

FLUID SPACES IN A CONTEMPORARY URBAN CONTEXT: QUESTIONING THE BOUNDARY BETWEEN ARCHITECTURE AND INFRASTRUCTURE

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The aim of this paper is to research the relations between the contemporary networked context and transformations in the understanding of architectural and infrastructural spaces, and to research the main models of fluidity within this relation. The contemporary urban context is characterized by globalization, transculturalism and increased technological development, which simultaneously change the everydayness, usage and perception of urban spaces and architecture. New networking phenomena occurring on informational, communicational and spatial levels transform the city and its architecture into constant processes of flows. Fluidity is positioned as the main problem of this research, simultaneously causing, and manifesting in, transformations of contemporary spatial conditions where the notion of *flow* becomes the new spatial quality. This research is focused on one of the main spatial manifestations of the fluidity phenomenon in contemporary cities – the dispersion of the boundary between architectural and infrastructural space. The aim of the paper is to present the idea that fluid spaces are characterized by: 1) increased loss of disciplinary boundaries; 2) loss of physical boundaries – inner-outer space overlapping; 3) dispersion of perceptual boundaries in space. The research is significant because it defines new meanings of spaces of flows and movement in a contemporary urban context.

Key words: fluidity, flow, architecture, infrastructure, boundary.

INTRODUCTION

The main idea presented here is based on the hypothesis that fluid spaces are expressed in diverse aspects of the dematerialization and loss of the architecture-infrastructure boundary. Globalization and the information revolution, which are the biggest contemporary phenomena, have shifted the values and appropriations of space on many levels. The new context of social and spatial networks has constantly changed and accelerated in terms of perception, communication, mobility needs, transfers etc. The dynamized network, based on continuous processes of flows – flows of information, traffic, money, energy – dematerializes its qualities into fluid, variable character.

Therefore, fluidity is positioned as the main conceptual phenomenon in a contemporary urban context, where the notion of flow becomes the new main determination of spatial use and design. Such dynamized conditions transform the relation between architecture and infrastructure and the position of their boundary in terms of the fading of typological boundaries and their hybridization. Functions of movement and mobility become the main and the essential ones in modern cities. Accordingly, such *spaces of flows* are the subject of this research.

This research starts with the hypothesis that fluidity in a contemporary urban context is notable through the position of the boundary between architecture and infrastructure, observed through transdisciplinary, physical and perceptual aspects of its dematerialization. The infrastructural character of contemporary architecture is mainly associated with networked infrastructural systems, which present new spatial and functional potential for the

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notion of place. Accordingly, new architectural patterns are made in the contemporary urban context. Contemporary architecture transforms into an infrastructure of flows, and infrastructure becomes the subject of the design as well. This relation between contemporary architecture and infrastructure becomes the expression of transformations and changes every-day urban experience. Additionally, the question of contemporary architectural form is replaced with new adaptable spatial patterns in which the notion of *flow* becomes the main design principle.

Recent research on the relationship between architecture and infrastructure includes changes in the meanings of *architectural* and *infrastructural*, and it opens up the ideas of the architectural qualities of urban infrastructure, but there have been no studies that link architecture and infrastructure to the phenomenon of fluidity by researching the position of the boundary in their interrelations. Stan Allen analyzed the theme of infrastructure as an object of architectural design, whereby we may recognize the indications of disciplinary boundary loss between architecture and infrastructure (Allen, 1999). Gilles Delalex continues Allen's ideas and directly links the urban and architectural scale of infrastructure, which is important for the development of the idea that infrastructure at all levels can be the subject of architectural creation, thus recognizing the transdisciplinary nature of the architecture-infrastructure relation (Delalex, 2006). The idea of contemporary architecture as a continuation of urban infrastructure and urban landscapes has been developed by a number of different authors (Delalex, 2006; Koolhaas *et al.*, 1998; Easterling, 1999; Angelil and Klingmann, 1999; and others). The change in the understanding of physical architectural elements as a continuation of the infrastructure and environment can be recognized in the theoretical positions of these authors, although each position focuses on a different aspect of understanding the notion of infrastructure in the context of architecture and the city. Delalex researches the theme of *infrastructural ground*, Easterling researches *infrastructural space*, while Koolhaas, Angelil and Klingman talk about architecture as an element of a dynamic system, formed with the urban environment and the new design principles by which such architecture can be created. Fluidity, as a phenomenon in architecture, has not been defined so far in the field of architecture and urbanism. Contemporary theoretical positions on the city and architecture introduce the notion of *flows*, *systems of flows* and *networks* from other fields, such as culture, sociology and technology. Stephen Cairns introduces the connection between the notion of *flow* and architectural typologies in architectural theory (Cairns, 2012), and Sanford Kwinter uses the term *fluidly* in the understanding and theories of "new urbanism" (Kwinter, 1998). David Goldblatt uses the term fluidity in architecture as a new aesthetic quality representing lightness and elegance (Goldblatt, 2007). Accordingly, the originality of this work is in the study of fluid spaces through the relationship between architecture and infrastructure, which questions the position of their boundary.

