of life[67]. Apart from the exhibition function, these facilities conduct research and run didactic classes. The function of water is implemented by creating the artificial environment for aquatic fauna and flora, which is the basic inspiration for the creation of such objects.

Objects of aquatic architecture such as oceanaria and river museums, which are significant from the point of view of science, research and exploration, are of various character and have a different spatial layout. Basic functions may be implemented in the facilities of simple structure similar to the pragmatic building layout of industrial plants, such as the museum of the river Mora in Portugal, designed by Promontorio Group[68]. However, a prestigious role of oceanaria requires more sophisticated spatial features. In this case, architectural expression may be connected with popular designing trends, for instance the Oceanarium in Tennessee, designed by Cambridge Seven Associates and Baltimore Aquarium. Another example, where the function connected with research and exploration of water is implemented through nautical forms, is the aquarium in Stralsund, designed by Behnisch Architekten [Example 11]. It seems that such expression of the scientific function connected with the exploration of water spaces by means of formal associations create timeless spatial effects, represented also by the object built in Valencia, designed by Santiago Calatrava[69].

The structure of an oceanarium consists of spaces dedicated to visitors and service rooms. The main goal of the oceanarium is to provide plants and animals with appropriate living conditions. Properly prepared water tanks constitute the main space of research and exposition. Apart from visible aquaria, specific rooms of the oceanarium include additional rooms with water containers in quarantine, the reserve of fresh sea water, filtering and water treatment facilities. Beyond the visitors' zone, oceanaria also house laboratories, hospitals and clinics in order to provide animals with veterinary care and optimum conditions for breeding. This also creates perfect conditions for research and exploration.

[67] In the World Ocean there are more numerous and various forms of life than on land. 'Life in the ocean means both the smallest bacteria and the whales – the biggest species ever living on Earth. The seas and oceans encompass great richness of plant and animal species. Each species has adapted to the water environment in a unique way' (**Hutchinson S., Hawkins L.** 2007). Oceans - Oceany; Carta Blanca Sp. z o.o. Warszawa, p. 107.

[68] http://www.archdaily.com/4921/mora-river-aquarium-promontorio-architecture/ 30.10.2022

[69] https://www.dreamstime.com/editorial-stock-image-oceanografic-aquarium-city-arts-sciences-valencia-entrance-to-valecia-spain-landmark-building-complex-designed-image56188819 30.10.2022

Architectural objects make use of different applications of water which result from the functions played by this material in human life. The foregoing cases of sports and recreation objects as well as transportation, therapeutic and research facilities have been used as the most representative examples of using the function of water in architectural objects. However, this set of implemented buildings, where water is the determinant of the object's purpose, is not a closed set. There are also other objects, the existing ones and the ones-to-be, which use and will use water in the creation of aquatic architecture.

1.3. Water as a material in architecture

Traditional building materials are characterized by durability, specific technical properties and rules of application. However, architecture being the art of space creation seeks novel solutions and materials. Initially, the application of new materials in construction causes a sensation, but after some time they become commonly used. The analogy can be found in the application of glass[70]. Water used as a material in building engineering also stirs emotions, sometimes opposite ones, concerning its resistance and applicability, however, it is more and more often used as a construction material. The significance of water as a material in contemporary architecture has been defined as follows:

– construction material,
– decoration (an artistic, visual and plastic element),
– factor shaping the climate of the environment and the rooms.

Construction material

Water in its solid state is an attractive construction material. Mechanical properties of ice and snow make it possible to construct supporting elements of the building as well as the interior furnishings. Snow and ices buildings which are nowadays constructed are created in an intuitive way. Because of their greater and greater panache and grand scale, including the height and span of the structure as well as its mass, such buildings may pose a threat to the users. Supporting structure adopts a form of walls, pillars, columns, posts, ceilings and domes. The structural strength of this material has not been fully investigated yet. Various macroscopic structure (ice, snow, ice snow) and variability of technical parameters depending on temperature, including melting and thus complete destruction of the object, are a considerable challenge when it comes to the definition of mechanical parameters. Such parameters would be helpful in the determination of the statics of buildings made from such materials. The application of water in the form of ice in architecture requires the creation of norms and legal regulations on the basis of experiments and material tests. The calculation norms concerning ice structures do not exist even in countries which have a big potential of using this material. Normalization of the issues of mechanics of ice and compact snow should precede the construction of objects which make use of these materials.

Water in a liquid state is an element of dividing space, usually in the form of an optical base or floor, but it may also play a function of a wall taking the form of a cascade or an aquarium. A massive aquarium filled with water can be a transparent partition of good acoustic parameters.

Water in a gaseous state, in the form of water particles suspended in the air, is difficult to apply in architecture. However, it is a spatial element which can be used as an urban accent, for instance as an artificial cloud.

Investigations of water as a construction material could become a progressive direction of studies of contemporary architecture, especially that the rules of application of water as a building material are not included in any legal regulations, as opposed to water used for technological and utility purposes.

[70] Nowadays, glass has become a well-known building material. However, it was only in the 20th century that the properties of this material were developed to such an extent that the application of glass became widespread and gained features of typical technological solutions (**Wala E.** 2012).

Frozen water

Architectural objects are made from frozen water, to be more precise, from *compacted snow*, *cast ice* (ice made using formwork) and *harvested ice* (ice collected from frozen water reservoirs). 'Work with ice actually is work with water'[71]. Experimental architectural objects of various kinds of ice were designed and built by leading world architects within the framework of an experimental show called *The Snow Show*. Architects and design studios that took part in that show included: Williams & Tisen, Asymptote, Anamorphosis, Juhani Pallasmaa, Holmer-Reuter-Sandman, LOT-EK, Ocean North, Enrique Norten, Zaha Hadid, Steven Holl, Tadao Ando, Arata Izosaki, Morphosis, Studio Granda, Future Systems, Diller+Scofidio and Lebeuss Woods. (**Fung L.** 2005). It can be easily noticed that the above-mentioned list features the most famous names of contemporary architecture, for whom water in its solid state has become an element of artistic expression.

Application of frozen water in the construction of an architectural space means something different to each creator – designer participating in the show. The features of the ice or snow material which are highlighted in these works include: purity and clarity (**Tisien E., Wiliams T.** 2005), environmental-ecological-technical and humanistic expression (**Asymptote** 2005) [compare: Example 3], formation of ice – the material of its own morphology formed as a result of a natural building process (**Georgiadis N.** 2005), impression of solidity given by the material in certain conditions (**Whiteread R.** 2005), diversity of artistic and plastic material such as transparent ice or non-transparent snow (**Barry R.** 2005), possibility of applying dyes to the material in the mass (**Lot-Ek** 2005), transparency and colour of the material (**Norten E.** 2005), equating the material with the arrest of the flowing of space (**Hadid Z**. 2005)[72], self-formation of the material as a result of melting (**Holl S.** 2005)[73] as well as an ephemeral and shapeless character of the material which can produce pure and minimalist forms symbolizing the flow of time and transformation of space (**Ando T.** 2005). Moreover, the symbolics of contradictions is emphasized (**Ono Y., Izosaki A.** 2005), changeability, blurring borders between the stability of ice and fluidity of water and the stimulation of imagination to think of unique associations (**Do-Ho Suh, Morpfosis** 2005).

Although the construction of architectural objects from ice has been known for a long time, it does not have its place in the main current of architectural creation. The reason for that is probably a temporary state of such buildings. That is why ice architecture still remains a sole experiment. Perhaps, due to that the construction from frozen water is treated rather as an artistic activity and not engineer's work. Presently built facilities are implemented in a rather spontaneous way on the basis of their creators' sole intuition. They do not provide their users with safety. The collapse of the ceiling and burying the users under the elements made from ice and snow may have tragic consequences. In spite of being made from water and light snowflakes, this material takes a form of a solid substance of a mass of about 1000 kg/m^3. A mass of snow burying people in an architectural object made from ice may have a similar effect to a mountain avalanche.

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[71] **Fung L.** (2005), *The Snow Show*, p.148.
[72] Frozen water in the form of an ice building in Kemi in Finland, designed by Zaha Hadid; http://www.fungcollaboratives.org/projects/past/the-snow-show-finland/artists/cai-guo-qiang-zaha-hadid/image-grid 30.10.2022
[73] Ice cube is not different, in terms of form or dimensions, from the commonly constructed buildings in Rovaniemi in Finland, designed by Steven Holl; http://www.fungcollaboratives.org/projects/past/the-snow-show-finland/artists/jene-highstein-steven-holl/image-grid/ 30.10.2022

The above-mentioned examples show how ice construction becomes the subject of artistic work of architects and artists. Ice and snow buildings contain utilitarian functions, which can be used by many people at the same time. Successful examples of ice hotels, such as in Jukkasjärvi in Sweden, designed by Åke Larsson[74], as well as chapels or exhibitions, such as Iced Time Tunel, designed by Tadao Ando and Tatsuo Miyaijma, suggest that the subject matter should be investigated from the perspective of building engineering and a set of rules and methods of the formation of ice buildings should be created. Such rules should be developed into legal regulations in the form of constructional standards.

Water in a gaseous state

Steam (water vapour), a substance invisible to the human eye, takes part rather in the destruction of architectural objects. This issue is tackled by the physics of the building. This branch of technical knowledge along with the so-called general building engineering deal among other things with the protection of buildings against unfavourable physical conditions connected with the permeation of steam through walls and partitions. Technical methods and solutions of proper shaping the building partitions are developed. These issues being in the realm of a related branch of science but still different from architecture do not constitute the subject of deliberations contained in this elaboration.

There were, however, attempts to create a building object from water in its gaseous state. If water in a gaseous state is to be visible to the human eye, it must take a form of aerosol sprayed in the air. The gaseous state of water is achieved by micro-drops of water suspended in the air. Such application of water as a volatile and changeable material, with a semi-real borderline, can be noticed in the implementation of *Blur Building* during Expo 2002, designed by Diller and Scofidio (**Jodidio P.** 2003) [Example 02]. A utopian idea, or rather an architectural manifestation, is demonstrated by Adam Sochacki's concept of the transformation of the Palace of Science and Culture in Warsaw (Pałac Kultury i Nauki w Warszawie) into a *Generator of Clouds (Stwarzacz chmur)*. In the proposed solution the body of the Palace of Culture is to be obscured by water vapours (steam) in a form of a cloud[75].

Water as a fluid material

Architectural space is divided by means of partitions or divisions, including floors, ceilings and walls. The perception of space depends to a great extent on the properties of materials which create this space. The Olympic Swimming Pool in Berlin, designed by Dominique Perrault [Example 10], features the lit floor of the vast swimming-pool hall, to be precise, the lit sheet of water, which strongly focuses the viewers' attention and influences the perception of space (**Jodidio P.** 2003). This work shows a role of water as the element dividing the interior space starting from the base. A theoretically transparent material constitutes an optical division of space; the lit water acquires the qualities of a building material of transparent and luminous[76] properties.

Architectural efforts consisting in the location of a building in an artificial water reservoir, for instance on its surface, may be observed in the building Himeji Children’s Museum designed by Tadao Ando. A minimalist character of the water sheet emphasizes the expression and unity of

[74] http://www.julianstubbs.com/wp-content/uploads/2014/09/ice-hotel-sweden.jpg 30.10.2022

[75] A conversation with J. Kozakiewicz presented in 'Architecture and Business' magazine – 'Architektura i Biznes' 2006, no 12 (Tomczak M. 2006).

[76] Transparent properties, i.e. translucent or see-through properties, or luminous properties, i.e. generating light.

architecture. The semi-sphere of Spa Baths[77], designed by Behnisch Architekten, is surrounded from all sides by water. It houses a swimming pool and it combines the interior with the external space using water as the optical basis. Zaha Hadid designed the BMW building in Leipzig[78] locating it on land but she made use of reflexive properties of water sheet in the surrounding artificial water reservoirs in order to emphasize the body of the building. In a similar way, the Absberggasse school in Vienna, designed by Rudiger Lainer, is partially placed in an artificial water reservoir. Oskar Niemeyer, the doyen of modernism, emphasized the sublime forms of the Publishing House in Mondadori through the subtlety of a flat sheet of water at the base of the building. The facilities of Spa Bergoase Mario Botty[79] built in the mountains are an example of the application of water not as a mere attraction, but also as the material contributing to the formation of space. A material function of water entails artistic, visual and plastic phenomena, which is the subject of the analyses presented further on in this work.

Falling water may 'form' a wall which creates not only a visual impression but also provides acoustic stimuli. Such use of water may be noticed in the implementation of the Water Pavilion for Expo 2008, designed by Carlo Ratti Associatti [Example 20]. Water constitutes a movable division of changeable functions. The external walls of the building are created by falling water, the whole system is integrated with electronic controlling which closes or stops water when someone intends to enter the interior. In the Parque de Catalunya in Sabadel, the water wall separates a cool relaxation space which is used day and night (**Batlle E., Roig J.** 2002). A motif of the wall created by falling water is repeated also in other designs, for instance: Waterwall – a pavilion designed by Aneta Kuboś, Sylwia Parol, under the supervision of Andrzej Duda. The purpose of this work is to manifest the character of water as a building material (**Kuboś A., Parol S.** 2001).

Artistic and decorative element

While investigating the relations of architectural objects with water, it is clearly visible that in some cases water acts in a very intense way creating forms, textures and spatial effects. A decorative function of water in the formation of architectural objects results from a diversity of phenomena connected with water (**Gustafson K.** 2002). A special role is played by the interaction of water and light, which is an indispensable factor for the obtainment of artistic effects created by water. The second crucial factor playing role in the perception of water in the built environment is its co-existence with other materials.

Artistic role of water

Water and light may become the content of an architectural concept, as in the case of a swimming pool in Lepe, designed by Ignacio Laguillo and Herald Schönegger. The application of a simple body of the building, regular shapes of rooms and internal devices along with an ideal flat surface of water lit with sunrays in a precise way – create an effect of perfection of water and light (**Place J.M.** 2005b).

Water attractions, such as fountains and geysers, are examples of aquatic objects using water on land. The purpose of the introduction of this medium is to make space more attractive through artistic, visual and plastic elements. Such relations can be seen in the implementation

[77] https://behnisch.com/work/projects/0190 30.10.2022
[78] http://www.zaha-hadid.com/architecture/bmw-showroom/ 30.10.2022
[79] https://arquitecturaviva.com/obras/spa-tschuggen-bergoase-en-arosa 30.10.2022

located at the Heiner-Metzger Square, designed by Atelier Dreiseitl. Also, the T-Mobile City was created by an architect Stephan Lenzen around the squares filled with fountains and pools.

Ordering of space and construction of an architectural composition around pools is a popular way of increasing the value of best locations, as for instance in the National Grand Theatre of China[80], designed by Paul Andreu. A similar solution can be found in the penthouse Ray 1 House in Vienna, designed by Roman Delugan and Elke Meissl[81]. A composition of a single-family house and a swimming pool was a solution applied to House Mirindiba, designed by Marcio Kogan.

The thermal baths Vals by Peter Zumthor were built on land without contact with the natural water environment. However, they make use of artistic and decorative properties of water and thus belong to a set of contemporary aquatic architecture not only due to the application of water as a utility function determinant. A similar type of facilities include: the water pavilion of St. Arbogast, Fridolin Welte and the swimming pool Liquidrom in Berlin, designed by the GMP Architecten[82].

In the analyzed objects, water as a building material is subject to conscious transformations as a result of designers' actions. Means of expression used by the creators of architectural space are achieved by the use of water in various ways. Water is used as a material having the following features:

- it reflects light[83].

The reflection of light is used in several ways. The surface of water multiplies the elements of the building being close to water. The water sheet reflects also natural elements, such as the scenery, sky or sun. The reflections of the sources of light, such as the sun or artificial lighting, create movable graphic phenomena on the building's elements. It often happens by chance but it could be also caused by designers' purposeful actions.

- it is transparent[84].

Transparency of water is the quality that arouses the most emotions. This feature is connected with the application of water in historic architecture, its mystic role and its *sacrum* (**Niemczyk E.** 2002a). In contemporary civilization, transparency and clarity are also qualities that are emphasized in the designs made for the institutions, such as banks or public institutions. The phenomena of light reflection and transparency co-exist in almost each built water reservoir.

- it has texture[85].

An ideally flat surface or ideal waves, flat immobile water surface or uniformity of the water texture rippled by the wind often constitute the urban floor in artificially created water flows in the parks and city squares, such as Postdamer Platz [Example 08]. Factors influencing the condition of the water surface in architectural elements always act according to physical laws, in a similar way to other cases. The behaviour of water is predictable and depends on the impact of certain external forces or the bed formation. This predictability of water behaviour and the opportunity of artistic creation found their place in many implementations.

[80] https://www.archdaily.com/1218/national-grand-theater-of-china-paul-andreu 30.10.2022
[81] https://www.dmaa.at/work/house-ray-1 30.10.2022
[82] http://www.liquidrom-berlin.de/de/ 30.10.2022
[83] Feierabend P. (2003) Pools. Feierabend Verlag OHG. Berlin., p. 142
[84] Baldon C., Melchior I. (1997) Reflections on the Pool: California Designs for Swimmin. Rizzoli International Publication. New York p. 175
[85] Feierabend P. (2003) Pools. Feierabend Verlag OHG. Berlin, p. 113

- it is luminous and adopts the shape of the container in which it is placed[86].

Water being a formless material fills in a container and adopts its form. What is interesting in the perception of such water containers is the fact that water dominates over the shape of a building element. Water is perceived as a plane or a solid body filling in the tank. The existence of the walls is intuitively omitted. Aquaria, where water is exhibited behind a transparent material, are a particularly expressive example. However, the perception of water collected in containers made from non-transparent materials also refers to water of a particular shape and not to the walls of the tank. A shape of the water body can be best seen when the whole volume of material emits light.

- it has colour[87].

Theoretically, water as a colourless material by definition is perceived as such. In fact, it adopts various shades. Clean water which has been poured into a glass is colourless, however, the same water poured into a bath tub acquires a greenish shade, in a shallow pool with white walls it gets a turquoise colour. In deeper objects we can see a blue colour, in even deeper – the dark blue. The colour of water is a resultant of its physical properties and visible light. The absorption of the light of long waves, i.e. the red light, already in the first layers of water deprives the light reaching the bottom of water reservoirs of this fragment of the spectrum. Also after the reflection from the walls of the tank, the light goes back the same way and again loses a part of its spectrum. The absorption of light spectrum starts from the red colour, then yellow, green, turquoise, blue and violet. In addition, the colour perception of water is influenced by the fact of light scattering in water particles; the biggest degree of scattering is achieved by the blue colour (**Bujniewicz Z. et al.** 2009). Due to these reasons, deeper water gets more and more blue. This phenomenon should be taken into consideration while designing swimming pools. In this case, the colour of the water surface is a dominant feature in a given space and should be adequately 'composed' into this space in order to achieve an intended artistic effect.

