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Displacing Architecture? From Floating Houses to Ocean Habitats: Expanding the Building Typology

The current research on the amphibious architecture lacks a proper, commonly shared vocabulary and typology of water-placed structures. In this paper, the state of typological works is described and a new typology based on three main distinguishing factors (relation to water, buoyancy and mobility) is given. Thanks to the different perspectives of civil- and naval architecture that are taken into consideration, this new typology encompasses the architectural objects of all sizes, functions and movability, built both in the water and on the water, divided into six types: overwater, waterside and amphibious buildings, floating structures and residential and facility vessels.

Keywords: amphibious architecture, floating architecture, buoyant architecture, building typology, houseboats.

I. Introduction

Since the beginning of the 21st century we have seen a dynamic growth of amphibious architecture. This water boom has its roots in the old call for living by the water, but it would not be possible without a couple of very specific circumstances that came into being in the last 15 years. The first reason for the interest in amphibious architecture is fear. The threat of a flood caused by the sea level rise, hurricanes or heavy rains – all correlated with the climate change – has become a fact and many flood mitigation strategies now incorporate some amphibious building techniques. The second reason is economy. The shortage of land available for development in the largest metropolises and the smallest states has pushed architects and engineers to reclaim the seabed or to build floating structures. At the same time, the shortage of energy resources – mostly the fossil fuels like gas and oil but also the renewables like strong and steady winds – has created a large sector of offshore research, mining and energy industry which seeks for the new types of the ocean structures and vessels. The third reason for substantial amphibious architecture growth is technology. Although building on the water is not a new idea, today, thanks to new materials and construction methods, waterside and floating structures are as durable and as comfortable as their land-based counterparts. They are as affordable, too.

When we recall the history of building in and on the water [1] or when we look on the number of its contemporary realizations, we certainly can call the amphibious architecture a mature discipline. But, if we try – for research or teaching purposes – to describe this phenomenon we experience major difficulties with defining the basic terms and classifying them all under the label of the amphibious architecture. The aim of this paper is to overcome these semantic and typological problems by analyzing the current state of research of the typology of water-placed architecture and proposing a new multidisciplinary approach to this problem.

II. Common Definitions and Typologies

The literature review showcases that the problem of water architecture vocabulary has at least three main causes. The first is the ambiguity of the main terms*. Amphibious is a* term coming from the Greek *amphi-bios* that means the potential of living both on the land and in the sea. In architecture and urban design practice, it is used in two meanings: as the general description for *aquatecture* [2] [3], which is the architecture shaped in the water context [4] [5]; and as the precise definition of the otherwise-ordinary building capable of floating on a flood waters [6]. Another popular term, *the houseboat,* may refer to at least three different types of amphibious dwellings: to a small motor yacht with a very high level of comfort, to a boat or a barge rebuilt into a stationary residence [7] and, especially in American literature, to a *floating house* [8–16].

The second reason is the metaphorical approach of some authors who focus on the ideology and perception of the building surrounded by water regardless of its other functional and technical features. It may results in using quite clear terms like *island buildings* [17] but also happens to be confusing when *floating architecture* [18] or *buildings on water* [19] [20] are being proposed for describing the ground-based structures.

The third reason is the multidisciplinary nature of amphibious architecture, which results in double terminology proposed by architects and naval engineers - a *floating system* [21] is an example of architectural equivalent for the well-known marine *hull*. This overlap results in merging civil and naval building rules in the new legislation [19,21,22,22–25].

Some efforts to propose the typology of the amphibious architecture have been already made. Grau, Ryan, Zevendingen and Kekez in ‘Building with Water. Concepts, Typology, Design’ presented the functional (arts and culture, recreation, living, industry and infrastructure) and natural (like, river, sea) typology [26]. Baker in ‘Built on Water. Floating Architecture + Design’ despite the metaphorical title gave a hint of aquatic structural concepts (pillars support, stilts elevation, pontoon floatation) [19].

Probably the most comprehensive study of the problem was given by Flesche and Burchard in ‘Water House’ in which they distinguished between ground-supported, floating, submerged and frozen architecture [1]. A more detailed picture taken from the Dutch flood-mitigation perspective was presented by Nillesen and Singelenberg in ‘Amphibious Housing in the Netherlands’ where the floating dwelling, the amphibious house, the pile house, the dyke house, the terp house and the waterside house were all described [25].