A comparative analysis of theoretical approaches to the problem of fluid spaces in contemporary cities was carried

out. Its main hypothesis is that fluid spaces are characterized by: 1) increased loss of disciplinary boundaries; 2) loss of physical boundaries – inner-outer space overlapping; and 3) dispersion of perceptual boundaries in space. The actualization of the fluidity phenomenon from these three aspects is its main scientific contribution. The aim is to present the potential of fluid spaces in the contemporary context of globalization, since it influences the development and diverse directions of cities and urban spaces transformations. In addition, the concept of the networked city, as one of the possible approaches in the understanding of contemporary patterns of urbanization and globalization, is also explored. The main conditions for contemporary conceptualizations in architecture and urbanism are identified.

The first section analyzes diverse theoretical approaches on the topic, while the second part focuses on an analysis of how architectural models of fluidity concepts are applied, by means of selected case studies. The main question asked is: how can the conceptualization of fluidity give adequate direction in the field of sustainable architecture and urbanism?

THE CONTEMPORARY URBAN CONTEXT AND GLOBALIZATION: FLUIDITY AS A NEW DESIGNATION OF THE NETWORKED CITY

In the contemporary context of the information age and global interconnectedness, the city becomes a complex system of flows within the networks, comprising architectural, infrastructural and social spaces, where the permanence of change leads to changes in the physical foundations of our everyday experience, perception and apprehension. Accordingly, form in the contemporary urban context could be understood as the following:

"Contrary to stances saying that form is a visual and aesthetic phenomenon, in the theory of urban morphology form is seen as a complex phenomenon and physical result influenced by different factors of development: socio-economic, functional, sociological, psychological, visual and perceptual" (Niković and Manić, 2018: 18).

This research is based on recognizing the phenomenon of fluidity as a contemporary phenomenon founded on these factors, as well as information overload, and elements of the urban structure losing their identity within the fluid, dynamic totality. The phenomenon of fluidity manifests itself as a consequence of globalization and ubiquitous interconnectivity, whereby flow, circulation, changeability, speed, etc. become the new determination of the city and its structure.

Talking about the context of contemporary changes in the urban environment, Stephen Graham and Simon Marvin introduce the term "sociotechnical process" while considering the influence of globalization, technological advancement and infrastructural networking on changes in city structure, architecture and culture. The development of technology infrastructure, its use and growth, transform the contemporary city into "a complex and dynamic sociotechnical process" in which cities and urban regions become places of perpetual flux of infrastructurally mediated

flow, movement and exchange (Graham and Marvin, 2001: 8). Thus, the architectural form becomes reduced in order to support the constant stream of information and communication effects, accentuating the message co-produced with the subject of the contemporary city.

This immediate relationship between the space and the subject, emphasizing transience and the fast accumulation of images and information in our mind, so fast as to turn our attention only to information that is useful and momentarily required, results in spaces called non-places by Marc Augé. Augé defines non-places as a total of all the air, rail and motorway routes, all the mobile cabins, means of transport, the airports, terminals and stations, and all the cable and wireless networks of installations and communication (Augé, 1995). Station signposts, airport markings, advertisements, screens and boards have become an essential and dominant part of our habitat, and “*infrastructure* takes over the contemporary urban landscapes” (Augé, 1995: 93). Non-places are embodied by constant high-intensity dynamics, where the phenomenon of flow is conjoined by the aspect of speed, which describes the quality of perception, usage and inhabitation of Augé’s non-place, thus the manifestation of architecture is primarily defined by the information effect it produces and the functional circulation it supports.

The concept of *space of flows* was introduced to the theories on the contemporary urban context by Manuel Castells in *The Rise of the Network Society*, where he said that in the contemporary network society, “interaction between places breaks spatial patterns of behavior in the city into a fluid network of exchange, which points to the need for a new space - *space of flows*” and that “the global city is not a place but a process” (Castells, 1996: 429). In Castells’ theory of urbanism, the technological and cultural changes in the information age are closely followed by problems of increased mass transit under the influence of the rising number of everyday activities and “time compression”, as a consequence of new spatial networks which intensify the flow and physical mobility of people in the city (Castells, 1996: 426). The phenomena within the domain of functional interconnectedness lead to a specific social and cultural fragmentation within the frame of fluid networks of global and local exchange.