Physical properties of water were used in the 3deluxe implementation designed by Cyberhelvetia[88]. Optical properties of water were projected in space in such a way that the user has an impression of immersion in the imitated water. In this case, the phenomena were as if reversed. It was not the water that created artistic impressions, but the water itself became the subject of artistic image and illusion (**Fischer J.** 2008).

Relations between water and other materials

Examples of the already-built architectural objects show the existence of artistic, physical and other relations of such facilities with water. The properties of water juxtaposed with architecture can be seen in contemporary implementations. Acoustic qualities[89] indicate the presence of water in the vicinity even at night. The scent of humid air influences the perception of space (**Woodward R.** 2005).

In Tanner Spring Park in Portland by Atelier Dreiseitl, water co-exists with a different alien material like steel. A controversial combination of materials is the main artistic accent. In the town

[86] Feierabend P. (2003) Pools. Feierabend Verlag OHG. Berlin, p. 139.

[87] Baldon C., Melchior I. (1997)Reflections on the Pool: California Designs for Swimming. Rizzoli International Publication. New York, p. 63.

[88] https://architizer.com/projects/cyberhelvetia/ 30.10.2022

[89] Feierabend P. (2003) Pools. Feierabend Verlag OHG. Berlin, p. 61.

hall square in Hattersheim, the incrustations or inlays of formed water streamways were applied. They were finished with a scenery element. Still water in shallow pools and lit flowing water juxtaposed with steel sheets is the fundamental element of the composition of the Waterhouse hall in Herne-Sodingen Academy by Atelier Dreiseitl. Water, natural stone and glass constitute the main elements of the composition of the building body of the thermal baths in Meran, designed by Baumann Zillich Architekten and Matteo Thun. These thermal baths are an example of the implementation of a therapeutical function (discussed in a different chapter) by means of perfectly co-existing materials (**Fuchs K.** 2006). The juxtaposition of concrete, being a material very distant to human beings, with water is a compositional procedure applied in the bathing facilities built in Kaltern in Southern Tirol, designed by Harnoncourt Marie Terese and Ernst Fuchs. This combination creates a humane recreational space (**Elser O.** 2006).

The texturization of the water surface using elements which disturb its flow as well as a cascade of a thin layer of water on specifically shaped ledges – make up a fragment of the urban floor of the municipal square in Gummersbach. A modern sculpture whose shapes are supplemented by a movable element of cascading water and in the winter by frozen ice trickles constitutes a decorative element of a housing estate in Bern-Ittingen in Germany (**Woodward R.** 2005).

Water cannot be called an ordinary building material. The range of its applications inspires people to discover its capacities anew. The symbolic and cultural significance of water is conveyed by contemporary implementations. For instance, the square Potsdamer Platz in Berlin was equipped with a water reservoir with a cascade. Water plays there a role of an artistic element which provides business people with the so-needed moment of relaxation relieving their tense nerves. A concept of re-building the park of Queens Botanical Garden by BKSK Architects is based on a designed water composition surrounding the building. Water elements of land development exist in the vicinity of buildings and structures which regulate water flows. Various cascades and streamways are elements which organize the space of the housing estates of *Sonnenhausen* in Glonn[90], *Arkadien Aspeng* in the vicinity of Stuttgart and *Echallens* near Lousanne[91]. A specially designed sculpture of glass and water decorates a natural water reservoir in Chaumont on the river Loire (**Dreiseitl H.** 2005).

Water in its nature is formless and passive, however, its different qualities come to light when water interacts with other materials, effects or phenomena. The phenomena going on in the water and with the use of water are presented in the adaptation of an old cooling tower in Gelsenkirchen[92]. The introduction of artificial lighting and setting different forms of water into motion present spectacular optical properties of this material. Water sculptures in Immenstaad[93] are placed in the water and form different shapes of water. As a result of specific relations between water and the building's body, facilities placed in the pools, which were built specially for this purpose, produce artistic and visual effects in addition to their technological qualities, for instance the building of the *Center of Exellence* in Stuttgart, designed by Kohlbecker Architects & Engineers (**Schwenk W.** 2005).

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[90] Water is universal. [in:] Dreiseitl H., Grau D. (ed.) New waterscapes. Birkhauser, pp. 70-71, 169.

[91] Geiger W.F. (2005), Think global, act local, [in:] Dreiseitl H., Grau D. (eds.), New waterscapes. Birkhauser, pp. 108-109.

[92] Schwenk W. (2005). Water as an open system.[in:] Dreiseitl H., Grau D. (ed.) New waterscapes. Birkhauser, pp. 114-117, 171.

[93] Schwenk W. (2005). Water as an open system.[in:] Dreiseitl H., Grau D. (ed.) New waterscapes. Birkhauser, pp. 120-123.

Using water and managing its resources should become a subject of contemporary research both in the scope of ecology and in the sphere of visual arts, such as architecture, sculpture, etc. There are many examples of artistic works using phenomena connected with water. The application of this material brings original effects in juxtaposition with other materials, in respect of creation of both new forms and new textures. Water juxtaposed with other materials may simultaneously build contrast and supplementation. This fact results from its dual nature, which on the one hand is submissive, but on the other, it constitutes a material creating its own image. Actually, all materials change their colours under the influence of water, whereas water changes its texture because of other materials. 'Water-traces' in Hannoversch Münden[94] are an artistic accent which uses enforced waving and confrontation with a different material. Artificially landscaped natural scenery at the nursing home in Stuttgart[95] is created by the combination of water activity and other natural environment factors. The elements of Heiner-Metzger Plaza in Neu-Ulm designed by Atelier Dreiseitl constitute an example of shaping the image of water as a result of the enforcement of its forms by using a device made of a different material.

Factor impacting the environment and the micro-climate of the premises

Material properties of water shape the creation of spatial structures based on solutions which can be called eco-technological. It means that the parameters and properties of water give possibilities and are an impulse for the creation of objects which use water as a cooling element or energy-accumulating element or use some water management buildings to protect nature or shape natural environment.

Water – as a material which changes the state of aggregation and moves constantly in the building – continuously undergoes technological processes. The changes of the state of aggregation, i.e. the changes of physical parameters, play a significant role in maintaining a special micro-climate of rooms or in the protection of the building against unfavourable conditions causing destruction. In the built environment, outside the buildings, water management is an important issue when it comes to its supply and retention. Water used in the shaping of the internal environment of an architectural object reveals its life-sustaining features; it cools and moistens the air surrounding the users (**Geuze A.** 2002). The very passive presence of water causes changes in the micro-climate of rooms along with their perception. These applications of water in architectural objects result in its ecological and technological functions. Due to a close connection of these issues in observed cases, they are often jointly referred to as eco-technological. The fact of taking into consideration this role of water in architecture leads to the creation of buildings which use the properties of water as a material.

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[94] Ipsen D. (2005), Towards a new water culture. [in:] Dreiseitl H., Grau D. (ed.) New Waterscapes. Birkhauser, pp. 134-137

[95] Ipsen D. (2005), Towards a new water culture. [in:] Dreiseitl H., Grau D. (ed.), New Waterscapes, Birkhauser, pp. 138-139

Ecological function of water

The purification of water in the Copenhagen harbour using proper technologies of water treatment and restrictive regulations concerning waste-water disposal resulted, after many years, in the restoration of clean water in the city. In the regenerated water areas, recreational or commercial facilities are built, such as the entertainment centre *Seoul Floating Islands* on the river Han. The purification of water raises the quality level of life in the city and creates opportunities of the formation of new areas of public space enhancing social contacts and relations (**Castle H.** 2005b).

The Prisma building in Nurnberg designed by Joachim Elbe[96] is an implementation which combines technical and spatial solutions in order to implement a system creating an internal climate. The building features glazed winter gardens and other simple technological solutions which make it possible to create architecture of an ecological character. Rainwater is used for the systems of air-conditioning, fire-fighting sprinklers and internal plants watering. In a different case, rainwater harvested in the Queens Botanical Garden in New York[97] is used for the creation of an artificial water flow surrounding the newly designed building (**Dreiseitl H.** 2005).

The management of rainwater is the simplest way of limiting the impact of buildings on the environment (**Hager G.** 2002). Elements collecting rainwater may form a part of the composition of architectural open space. Such an approach may be found in the implementation of the system of rainwater harvesting in Kronsberg in Hannover[98]. In this implementation, designed for EXPO 2000 by Atelier Dreiseitl, artistic and decorative elements of the land development play an additional function – they take part in the water management of the urban district. It is similar to the Scharnhauser Park in Ostfildern where rainwater harvesting areas formed a complex of greenery improving the quality of life in the neighbouring housing estates. The Toppilansari Park in Oulu[99] is a public space which was created by means of solutions serving the purpose of rainwater management. Geometrical pools of the Botanical Garden in Bordeaux, designed by Katharina Mosbach, are an example of the application of accumulation cisterns for the collection of rainwater, which is used later on for the purpose of watering plants in the botanical exposition (**Place J.M.** 2006). The foregoing implementations make use of the elements of water management and thus attribute characteristic ecological qualities to recreational functions creating in this way a high-quality public space (**Geiger W.F.** 2005, **Andersson S.L.** 2002).

The management of rainwater resources may result in the construction of open reservoirs on the buildings' ground floor level over which objects are built, such as the DWR Headquarters in Amsterdam, designed by Herman Hertzberger. Appreciation of an ecological role of water in the urbanized environment motivates people to regenerate rivers and leads to the creation of new areas of *waterfront*, also in post-industrial urban areas, such as the river Emscher in the Ruhr Valley.

The implementation of water space at the Berlin Potsdamer Platz by Renzo Piano and Christof Kohlbecker [Example 8] is a presentation of functions played by water in the creation of the micro-climate of urban spaces. The ING Bank in Amsterdam, designed by Norman Foster [Example 12], makes use of water not only as a symbol of clarity and honesty[100] of conduct, but

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[96] Dreiseitl H., Grau D. (2005) New waterscapes. Birkhauser, p. 55.

[97] Dreiseitl H., Grau D. (2005) New waterscapes. Birkhauser, p. 60

[98] http://www.urbangreenbluegrids.com/uploads/002-Kronsberg-001-Dreiseitl-1300x650.jpg 28.10.2022

[99] https://www.dreiseitlconsulting.com/toppilansaari-park 28.10.2022

[100] Woodward R. (2005), *Water in Landscape*, [in:] Dreiseitl H., Grau D. (eds.), *New Waterscapes*, Birkhauser, pp. 36-37. In spite of high technological awareness of the contemporary civilization, some people still need a justification of the role of water in architecture in the form of references to traditional immaterial values associated with water.

also and chiefly as a medium controlling the micro-climate of the rooms. The building is shaped around elements serving the purpose of water management, which are placed from the roof of the object to a natural reservoir located at the base of the building (**Dreiseitl H.** 2005).

The application of biologically active roof surfaces, the so-called green roofs, is another significant application of water as an ecological factor in contemporary architectural objects. Biologically active surface is the one covered with plants but also the surface of open waters. This role and significance of natural water surfaces are taken into consideration by contemporary legal regulations[101]. The application of green roof surfaces enables the implementation of ecological and scenery functions, like in the town hall in Chicago, designed by Wiliam McDonargh, or natural 'landscapes' on the roof of the Copernicus Science Centre - Centrum Nauki Kopernik in Warsaw [Example 23]. In a residential building in Bodrum in Turkey, designed by Global Architecture Development[102], pools or reservoirs were designed on the roof in order to collect rainwater and thus cool the building.

The simplest use of the roof in the scope of rain harvesting is the collection of rainwater and directing it to storage cisterns, as in the McLaren laboratory building near London, designed by Norman Foster [Example 06]. In this technological centre water not only reflects light and helps to create a micro-climate, but also it has a special quality thanks to the shape of the water cistern – it enhances a natural motion and smooth circulation of water. The dynamics of water is accompanied by the exchange of heat, which reduces the need for mechanical solutions of energy re-circulation (**Castle H.** 2006b).

Technological function of water

In closed cubature, water circulation is analogical to its circulation in the natural environment. Water flowing through the building plays a function of a substance conveying energy, especially in the facilities such as indoor swimming pools and water parks due to the occurrence of vast tanks of big surfaces and a high dynamics of water flow. The directions of media and water circulation in the building are similar in most objects, however, some implementations have specific solutions, such as an internal water reservoir, which are of importance as far as a technological role of water in architecture is concerned[103].

An architectural object receives the following factors: water, heat energy, electric energy, ventilation air, sunlight energy. In return, the object emits the following physical factors: sewage and waste water, heat energy, used ventilation air, light energy (its impact can be omitted).

Inside the architectural object there are processes of energy transitions. Intake air gets warmed up and becomes humid in contact with water. Water absorbs heat of steaming resulting from the process of drying off wet surfaces. Next, the air with the steam are subject to processing in air-conditioning systems and removed from the building. Water is heated and fed into the system of water treatment, used in the sanitary and technological processes and then channelled away in the form of cooled waste water. All these processes make use of water as a technological factor serving the purpose of energy saving.

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[101] Decree of the Minister of Infrastructure of 15 June 2002 on the technical conditions that should be satisfied by buildings and their sites, Section 3, Item 22.

[102] https://www.archdaily.com/49556/exploded-house-gad 28.10.2022

[103] Detailed description of the phenomena of energy flow and water circulation in the facilities featuring swimming pools has been provided in: (**Bujniewicz Z.** 2007), Selected formal and spatial solutions of water parks depending on the sources of media, [in:] Swimming Pool Facilities – Fittings and Systems. 4th International Scientific and Technological Symposium, Silesian University of Technology - Politechnika Śląska, pp. 23-37.

In the object equipped with a water tank, such as a swimming pool or a fountain, energy management starts exactly from the water. An open reservoir in a room holds water which has certain energy parameters (temperature, mass, surface). Such a space is filled with air of big cubature and usually a relatively high temperature and humidity. The water in the tank evaporates and absorbs heat. The humidity of the air increases in the room. The degree of evaporation is proportional to the water surface and also depends on the movement of its splashes or sprays, etc.

Water in the swimming pools and the air get warmed up from the sunlight. The heating of pool water directly by the sun is a desirable phenomenon and frequently applied in many implementations. Another way of using water as an energy carrier is cooling rooms which get overheated due to the sunshine. The activation of sprinklers creates water aerosols. Water in the form of tiny droplets or mist very quickly absorbs heat from the surroundings. The following devices are used: fountains, spray showers, ultrasound systems generating the so-called cold steam, sprinklers creating artificial rain.

Warm and humid air which collected the warmth coming from the process of water vaporization is directed to the ventilation system. Heat exchangers between intake air and exhaust air as well as heat pumps collecting energy from the exhaust air, which are designed in air-conditioning systems, absorb the heat used for heating the air and the consumed heat of the vaporization process.

The heat recovered in air-conditioning systems, including very important heat from the vaporization process, is used to warm up the intake air. Condensed steam may be let into the rainwater system. Rainwater harvested in a cistern may be partially purified and used for sanitary purposes, for instance, for flushing the toilets. The waste water coming from the rinsing of filters and showers as well as warm pool water which was splashed out of the swimming pool constitute factors of high thermal parameters. The heat contained therein can be recovered in a special device, usually based on a heat pump. The above-described process makes up a cycle of the circulation of water as a heat carrier. The presented phenomena show that water is a technological factor here which creates the internal micro-climate of an architectural object and thus plays an important role in the scope of ecological impact of the building on the natural environment.

Technical application of heat transfer and the changes of water aggregation states may be seen in a functional solution combining ice and water, which was applied in the sports facilities Słowianka in Gorzów Wielkopolski, designed by the ETC Architekci – Tomasz Markowski, Marek Romaniszyn[104]. Thanks to the concept of locating a group of swimming pools and an ice rink in one spatial structure, it was possible to ensure a perfect heat energy transfer. The heat received from the water during the freezing process of the ice rink is carried to the group of swimming pools to warm up the air and water (**Trammer H.** 2005).

The role of water and its proper management can be seen in a building of the exhibition pavilion Water Worlds in Neeltje Jans in the Netherlands, designed by the NOX, Oosterhuis Associates. The surrealist pavilion providing information on water management is located just off the coast, at the North Sea. The pavilion presents not only a Dutch practical problem of flooding and flood prevention, but also other issues related to water, such as aesthetic ones or impressions (**Cleef C. van** 1998). Another object, which uses the location on the coast in the close vicinity of the sea for eco-technological purposes, is the Cultural Centre in Noumea in New Caledonia, designed by Renzo Piano[105]. Characteristic and eye-catching high facades are not just a formal

[104] https://etca.com.pl/ 28.10.2022
[105] http://www.moma.org/visit/calendar/exhibitions/117 28.10.2022

application. These elements take part in the regulation of the internal micro-climate when during hot summer days they direct and let in cool breeze blowing from the sea, which in this case plays a role of a heat receiver. When there is no breeze, properly shaped elements let in or stop the air coming from the land (**McInstry S.** 1998).

The application of water as a material in architecture can be divided into three groups: material, decoration and factor shaping the micro-climate. Obviously, water is highlighted as an artistic and visual element being the subject of artistic implementations. Another use of water is its application as a building material, which not only plays a decorative function but also builds an architectural form. Water may also build forms in a literal way being an ice construction or a cloud formation made up of suspended water droplets. Moreover, water creates architectural forms by means of space division building optical divisions, such as water floors or walls made of cascading water. Water as a material influencing the micro-climate of rooms requires the application of specific architectural forms, spatial relations between objects or relations with natural reservoirs.

1.4. Water as an artistic inspiration in contemporary architecture

The role of water in contemporary art was discussed in the 1960s. Works of art of that period show inspirations drawn from water being a fluid, gaseous or solid material (ice). The motion of the material being the subject of a work and its texture prone to modifications as well as structural changeability became the subject of interest for artists an designers. Along with the development of a perception level and interpreting skills of recipients, artistic creation used more and more often references to the water environment. Such references could be seen at various levels. They occurred in functional, aesthetic and emotional areas.

What is also interesting is the current references to water in contemporary architecture. An inspirational function of water takes form in the observer's mind. The mechanism of perception is based on the process of building up associations, inspirations and emotions. The basis for these is provided by knowledge, sensitivity, a level of education, culture, experience and upbringing. The creative and immaterial function of water in architectural designing reveals itself in the creation or 'read-out' of ***associations*** and ***inspirations*** made on the basis of:

- formal references,
- cultural references,
- references to science and natural phenomena.

Formal references

Nautical objects, such as ships, steam ships and sailing boats, are elements which inspired an aesthetic current clearly present in modernist architecture (**Fischer J.** 2008). Also, single objects of contemporary architecture draw from the aesthetics of open sailing canvas, as for instance the Boat Dock haven, in Lake Austin, designed by Juan Miro and Miguel Rivera[106].