III. The Analysis of the Common Typology

In the first phase of the research the most popular types of aquatic structures – two with flood resilience origin, three allowing living by the water, and one vessel – were selected as the most representative amphibious forms and defined as follows:

- *static elevation building* - a building located out of a water basin that is supported by an openwork structure high enough to allow the flood water to flow under the building without any damage;
- *amphibious building* – a building located out of a water basin and set on the ground but capable of floating on the rising flood water thanks to its low mass and special structural elements like the buoyant foundation [27] or a watertight basement that displaces surrounding water, held in place by two or more vertical piles along which it can vertically regulate;
- *waterside building (building in the water)* – a building located in direct proximity, partly or entirely in a water basin, and erected on a waterproof foundations*;*
- *pile building*, *stilt building* - a building located partly or entirely in the water basin that is supported by a ground-based openwork structure rising it over water for a designed height*;*

- *floating building (building on the water, boathouse)* – a building located in a water basin, partly submerged, floating on the water surface thanks to its low weight and special structural elements like the buoyant foundation or the watertight basement that displaces surrounding water, that is held in place by variety of systems like mooring piles (dolphins), stopping piles, anchors, mooring lines and combination of those;
- *houseboat* – a small watercraft designed with no concessions to quality of living aboard which usually hampers the nautical and the aesthetical value of the craft.

In the next step, six selected types were analyzed in terms of ten basic aquatic features. The results are compiled in the Table 1.

Table 1: The compilation of current typologies of amphibious architecture. The current typologies are based on the context of the building. The watercrafts are excluded except for the houseboats.

	static elevation buildings	***amphibious buildings***	***waterside buildings***	***pile buildings***	***floating buildings, boathouses***	***houseboats***
relation to water	*elevation*	*floating*	*delimiting*	*elevated*	*floating*	*cruising*
application	*flood-prone land*		*water banks*	*water*		
context	*land*					
			water			
legal definitions	*real-estate*					
					mobility - watercraft	
buoyancy	*non-buoyant*	*buoyant*	*non-buoyant*		*buoyant*	
supporting substance	*ground*					
		water			*water*	
mobility	*static*	*kinetic*	*static*		*portable*	*transient*
propulsion	*unpowered*					*self-powered*
base type	*piles/stilts /columns*	*pontoon /float/raft*	*waterproof foundation*	*piles/stilts /columns*	*pontoon /float/raft*	*hull(s)*
discipline	*civil architecture*					
		naval arch.			*naval architecture*	
						industrial design

The compilation shows that a common typology is based on the context of the building – the main distinguishing factor due to its evident character. The following disadvantages of this approach were observed:

- there is no clear connection between the structures of three different origins: the flood-resilient house, the water dwelling and the watercraft;
- the technical features seem to be irrelevant to the typology;
- despite the fact that watercrafts were the first amphibious structures, they are hardly represented in the typology.

IV. The Proposal of a New Typology

After showcasing some disadvantages of the common classification of the amphibious architecture, research for a new better typology was started with special regard to the following guidelines:

- design approach - it should reflect different design concepts, methods and tools that are being used for water-related structures;
- emphasizing mobility – it should not only distinguish fixed and mobile objects, but also organize them by the level of mobility;
- emphasizing the space relation to water – it should indicate how the structure is located in relation to water with the special regard to the fact that both the aquatecture and the water may change their position over time.

An important element of the new multidisciplinary approach was extending the field of amphibious architecture to the marine structures. This is not a new problem: Le Corbusier [28], Fuller [29] and the Japanese Metabolists had already explored it in their manifestos and projects. Today architects like Norman Foster and authors like Quartermaine [30] continue the idea of including watercrafts to the scope of architecture. In this paper, a moderate attitude to this problem has been taken: vessels are accepted as a form of the aquatic architecture only if their purpose goes beyond the simple function of as a mode of transportation.

As a result of expanding the scope of analysis and redefining typological objectives, the following types of amphibious structures were proposed:

- *overwater building* (*pile building, stilt building, static elevation building)* – elevated, static and non-buoyant building supported by the ground-based (or bottom-based) openwork structure raising it for a designed height over any kind of permanent or temporary water.
- *waterside building (waterfront building, building in the water)* – water-boundary, static and non-buoyant building located in direct proximity to, partly or entirely in the water basin, erected on waterproof foundations not intended to float*;*
- *amphibious buildings* – floatable, kinetic and buoyant building located out of the water basin set on the ground but capable of floating on the rising flood water thanks to its low weight and watertight base;
- *floating structure* – floating, portable and buoyant, partly submerged structure resting on the water surface thanks to its low weight and special structural elements like buoyant foundation or watertight body (the hull) that displaces surrounding water, kept in place by variety of systems like mooring piles (dolphins), stopping piles, anchors, mooring lines and combination of those; includes structures of different functions, applications and sizes like *floating building (building on the water, boathouse), living barge, offshore floating platform, Very Large Floating Structure (VLFS), floating habitat, floating city,* as well as the ships that require a fixed position to fulfill their purposes like *lighthouse ship, botel, floatel and museum-ship;*