In this context, Castells says: “the technological infrastructure defines new spaces” (*ibid.*, 1996: 426). The space of flows refers to a socio-spatial context in the contemporary paradigm of networking and, as he says, “space does not reflect society, it expresses it” (*ibid.*, 433), thus we can establish a relation between social transformations and the transformation of the value system in architecture. In this way, the contemporary urban experience is based on the functional and symbolic meaning of the space of architectural flows within the context of mass migrations of the population and tourism. “Network Fever” by Marc Wigley describes the preoccupation of the modern and postmodern context with networking and new ways of thinking about the architecture and city structure, expressed by the form of fluid, interconnected central functions and communication lines that transform the constructed environment into complex systems of functions and flows (Wigley, 2001). Architectural design becomes a process of managing the

relation between nodes and exchanges within the network, and the management of flows in architecture becomes the fundamental organizational and formal principle (Pawley, 1998). In this respect we underline the emergence of the new value system in architecture in which “technologies and infrastructures simply and deterministically shape both the forms and worlds of the city and wider constructions of society and history” (Graham and Marvin, 2001: 9). Infrastructural landscapes followed by socio-technological processes form the contemporary experience of culture, city and “structures of feeling’ of modern urban life” (*ibid.*, 2001: 12). As a result, by increasingly participating in the urban structure, infrastructural landscapes shape our experience and perception, and carry the meaning of society and culture development.

Diverse directions of urban transformations are influenced by globalization processes. An ecological approach to contemporary urban development is recognizable in theories that deal with the infrastructural landscapes in contemporary cities. James Corner (2006) notes that contemporary urban dynamics are increased with the effects of mass tourism and massive urban growth, resulting in transdisciplinary interactions between architects, urbanists, designers, landscape designers, engineers etc. Referring to Victor Gruen’s “cityscape” concept of an urban environment consisting of buildings, paved surfaces and infrastructures – “technoscapes”, “transportation-scapes”, “subcityscapes” etc., Corner (2006) introduces infrastructural landscapes as a significant infrastructural element in the city. The potential of such an approach is, as he says: “the ability to shift scales, to locate urban fabrics in their regional and biotic context and to design relationships between dynamic environmental processes and urban form” (Corner, 2006: 24). The same study also states that such “fluid urbanism” is based on dynamic relations, implying the complexity of interaction between the elements, rather than forms. Therefore, Corner’s *Terra fluxus* evokes the meaning of the urban context as a dynamic field of constant shifting processes occurring within it. In this context, the relation between architecture and infrastructure loses its boundaries because the separation between the environment and buildings becomes blurred. A similar theoretical approach can be noticed in Elizabeth Mossop’s “landscape urbanism”, which also conceptualizes contemporary cities as dynamic systems where the disciplinary position of architecture is transgressing urban discourse and practice, and infrastructure is the most important generator of public landscapes (Mossop, 2006: 166). In the chapter “Blurring boundaries and hybrid landscapes” Mossop presents the importance of intellectual shifts in contemporary landscape urbanism, influenced by architects Kenneth Frampton, Peter Rowe and Rem Koolhaas, who transformed the disciplinary divisions in the complexity of contemporary urban patterns (*ibid.*, 2006: 170-171). On the other hand, the economic aspect of urban transformations influenced by globalization processes is discussed by John Forrester in *Urban dynamics*. Forrester provides the understanding of complex urban systems in which urban problems are examined in terms of the interactions between the elements of the urban structure (*ibid.*, 1969). The urban context is presented as a dynamic system where the *flows* are the main determiners

of interactions between urban elements (*ibid*). In this approach, architecture becomes a tool of the economic infrastructure in cities.

UNDERSTANDING THE BOUNDARY BETWEEN ARCHITECTURE AND INFRASTRUCTURE IN CONTEMPORARY FLUID SPACES

Contemporary interpretation of the urban environment erases the conventional boundaries between the meaning of *infrastructure* and *architecture*. The ambiguous relationship between architecture and infrastructure in the contemporary city environment is evident not only globally, but also in the new design concepts and the new formal strategies of architecture and urbanism. A wider interpretation of infrastructure opens up the space for emphasizing its generative role in terms of its direct impact on the built environment, and thus on creating the contemporary notion of place. Accordingly, beyond the systems and networks of communications and resources, the infrastructure includes all constructed facilities and constituent environments, as well as public spaces for cultural and social programs.

In architectural discourse, the phenomenon of the boundary has been defined by both the physical elements of space and social parameters shaping the value system. The significance of the boundary in a contemporary urban context, and its role in creating a new value system of architecture, is determined by the users of the space and their comprehension of its meaning.