Buildings with aquatic features which were built on land, not even in the vicinity of water, include the skyscraper Aqua Tower in Chicago, designed by Jeanne Gang[107]. The elevation of the tower is inspired by the waves of a lake but the building itself is located far away from the lake. A macroscopic **form of undulating structure** became an inspiration for the form of the Gugenheim Museum in Bilbao located on the shore, designed by Frank Gehry[108]. An object which brings associations with an image of water is the airport in Kansai with shimmering 'waves' of the roof, designed by Renzo Piano. The group of contemporary buildings referring to nautical architecture includes the Silesian Bank – ING Bank Śląski in Katowice, designed by Denton – Corker - Marshall[109], whose 'hull' elevation and 'lifeboat' balconies unambiguously define the character of this object and impose such interpretation.

The natural **water environment** is inspiring and provokes atypical solutions. The location of facilities in water reservoirs results in unexpected directions of the designing process. The buildings adopt completely different forms, gain meaning and symbolics going beyond normal

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[106] http://www.mirorivera.com/lake-austin-boat-dock.html 28.10.2022
[107] https://studiogang.com/project/aqua-tower 28.10.2022
[108] https://pl.wikipedia.org/wiki/Muzeum_Guggenheima_w_Bilbao#/media/Plik:Bilbao_-_Guggenheim_aurore.jpg 28.10.2022
[109] The author of this monograph played a function of an authorized designer in the designing team.

perception of space, as in the case of the Museum and Cultural Centre NORVEG in Rorvik, designed by Gmunddur Johnsson[110].

Elements of **water life** were the inspiration for the creation of an object on the river Mur in Graz, designed by Vito Acconci[111]. The building of the Cultural Centre in Graz, designed by Spacelab/UK, Spacelab Cook/Fournier GmbH[112], also brings associations with a nautical creature (**Fischer J.** 2008). Marine fauna does not cease to fascinate. Through the media providing information on new discoveries, it enhances and stimulates imagination becoming a source of new inspirations for architects. A special attention should be paid to organic structural solutions, often adopting the form of biomimicry[113] in architecture, i.e. buildings and constructions becoming similar to living organisms by means of transposing their structural features onto spatial and structural solutions of buildings (**Castle H.** 2006a).

Formal references are skilfully read by the recipients of architecture. The ease of ascribing water forms references to architectural elements results in the popularity of using such associations. A reference to water may be a trivial formal measure, such as the application of undulating roofs over swimming pool buildings. An aesthetic reference to the effects caused by water, which is adopted in order to highlight a composition of architectural objects, seems to be a better method of showing inspiration. Forms of water serving the purpose of inspiration come from its structure and associations connected with the natural water environment. The applied structures have undulating forms which reflect light and bring associations with nautical objects created by the civilization.

Cultural references

Inspirational optical phenomena connected with the passage of light through water have a lot of symbolics, obviously apart from artistic visual effects. This symbolics revolves around light and purity. Water as a metaphor of purity and clarity is often used to attribute these qualities to the buildings of public trust. Transparency of architectural elements and in particular of the materials used in construction is transposed onto the image of people working there. This kind of solution was used in the construction of the town hall in Kibi-Cho in Japan, designed by Kengo Kuma[114]. The examples quoted in this section present objects designed by authors deeply rooted in culture and tradition.

Tadao Ando in his implementations called *Church on the Water*[115] and *Church of the Light* presents formal minimalism of water as a material. It is expressed by its transparency and the fact that water assumes the shape of its container. Water may be an element emphasizing minimalist solutions in architecture, as for instance in the building of the Langen Foundation[116], designed also by Tadao Ando.

The location of an object in the vicinity of water or on its surface is a synonym of luxury. It is not a typical location of a building or construction, so such measures stir additional emotions.

[110] https://en.wikipedia.org/wiki/Norveg 28.10.2022

[111] https://www.graztourismus.at/en/sightseeing-culture/sights/island-in-the-mur_shg_1470 28.10.2022

[112] https://en.wikipedia.org/wiki/Kunsthaus_Graz 28.10.2022

[113] Mimicry – acc. to the Dictionary of the Polish Language: 1. in biology: a kind of mimetism, similarity to another species, usually for defensive purposes; 2. imitation of somebody else's behaviour, appearance, way of speaking in order to become concealed in a group or indistinguishable in a group.

[114] http://www.kisho.co.jp/page/239.html 28.10.2022

[115] https://www.archdaily.com/97455/ad-classics-church-on-the-water-tadao-ando 28.10.2022

[116] https://en.wikipedia.org/wiki/Langen_Foundation#/media/File:Langen_Foundation.jpg 28.10.2022

By building on a port canal in Copenhagen, a new space was created in the city and prestigious features of the neighbouring district were highlighted. A floating swimming pool made from wood was placed on the canal, designed by Julien de Smedt and Bjarke Ingels. Such a combination of materials emphasizes the symbolics of water as a natural material. The introduction of a wooden island into the city has a positive influence on the perception of space and constitutes an ecological element in the urban space. A natural object in a city district is treated as an element of luxury in our culture.

References to water science and water environment

In contemporary world, immaterial and emotional associations are connected more with a physical image of water processes than with metaphysics. In early cultures, inspirations from water referred more to a group of phenomena of a supernatural character. The present state of education and an interdisciplinary character of science bring associations with geophysical, environmental or other phenomena being the domain of the science of flora and fauna as well as the science of geological features[117].

Common knowledge of water is a source of inspirations and associations with water. Water[118] makes up over 80% of the content of living organisms. Moreover, it is the source of life. However, it also poses a threat. Water takes up around ⅔ of the surface of our planet and provides the basis for life development. Atmospheric phenomena as well as the transition of the matter and energy in the natural environment are based on the physical properties of water. Water occurs in different forms in the natural environment. Water is steam and clouds, salty sea water and floating icebergs containing potable water, glaciers and rivers, seas and oceans. Through vaporization, condensation, liquefaction, flowing and freezing - water constantly gets transformed from one state into another; this is a cycle of water circulation in the natural environment. The laws of physics exerting their impact on water result in simple yet amazing artistic visual effects. They include the phenomenon of a rainbow, a variety of snowflakes or visual effects connected with the reflection of light on the water surface.

Human beings use water as a beverage, solvent, factor transporting heat, for recreation and sanitation, industrial and technological purposes and food preparation. Clean potable water may be the reason for political struggle and unrest in overpopulated regions. Water is a perfect solvent of mineral and organic substances, hence its role in feeding the organisms on Earth. Water space is inhabited by species which are specially equipped in terms of their physiology to live in such environment, such as fish or mammals (dolphins, whales).

Human physiology is not adapted to living in the water and even the most romantic pursuits described in literature[119] will not rid us of the existing barriers, a human being is a land creature. However, something pushes people to live, rest or work in the vicinity of water. Great emotions are connected with water, which were recorded in the most popular works of civilization: Homer's *Odyssey*, Jules Verne’s books, feats of engineering, conquering the seas on oil rigs and industrial

[117] While this monograph was being finished, Hydropolis – the centre of water science was opened in the city of Wrocław. The centre provides a lot of information in the subject matter discussed here below. Source: hydropolis.pl, 05.06.2015.

[118] Source: www. biophysics.org, www.unep.org/vitalwater/01.htm, 30.07.2015 and others.

[119] Jacques Mayol (2009) – one of the-then most famous people diving with a held breath - described his adventures connected with free diving and the term of *homo delphinus* in a book under the same title.

installations, exploration of the ocean space by great explorers and solitary sailors. No doubt, these are examples of the durability of human relations with water and human fascination with this environment. Scientists and dreamers, such as Jacques Cousteau, and the heirs of their ideas like: Joachim Hauser, Bruce Jones or Paweł Podwojewski look far into the future.

Scientific studies of water, its chemical composition and physical properties constitute common knowledge. Everybody takes water for granted, its presence in the surroundings is obvious to each user. Its practical applications are well known in the civilized world. This knowledge results in pragmatic understanding of the relation of water and architecture. However, the bulk of traditions, beliefs and symbols orders a human being to perceive water as a challenge or a natural element. This is a remnant of primordial relations and fascinations of ancient civilizations. There are two noticeable ways of water influence on the contemporary man. On the one hand, growing scientific knowledge results in a pragmatic approach to water as a medium and a chemical substance of certain technical parameters. On the other hand, mythological interpretations of water symbolics are still vital.

Apart from quite simple and natural formal associations, the phenomena connected with the **action of water** in the natural environment may become an inspiration. This happened in the case of the concept of the Copernicus Science Centre - Centrum Nauki Kopernik in Warsaw [Example 23] where erosion of the ground caused by the river became the inspiration for the authors of the design. The inspiration with water impact served the purpose of the creation of the basis of the aesthetic and structural concept of the facilities. Elements constituting the references to water action in the environment take a form, for instance, of gargoyles on the elevations[120].

The implementation of the Paul Klee Centre in Bern[121] also brings associations with water. The author Renzo Piano deliberately implemented different ways of perception there. The object may be treated as a formal inspiration drawn from water waves, but also can be seen as the object creating the fluidity of the building surroundings, making an impression of the fluid, undulating ground (**Diethlem A**. 2005).

Mechanical phenomena and technical capabilities may also be the source of inspiration for architects. For instance, rainwater flowing from the roof of a school building in Owingen, designed by Atelier Dreiseitl[122], drives a water-wheel, which along with windmill sails exhibits the impact of natural forces on human life (**Dreiseitl H.** 2005). The sound connected with the flow of water is sometimes an impulse for the creation of artificial waterfalls or streams.

Contemporary people treat water as the material environment. After many centuries of applying the term of a natural element to water, water itself has lost its mystic and poetic qualities. Daniel Libeskind in the Imperial War Museum[123] referred to water as one of the three environments where war was waged (**Pilawska J.** 2006). From the perspective of these investigations, it is vital that the author of this implementation avoided associations with natural elements, which instinctively come to mind in this case (e.g. fire can be easily presented as a

[120] An element of a purposeful placement of water flow on the elevation in order to exhibit erosive properties of water in the natural environment. It is often criticized as an error in building engineering, in this case, only after a thorough explanation of its purpose and history of creation does it become understandable. The author of this monograph is one of the authors of the Copernicus Science Centre in Warsaw, the designing team consisted of the following architects: Jan Kubec, Magdalena Gilner, Michał Tomanek, Zbyszko Bujniewicz.

[121] Diethlem A. (2005) Zentrum Paul Klee in Bern Renzo Piano Building Workschop, source: Baumeister. No.1. pp. 38-47

[122] Dreiseitl H., Grau D. (2005) New Waterscapes. Birkhauser p.59

[123] https://www.iwm.org.uk/visits/iwm-north 28.10.2022.

symbol of war). However, the subject of water has been treated here in a modern way without attributing any archaic meanings to it.

Multiple meanings, various forms, a great impact of water on life and natural environment are the source of aquatic inspiration in contemporary architecture. Water, which is present in nature in numerous forms and states occurring in many ways and exerting its influence directly or indirectly on the matter, provides artists and designers with associations and emotional references.

1.5. Water in the built environment which don't create its aquatic character

Water as the environment of nautical objects

Natural water environment (oceans, seas, lakes, rivers, ponds) has been the space where vessels created by human creativity have served the purpose of transport and circulation for centuries. They obviously make use of natural nautical properties of water reservoirs[124]. The condition which distinguishes nautical objects from others is their purpose; they are dedicated to the transport and circulation of goods and people. Objects of this type belong to the field of nautical architecture or ship building and are not included in the scope of aquatic architecture.

Ships, boats and sailing ships have always constituted elements of water reservoirs development and symbols of civilization progress. Their main goal is to cover vast distances of the seas and oceans contrary to building facilities located in the water whose purpose is the existence in this environment and playing different functions. Mobility is a basic feature of non-architectural objects which function in the water environment. It is not, however, a condition which automatically excludes such facilities from the set of architecture as there are also implementations of mobile aquatic architecture, such as floating sports halls or stadiums.

Sanitary, life-sustaining and fire-fighting functions of water

In 613 examples of the investigated objects of contemporary aquatic architecture, the very presence of water in the services function did not constitute the basis for the classification of the object to the set of aquatic architecture. This particular function of water results from basic requirements in contemporary building engineering. The supply of water to the building is a legal requirement[125]. The water is supplied to the building for hygienic, sanitary, consumption and fire-fighting purposes. Current regulations treat the obligation to supply water and dispose of waste equally with other media, such as electric energy, gas, heat power or a telecommunication signal. Due to these reasons, the function of water connected with its sanitary and life-sustaining roles is obvious from a modern man's perspective.

Cleanliness constitutes a basic parameter of the supplied water. 'Let's learn how to manage water in the future. [...] its quality and not quantity is the problem'[126]. Around one hundred years ago, standard bacteriological tests of potable water were established. The adopted standards properly control basic hygienic safety of water in the fittings, swimming pools and other cisterns or reservoirs. The maintenance of a proper state of water may be divided into activities restoring a proper level of micro-organisms in the water after its contamination and activities connected with prevention and water purification. A preventive disinfection of water ensures the supply of a 'healthy' medium. The most popular methods of water disinfection are as follows: chlorination with chlorine dioxide, ozonation, ionization, disinfection with ultraviolet light (UV), disinfection with ultrasounds. Only after health and hygiene requirements are fulfilled may a different role of water in architecture be pondered on (**Piechurski F., Bujniewicz Z.** 2005).

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[124] *Navigare necesse est, vivere non est necesse – sailing is necessity, life is not*.
[125] Building Law and Decree on technical conditions of buildings and their location.
[126] **Ipsen D.** (2005), *Towards a New Water Culture,* [in:] *New Waterscapes*, pp. 130-131.

Environmental engineering is a field of science concerned with the application of technology to the management of indoor environment and supply of media to buildings. The issues of water supply and waste water disposal are not the subject of hereby studies as they belong to a different branch of science. Also, the so-called water treatment technology, which accompanies spatial solutions taking into consideration the application of water in artificial tanks, is not encompassed by these investigations. In spite of the creation and production of special forms of machines and devices which enable the use of water, it should be stated on the basis of the conducted observations that an object equipped with basic sanitary equipment does not acquire aquatic features.

To sum up, it can be stated that water supplied to the building plays a significant role in maintaining hygienic and sanitary conditions as well as the basis of existence. However, sole sanitary, life-sustaining and fire-fighting functions of water in contemporary architecture do not make an object aquatic. Water plays in this case a service function and becomes an element of technical fittings.

Water physics in buildings and structures

A human organism must maintain a steady temperature in order to live. Human beings first invented clothing, then built shelter serving the purpose of thermal and mechanical protection against the surrounding world. Mechanical protection secures against cuts and injuries as well as rainwater. Protection against water is the most significant aspect as far as thermal protection of the organism is concerned. Thermal conductivity of water is several times bigger than that of air. The necessity of keeping the surroundings dry resulted in the creation of different types of roofs. Roofs and their parts responsible for water disposal are distinctive architectural elements connected with water. Historic architecture reveals special forms serving the purpose of water management in the building and its surroundings (**Krenz J.** 2007). Such elements include gargoyles carrying water off the roofs as well as fountains. Both of them were utilitarian and decorative elements in early city designs (**Niemczyk E.** 2002a).

A great number of elements of the building, which has been evolving through architectural styles, aims to mechanically protect an object from water. For instance, a cornice was created due to the necessity of protection of outer walls from moulds, stains and water penetration. Hood moulding also serves the purpose of protecting windows and doors against water and damp patches. A shape of the roof and in particular its pitch have a close connection with the climate prevailing in the area of object location. Materials used for the roofing play a waterproof role only if they are placed at a proper angle. In a dry climate, without frequent rains, roofs were always flat or built with a slope of an angle of 15–20^{O} (for instance in classical architecture). In the areas of Roman conquest this roof angle did not prove useful, hence new types of roofing were developed. First of all, the roof angle increased in the Gothic period reaching 60^{o}. In a rainy climate of China and Japan, the traditional architecture also featured steep roofs (**Mączeński Z.** 1956).

Architecture as the science which combines different branches of artistic creativity is a set of interdisciplinary issues. Different fields of technical science deal with the issues of water management and protection against water in the built environment. Solutions created by other specializations of building engineering have influence on the final shape of an architectural work. These subjects belong to different fields of science and thus are not encompassed by this research. These fields do not create spatial solutions which contribute to the development of architectural solutions. Water in different states of aggregation in building objects is a substance which is studied by the field of the physics of buildings. Water and its interaction with other materials is a vast branch of science called materials science as well as general building engineering dealing with anti-damp protection of buildings. It is obvious that anti-damp protection of buildings, i.e. the shape of roofs or foundations, has an enormous impact on the architectural form. However, this area of studies connected with climate, accessible materials and technological development constitutes a separate field of technical knowledge. The investigated set of architectural facilities did not reveal that water treated as an object was able to create the architecture of aquatic qualities.

Contemporary architecture, which has been developing since the beginning of the 20th century, broke off from the strict connection between a form and ornaments of the building and the climate prevailing in the area of the building location. That was possible thanks to the evolution of building materials. Architectural details and the roof angle resulting so far from the choice of material for mechanical protection and water drainage began to be unnecessary and hence obsolete. Finally, it faded out making way for the development of modernism (**Michejda T.**[127] 1932).

In contemporary architecture, the role of water in shaping the buildings and their details is not as enormous as in the historic architecture. Contemporary designers are equipped with excellent waterproof materials, therefore the protection against a destructive impact of water on building materials does not require the application of such sophisticated solutions of architectural details.

[127] One of the most significant Silesian architects of the inter-war period.

1.6. Systematics of the functions of water in architecture - summary

This chapter presents the role of water in architecture as well as its functions in the creation of architectural objects. Their systematics has been shown in the table below. The table presents both functions creating aquatic architecture and functions which do not play such a role. Each function is juxtaposed with a set of determinants (indicators). Finding them in a functional and spatial structure of architectural facilities means the presence of a certain function of water.

Table 1

Systematics of the functions of water in architecture. Functions creating an aquatic character and functions which do not decide about such a character of the object [author's own study]

Functions of water creating aquatic architecture	
Functions	*Determinants (Indicators)*
environmental	obstacles and technical challenges
	location on the waterfront
	location in the water space
object purpose determinant	sports and recreation
	transport and circulation
	therapeutic
	scientific
architectural material	building material
	decoration
	shaping the climate of environment and micro-climate of rooms
creative inspiration	formal references, including nautical ones
	cultural references
	references to water science and knowledge of water environment
Functions of water which do not create aquatic architecture	
nautical	shipbuilding of vessels and submarine boats, the so-called *naval architecture*
technical	interaction with other materials, the so-called *physics of the building*
	protection of the building against the impact of damp and water, the so-called *general building engineering*
services	sanitary fittings
	life-sustaining use of water
	fire-fighting

The description of the determined functions of water in an architectural object has been presented below. It includes also quantitative data concerning the frequency of their occurrence in a studied group.