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Table 2: Proposal for the new typology of amphibious architecture. The proposed typology is based on the spatial relation between the water and the structure. Watercrafts are included as two new types.

	overwater buildings	***waterside buildings***	***amphibious buildings***	***floating structures***	***residential vessels***	***facility vessels***
sub-type			***buoyant architecture***			
examples	*static elevation buildings, pile/stilt buildings*	*shore- and land based buildings incapable to float*	*shore- and land based buildings capable to float*	*floating dwellings, VLFS, offshore platforms, sea-habitats, lightships, botels, ship-museums*	*houseboats, mega yachts, cruisers*	*aircraft carriers, hospital ships, prison ships, power plant ships*
relation to water	*elevation*	*delimiting*	*floating*		*cruising*	*navigating*
application	*flood-prone land*		*flood-prone land*	*water*		
	water banks					
context	*water*			*water*		
	land					
legal definitions	*real-estate*					
				mobility - watercraft		
buoyancy	*non-buoyant*		*buoyant*			
supporting substance	*ground*					
			water			
mobility	*static*		*kinetic*	*portable*	*transient*	
propulsion	*unpowered*					
				self-powered		
base type	*pilles/stilts /columns*	*waterproof foundation*	*pontoon /float/raft*			
				hull(s)		
discipline	*civil architecture*					
			naval architecture			
					industrial design	

- *residential vessels* – cruising, transient and buoyant watercraft designed especially for living onboard, used as 'a place to be in' and not as a mean of transportation – like *houseboat, mega yacht, cruising ship;*
- *facility vessels* – navigating, transient and buoyant watercraft designed to combine water mobility with the function of the land facility that needs to be substituted offshore – like *aircraft carrier, hospital ship, prison ship or power plant ship.*

To test the new typology, six selected types were analyzed in terms of ten basic aquatic features in the same way as the former typology was examined. The results are compiled in the Table 2. What can be noticed is that in all categories except for the context, the gradual change of the features between the types was achieved. As an evidence of the validity of the proposed approach, several continuums of properties were shown in the key typological categories:

- relation to water: elevation – delimiting – floating – cruising – navigating
- mobility: static – kinetic – portable – transient
- buoyancy: not buoyant – buoyant

V. Buoyant Architecture

The general definitions should also be reformulated on the basis of the proposed typology. Amphibious architecture should be expanded to encompass watercrafts of strong architectural characteristics, like residential and facility vessels. Additionally, thanks to the clear division between non-buoyant and buoyant objects, a new subcategory of *buoyant architecture* may be introduced. It will be defined as the part of *amphibious architecture referring to the buoyant (floatable) elements of the built environment*. Buoyant architecture must be seen in two very promising perspectives of sustainability and mobility.

The idea of sustainability is embodied in the very nature of buoyant architecture: a floating building cooperates with water rather than opposing it [31] [27]. It undergoes water level fluctuations and it reacts to water's movement so it is adaptive and kinetic by definition. The initial problem of buoyant architecture – infrastructural isolation – is now an advantage as new autonomous technologies of energy production, rainwater collection, seawater desalination and wastewater purification may be harvest. [18,32,33].

The second advantage of the buoyant architecture – the level of mobility [34] – is overwhelming in comparison to land-based buildings. Either portable or transient, these floating structures can be easily reconfigured or moved (or they can move themselves) despite their often enormous sizes and without detriment of the comfort of their users.

VI. Conclusion

The author believes that the proposed multidisciplinary typology has following advantages:

- modern structure – focuses on sustainability and mobility;
- openness and inclusiveness – may be detailed or extended to encompass more types of buildings, vessels or water engineering structures;
- interdisciplinarity – enables cooperation and technology transfer;
- activating potential – invites architects to explore new design territories;
- cohesion and clarity.

The obtained typology is clearly functional – but not in the terms of the structure's purposes. Here an architectural object is being classified on the basis of how it interacts with its eternal adversary – water [20] and what technical means does it take. Therefore, this typology may became a useful tool in the

hands of designers of all disciplines who want their architecture to cross, delimit, float, cruise or navigate the vast expanse of water.

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