Bearing in mind that architectural form becomes a support to the constant circulation of information and communication effects, the manifestation of architecture is defined by contemporary urban experience. The fluidity of the boundary is examined through the concept of flow in architecture. The perceptual evaluation of space is formed by users' impressions of the fluidity of the spatial boundaries during their movements; it describes the unity of static and dynamic architectural elements. The qualities of diffusion and dispersion give the boundary the dialectic relation of enclosing and interlacing through integrating the characteristics of content and form by the fusion of constructions, activities and events. Therefore, with regard to function, hybrid integration of transportation, mobility, public and cultural spaces become a unified system.

In the following sections, the problem of the boundary between architecture and infrastructure will be critically analyzed through the criteria: **1) loss of disciplinary boundaries, 2) loss of physical boundaries, 3) dispersion of perceptual boundaries in space** with the idea of presenting their merging to form uninterrupted urban landscapes that increasingly characterize the contemporary city environment. The main research methodology in this paper relates to the examination of theoretical approaches and their application in selected examples of architectural practice through the analysis of the opuses of representative authors.

Loss of disciplinary boundaries

The loss of disciplinary, physical and perceptual boundaries between architecture and infrastructure stems from

modernist utopian projects such as *Walking City* and *Plug-in City* by Archigram, and *Fun Palace* by Cedric Price in which architecture behaves like infrastructure and vice versa. Cited examples of the architectural avant-garde elaborate the concept of redefining the status of architecture as an object, symbol or monument, into the convergence of places and ever-changing programs and events. Furthermore, Japanese Metabolists, with their megastructures, likewise erasing disciplinary boundaries between architecture and infrastructure, presented the concept of architecture as an interconnected system. These utopian concepts, although never effected, are important for understanding the roots of the ideas brought to life and executed by contemporary architecture. The question of the boundaries between architecture and infrastructure can be put into perspective with technological changes which alter the contemporary urban context in a physical sense.

The question of the disciplinary boundary between architecture and infrastructure in this context is not only the question of parallel and correlated changes between technology and the tectonic qualities of architectural form, but also the new meanings taking shape at their intersection. Innovations and new meanings create new design principles and values which occur in between the complexity of managing the flows and designing the form, which is not merely infrastructural. Therefore, new meanings and spatial manifestations are developed through mutual intention through both technology and architecture to shape our perception within culture and the city. *Rem Koolhaas, Stan Allen* and *Keller Easterling* explore the needs and possibilities of fusing infrastructure, architecture and landscape into a unique dynamic system (Koolhaas *et al.*, 1998; Allen, 1999; Pawley, 1998; Easterling, 1999). By exploring formal transformations and hybrid structures, both in the sense of form and meaning, contemporary architectural practice often transcends architecture's conventional field of study. The transdisciplinary transformation of architecture links the architecture and infrastructure with the landscape, resulting in the natural and urban space lacking clear edges. Therefore, the loss of disciplinary boundaries in terms of understanding the fluidity in a contemporary urban context is a matter of coordinating complex functional and design principles, whereby flows in space stay functionally separated according to protocols and infrastructural principles, but the structure they belong to overcomes the infrastructural utility and becomes a matter of architectural design. Accordingly, disciplines such as design, architecture and urbanism transgress into traffic, structural engineering and technology, and vice versa, providing new models of built achievements and transforming the contemporary cities.

Loss of physical boundaries

The loss of physical boundaries in terms of fluidity researched in this paper refers to the complex structures in which functions based on the articulation of flows in space remain separated while the whole form of space becomes unified, fluid and liquid with no sharp edges, and it almost becomes hard to recognize their zonal and spatial beginning and end.

Stephen Cairns (2012) in his text "Flows", referring to Manuel Castells' theory, links the spaces of flows to airports, railway stations, terminals, intermodal transfer areas, telecommunication infrastructure, harbors, ports and computerized trading centers. Castells describes "communication exchangers" (Castells, 1996: 453) as "the significant building types of the space of flows". Castells says that, when it comes to architecture, the spaces of flows are: corridors and halls which connect places around the world and we have to understand them as places of exchange, shelters, homes and offices of the contemporary society (*ibid.*, 1996: 448). Castells notes that how we relate to airports, to train and bus stations, to freeways, to customs buildings, etc. is how the new urban experience is formed (*ibid.*, 1996: 407-459). In the relation between technological discourse and architectural productiveness, Sanford Kwinter's new "soft urbanism" defines the city as: "the medium of the flow of population, information, goods and communication, i.e. the formation of functions and the changeable field of perception" (Kwinter, 1998: 586). Corresponding to Manuel Gausa's understanding of the contemporary urban environment: "which can be understood as an endless interior of blurred boundaries, where the citizens are located in the form of flow" (Gausa, 2003: 230), Kwinter talks about negating the limits of three-dimensional space and boundaries between the interior and exterior, where the architecture consists of social, economic, biological and spatial elements.