Environmental function of water

There are various reasons for the location of architectural objects on water. They might be traditional boat houses in Thailand or the concentration of boats creating a floating market. The ways of implementation of contemporary architectural objects in the water environment as well as the purposes of their building may be various. Contemporary civilization enters this domain due to stately and representation purposes as well as a desire to manifest its technical and economic capabilities. However, practical reasons may also be noticed. Human beings have always dwelt in different environments, therefore the surface and the depths of seas and oceans have become the goal of such expansion. These areas are to some extent inhabited on a temporary basis. It is connected with work or exploration. International waters have an unexplored potential as the space where stateless implementations could be introduced. Such places could become the areas of creation of the framework of new cultures or the space of free trade. It should be emphasized that the existing oil rigs built in the sea are such extension of the human living environment. In the cities, water reservoirs are sometimes the only areas free of building development. In some urban centres, the location of residential buildings as well as of services and commercial objects has influence on solving transport and circulation issues.

Function of object purpose determinant

Water is an element occurring in the natural environment and the built environment (**Fuses J.**, **Viader J.M.** 2002). Both in architectural space and in nature, water constitutes a magnet attracting human beings. The reason for such behaviour might be probably found in the prehistory of mankind and all civilizations (**Niemczyk E.** 2002a), but also in solely hedonistic approaches. Humans like staying in the vicinity of water. Water inspires, delights, intrigues, allures and engages all senses. It is an exceptional material. It is visible but colourless, you can go into water but you can also hit it, it brings soothing but also poses a threat. Such a substance constitutes an attraction placed in building objects, the attraction that determines the buildings' function.

Indoor and outdoor swimming pools as well as water parks are constructed irrespective of the natural occurrence of water. There are obviously implementations in the vicinity of natural water environment but also implementations far inland. In such facilities it is the water that is the main functional element and other spaces are subordinated to it. The examples of such facilities include the Olympic Swimming Pool in Berlin designed by Dominique Parrault or the Nautical Center in Mantes-la-Jolie designed by the same architect as well as the National Centre of Water Sports in Beijing designed by the PTW Architects.

Water plays a fundamental function in recreational, transport, therapeutic and scientific facilities. Using various properties of water and capabilities of modern technology, architectural objects are constructed where water imposes certain elements of the structure of architectural space (**Fischer J.** 2008).

Function of architectural material

The conducted studies were aimed at observations in what way the substance so commonly occurring in nature is used by designers as a material in the creation of architectural space. The features of water were sought in the built environment.

Water occurs in solid, fluid and gaseous states in the natural environment. Vapour is an invisible substance and does not play a creative role in architecture. It is rather a cause of the deterioration of buildings as it permeates through partitions and condenses in the layers of walls and roofs causing the destruction of architectural objects. In its volatile state, water is perceived as mist and clouds. It is a condensed steam whose microscopic droplets are suspended in the air and are mechanically carried by air particles.

On the basis of the presented analyses, various applications of water in contemporary architecture can be revealed. One of the ways of using physical properties of water is its application for artistic and visual purposes in order to achieve certain objectives. These actions are similar to work with other materials. Unpredictability of water behaviour in an architectural object and its subordination to the laws of nature remind of the application of sunlight in architecture[128]. It is proposed that architects' and artists' actions connected with the creation of water image in architectural objects and the application of water as an element of a spatial composition should be classified in a set called **aquatic plastic arts.** Prediction of a way of occurrence and formation of water in architectural space constitutes a significant new research issue. Development of knowledge within the scope of **aquatic plastic arts** – as solutions emphasizing the architecture of buildings and structures by means of phenomena taking place in water – requires interdisciplinary research. Such research should aim to determine and develop particular features, properties and applications of water material for decorative purposes.

Eco-technological (technological and ecological) significance of water as a factor shaping the environment in contemporary architecture can be noticed mainly in the objects which were constructed specially for the functions connected with water. These are implementations where water is a purpose determinant for which users visit or use such a place. The presented analysis (6–8%) shows that water plays technical functions mainly without the relation with other applications of water in architecture. It seems that especially the eco-technological role of water would require a more frequent application in architectural objects, for instance in the implementations where water plays a role of object purpose determinant[129].

Architectural objects using water as a technological factor require spatial solutions which take into consideration energy conversions of water. The application of special technical solutions is necessary in the case of treating water as an ecological factor making the building environmentally friendly. Contemporary architecture comes up with a new set of issues clearly connected with the technology of using water for the creation of a micro-climate of the interior. The so-called ecological effects are achieved by means of specially designed architectural forms [Case 26].

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[128] Per analogy to the issues connected with the creation and perception of architecture as a result of the operating sunlight. This issue was described a dozen or so years ago by M. Twarowski. The phenomena using the operation of sunlight on the architectural form in order to exhibit some features – were called helios plastic arts (**Twarowski M.** 1996).

[129] For instance swimming pools which are perfectly suited for such fusions.

Function of creative inspiration

The foregoing deliberations allow us to remark that an inspirational function of water is based on the references to forms, culture and knowledge of the environment in the human imagination. Such references and associations arise in two different moments. The first references may come during the designing process (**Zumthor P.** 2007). They constitute inspiration for architects and their implementation in the subsequent designing phases contributes to the cohesion and expression of the whole design[130]. What is the role of inspiration in designing? What is inspiration itself? How does it differ from imitation? It is a phenomenon which is very difficult to describe in scientific terms, whose meaning is intuitively felt rather than precisely defined. The terms of intuition and inspiration appearing together point out to the subject matter connected rather with subjective inquiries in the scope of psychology or sociology. The explanation of the term of inspiration may provide answers to several questions.

In what way does inspiration differ from imitation? It seems that the simplest answer is as follows: imitation is a repetition of solutions within one field, whereas inspiration transfers solutions from one field to another. For example, the inspiration of natural creation stimulated the imagination of designers to shape the structure of the form of the Kunsthaus building in Graz. Without further deliberations on the essence of inspiration but rather following the directions prompted by intuition, we may conduct observations of architectural objects in search of associations, forms and meanings connected with water (**Majewski J.S., Kubaczka M.** 2001).

Many properties and phenomena connected with water, in the material, cultural and social spheres, have become inspiration for the creation of architectural forms. An inspiring role of water in the constructed architectural object consists in the creation of proper associations in users[131]. The aquatic functions connected with the object do not have to be confirmed by the building's function (for instance, the Gugenheim Museum in Bilbao or the Silesian Bank - Bank Śląski). These examples prove that it is the associations that tell us to classify the aquatic character of such facilities in the category of intellectual experiences.

[130] Notes made by Peter Zumthor on his concept of the design of the Vals thermal baths explain the symbiosis of the structure and natural surroundings (Zumthor P. 2007).

[131] The role of associations in the perception of architecture is emphasized by Stefan Kuryłowicz (2000) in his monograph *Idea and its implementation with reference to the office tower 'Nautilus' - Idea i jej realizacja przy okazji opisu biurowca „Nautilus”.*

Chapter 2. CONDITIONS OF CLASSIFYING OBJECTS AS AQUATIC ARCHITECTURE – SELECTED CASES OF AQUATIC FACILITIES

The previous analysis was conducted in order to find and attribute a function to water in an aquatic architectural object. Also, representation and stately functions of water in contemporary architecture were indicated. These functions constitute the structure of the adopted procedure, which will serve the purpose of the development of a diagram of classifying objects as a part of the set of aquatic architecture. The analysis contained in this chapter deals with the occurrence of the following (previously described) functions in the selected cases of aquatic architectural objects:

1. environmental function which is determined by:
   a) water as a natural obstacle constituting a technical challenge,
   b) object's location on the waterfront,
   c) object's location in the water space;
2. function determining the object's purpose:
   a) sports and recreation,
   b) transport and circulation,
   c) therapy,
   d) science;
3. function of an architectural material, such as:
   a) building material,
   b) decoration (artistic elements),
   c) factor shaping the climate of the environment and the micro-climate of rooms;
4. function of creative inspiration by means of:
   a) formal references, including nautical ones,
   b) cultural references,
   c) references to environmental and water science.

2.1. Selection criteria of examples

The studied cases of architectural facilities of an aquatic character were taken from three following sets:
- objects of world aquatic architecture,
- author's own designs,
- objects designed by students within the framework of their diploma theses executed under the author's supervision.

World architecture

To illustrate world implementations, the author chose significant objects, which are recognized by literature, can be found in publications or on the Internet in the form or presentations. The chief criterion deciding on the classification into the set of analyzed objects was the person who designed them. The described group belonging to world architecture includes objects which were designed by renowned and acknowledged architects, the winners of numerous trade prizes or international awards. The second criterion was the popularity and uniqueness of a building. If the building is innovative or widely recognized as unique, it was also taken into consideration in the selection process of examples.

From a numerous set of implementations 21 examples were chosen including works designed by such architects as: Hani Rashid, Lise Anne Couture, Norman Foster, Elisabeth Diller and Ricardo Scofidio, Tadao Ando, Renzo Piano, Peter Zumthor, Dominique Perrault, Stefan Behnisch, Herman Hertzberger, Michael Meredith, Hilary Sample, Tom Wright, Zaha Hadid, Winy Maas, Jacob van Rijs, Nathalie de Vries, Carlo Ratti.

Author's own designs

The author of this monograph has executed one hundred and several dozen designs (in different stages of implementation) for 24 years of his professional career. Around 100 works constitute the designs of buildings where the author played a role of a designer. Approximately 30% of works were finished in the concept-development phase. Additionally, in about 50 objects the author played a function of a supervisor checking administrative procedures in the process of obtaining building permits. Approximately 75% of the designed facilities were implemented. The group of implemented objects includes 19 structures which reveal aquatic features (compare Annex no 3). The participation of designs of aquatic objects in all executed designs amounts to about 14%. This value is similar to the percentage of designs of aquatic architecture in contemporary implementations included in *The Phaidon Atlas of Contemporary World Architecture*. A slightly bigger number of aquatic designs (by around 1%) in the author's whole set of designing works results probably from the fact of author's specialization in this field. The designing studio run by the author obtained a certificate from the European Waterpark Association[132] in 2001.

The below analysis focuses on 8 examples which best present the directions of artistic search and experiments contained in the author's designing solutions.

[132] EWA, European Waterpark Association with the seat in Leipzig (Germany) is an organization associating operators, owners, collaborators and designers of water parks in Europe.

Diploma designs

Under the author's supervision approximately 50 diploma works were executed by the students of the Faculty of Architecture at the Silesian University of Technology. There were 17 designs of objects of an aquatic character (compare Annex no 2) among all works. These diploma designs were made between 2000 and 2015.

All diploma theses were done according to one procedure. In the introduction, the subject referring to the relationship of water and architecture was established. The research question was as follows: If certain aquatic factors are adopted, can a proper technical design of the object be obtained in compliance with modern aesthetic standards? All diploma works were executed according to the same schema. The analysis of similar architectural facilities was conducted in the scope of their function and location. Designing solutions were based on the obtained results from the analysis.

All designs were based on the following rules:

– designing solutions must make use of recognized technologies,

– functional and spatial systems must comply with climatic conditions of the place of their location,

– none of the solutions may generate unnecessary, unjustified or excessive costs,

– designed facilities must have functional parameters complying with the rules of ergonomics or architectural and building regulations.

The executed diploma works resulted in conceptual designs of architectural objects of an aquatic character in which water played characteristic functions. All designed objects had features showing big probability of technical implementation. All executed designs revealed innovative features in the scope of spatial solutions, a method of use or localization options. From the set of the developed designs ten designs were selected to be placed in the set of investigated objects.

Joint criteria for all source sets

In total, 38 objects representing contemporary architecture were selected. The composition of the set is as follows: examples of world architecture executed by other architects [21], diploma designs executed under the author's supervision [10], author's own designs [7].

Common criteria for all objects are as follows:

– Period of time

All selected facilities were designed after the year 1990, i.e. they encompass the past 25 years of architectural design.

– Types of objects

All objects show aquatic qualities. These features were recognized on the basis of observations, expert's opinion and assessment of designs, images presented in the form of photographs or visualizations, or on the basis of author's description of a given object.

– Architectural value

The selection of diploma designs was based on the reviews and final assessment of the examination committee. The critical elimination of own elaborations and the selection of works designed by renowned architects make it possible to assume that the analyzed examples present an adequate level of spatial solutions. The set of own works includes designs which obtained the total number of 7 awards, honourable mentions or nominations[133]. The selected diploma designs include 4 works which obtained awards, nominations or honourable mentions[134].

– Location

The geographical scope of research on architectural objects was not limited as the research is concerned with the whole set of contemporary architecture without any limitations to specific locations on Earth. The examples include Polish designs and implementations (12), European ones (19) and world ones (7) (compare Table 2).

Table 2

List of the locations of objects presented in the analyzed cases of aquatic architecture [author's study]

Location		
POLAND	EUROPE except Poland	WORLD beyond Europe
Szczyrk Zabrze Sosnowiec Żywiec Warszawa (Warsaw) x 2 Katowice x 2 Bydgoszcz Hańcza Lake Kraków (Cracow) Dąbrowa Górnicza	Hammerfest, Norway Kemi, Finland Verdon les Bains, Switzerland Copenhagen x 2 London x 2 Berlin x 2 Saragossa Brussels x 2 L. Malaren, Vasterls, Sweden Amsterdam x 2 Newcastle, UK Stralsund, Germany Vigo di Fassa and Ramsau a.D. Vals, Switzerland	Pekin, China Strandbroke Island, Australia Osaka, Japan Tsuna, Hyogo, Japan Dubai, United Arab Emirates Ontario Lake, Canada Phangnga, Thailand
Total: 12	**Total: 19**	**Total: 7**

[133] The main seat of the Silesian Bank - Bank Śląski in Katowice:
- Honourable mention by the Voivode of the Silesian Province and the SARP for the best implementation in 2000.

Copernicus Science Centre in Warsaw:
- Prizewinner of the International Architectural Competition in 2005.
- Prizewinner in the plebiscite Polish Architecture XXL as the most interesting building in the category of culture and science, 11.03.2011.
- The most beautiful building in the capital city. The prizewinner in the Internet plebiscite organized by the TV programme the Rhythm of the City by TVN Warsaw for the most beautiful building of the capital city 07.12.2010.
- The title of the 'Construction of the Year 2010' in the competition organized by the Polish Association of Building Engineers and Technicians with the participation of the Ministry of Building Engineering and Construction and the Main Office of Building Supervision, 12.07.2011.
- Nomination for the Mies van der Rohe international award for European architectural objects, 08.12.2010.
- Award of the Minister of Culture and National Heritage for the best object serving cultural purposes in the 2nd edition of the competition 'Life in Architecture' for the most interesting Polish building implementations in the years 2000-2012, 06.12.2012.

[134] A. Domagała, D. Podgórna, M. Bałdys, A. Kołodziej.

– Accessibility of materials

The examples were drawn from literature, archives of the Silesian University of Technology, own records of designing documentation, Internet presentations prepared by experts or authors of given designs. All analyzed cases are provided with accessible materials such as descriptions in printed publications, technical or author's descriptions, drawings of basic functional and spatial solutions, visualizations or photographs. There is one exception, namely the author's experiment to build snow shelters, which was implemented without any design. The tables of examples include the publication of the objects' images whose copyright belongs to their designers. The tables aim to give a general character of a building. Detailed presentations can be found on the Internet websites, the addresses of which have been quoted in the captions.

2.2. Analyze of selected architecture examples

1

Floating House
World Architecture

Designer:
MOS Architects
Michael Meredith, Hilary Sample

Implementation date:
2005

Object function:
Residential building floating on water

Object size:
186 m^2
1100 m^3
N/A ha

Location:
Ontario, Canada

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

This design combines a traditional house with the conditions referring to *site-specific* typology. In this special place, on an island on Lake Huron, cyclic changes connected with the seasons of the year prompted solutions complying with the world trends in environment protection. In order to adapt to a constant dynamic change of the water levels, the house floats on the surface of the lake. The building is set on a foundation made in the form of steel pontoons.
The construction of this house was sparked off by the idea to combine traditional technology of building engineering with unusual location. The location on the water contributes to great attractiveness of the house, however, it causes considerable difficulty in the building's implementation. The manifestation of the feasibility of the construction of traditional residential forms on the water cost a lot of effort in the scope of logistics (materials transport) and assembly. The pontoons constitute a counterpart of the foundations of a traditional structure. The residential house with spatial solutions typical of land architecture has become a proof of the possibility of building similar forms to land architecture on the water.
An aquatic quality of this building is determined only by its location.

Fig. see: http://www.archdaily.com/10842/floating-house-mos 28.10.2022

BLUR BUILDING
World Architecture

Designer:
Elisabeth Diller & Ricardo Scofidio

Implementation date:
2002

Object function:
Temporary exhibition facilities built for the World Exhibition

Object size:
approx. 600 m^2
approx. 12000 m^3
approx. 2 ha

Location:
Yverdon-les-Bains, Switzerland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material	■	
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

An openwork structure was designed on the surface of the lake. Its 'filling' and optical mass are made of a cloud. This artificially created cloud or haze constitutes the boundaries of the object space. Thirty thousand nozzles generate micro-droplets of water suspended in the air. It is an example of the application of water in its gaseous state to create architectural space. Water in its volatile state as a material seemingly worthless to building engineering becomes a major attraction of the building, its boundary and form. This is an example of aquatic architecture whose creation is connected with technological advances and new methods of water management.

Fig. see: https://academics.design.ncsu.edu/student-publication/elizabeth-diller-richard-scofidio-and-charles-renfro/ 22.10.2022

3	ABSOLUTE ZERO. A LIGHTHOUSE OF TEMPORALITY World Architecture

Designer:
ASYMPTOTE
Hani Rashid, Lise Anne Couture
Team: Noboru Ota, Jill Leckner

Implementation date:
2003
Object function:
Temporary object made of snow and ice
Object size:
approx. 180 m^2
approx. 600 m^3
N/A ha
Location:
Kemi, Finland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material	■	
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

'As artists and thinkers, the authors commented on the notion of order, because it refers to the relation to nature beyond a scientific debate. From this perspective, they can propose the possibilities which could be dangerous to human conditions in certain reality. This work aimed to use the forces of nature to create the built environment. The architecture of a building and its resultant interiority is passed in a traditional way, like telling old tales, through advanced ideas, like engineering, and by means of mathematical formulas. Working on the boundaries of these phenomena, designers have tried to reveal contemporary and traditional views on the place of a human being in technological and natural space, which seems to be an intriguing issue on a global scale'[135].

Fig. see: http://www.asymptote.net/#!snow-show-slide-show/colg 28.10.2022

[135] Asymptote in: **Fung L.** (2005), *The Snow Show. Thames and Hudson*, New York, p. 154 [Author's translation].