Such a contemporary context transforms the physical boundaries in architectural space. Architectural form increasingly becomes a continuation of the infrastructure or an extension of a landscape. In relation to the phenomenon of flows and the dynamics of a contemporary context, the architectural form becomes open to their influence, and its physical elements become dynamic fragments integrated into a unique assemblage. By blurring the boundaries between the interior, exterior, object and context, and by overlapping architectural layers of events, form and function, the architectural structure becomes a new determination of contemporary architecture in the urban environment.

Dispersion of perceptual boundaries in space

Fluid spaces are characterized by the loss of perceptual boundaries, in which the infrastructural flows become part of the architectural spatial experience in the contemporary urban environment. The perceptual experience of fluid spaces comes down to functional, momentarily useful information, namely the accumulation of visual images at high speeds, at which the sequences of space cannot be separated from the sequences of movement in the space itself. Based on everyday observations, experiencing the social and spatial context as a network of flows composed of dynamic forces and mutual relations of elements shapes the experience of the contemporary urban context as a dispersed field of effects. In this field, the perception of constant changes creates the spatial experience of architecture as an integral element of a dynamic urban system. Accordingly, the spatial perception characterized by increasingly dynamic and fluid effects overlapping in space changes the structure of our living space from a system of solid boundaries to a system of connections, networking and flows.

By perceiving flows of movement, we are equally informed about the material and immaterial properties of space and we may equally conceptualize space by form, dynamism, speed and flows as the main aspects of fluidity. Flows of movement are determined by constant variability – a change of position over time, by which we equally observe differences, repetitions and changes that form a fluid continuity. The perception of variability and mobility, and the differences in their intensities, blurs boundaries in space and between spatial zones. In addition, the perception of flows in space, as well as the perception of space by movement, are equally important aspects of experiencing contemporary fluid spaces, in which by moving through space, the continuity and mutual integration of the architecture and our experience is achieved. The perception of the whole is built on the basis of the cognitive process of assembling sequences of space, i.e., visual images that we perceive with movement. Therefore, fluid spaces in a contemporary urban context are considered through dispersion of the perceptual boundaries. These boundaries are fluid and softened so the zones and programs overlap and dissolve into each other. The form of such spaces frames programs and action occurring within, while allowing the perception of the users to flow freely and change constantly.

MODELS OF FLUIDITY IN A CONTEMPORARY URBAN CONTEXT

Based on the previously defined criteria that identify the characteristics of fluid spaces in terms of disciplinary, physical and perceptual boundary redefinitions, reference examples will be presented of some selected projects that manifest one dominant aspect, while others equally fulfil all aspects of fluidity within relevant typological groups. The loss of physical, perceptual or disciplinary boundaries in fluid spaces is mutually conditioned and interconnected. Accordingly, examples of contemporary architectural practice are selected to present how the notion of fluidity, manifested through disciplinary, physical and perceptual boundary dispersions, creates new meanings, knowledge and potential in a contemporary urban context (Figure 1). The research covers the works of Santiago Calatrava, FOA Architects, Zaha Hadid, SANAA, Rem Koolhaas's OMA and UN studio, and the selected projects respond to all three set aspects of the manifestation of fluidity in the context of the loss of the architecture-infrastructure boundary.

Architecture, interpreted and designed as an extension of infrastructure (as shown in the works of Santiago Calatrava, OMA, Zaha Hadid, FOA architects, UN studio *et al.*), is recognized also as an extension of the landscape, urban as well as natural. That being so, the architectural form arises based on flows from the contexts it absorbs and remodels in the interior space. Through superimposition of architectonic and infrastructural layers and blurring of boundaries between them, the architectural form becomes an open tectonic field, countering traditional notions of architecture as a finite entity. This form is not necessarily mobile, but shaped so it can assimilate the architectural and environmental trends in a kinesthetic and empirical way. Architectural form is defined by Angelil and Klingmann (1999: 24) as "accumulations, connections, densities and fluctuations", and this use of

the term determines the city and its architecture to be a dynamic system where the flows and the shaping of space they occupy erase the boundaries between architecture, infrastructure and landscape. Both spatial, and consequently formal, constellations develop as uninterrupted fluctuating processes and new interpretations of architectural design and methodologies. Therefore, the fluid spaces analyzed in this paper are characterized by the transformation of the architecture-infrastructure boundaries as presented below.

One of the most distinguishable examples of traditional **disciplinary boundary loss** due to the artistic and complex tectonic treatment of structures, which are simultaneously infrastructure and architecture, is Santiago Calatrava. Large infrastructural units, primarily bridges and terminals, in a unique way embody and affirm the aesthetics of form by the tectonics of their construction and shaping of the structural elements, mainly linear, whose repetition and translation fashion surfaces. Selected Calatrava projects, such as the Orient Station in Lisbon, Liege-Guillemin station in Liege, the World Trade Centre Hub Terminal in New York, Lyon Airport Station etc., are typologically and functionally in the domain of city infrastructure and engineering, but according to their aesthetic and tectonic quality they without doubt go beyond their infrastructural meaning. The architectural design principles involved in creating these spaces are the principles of fluidity, where the coordination of flows of movement and traffic also become a matter of experience, perception and architectural form. Calatrava's works are structurally complex achievements in which the disciplines of architecture and urbanism are intersected with engineering and technology in the most specific way. A similar example of disciplinary boundary loss is Yokohama Terminal by FOA Architects, which is one of the most representative examples of where function, complex tectonics and shaping surpass the infrastructural meaning and transform the architectural disciplinary framework. Yokohama Port Terminal is a masterpiece of formal design, as well as a functional articulation of protocol. This project is also an example of how new technical and technological possibilities, which transform formal and tectonic possibilities in architecture and infrastructure, contribute to socio-technological transformations in contemporary society. Buildings by Zaha Hadid are the most obvious examples of the formal expression of dynamic spatial fluidity. The hybrid nature of her methodology and absence of standard architectonic classification are both the cause and result of specific fluid shaping of form, characteristic of the greater part of Zaha Hadid's opus. Selected projects, such as the Bridge Pavilion in Zaragoza, Galaxy Soho in Beijing and BMW Centre in Leipzig, are representations of specific overlapping and transgression of architecture and engineering, i.e., the loss of their disciplinary boundaries. Complex structures and forms, characteristic of Zaha Hadid's opus, require constant technological and technical innovations which go beyond the common architectural domains. Ryue Nishizawa from SANAA created Kumamoto Station in Tokyo as an extension of its infrastructural functions, attempting to generate a calming, park-like square area in a complex environment for mass transit. Composed of multiple roofs, all meandering and organic in shape, this recent example of SANAA's work represents the well-known architectural philosophy and

principles of this group, this time applied in defining the architecture-infrastructure boundary in the contemporary city of Tokyo. UN studio's Arnhem Central Transfer Terminal also demonstrates design principles based on the integral flow of movement within an object and in its environment. The design process of this facility involved exploring human flows and different modes of transport in order to make the terminal a "transfer machine" that incorporates the full spectrum of public urban transport and individual passenger needs of the user. The methodological process of UN studio in many projects is *flow-based*. Therefore, the flow is a methodological tool of architectural form shaping that is functionally organized. Accordingly, such design methodology follows the unique nature of flows and the spontaneity of events in the context in which they exist, while articulating them into a dynamic system of architecture, infrastructure and urban landscape with no defined and sharp boundaries in between. In addition, Rem Koolhaas (OMA) integrates urban infrastructure into an architectural object in the Tate Modern project, as well as in Jussieu library and Cardiff Opera, thus directly transgressing the interrelationship between the disciplines of architecture, urbanism, engineering and technology.

Calatrava's works, mentioned above, are mainly terminals and bridges that are masterpieces of both architecture and infrastructure, representing spaces where areas are overlapped to make the whole space flow and manifest the **physical boundary loss** between inside and outside. The structures are transparent and the combinations of materials and shapes transform the meaning of the physical boundary. Functionally divided flows of traffic and pedestrian movements, as well as the integration of other diverse programs, are organized and shaped to create one unique, dynamic, fluid spatial whole. Another space without sharp physical boundaries between functionally distinct zones is Yokohama Terminal by FOA Architects. The terminal is designed through a diagrammatic take on the research of flows and movements of all sorts (physical flows of people, vehicles and ships as well as motions of fluids – air and water within the premises). The terminal represents the fluid shaping of volume, with no boundaries between the interior and exterior spaces, where the spaces entirely dissolve into each other and flow unceasingly. Zaha Hadid's unique formal expression conveys the blurring of boundaries between the elements for a larger urban scope, as well as in the interior. On a city scale, the architectural form is developed by assimilating the flows from the environment in constructing a unique system with no boundaries between landscapes, infrastructure and architecture. On the other hand, by shaping the volume of the interior space, by curving the membrane of space and by fluid forms of walls, ceilings and floors, she creates specific kinesthetic impressions in which the flows and motions are the base of formal and methodological principles. The boundaries between spaces and areas within one formal whole are blurred, elastic and sometimes completely absent in a unique free-flowing and fluid space. The absence of boundaries between inside and outside, internal and external flows, and those between the interior and exterior, landscape and architecture, is characteristic of the work of SANAA Architects. The distinct features of oriental culture