4

HOTEL BURJ AL ARAB,
World Architecture

Designer:
Tom Wright
Implementation date:
1994-1999

Object function:
Services object including:
hotel, recreation and services facilities
Object size:
height 321 m
no data m²
no data m³
no data ha
Location:
Dubai, The United Arab Emirates

			Water Impact
Water Functions	environmental	obstacle	
		on the waterfront	
		location in the water	X
	determining object purpose	sports and recreation	
		transport and circulation	
		therapeutical	
		scientific	
	material	building material	
		decorative material	
		eco-technological	
	inspirational	formal references	X
		cultural references	
		references to science and environment	
On land, without contact with water environment			

he hotel building is located 280 m from the beach on an artificial island. The hotel houses 202 suites from 169 m^2 to 780 m^2, several restaurants, including one located under water. The building features a several-storey aquarium with a living coral reef. The object is decorated with water cascades and fountains.

Due to the standard of services related to the shape of the building and its furnishings, the quality of the hotel considerably surpasses the standards of a five-star hotel. However, the owners adopted the classification of five stars using an additional adjective of *deluxe*. It refers to an actual standard of the building. Explicit references to *naval architecture* place this implementation in a set of buildings in which formal aquatic inspiration played an important role in the formation of the functional and spatial system.

Fig. see: https://en.wikipedia.org/wiki/Burj_Al_Arab 28.10.2022

5 **DIVING POOLS**
World Architecture

Designer:
John Beernaerts
John Nuttyheart

Implementation date:
2004
Object function:
Facilities including: diving pools for recreational and research purposes

Object size:
approx. 1520 m^2
no data m^3
no data ha
Location:
Brussels, Belgium

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

The accessibility of technology resulted in the development of organizations dealing with scuba diving. A new branch of recreation has been developed. Scuba diving is generally practised in open waters, such as seas, lakes or rivers. However, it gave rise to the demand for artificial pools serving the purpose of this type of recreation. In 2004, a diving pool Nemo 33 designed by John Beernaerts was constructed in Brussels.
It is an artificial water tank of a depth of 33 m. The deepest range is provided in a circular tube. In the upper part there are spaces of a smaller depth serving the purpose of diving classes not connected with achieving maximum depths. Water temperature in Nemo 33 is kept at a level of 30^{O}C, which makes diving conditions very comfortable. A similar aquatic function is played by a diving pool Y-40 constructed in the town of Montegrotto in Italy. This water tank reaches a depth of 40 m. The foregoing objects are examples of newly-built aquatic architecture serving the purpose of preparing and training users with scuba diving equipment[136]. They constitute a new kind of implementations in the scope of aquatic architecture - a new type of built space.

Fig. see: https://www.nemo33.com 22.10.2022

[136] Individual equipment of a diver enabling them to breathe under water; it consists of oxygen supply in a compression cylinder, a scuba – a self-contained underwater breathing apparatus – feeding the air and reducing its pressure.

McLAREN LABORATORY

World Architecture

Designer:
Norman Foster

Implementation date:
1998-2004

Object function:
Laboratory facilities housing research and manufacturing centre

Object size:
63 000 m^2
approx. 294 000 m^3
50 ha

Location:
London, the UK

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

The manufacturer of high-quality racing cars - McLaren company entrusted Norman Foster with the design of their plants in the vicinity of London. Using cutting-edge technology, this architect in cooperation with Atelier Dreiseitl, an experienced company in water management and application of water for ecological purposes, designed the building where water constitutes an element of architectural composition and a factor creating an internal micro-climate. Using artificially created water reservoirs in the form of the so-called lake and gutter, the surface water is collected, transported, cooled and used as a technological factor. Water being subject to physical transformations, such as vaporization, condensation and atomization, is cooled and may be used for the cooling of the facilities. The water prepared in the cascade and cooling tower goes through a system of heat exchangers and coolers. Having been prepared in this way, the water is supplied to the heating and ventilation systems of the object. This implementation enveloped in water is an example of a technological role of water in ecological building investments.

Fig. see: https://arquitecturaviva.com/works/centros-de-tecnologia-y-produccion-de-mclaren-10 22.10.2022

WATER TEMPLE
World Architecture

Designer:
Tadao Ando

Implementation date:
1991

Object function:
New hall of a Buddhist temple

Object size:
approx. 450 m^2
6000 m^3
0.3 ha

Location:
Tsuna. Hyogo, Japan

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references	■	
		references to science and environment		
On land, without contact with water environment			■	

Scenery-connected urban and architectural structure called the Water Temple constitutes a new entrance hall to a Buddhist chapel. The combination of meanings and metaphysical features of water provides the structure with remarkable cohesion of ideas. The architecture and its elements, such as pure forms of concrete walls and water, co-exist with spiritual heritage. Water symbolizes purity, abyss, infinity and inaccessibility. A cultural message and significance of water in most civilizations are often exhibited as the combination of material and space. Similar meaning is attributed to water in another work by this architect, namely the Church on the Water. It is a Christian temple, where the main element in the form of the cross is placed in a water reservoir. It symbolizes in a contemporary way what is perfect, unattainable and unsurpassable. The flat surface of water symbolizes an ideal, from which a human being is cut off by means of an invisible border. This barrier is present first of all in human behaviour and emotions. The water obstacle can be crossed over. These two masterpieces perfectly show contemporary cultural references of architecture to water in the sphere of inspiration and associations.

Fig. see: https://arquitecturaviva.com/works/templo-del-agua-higashiura 29.10.2022

8

POTSDAMER PLATZ

World Architecture

Designer:
Renzo Piano,
Christoph Kohlbecker, Atelier Dreiseitl

Implementation date:
1997-1998

Object function:
Urban square among public utility buildings

Object size:
approx. 400 m^2
N/A m^3
approx. 1.0 ha

Location:
Berlin, Germany

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material	■	
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

A city square is a traditional place of occurrence of water in urban space. Since the earliest epochs, the placement of a water element in the form of a pond or a fountain has provided the place with splendour and attractiveness. In one of the biggest European capital cities, an urban square was built in the area which was cleared for investment purposes after the fall of the Berlin Wall. The square was designed among a group of prestigious office buildings. Meticulous architecture of this site makes use of urban and architectural methods of shaping the city's climate and atmosphere. Underground cisterns for rainwater along with the runoff to the nearby river constitute a system of water management and provide the quality of living space. Annual fluctuations of temperature in the vicinity of rainwater cisterns are smaller. This brings a cooling effect in the summer and a warming-up effect in the winter. The system is connected to pools equipped with cascades, which are not only an element of an ecological way of creating the urban interior climate but also play a decorative function. The designed flow of water over the meticulously formed ledges constitutes an artistic element. Water and in particular optical and non-optical phenomena connected with its existence contribute to its visual and environmental impression made on the urban space.

Fig. see: http://www.dreiseitl.com/ext/cmp_content_gallery /925.jpg 29.10.2022

9

THERME VALS
World Architecture

Designer:
Peter Zumthor

Implementation date:
1996

Object function:
Group of bathing pools in the form of public thermal baths

Object size:
2500 m^2
8000 m^3
0.8 ha

Location:
Vals, Switzerland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical	■	
		scientific		
	material	building material	■	
		decorative material	■	
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

The building was designed in the Alps. Its architecture is to reflect elements of the natural landscape of the mountains. The designer chose quartzite as a material representing mountains. This stone is a popular mineral in the surroundings. The water in the designed object is used in contrast to the stone. Physical and artistic properties of water are a dominant expression of internal spaces in the thermal baths in Vals. The contrast of nature, i.e. a stone material and water, was highlighted in the buildings of thermae. Water fills in all recesses and crevices; its surface is ideally smooth or rippled; it is changeable in contrast to the solid surface of stone, which is also full of variety. Apart from the stone, water is a dominant material influencing the perception of the building space. The water is a medium and simultaneously the matter creating space boundaries. It is a material creating forms (geometrical bodies) which fill gaps in a different material; it is also an ideally flat basis for the views and perspectives; it becomes an architectural material.

Fig. see: http://www.archdaily.com/13358/the-therme-vals/500f245228ba0d0cc7001d3d 29.10.2022

OLYMPIC SWIMMING POOL

World Architecture

Designer:
Dominique Perault

Implementation date:
1992-1999

Object function:
Complex of sports facilities including an olympic swimming pool

Object size:
23 980 m^2
357 115 m^3
10 ha

Location:
Berlin, Germany

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material	■	
		decorative material	■	
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

The building was designed on the former borderline between areas of the East and West Berlin. The construction of this object was connected with the nomination of the city to the group of cities which had a chance to become a venue for the Olympic Games in 2000. The Olympic Games did not take place in Berlin but the constructed facilities serve the inhabitants of Berlin. The facilities consist of two objects, namely a velodrome for bicycle racing (track cycling) and an olympic swimming pool. The whole complex took a form of two clear geometrical bodies, such as a prism with the base of a rectangular and a cylinder. The buildings are surrounded by an earth embankment making an impression that the structures are sinking in the ground. While entering the facilities, the user must first climb up the embankment over the roofs of the buildings. Due to this reason, the roof surfaces take form of an additional elevation. Water plays a functional role in this implementation. The object was built in order to provide an artificial water basin of the olympic dimensions as well as a diving tower, which obtained an unusual characteristic spatial structure. There are additional functions located around the main swimming hall, including a training swimming pool measuring 25 m. Interacting with artificial lighting, water not only shapes the space but also creates intriguing visual effects.

Fig. see: http://www.perraultarchitecte.com/en/projects/2464-velodrome_and_olympic_swimming_pool.html 29.10.2022.

11

OZEANEUM
World Architecture

Designer:
Stefan Behnisch, Martin Haas, David Cook (Behnisch Architekten)

Implementation date:
2002-2008

Object function:
Oceanarium

Object size:
17 400 m^2
90 900 m^3
10 ha

Location:
Stralsund, Germany

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific	■	
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

The Oceanographic Museum is located on the *waterfront* and in the close vicinity of the old town in Stralsund, which was enrolled on the UNESCO heritage list. The object plays scientific and recreational functions. Research tasks are carried out in pools where water-life ecosystems were created. A freely shaped open structure is flooded both by the crowds of visitors and the sunlight coming from all directions. Such a form of the object is to bring associations with stones being flooded by water[137]. The changeability of the space perception is to continuously evoke associations with natural marine landscape. Curved lines of the forms easily reveal the designers' inspiration. The external form evokes explicit associations with naturally corrugated formations shaped by water. The interior has curved natural lines and forms making an impression of the immersion in the natural fluid world shaped by water. Environmental references in the way of shaping the body of the object seem to be well recognized by users and appreciated by critics. This object received seven important architectural awards, including the title of the European Museum of the Year.

Fig. see: http://www.ozeaneum.de 29.10.2022.

[137] On the basis of: http://behnisch.com/projects/147, as of 07.08.2015.

12

ING BANK HEADQUARTERS - VIVALDI TOWER

World Architecture

Designer:
Norman Foster

Implementation date:
2005-2007

Object function:
Office building

Object size:
30 000 m^2
91 000 m^3
approx. 1.7 ha

Location:
Amsterdam, The Netherlands

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

Intangible references to the flow of water reminding of the flow of money[138] seem to be of little significance here. In this case, the emphasis of such meaning appears to be unnecessary as the essence of this design is rainwater management and its role in the shaping of micro-climate and the protection of natural environment. Water in this design has technological significance and plays an important role in the creation of a pro-ecological image of the building and investor. Rainwater is collected in an internal pool-pond. This element constitutes the centre for the creation of recreational and social functions of the object. Retention of water starts already on the roof surface. The water is directed then into an internal patio housing the main reservoir. The level of water in the reservoir fluctuates by about 10 cm, which encourages the growth of plants. The water in the open pool has a chance to evaporate some amount before it is let into the municipal runoff system. This system of water management retains 80% of rainwater. This ecological element introduced into a modernist structure of the building breaks off from a minimalist concept of juxtaposing simple geometrical bodies with water. This building shows ecologically shaped architecture in an innovative way.

Fig. see: https://people.utm.my/lylai/files/2017/06/Waterscapes_37.pdf 29.10.2022

[138] Dreiseitl H. (2005), *Integrated Water Design for ING Bank*. Amsterdam, p. 36.

13 **GATESHEAD MILLENNIUM FOOTBRIDGE**
World Architecture

Designer:
Wilkinson Eyre, Gifford&Partners

Implementation date:
2001

Object function:
Bridge

Object size:
N/A m^2
N/A m^3
approx. 0.01 ha

Location:
Newcastle, UK

Water Functions	environmental	obstacle	■	Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

Blinking eye[139] – is the name of one of the most innovative bridge structures serving the purpose of water obstacle crossing. Unprecedented structural solutions consisting in unusual methods of bridge opening and closing are the main asset. Contemporary technical capabilities enable the implementation of daring technical experiments. Despite the fact that this structure does not boast a record length, span or other parameters, it has become a recognizable sign of technical capabilities and a symbol of new ways of overcoming water obstacles. The bridge was designed for pedestrians and cyclists, however, its remarkable technical solutions place this object in almost every publication dedicated to contemporary spatial solutions of bridges. This structure is an example showing that an encountered water obstacle may provoke the creation of innovative spatial solutions.

Fig. see: https://upload.wikimedia.org/wikipedia/commons/f/f8/Gateshead_Millennium_Bridge_-_coming_down.jpg 27.10.2022

[139] Perino A.S., Faraggiana G. (2004), *Bridges*, p. 169.

14

LONDON AQUATICS CENTRE
World Architecture

Designer:
Zaha Hadid

Implementation date:
2005-2011

Object function:
Swimming centre

Object size:
28 000 m^2
no data m^3
approx. 1.7 ha

Location:
London, UK

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

The object was described by the designer as 'inspired by the fluid geometry of flowing water'[140]. It unquestionably evokes associations with a liquid material. The space and elements of the interior furnishings also seem to drift or present the forms frozen in its dynamics. The vicinity of the river emphasizes even more an aquatic character of this building. The shape of the roof in the form of a wave is a deliberate reference to the natural environment. The expression of the building is definitely directed at evoking associations with undulating space or water forms.

Fig. see: http://www.zaha-hadid.com/architecture/london-aquatics-centre/ 22.10.2022

[140] http://www.zaha-hadid.com/architecture/london-aquatics-centre/, as of 26.07.2015.

15

SILODAM
World Architecture

Designer:
MVRDV
Winy Maas, Jacob van Rijs, Nathalie de Vries

Implementation date:
1995-2003

Object function:
Residential structure

Object size:
19 500 m^2
no data m^3
approx. 1 ha

Location:
Amsterdam, The Netherlands

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

This residential object has a container-shape structure, which is a reference to the nearby port[141]. The building typologically belongs to urbanized landscape, however, it is located on the surface of water. It consists of 157 dwelling units, offices, working spaces, commercial objects and public spaces. The structure of the building is 20 m wide and 10 floors high. The changeability of the development of the internal space is reflected on the elevation of the building as an image of the functional structure. Conceptually, this building is set at the beginnings of modernism and is connected with the Marseilles Housing Unit and other similar solutions. Great advantages of the Dutch object lie in its diversity and connection with the water environment. The building which could have been implemented on land was constructed in the harbour, at the end of a long pier. Functions that connect it with the water, such as a boat haven, give even more aquatic character to the building.

Fig. see: https://www.mvrdv.nl/projects/163/silodam 29.10.2022

[141] http://www.mvrdv.nl/projects/silodam, as of 05.03.2015.

16

UTTER INN
World Architecture

Designer:
MIKAEL GENBERG

Implementation date:
2000

Object function:
Recreational house

Object size:
32 m²
100 m³
N/A ha

Location:
Lake Mälaren, Vasterĺs, Sweden

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

One of the very few implemented objects of underwater architecture. A small scale of the investment facilitated the implementation and operation of this object. It is a recreation house for hire. A shallow underwater location of the bedroom facilitates the light access from the water surface and enables the observation of the underwater world and its seasonal changeability. Seemingly, this object is like a typical Swedish hut placed on a raft. However, it is its underwater part containing a bedroom that contributes to its uniqueness. This object is called a hotel but in fact it is one hut with an underwater bedroom. However, some hotel services may be ordered, such as meals, which are delivered by boat. This object is an experiment and a test of potential clients for such building development. It may be a prototype of some bigger investment. This object constitutes a perfect example of the possibility of the construction of underwater buildings in economic, technological and organizational terms. It is completely different from never-implemented utopias of underwater cities and their functional and spatial structures.

Fig. see: https://visitvasteras.se/hotell-utter-inn/ 29.10.2022

17 **INTERNATIONAL AIRPORT**

World Architecture

Designer:
Renzo Piano

Implementation date:
1994

Object function:
Airport

Object size:
296 000 m^2

Length:
1.7 km

Cubature of the artificial island:
21 mln m^3

Location:
Kansai, Osaka Bay, Japan

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

In spite of some references to a glider in designer's descriptions, this object provokes additional associations of a rather nautical character. The author's interpretation[142] pointing out to the inspiration by the glider's hull and wing significantly disagrees with the users' perception of the object. In a massive body of the airport building with an undulating roof the users rather see the resemblance to the sea surface, especially that the object is located on an artificial island in Osaka Bay. The process of the object construction was a human struggle with the forces of nature. The stabilization of the artificial island was not immediate and monitoring of the subsidence of the object and runways has been carried out till today. In Japanese realities, in the country where there are no easy land development areas, the construction of the airport on the inshore waters was the next surpassing of the boundaries and opening of new directions of development. The expansion onto inshore waters or rivers or other natural water reservoirs seems to be highly justified in such conditions.

Fig. see: http://www.rpbw.com/project/kansai-international-airport-terminal 29.10.2022

[142] http://www.rpbw.com/project/35/kansai-international-airport-terminal/# as of 24.05.2015.

18

COURAN COVE ISLAND RESORT
World Architecture

Designer:
Jackson Architecture

Implementation date:
1998

Object function:
Recreational and leisure resort

Object size:
no data m^2
no data m^3
151 ha

Location:
Strandbroke Island, Australia

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation	■	
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

'Tourism and environment'[143] are the objectives in this implementation. This is an object belonging to a current of eco-tourism.This holiday resort was built in an unspoiled landscape of rainforests providing the users with a full range of recreational and leisure services. It is equipped with devices serving the purpose of environmental protection and minimization of the impact on the environment. Complete infrastructure was built to equip the facilities with electric energy, fresh water, utilization of sewage and waste. The objects are located on the surface of water in the form of buildings standing on stilts set in the water bed. Also, the land surface on islands has been used. A natural water reservoir plays a function of a yacht haven. Artificial reservoirs built on the island play a function of sports and recreational swimming pools. The object is built in a pragmatic way using natural advantages of the site, which confirms the fact that the designers were not looking for an inspiration by force. The natural water environment dominated the spatial and functional systems as well as technical solutions.

Fig. see: https://www.expedia.com/Gold-Coast-Hotels-Couran-Cove-Island-Resort.h6501527.Hotel-Information 29.10.2022

[143] Designer's assumptions are presented in: http://www.jacksonarchitecture.com.au/data/projects/00000059/1998-Couran-Cove-Resort.pdf, as of 08.03.2015.

19 OFFICE BUILDING OF A BIOPHARMACEUTICAL COMPANY

World Architecture

Designer:
ASSAR Architects

Implementation date:
1997

Object function:
UCB world headquarters – an international manufacturing company with biopharmaceutical headquarters

Object size:
25 000 m^2
70 thousand m^3
approx. 9 ha

Location:
Brussels, Belgium

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

A proper shaping of the building and artificial water reservoirs enabled the realization of environmental objectives. The user's and investor's high ecological awareness made it possible to form this building in such a way as to enable proper management of energy. Activities connected with the heat flow involve water as a medium which easily stores and gives up heat. An external artificial water reservoir plays ecological and technological functions apart from a compositional role. However, the very visual effect is not an end in itself. The implementation of water reservoirs next to the objects using the latest technology contributes to the natural environment protection. Water reservoirs accumulate rainwater and simultaneously take part in the cooling or heating processes of the building. This object was granted an award by the RICS[144] in a category of energy respect in 2001..

Fig. see: https://www.ordina.be/en/wp-content/uploads/sites/9/2018/08/ucb.jpg 29.10.2022

[144] RICS – Royal Institution of Chartered Surveyors – associates specialists in building engineering as well as the operation of buildings and real estates. The institution deals with planning, evaluation, cost estimation and management. Source: http://www.rics.org/uk/about-rics/who-we-are/, as of 18.10.2015.

20

DIGITAL WATER PAVILION

World Architecture

Designer:
Carlo Ratti Associatti

Implementation date:
2008

Object function:
Exhibition pavilion at EXPO 2008

Object size:
approx. 50 000 m^2
939 thousand m^3
approx. 8 ha

Location:
Saragossa, Spain

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material	■	
		decorative material	■	
		eco-technological	■	
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

Water pavilion constructed for the Expo exhibition is an interactive structure whose boundaries are built from electronically controlled walls. Water curtains open when a person approaches and let them in. It is a changeable and multi-functional space. The objective was to use water as an architectural material[145]. The electronically controlled flow of water droplets enables the operation of the walls. This system makes it possible to open entrances and present graphic or visual effects. The structure of the water wall changes in accordance with the programmed flow. In this way, various patterns and visual effects are created on the walls. Automation can be adjusted to a certain time of the day and a number of visitors. An inter-active aspect between the building and the user is executed in this way. Using the designed system of water pipes and their controlling, the user may configure the pavilion for the use in different ways. It is an aquatic object where water is used as a material of partition walls. Moreover, the visual properties of water are used as well as its interaction with the light. Additionally, water streams are a perfect regulator of temperature in the hot climate of Saragossa.

Fig. see: http://www.carloratti.com/project/digital-water-pavilion/ 29.10.2022

[145] http://www.carloratti.com/project/digital-water-pavilion/, as of 15.06.2015.

Designer:
PTW Architects CSCEG Design ARUP

Implementation date:
2003-2007

Object function:
Olympic swimming pool

Object size:
approx. 50 000 m^2
939 thousand m^3
approx. 8 ha

Location:
Beijing, China

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references	■	
		references to science and environment		
On land, without contact with water environment			■	

A clear reference to water as a material obscures other aspects of the water impact on this object. In Chinese beliefs, circular shapes symbolize heaven. This symbol was executed in the form of the nearby olympic stadium. A cuboidal shape symbolizes Earth. The fact of covering the object with the elevation evoking associations with water is a strong reference to Chinese architecture which distinctly applies symbolics[146]. The fact of using references to traditional associations is astonishing, particularly in the juxtaposition with advanced modern technology, which suggests a rather pragmatic way of thinking and a superficial way of interpreting the reality. Modules made from the ETFE[147] not only evoke associations with water, but first of all, take part in the heat management of the building and play a role in the lighting of the swimming hall[148].

Fig. see:
https://en.wikipedia.org/wiki/Beijing_National_Aquatics_Center#/media/File:Beijing_National_Aquatics_Centre_1.jpg 29.10.2022

[146] Source: PTW Architects.
[147] ETFE – Ethylene-tetrafluoroethylene – is a plastic material in the form of a foil, which shows excellent optical properties and bigger resistance to the UV radiation than other plastics as well as self-cleaning properties. Source: https://en.wikipedia.org/wiki/ETFE, as of 18.06.2015.
[148] Similar solutions were used in Allianz Arena in Munich, designed by: Herzog & de Meuron, and in the Eden Project by Nicholas Grimshaw, however, in these locations these forms do not evoke aquatic associations.

22	**BANK ŚLĄSKI HEADQUARTERS** **Own Design**
	Designers: **Denton-Corker-Marshall** **Mark Kubaczka, Jowita Kubaczka,** **Steve Jones, Phill Gusack, Janusz Wróbel,** **Wojciech Badowski,** **Zbyszko Bujniewicz** Implementation date: **1997-2000** Object function: **Office buildings including:** **bank space and space for rent** Object size: **27 905 m^2** **125 233 m^3** **2.2 ha** Location: **Katowice, ul. Sokolska, Poland**

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

The only bank headquarters in Poland built outside the capital city of Warsaw. The owners of Bank Śląski entrusted the development of the design to a renowned international company Denton Corker Marshall with the seat in Australia. The design of the building was developed by architects working in specially created offices in Warsaw and Katowice.

The interpretation of the designers' inspiration is facilitated by the below analysis: 'a massive edifice of the Bank Śląski Headquarters like a flagship of Uppersilesian economy is heading for the centre of Katowice city. Colourful accents are distinctly visible against shining metallic broadside of the elevation [...] The elevation, which is as smooth as the ship's broadside, is clad with silvery metal panels [...]. Several balconies on the wall of the longer building remind of lifeboats being lowered from the ship. Bright colours of orange, light blue and yellow evoke irresistible associations with the Dutch de stijl of the 1920s'[149]. Explicitness of the nautical inspirations of the authors of the Bank Śląski was so strong that the designing studio building the second phase of the project continued the character of the building development using even more direct aquatic references inspired by naval architecture.

see: annex Fig. 2.

149 Majewski J.S., Kubaczka M. (2001), *Bank in Katowice – Bank w Katowicach*, [w:] Porębska E.P. (editor), 'Architektura murator', no 1, Warszawa, p. 26.

23

COPERNICUS SCIENCE CENTRE

Own Design

Designers:

Kan Kubec

Magdalena Gilner

Michał Tomanek

Zbyszko Bujniewicz

Implementation date:

2006-2010

Object function:

Services object and science museum including: exhibition rooms, research laboratories and technical facilities

Object size:

17 440 m^2

116 000 m^3

4.07 ha

Location:

Warszawa (Warsaw), Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment	■	
On land, without contact with water environment				

This architectural object supplements the space with one more 'natural form'. The architects made use of elements of the natural scenery and created an imitation of the natural landscape. This is the architecture that seeks symbiosis with nature. The superior objectives of the design were as follows:

- regaining natural characteristic elements of the waterfront (the borderline between land and water) in the part of the left urbanized riverside of the river Vistula (Wisła), modelled on the right riverside which still remains environmentally intact;
- a new landscape quality was created as a result of the simulation of the processes of river erosion and rainwater erosion in the design;
- water erosion became a method for the construction of external functional spaces and architectural elements: sandbanks, an urban beach, stone gardens, overflow areas, pools, basins and an artificial hill, as well as internal craters/patios, external walls/elevation. The dome of the planetarium was hidden in an erratic boulder (the geometry of erosion). This is the most protruding part of the complex in the direction of the river Vistula (Wisła) and at the same time its chief dominant feature. What seems to be a heavy shapeless boulder, a geological remnant of remote epochs in the daylight, at night glows with an internal light like a meteor, a chipped-off fragment of the universe, showing its internal structure[150].

The design was selected as a result of an international competition.

See: annex Fig. 3.

[150] On the basis of the author's description of the design.

24	BRIDGE OVER THE SOŁA RIVER Own Design

Designers:
Marek Wazowski, Andrzej Radziecki, Andrzej Bzowka, Krzysztof Bar, Jerzy Śliwka, Piotr Wanecki, Michał Tomanek, Zbyszko Bujniewicz

Implementation date:
1999

Object function:
Civil engineering construction

Object size:
Continuous integrated bridge of the total span of 450 m, the bridge span of 90 m

Location:
Żywiec, Poland

Water Functions	environmental	obstacle	■	Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

The Bridge over the river Soła is located in the administrative area of the Żywiec commune. The bridge crosses the river around 800 m away from the existing road bridge in the city centre. The total span of the construction amounts to 450 m. It surpasses the river channel of a width of 90 m and the adjacent floodland, which is limited by embankments asymmetrically located in relation to the river channel. The axis of the bridge is perpendicular to the obstacle. The designed bridge crossing was implemented in the administrative area of the Żywiec commune, on the road between Zwardoń and Sucha Beskidzka. The axis of the bridge was designed in accordance with a general plan of spatial development of the town and was agreed on with the road authorities, such as: DODP Kraków (Cracow) and BPRSD PSSD 'Południe' (South). The bridge axis is a straight line in a projection. On the west riverside, the bridge axis crosses the axis of Wesoła street in the vicinity of the crossroads of Wesoła street and Podlesie street. Further, on the extension of the bridge axis, in the place of the intersection with the road in the direction of Bielsko-Biała – Zwardoń designed by the BPRSD PSSD 'South' - a grade-separated road junction is to be built in the future. The shape of the bridge with a highlighted river span emphasizes the place of overcoming a water obstacle. This is an integrated continuous bridge with the two-box steel section and a concrete platform. The application of metal plates was innovative and state of the art in the-then Poland.

See: annex Fig. 4.

25

WATER PARK

Own Design

Designer:
Zbyszko Bujniewicz
Collaboration:
Tomasz Łopuszyński, Andrzej Tracz
Design date: **2001**
Building permit:
486/01 as of 12-06-2001
Implementation interrupted
Object function:
Water park facilities including:
a set of indoor and outdoor swimming pools
Object size:
7 506 m^2
44 550 m^3
4.40 ha
Location:
Zabrze, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical	■	
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

It was the first of three water parks designed in the form of a central establishment. According to the investor's wish and marketing policy, the object was supposed to be in the scope of the so-called amusement architecture. This kind of expression of architectural forms was in compliance with the image strategy of the investor. It resulted in designing the form which is partially established in the passing epoch of post-modernism. This object as well as a twin-object in Zielona Góra were designed in a traditional system of suspended swimming basins. A single-space hall determining the function of the building consists of pools serving different purposes. The shapes of swimming basins create favourable conditions for swimming lessons, sports training and recreation. The object interior was designed in the style of a tropical jungle. The interior stylization is typical of the best functioning water parks in the world. This object features an unprecedented solution of the changeability of the function of training swimming pool. This pool was designed and equipped with a capacity to change into a whirlpool with a rapid river flowing in the circumference of the pool. This enables a change of a training function into a 'river flow' function at peak hours when the water park is overcrowded and training impossible. It is an innovative solution.

See: annex Fig. 5.

26	**SPORTS WATER PARK** **Own Design**

Designer:
Zbyszko Bujniewicz
Collaboration:
Tomasz Łopuszyński, Andrzej Tracz
Design date:
2000
Building permit:
205/2000 as of 10-11-2000
Object under construction
Object function:
Services object including:
a set of indoor swimming pools
and recreational rooms
Object size:
5688 m^2
45 000 m^3
1.2 ha
Location:
Szczyrk, ul. Wrzosowa, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical	■	
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment	■	
On land, without contact with water environment			■	

'Orle Gniazdo' ('Eagle's Nest) is a transformation of the Beskidzkie Congress and Recreation Centre, which after modernization will provide its guests with: a complex of conference rooms for approx. 1000 people, exhibition rooms of the surface of about 5000 m^2, a large multi-functional and sports hall, tennis courts, bowling facilities, a fitness club, saunas, solaria, a water park, sports equipment for hire, restaurants and bars, a disco, a large manned car park, own ski-lift with a lit piste of the length of 1300-2000 m. 'Orle Gniazdo' ('Eagle's Nest') is the highest-altitude hotel complex in the Beskidy Mountains. The location at an altitude of 700 m provides perfect conditions for training and recreation. The water park under construction will be a sports and recreational complex. A remarkably big number of attractions in the water park swimming pools is to attract visitors and ensure a big popularity of the object. The character of the interior of these facilities will be created by the designed natural scenery of waterfalls and cascades. Additionally, the sports and recreational facilities are supplemented with services offering relaxation and various treatments. A therapeutic role of the recreational object will be reflected in the designed complex of saunas with access to the external space and a set of biological renewal establishments for athletes as well as health and beauty spas for individual clients.

See: annex Fig. 6.

27

SPORTS WATER PARK
Own Design

Designer:
Zbyszko Bujniewicz
Collaboration:
Tomasz Łopuszyński, Andrzej Tracz
Design date: **2003**
Building permit:
7/03/A as of 07-01-2003
The object was not implemented
Object function:
Water park facilities including:
a set of indoor and outdoor swimming pools
Object size:
10 177 m^2
51 000 m^3
4.7 ha
Location:
Sosnowiec, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical	■	
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

Analyses of similar facilities and their functioning in Europe and beyond provided an inspiration for this design. Also, private contacts of the author with the European Waterpark Association enabled the author to gain necessary knowledge in this scope.
The internal space is to create an impression of an unreal land where the scenic decoration of the interior will take the form of the 'Lost Atlantis' . The building was designed in such a way as to minimize energy losses, use rainwater and obtain solar energy. All these assumptions were satisfied by means of simple spatial solutions. The circulation of water in technological devices refers to the circulation of water in nature. For cooling purposes of the hall, an artificial rain was designed. Rainwater is collected in reservoirs and vaporization heat is received by air-conditioning equipment. A partially glazed dome enables deep solar penetration and warming up of the water in the winter, whereas in the summer it restricts the solar exposition.

See: annex Fig. 7.

28

IGLOO

Own building experiment

Designer:
Zbyszko Bujniewicz

Implementation dates of objects:
2009-2012

Object function:
Temporary objects made of snow and ice

Object size:
in total approx. 60 m^2
in total approx. 160 m^3
0.01 ha

Location:
Ramsau am Dachstein, Austria
Vigo di Fassa, Italy

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material	■	
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment			■	

Depending on the accessibility of material, the structures were made of ice or compact snow. The igloo in the lower picture was built from ice bodies laid on one another. It provided shelter against the surrounding frost. It was possible for two people to be inside and have a conversation at a considerably higher temperature than in the external surroundings. The structure in the upper picture is an igloo made of naturally compact snow (in a snow drift). In order to obtain a bigger span, it was necessary to place snow pillars in the interior. The structure served the purpose of a dining hall for about 10 users. The snow and ice structures were built without any calculations or stability checks. The solutions were adopted in an intuitive way through trial and error. In spite of a primitive way of construction, in no case did the uncontrollable destruction of the object happen. What is more, these objects even reinforced their stiffness and stability as well as capacity to bear external loads. A conclusion which may be drawn from these experiments is that the increase of the span and size of such structures is impossible without examination and determination of standards as well as without differentiation of snow and ice types as a building material. In certain situations such expansion could pose a threat to the users of the object. In order to develop this branch of architectural creation, it is necessary to establish standards on the basis of future investigations.

See: annex Fig. 8.

29

FLOATING SPORTS AND ENTERTAINMENT HALL

Diploma Design

Designer:
Magdalena Bałdys
Supervisor:
Zbyszko Bujniewicz
Design date:
2013
Object function:
Facilities for sports and artistic events
Object size:
12 300 m^2
approx. 120 000 m^3
1.3 ha
Location:
Changeable location (Copenhagen), Denmark

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation	■	
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

Organization of mass events, such as concerts, sports competitions at an olympic games or world-championship level. It is a periodical enterprise which often changes its location. Many seaside or riverside cities are the organizers of the above-mentioned events. After organization of a certain event, such facilities pose a big problem in terms of costs of maintenance and no other possibility of using them. Putting two and two together, the architect thought of designing a floating multi-functional sports hall. The proposed designing solution has hybrid features, which means that it combines technical solutions typical of land architecture with methods used in naval architecture (shipbuilding). The designed building can hold 10 000 spectators depending on the arrangement system. The idea of mobility assumes that the object may be transported to different places. The condition is that the next destination should have access to a waterway of certain parameters. The designed floating facilities show the features of feasibility in terms of technical and economic conditions. The sports hall was presented in a few locations.

See: annex Fig. 9.

<table>
<tr><td>30</td><td>GATE TO THE CITY OF KOBENHAVN
Diploma Design</td></tr>
<tr><td colspan="2">Designer:
Ewa Dudek
Supervisor:
Zbyszko Bujniewicz
Design date:
2012
Object function:
Multi-functional services object including offices, restaurants and a hotel
Object size:
113 100 m^2
approx. 360 000 m^3
3.2 ha
Location:
Harbour wharf in Copenhagen, Denmark</td></tr>
</table>

<table>
<tr><td rowspan="13">Water Functions</td><td rowspan="3">environmental</td><td>obstacle</td><td></td><td rowspan="14">Water Impact</td></tr>
<tr><td>on the waterfront</td><td>■</td></tr>
<tr><td>location in the water</td><td></td></tr>
<tr><td rowspan="4">determining object purpose</td><td>sports and recreation</td><td></td></tr>
<tr><td>transport and circulation</td><td></td></tr>
<tr><td>therapeutical</td><td></td></tr>
<tr><td>scientific</td><td></td></tr>
<tr><td rowspan="3">material</td><td>building material</td><td></td></tr>
<tr><td>decorative material</td><td></td></tr>
<tr><td>eco-technological</td><td></td></tr>
<tr><td rowspan="3">inspirational</td><td>formal references</td><td></td></tr>
<tr><td>cultural references</td><td></td></tr>
<tr><td>references to science and environment</td><td></td></tr>
<tr><td colspan="3">On land, without contact with water environment</td><td></td></tr>
</table>

The building is located in the harbour, on two opposite sides of the water basin. A massive size and an expressive character of the building make it easily identifiable both from the water and land. This contributes to the fact that this structure plays a significant role in the urban space. As Rem Koolhaas wrote: 'skyscrapers have become new lighthouses which send out light far into the sea space, but actually these signals are picked up by the city and its inhabitants'[151]. In the epoch of electronic navigation, the significance of the light sent out to the sea is not as profound for shipping as it used to be before. Nowadays, the silhouette of a lighthouse is a recognizable landmark in space. Architectural complexes of considerable dimensions become the symbols of the city and its icons. Moreover, the location at the city gate, namely in the harbour, makes the whole establishment the city's flagship. It may be said that an attractive location on the *waterfront* along with an innovative form may create icons or landmarks of a given place[152].