are reflected in the contemporary architectural tendency to enable the unobstructed circulation of air, light and movement of people within the architectural space. SANAA's architecture is defined by bright, weightless surfaces that are as transparent and open as possible. As a result of assimilating the flows from the environment and inner space, the form is revealed by shaping the surfaces that partly enclose the space. The Dutch Embassy in Berlin by OMA is another example of architecture where the flow of movement through an object is main the design principle that determines the form. The free flow of the ramp, which zigzags through eight levels, determines the organization of space and programs and dematerializes the boundaries between the spaces and programmatic zones. This design approach, on the other hand, enables the coexistence of architecture with the environment through a form that tracks the external and internal movements of people, and the circulation of air, vapor and humidity. The volume of flows that diagonally permeates the cubic form is also projected onto the object's membrane, which visually dematerializes the facade itself into the form of flow, and dematerializes the boundaries between inside and outside. In relation to Koolhaas's view of the city as a form of landscape evolving in the form of a dynamic process, the architectural form loses its autonomy and isolation and opens itself to the processes that make up its environment. The architectural object is not a closed entity, but integrates into the context through fluid and dynamic processes, achieving the connection of interior and exterior space and becoming a continuation of the infrastructure and landscape with no sharp physical boundaries in between. UN studio's Arnhem Central Terminal was also intended to blur the physical boundaries between exterior and interior in a form that represents the extension of the urban landscape to the interior of the building, where ceilings, walls and floors overlap and the common understanding of physical spatial boundaries is lost.

The works of Calatrava mentioned so far are examples of architecture-infrastructure boundary loss on many levels. One of these levels is most certainly the **dispersion of perceptual boundaries**, with no boundaries between the interior and exterior spaces creating a very dynamic, unique ambient. The spatial limits of perception are softened and dispersed, the spaces entirely dissolve into each other and flow unceasingly. The opus of Zaha Hadid is characterized by the design methodology and principles by which specific perceptual qualities in space are created. The Bridge Pavilion in Zaragoza provides the experience of inner-outer space overlapping while moving through the space, which is accomplished by the effects of a semipermeable membrane of the space in the design of the façade. Projects such as Galaxy Soho in Beijing, the BMW Centre in Leipzig, Heydar Aliyev Center in Baku, and many other designs by Hadid were designed so that during movement through the space, dynamic forms, materials and programs overlap with no boundaries in between them. Programs take their own functional spaces and develop within a fluid whole, while the perceptual experience is in constant change – dynamic, fluid and continuous. SANAA's projects such as Toledo Museum of Art, the Glass pavilion in Toledo, University café in Okayama, the meandering river building at Grace

Farms in Connecticut, Rolex Learning Center in Lausanne, Serpentine Gallery Pavilion etc. are examples of the form of surfaces which enable the kinesthetic experience of the interior and sensory unity of the context and architectural space. Voids and the absence of solid walls provide views in every direction, allowing the external environment to be seen and become part of the interior. This loss of perceptual boundaries in space is emphasized by the city or nature as a background. Therefore, the fluid space appears to frame the activity and action which is taking place within, while allowing the perception of the users to flow freely between inside and outside. In the Terminal 3 project by UN studio, the shaping of the horizontal surfaces creates a soft form that follows the spatial fluidity, flows of movement and events in it. A similar design principle, by which form develops as a support for flows and events, is noticeable in the Center for Virtual Engineering in Stuttgart. Through the adaptability of architecture to the processes of communication, subjectivity and experimentation, the architectural program becomes hybridized and the form flexible, with visible loss of both physical and perceptual boundaries.

CONCLUSION

The main idea of this paper was to position the phenomenon of the fluidity of a contemporary socio-spatial context into the spatial perspective, with the aim of questioning the boundary between architecture and infrastructure. These boundaries were researched in terms of meaning, perception and the function of architectural and infrastructural space in a contemporary urban context. The relations between architecture and infrastructure have been transformed according to new dynamized conditions where mobility, speed, movement and *flows* become the necessities of contemporary urban life. Accordingly, the phenomenon of fluidity is the main conceptual phenomenon in a contemporary urban context, in which the notion of flow has become the new main determination of spatial use and design.

The theoretical framework in this paper is based on a transdisciplinary synthesis of recent approaches to the problem of fluidity and the contemporary concepts of the theory of architecture and urbanism, in order to explain the relations that have been made, their origins, and the possible forms of their interpretation. This research examined the relevant theoretical approaches through their application in the opuses of representatives of contemporary architectural practice, such as Santiago Calatrava, FOA Architects, Zaha Hadid, group SANAA, Rem Koolhaas's OMA and UN studio, with the aim of analyzing how selected projects by these authors fulfil all of the aspects of fluid spaces: the loss of disciplinary, physical and perceptual boundaries in the relation between architecture and infrastructure.