See: annex Fig. 10.

[151] In *Delirious New York* (1997).
[152] Lynch K. (2011), *The Image of the City. Archivolta.*

31 WATER SPORTS AND RECREATION CENTRE

Diploma Design

Designer:
Aleksandra Domagała
Supervisor:
Zbyszko Bujniewicz
Design date:
2011
Object function:
Recreation and services facilities, including: a hotel, sports and recreation facilities, social facilities
Object size:
11 000 m^2
approx. 46 000 m^3
3.4 ha
Location:
Artificial Lake Pogoria IV
Dąbrowa Górnicza, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

The location of spa resorts nearby water is a well-known undertaking. There are many implementations in the vicinity of water that offer sports and recreational services. The maintenance of such facilities is difficult due to seasonal activity of the clients. The operators of such facilities look for more and more attractive functional and spatial solutions, which could additionally attract more clients. One of the solutions is the location of buildings on the water in the form of floating objects or objects built in the water[153]. Also, the construction of artificial water reservoirs is an opportunity to create facilities in the water area. Such conditions provide several premises which enable the whole process. Ground conditions are typical of land so the conditions for the building foundations are well known from the beginning or easy to examine before the flooding of the basin. Usually, there is water wildlife in water reservoirs which should be protected. This could hinder the implementation. In the case of artificial reservoirs, an object may be built before flooding, which reduces the cost of construction. The location in or on the water creates favourable conditions for traditional sports and recreational activities on the water reservoirs and thus generates different functions. The designed water sports and recreation centre is located partly on land and partly on water. The buildings on the water are connected with the land by means of piers

See: annex Fig. 11.

[153] For instance, on Lake Jamno there are floating hotel rooms, http://www.hthouseboats.com/, as of 24.07.2015

32

SPORTS AND RECREATION CENTRE

Diploma Design

Designer:
Dorota Kniażewska
Supervisor:
Zbyszko Bujniewicz
Design date:
2009
Object function:
Recreation and services facilities, including: training rooms, sports and recreation facilities, social facilities
Object size:
7 800 m^2
30 000 m^3
3.1 ha
Location:
Flooded Zakrzówek quarry
Kraków (Cracow), Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water	■	
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

Open recreational areas become subject to urbanization in the process of cities' expansion. Local development plans often assign such locations to be sports and recreation centres. A contemporary trend to do sports or spend leisure time in the form of active recreation generates a demand for such services. In the area of a closed and flooded quarry, a service and recreational object was designed. The edges of the quarry have the form of tall vertical walls. There is only one entrance to the water basin, which used to be a technological road in the past. A functional and spatial solution plans encompass the construction of facilities on the ground level and on the water-sheet level. The facilities on the water were designed as floating objects. The purpose of floating objects and their technical solutions make it possible to predict the feasibility of such implementations. The designed land and water development enhances the security of the use of these premises, which at present are being used in an uncontrollable way (except for the existing diving centre).

See: annex Fig. 12.

33 **H$_2$OUSES – FLOATING HOUSES**
Diploma Design

Designer:
Anna Kołodziej
Supervisor:
Zbyszko Bujniewicz
Design date:
2009
Object function:
Complex of floating residential objects, moored to the riverside
Object size:
from 390 to 812 m^2
from 950 to 2077 m^3
approx. 6 ha
Location:
Warszawa (Warsaw), Poland
and selected rivers in other cities in Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

'Communes are not able to satisfy a constantly growing demand for building plots […] particularly in the city centres, […] which results in a drastic increase in their prices'[154]. 'Exorbitant prices of land drive normal functions from the city away to its suburbs. The centres witness the construction of office towers and huge commercial complexes'[155]. The plots in the city centre are available exclusively to big and rich corporations and companies. Due to the cost of land, investments are made in the form of high, multi-storey buildings of a small surface area. This way of building considerably influences the skyline of historic parts of the cities. Life is moving towards the outskirts. The city stops being dweller-friendly as this opportunity is offered only by a densely populated city[156]. The location on the water in the city centres makes downtown space more attractive. There is no Paris without the Seine, London without the Thames and Rome without the Tiber. All these cities owe their greatness to rivers as they have shaped their individual faces. On the other hand, the rivers owe their fame to the cities[157].

See: annex Fig. 13.

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[154] Sowa A., translation: Mazur K., *Little and Less - on the Housing Policy in the EU Countries - Mało, coraz mniej – o polityce mieszkaniowej w krajach Unii.*, 'Architektura – Murator', 2005, no. 11 (134), p. 92.
[155] Mazurek W. (2007), *A Recipe for a City. A Conversation with Vittorio Magnago Lampugnani. - Przepis na miasto, rozmowa z Vittorio Magnago Lampugnanim*, 'Architektura & Biznes', no. 1, pp. 70-75.
[156] Ibidem.
[157] Pancewicz A., *River in the Townscape - Rzeka w krajobrazie miasta*, Publishing House of the Silesian University of Technology - Wydawnictwo Politechniki Śląskiej, Gliwice 2004, p. 5.

34

UNDERWATER HOTEL FOR SCUBA DIVERS

Diploma Design

Designer:
Radosław Winnik
Supervisor:
Zbyszko Bujniewicz
Design date:
2012
Object function:
Recreation and services object including: training rooms, a hotel, technical and social facilities
Object size:
2100 m^2
approx. 6 000 m^3
approx. 1.5 ha
Location:
Hańcza Lake, Podlaskie Province, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water	■	
	determining object purpose	sports and recreation	■	
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

New forms of active recreation generate new architectural functions. The increasing trend to do the scuba diving results in the demand for accommodation and diving facilities. The designed object is to serve scuba divers. It is equipped with functions and includes sites with favourable conditions for doing this sport. It is located on one of the deepest lakes in Europe. This water basin is often visited by experienced scuba divers. A maximum depth of the reservoir amounts to 106 m. Hańcza Lake is a postglacial channel lake, which was created by the melting water of the glacier. The water in the lake is very clean and clear so the visibility is even up to 12 m. These are favourable conditions for the implementation of architectural recreational objects. The location of the lake is well known and provides an easy access to potential users. The location of the object in the water creates favourable conditions for its purpose, i.e. a hotel and diving base. The object features also a first aid point as well as a permanent connection with dry land, which increases safety conditions and enables effective evacuation in case of an injury or accident[158]. Spending the night underwater may be a great attraction for diving aficionados.

See: annex Fig. 14.

[158] Dąbrowski M. (2005), *Rescue and Lifesaving in Diving - Ratownictwo nurkowe*, Wyd BEL studio, Warszawa.

35

YACHT HAVEN
Diploma Design

Designer:
Aleksandra Turska
Supervisor:
Zbyszko Bujniewicz
Design date:
2011
Object function:
Services and recreation object,
including: office facilities, catering establishments, social and technical rooms
Object size:
2 950 m^2
approx. 10 000 m^3
2.8 ha
Location:
Bydgoszcz, the river Brda, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation	■	
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references		
		cultural references		
		references to science and environment		
On land, without contact with water environment				

In the cities located on the shores of water reservoirs, the facilities for the reception of vessels and the services rendered for them constitute an important element of the development of waterfront areas. The waterfront is built up with marinas, yacht havens, sailing ports or river navigation ports. '[…] inland sailing has the same requirements in relation to yacht ports as sea or ocean sailing. Due to this fact, the process of designing yacht ports and marinas should first of all determine the size and number of vessels which will be served by a new […] yacht port '159.
The designed object is to serve the purpose of water sports and stimulate the part of the city where it is located. An increasing number of buildings and facilities built on the waterfront, which highlight spatial, ecological and utility values of this area, contribute to the integration of the city with waterfront areas and prevent the city from 'turning its back on the river', as was observed in other cities160.

See: annex Fig. 15.

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[159] Yacht Port/Haven: includes a group of port basins, hydrotechnical constructions, civil engineering buildings, buildings on land as well as technical devices ensuring a safe stopover and servicing of yachts and other pleasure boats or sailing units. Marina is a yacht port combined with supplementary residential buildings. Mazurkiewicz B., *Yacht Ports – Marinas. Designing - Porty jachtowe – mariny. Projektowanie*, Wyd. FPPOiGM, Gdańsk 2004, p. 44 and p. 42.
[160] Pancewicz A. (2004), *River in the Townscape - Rzeka w krajobrazie miasta*, Publishing House of the Silesian University of Technology - Wydawnictwo Politechniki Śląskiej, Gliwice, p. 5.

OCEANARIUM
Design Experiment

Designer:
Magdalena Lorek
Supervisor:
Zbyszko Bujniewicz
Design date:
2010
Object function:
Services, recreation and scientific object, including: aquaria, office facilities, catering establishments, social and technical rooms
Object size:
29 000 m^2
287 454 m^3
6 ha
Location:
Katowice, Dolina Trzech Stawów, Poland

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific	■	
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

Oceanarium is an object which in an artificial way recreates on land the conditions of marine life. The shape reminding of a lying drop of water became an inspiration for this design. Formal associations with water in the form of a drop - the 'blue planet' – were present through the whole designing process. The location of the object on the shore of a water reservoir was an additional aquatic element. The designed museum space enables comfortable touring and learning from the exhibition of the underwater world. The design dealt with the issue of creating space for the exhibition of living organisms of plants and animals whose natural environment is water. The building took the form of a powerful spatial expression. The identification of a function contained in the building is facilitated by formal associations created by the outer layer.

See: annex Fig. 16.

37 **TSUNAMI MEMORIAL**
Diploma Design

Designer:
Dominika Marek
Supervisor:
Zbyszko Bujniewicz
Design date:
2008
Object function:
Services object including: exhibition and office facilities containing the alert centre
Object size:
5027 m^2
approx. 17 000 m^3
13.0 ha
Location:
Phangnga, Thailand

Water Functions	environmental	obstacle		Water Impact
		on the waterfront		
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment	■	
On land, without contact with water environment			■	

The designing task aimed to create a memorial place reminding of a disaster which is caused by a very dynamic phenomenon occurring in the water environment[161]. The designed object is to be a memorial and it has a symbolic location. The building is to implement educational objectives in the scope of geophysics with a particular focus on marine issues. It is also to be the commemoration of the rescuers' courage and the memorial of casualties. Another important function placed in this building is the research and alert centre warning of the tsunami coming. The use of shapes occurring in the water environment can be seen as a wave engulfing a composition of scattered internal elements. The expressive form of the designer's statement shows emotions connected with this subject. The deconstruction of symbolic elements is calmed down by a research building whose work is to ensure safety of the region.

See: annex Fig. 17.

[161] The author purposefully avoids using the word 'element' as an archaic way of perception of reality. A contemporary civilized person does not perceive the world as the place of struggle of four natural elements. Nowadays, people observe phenomena, processes and interactions.

38

ARCTIC CULTURE CENTRE
Diploma Design

Designer:
Diana Podgórna
Supervisor:
Zbyszko Bujniewicz
Design date:
2005
Object function:
Services object including: exhibition, theatre, concert, didactic and office facilities
Object size:
5201 m^2
18 000 m^3
0.25ha
Location:
Hammerfest, Norway

Water Functions	environmental	obstacle		Water Impact
		on the waterfront	■	
		location in the water		
	determining object purpose	sports and recreation		
		transport and circulation		
		therapeutical		
		scientific		
	material	building material		
		decorative material		
		eco-technological		
	inspirational	formal references	■	
		cultural references		
		references to science and environment		
On land, without contact with water environment				

The design of the Arctic Culture Centre was inspired by a motif of floating polar ice pack. Four local communities striving to preserve their own identity are symbolized by four objects in the form of ice solids. The centre aims to preserve culture in the way an ice cube preserves frozen leaves. This object is a clear sign, legible both from land and from the sea. The transparent envelope of the building and its structure create a changeable expression of the object at different times of the day and in different seasons of the year. Forms of ice solids floating in the fiords have become an inspiration for the creation of this object's architecture. Monumental ice walls rise up over the sea level. Deep ice crevices and fissures create three-dimensional sculpture-like images. The colour and structure of ice depend on the way of its formation and the content of air. Spectacular optic phenomena take place in varied texture of ice surfaces. The inspiration provided by ice solids leads to the creation of a set of architectural means of expression.

See: annex Fig. 18.

2.3. Diagram of classification of a structure into aquatic architecture

Classification of an object into aquatic architecture consists in the discovery of certain functions of water, i.e. environmental functions of water, water as a purpose determinant, a material, an inspiration. The process of assigning a given object to aquatic architecture is based on interpretations, associations and sensitivity. A superficial everyday classification of implemented facilities is carried out by both professional critics and ordinary users.

The classification of objects implemented in the water environment is simple and natural. Basic observational skills and spatial orientation enable the observer to assess the location of the object connected with water and classify it accordingly. It is a function which can be correctly found even by an unprepared user. In order to find other functions of water, additional knowledge on the facilities is necessary. Such knowledge is of a general and professional character and results from education and experience. That is the reason why such an analysis should be performed by researchers, designers, creators – because the discovery and definition of water functions require a proper content-related preparation. The investigator should show a proper level of perception and qualifications.

Aquatic character of architecture results from various associations, interpretations, observations and is connected with the observer (the investigator). The mechanism (process) described here aims to facilitate unambiguous classification of objects, in accordance with the definition provided in part one and the systematics presented in part two.

Architecture	+	Water impact	=	Aquatic architecture

Fig. 1. Diagram of the process of assigning an object to the group of aquatic architecture [own study]

The process of assigning an object to the group of aquatic architecture takes place in two stages. The first one consists in finding an achitectural object by way of elimination of non-architectural objects in the built environment, e.g. nautical objects (vessels, ships, machines). The second stage is more complicated. Its most important activity is a proper discovery of functions of water in a building object.

Buildings and constructions placed in the water or in its vicinity are subjected to an intensive influence of this environment. Both as the natural environment and artificial reservoirs, water imposes the character of land development. The architecture of objects built in a close spatial relationship with the water environment is certainly aquatic. It means that if a building or a construction is located on the shore, on water or under water, the impact of the environment of the location conditions is so significant that this object is perceived as aquatic even if its other spatial or functional features do not indicate that. Architectural objects which are closely tied to water basins come into being in two spatial contexts: in the natural environment and the urbanized context of the city.

Water in the urbanized context occurred as early as in the oldest urban complexes of prehistoric and classical cities as well as in the cities of the Far East culture. In the cities, water reservoirs have played a transport and circulation function facilitating both traditional and contemporary trade exchange (port cities). They have also played an ecological function as well as an urban-planning and compositional one. It is difficult to find a significant city nowadays which would not be located on the river or by the sea. In the natural water environment and landscape, there are mainly facilities serving the purpose of recreation and other forms of making use of the environment (**Wylson A.** 1986).

The presented cases of architecture include many examples of aquatic architecture created beyond the water environment. This fact results from the definition which was formulated in Chapter One. The set of aquatic architecture includes not only objects having a close relationship with water in the natural environment but also implementations evoking associations with water, its visual effects and impact. Moreover, objects where water determines the purpose of a building or construction are also aquatic. If an aquatic object is located beyond a water reservoir, the aquatic character of the implementation comes into being when it is possible to distinguish at least one function of the water. Water playing one of the above-determined functions in architecture constitutes a kind of impulse stimulating aquatic perception of an architectural object.

The conducted studies of the examples of 39 objects make it possible to observe the mechanism of creation of aquatic architecture. The analyses confirmed the character of the constructed architectural objects under the influence of the environmental function of water or other functions of water in the case of their location beyond natural water reservoirs. The location of facilities in the water or on the shore is sufficient to attribute an aquatic character to them. In numerous cases, the architectural structure of the object located in the water is similar to that of a building on land. Sometimes, buildings are deliberately given spatial features which do not relate to the specific location in the water [Case 01] (a floating building). Another time, the form of a building refers to its aquatic location [Case 33] (floating flats) or its spatial structure results from the consideration of specific requirements of the location in the water and the necessity of floating on the surface [Case 29] (a floating sports hall). On the basis of observations, it can be stated that buildings located in the vicinity of water reservoirs may interact with the water environment or may ignore this fact, however, the very location attributes an aquatic character to them.

Another way of creation of aquatic architecture is overcoming a water obstacle. Cases of aquatic architecture which were constructed in order to provide security against water or to tackle a water obstacle are difficult to 'read' without deeper knowledge about their genesis. In some designs, the threat of being flooded by the water from a nearby stream gives the hotel aquatic qualities. The necessity of the construction of special protection elements in the building's basement and ground floor contributed to the formation of the object of an amphibious character despite the fact that its external form does not directly refer to water.

It is difficult to interpret an aquatic character of a building which is not located nearby a water basin, also in the cases when aquatic features are given by the function of water determining the object's purpose. This fact is confirmed by the implementations whose images do not reveal aquatic qualities. For instance, the external form of a water park [Case 25] does not suggest belonging to the group of aquatic architecture. It is its purpose - determined by recreational, sports and therapeutic functions of water – that properly classifies such an object.

Also, more extensive knowledge of facts or designer's intentions is required in the case of some solutions inspired by water or phenomena connected with water, as for example in the Copernicus Science Centre [Case 23]. Gargoyles spitting water onto the elevation are the expression of erosive properties of water. In a similar way, greater sensitivity of the observer as well as the ability to analyze architectural forms are required in order to notice aquatic features of the Bank Śląski headquarters [Case 22]. Only the associations with a ship hull and analogies to lifeboats, which were intended by the designers, attribute an aquatic character to this object.

The discovery of water as a material seems to be very natural in the case of using water as a material or decoration [Case 20] (*Digital Water Pavilion*). However, the interpretation of the application of water as an instrument shaping the environment requires a more extensive preparation in the scope of technical knowledge. Elements of the water park in Sosnowiec [Case 27], which seemingly serve the sole purpose of architectural expression, constitute elements of energy management of the building. Thanks to their special shapes and forms, they are used for cooling the water and accumulation of energy. Water may simultaneously play several functions in aquatic facilities. They are independent of one another, i.e. they may occur as a single function or in a group.

SUMMARY AND FINAL CONCLUSIONS

The presented course of reasoning showed different faces of contemporary aquatic architecture. On the one hand, it revealed impact of the natural environment on the formation of architecture, on the other hand it presented creative inspirations accompanying architects in the creation of the spatial and functional structure of objects. Aquatic architecture has turned out to be a field drawing both from cultural references and new technologies, whereas a novel approach to water as a material has resulted in modern spatial effects.

Water has always been the focus of interest due to its life-giving role as well as its unpredictable character as a natural element. Symbolic features, which were so significant in historic architecture, are no longer so important in the shaping of contemporary space. Nonetheless, artists and designers are inspired by water and make use of references and associations with water. Such references differ nowadays as the contemporary inspirations are provided by analogies to the knowledge of water as the environment and its life-sustaining role responsible for the life on Earth. They have replaced the references to water as a mythic element.

Scientific results of the research presented in this monograph are the following cognitive goals which were achieved by the author:

- specification of the way of inclusion of an architectural object into the set of aquatic architecture,

In order to develop a diagram of classification of an object into the set of aquatic architecture, the systematics of the functions of water in aquatic architecture was specified. It creates a 'common denominator' for all analyses of the objects of aquatic architecture. Aquatic architecture comes into being as a result of the location of an object in the water environment. It can be also created or discovered in the functional and spatial structure revealing the signs of functions of water which play a significant role in the use or shaping of the object. Classification of a given object into the set of aquatic architecture depends on perception, knowledge, culture and professional experience of the observer. Using the proposed diagram, the studies of the selected set of 39 cases of aquatic architecture were conducted. The investigations showed that in each studied object water played at least one of the following functions: purpose determinant, architectural material, creative inspiration or natural environment. It was determined that the adopted schema based on the analysis of water functions unambiguously classifies objects into the set of aquatic architecture.

A considerable number of observations results in high probability of finding even small creative enterprises in the field of aquatic architecture. The conducted investigations enable the formulation of the following final conclusions:

1. **Aquatic architecture – systematics and classification into the set.** Own studies presented in this work define a set of objects representing contemporary aquatic architecture. These are objects where water plays an environmental function (location on the waterfront, objects set in the water, floating, underwater, amphibious objects as well as objects overcoming a water obstacle); or water plays certain functions determining purpose (sports and recreation, transport and circulation, therapeutic and scientific purposes); or the function of a material in architecture (building material, decoration – artistic and plastic arts elements, factor shaping the climate and micro-climate); or the function of creative and artistic inspiration (formal and cultural references, references to water science and knowledge of water environment). The determination of one of the foregoing functions of water in a building is a condition for the

creation of aquatic architecture. Occurrence of water in buildings only in the form of water supply (such as other utilities: gas, electricity, etc.) or a physical substance does not create solutions of an aquatic character.

2. **Factor shaping the built environment.** The application of spatial solutions creating favourable conditions for the use of the properties of water as a material conducting energy serves the purpose of the creation of the internal climate of the building. The use of the properties of water as a material undergoing physical transformations places aquatic architecture near environmentally friendly or ecological solutions.
3. **Water as inspiration in architecture**. Similar to historical times, nowadays water also provides creators of architecture with immaterial inspiration. However, contemporary references have lost their religious, mystic and symbolic character in favour of the references to phenomena occurring in the environment as well as associations with common scientific knowledge resulting from a level of education.
4. **Water as a building material**. Water has been traditionally used in many architectural implementations. The application of water in three states of aggregation in architecture is being observed on a bigger and bigger scale. The construction of ice and snow objects is becoming more and more daring. Visual, plastic and artistic properties of water as a material are applied in contemporary architecture in an intuitive way that is why the research on visual, plastic and technical properties of water should precede the application of water as a material in architecture.
5. **The function of the building determined by water**. Some kind of buildings are designed especially to use the water. Among that buildings are sport and recreation, transportation, science and research, treatment and health care buildings. Those buildings are most obvious aquatic architecture.

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CONTEMPORARY AQUATIC ARCHITECTURE

PART 2. DESCRIPTION AND SYSTEMATICS

Abstract

The purpose of this monograph is to present the classification of the functions of water in architecture, to present the mechanism of creating aquatic architecture

In aquatic architectural structures, water plays the following functions:

- the function of an environment, in the structures situated on the borderline of land, in water, or as floating structures or underwater structures, overcoming the technical obstacles and challenges,
- the function determining the purpose of structures (for example: sports and recreation, transportation, therapy),
- the function of a construction material, an artistic and decorative element, a factor that affects the constructed environment,

the function of creative inspiration through formal and cultural references, as well as references to knowledge and environmental phenomena.

If water plays at least one of the functions: environment, detrmninig of purpose, materilal or inspiration in an architectural structure, then the structure is classified as aquatic. Water functions consisting only in meeting the life-sustaining, sanitary, fire-fighting needs, and appearing in the form of physical substance in buildings, do not allow to classify such structures into the analyzed group.

WSPÓŁCZESNA ARCHITEKTURA AKWATYCZNA

CZĘŚĆ 2. OPIS I SYSTEMATYKA

Streszczenie

Celem niniejszej monografii jest przedstawienie klasyfikacji funkcji wody w architekturze, przedstawienie mechanizmu powstawania architektury wodnej

W wodnych strukturach architektonicznych woda pełni następujące funkcje:

- funkcja środowiska, w obiektach położonych na pograniczu lądu, w wodzie, lub jako konstrukcje pływające lub konstrukcje podwodne, pokonując przeszkody i wyzwania techniczne,
- funkcja określająca przeznaczenie obiektów (np. sport i rekreacja, transport, terapia),
- funkcja materiału budowlanego, elementu artystycznego i dekoracyjnego, czynnika wpływającego na budowane środowisko,
- funkcja inspiracji twórczej poprzez odniesienia formalne i kulturowe, a także odniesienia do wiedzy i zjawisk środowiskowych.

Jeżeli woda pełni w strukturze architektonicznej przynajmniej jedną z funkcji: środowiskową, wyznaczającą cel, materiałową lub inspiracyjną, to obiekt ten klasyfikuje się jako wodny. Funkcje wody polegające jedynie na zaspokojeniu potrzeb życiowych, sanitarnych, przeciwpożarowych i występujące w postaci substancji fizycznej w budynkach, nie pozwalają na zaklasyfikowanie takich obiektów do analizowanej grupy.

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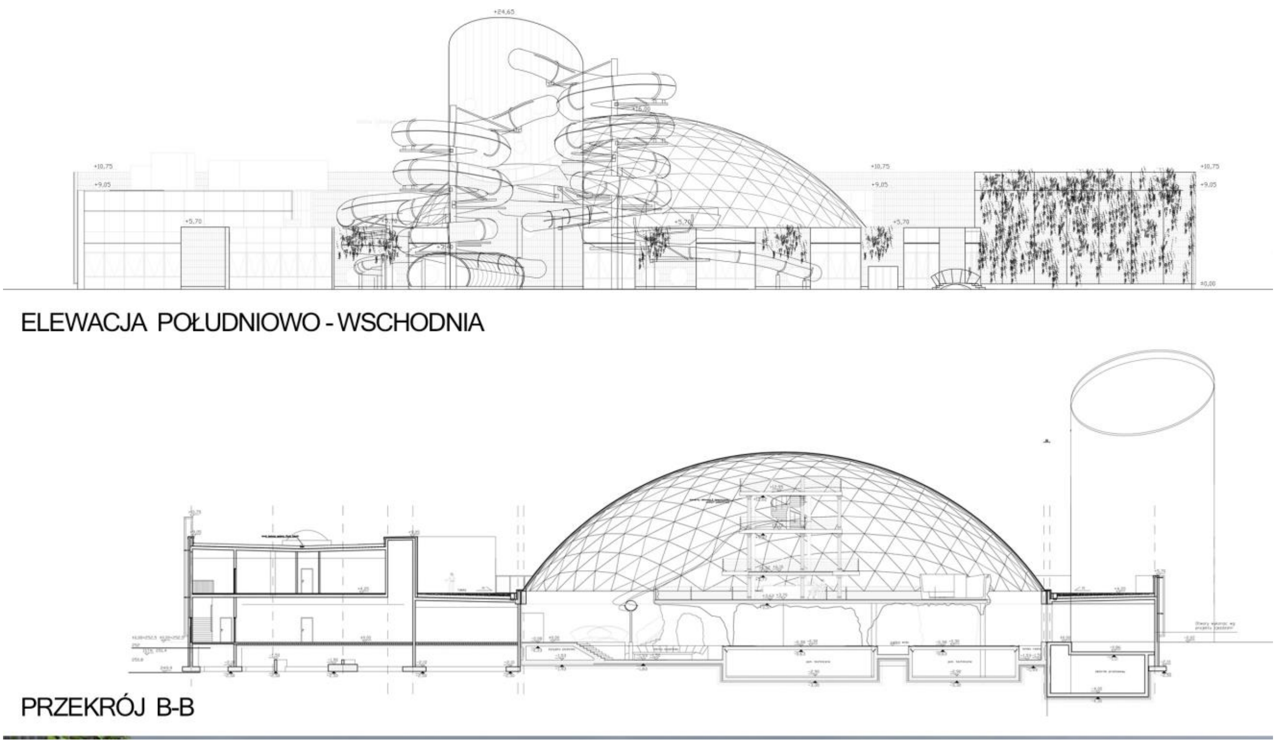

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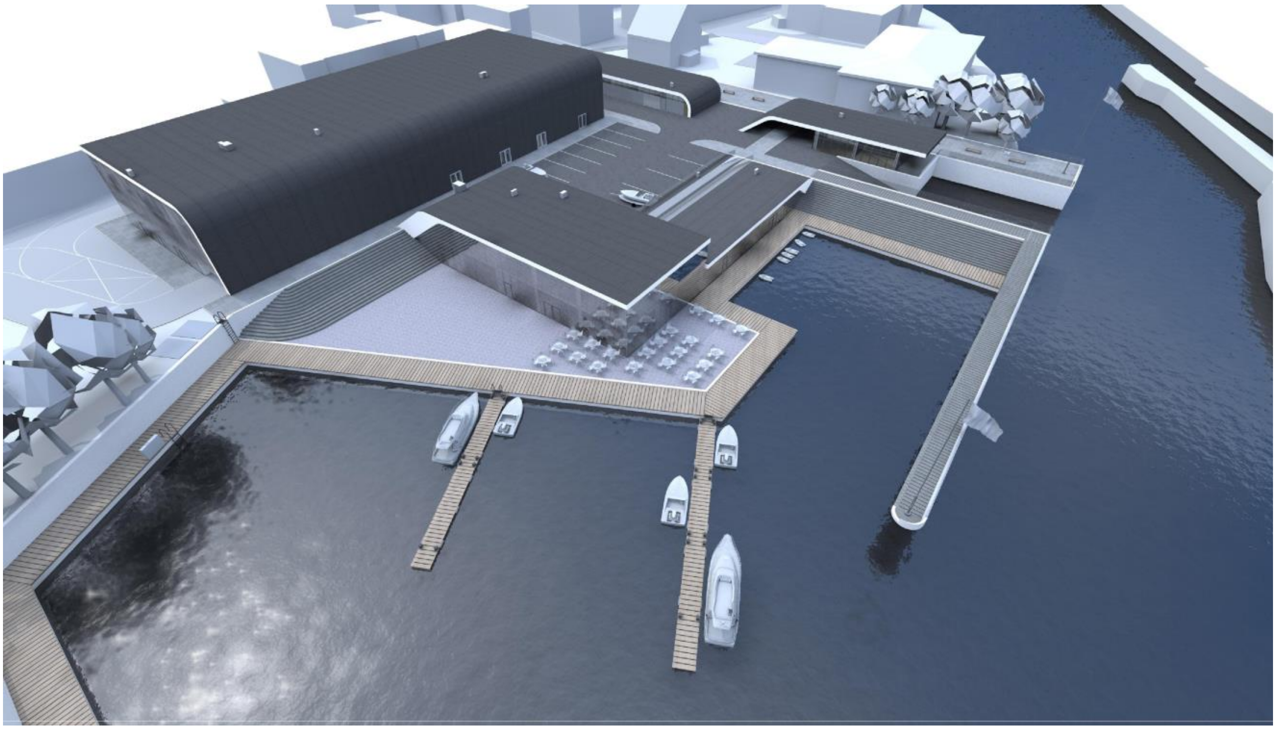

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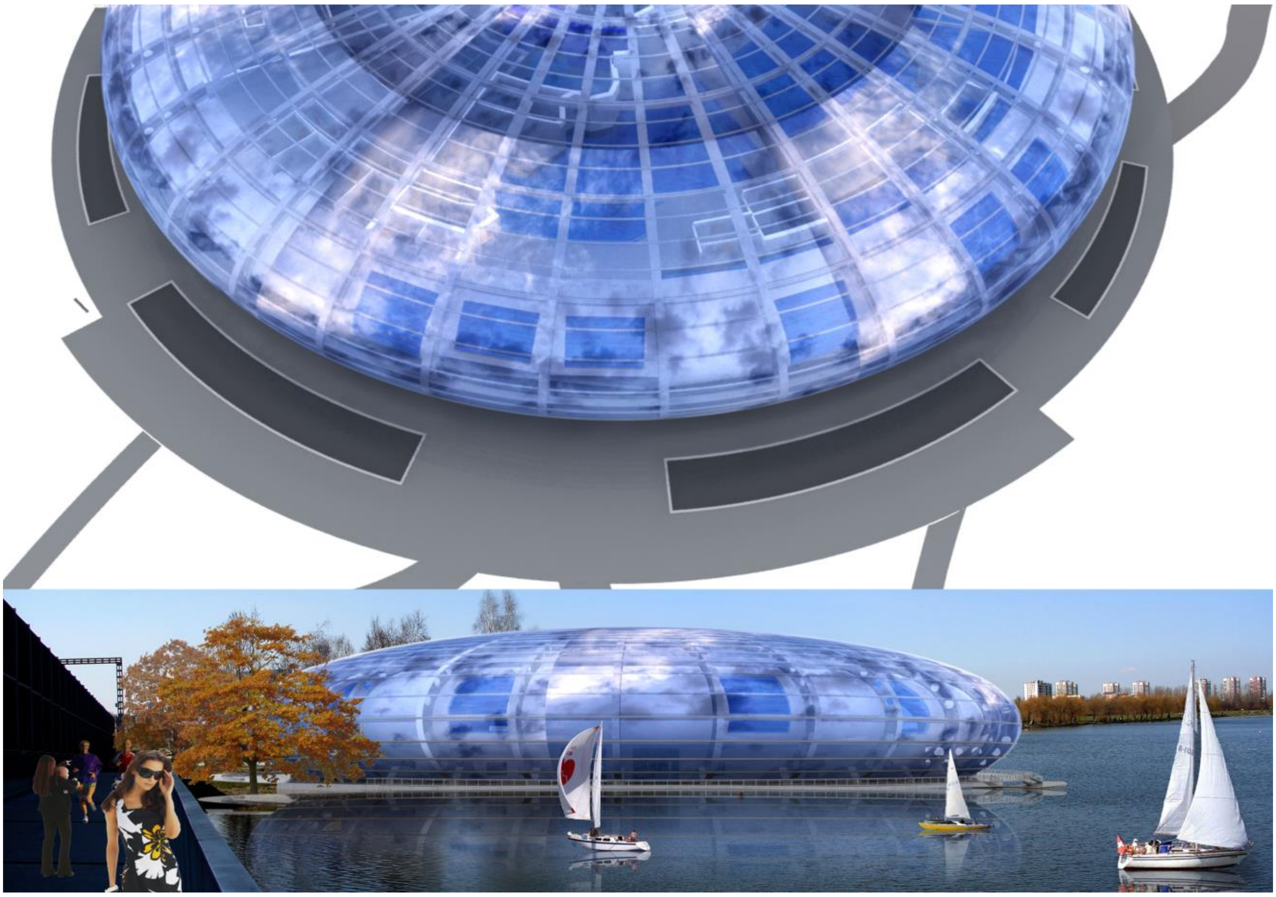

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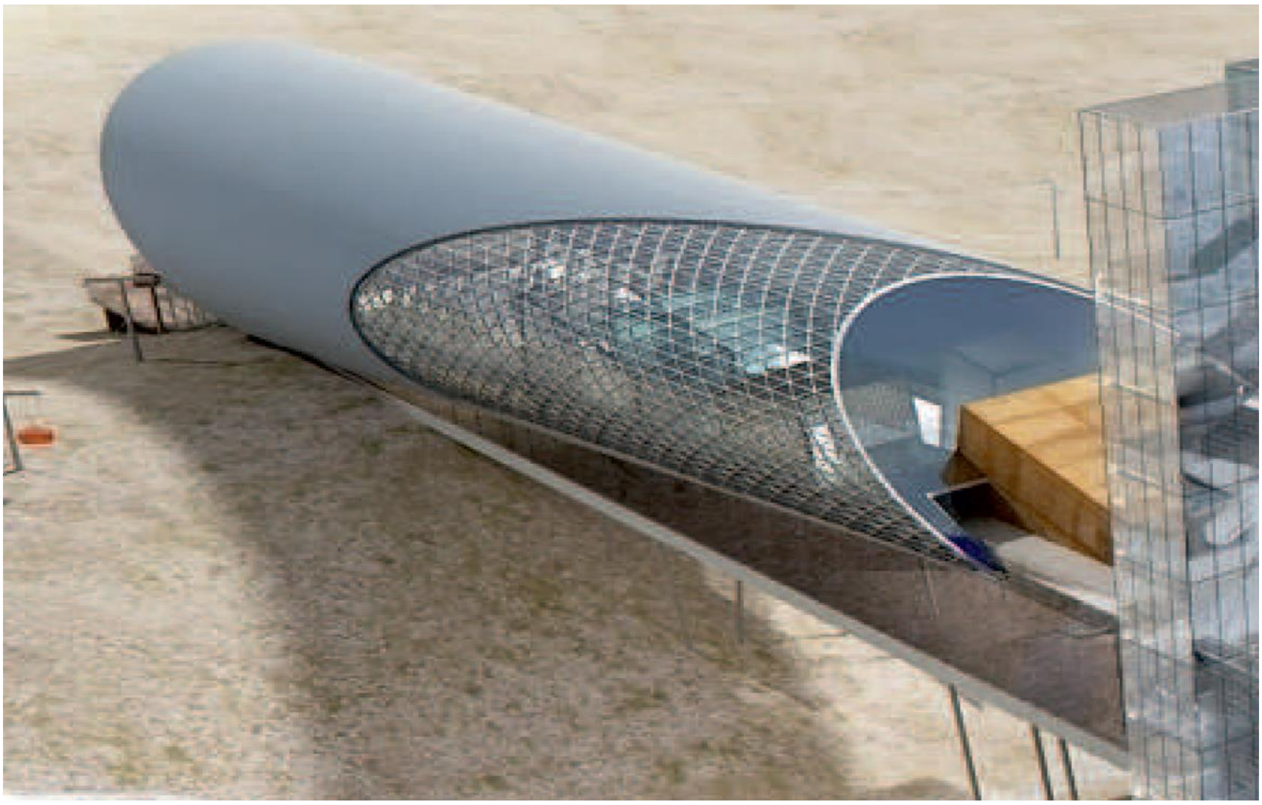

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