Although the ideas of overlapping architecture, infrastructure and landscape in an urban context, which becomes a space with no defined boundaries, started with modernist utopian concepts, contemporary technological innovations have allowed the rethinking and implementation of these ideas. Therefore, both architectural and infrastructural form become an expression of the position in a process of constant dynamics.

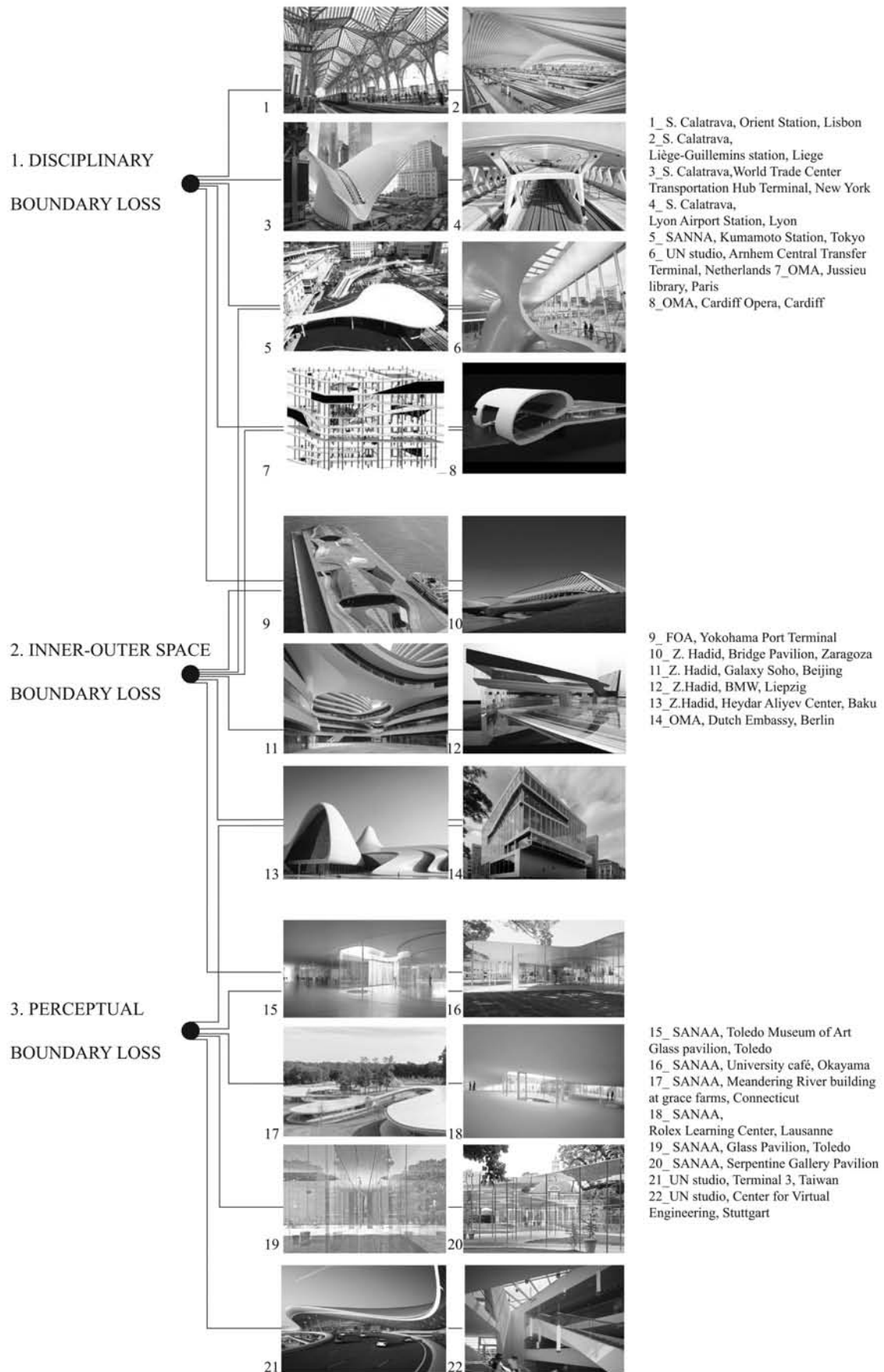


Figure 1. . Classification of contemporary architectural examples in terms of boundary loss (Source: authors)

Identifying several key models of fluidity in accordance with the basic hypothesis of the paper has created the basis for further interpretations of this complex problem and its impact on the global transformation of cities and urban spaces. The hypothesis and the aim of the research were confirmed.

Flow has become the new relational, kinesthetic, aesthetic and formal determination of contemporary architectural space in the urban context. Accordingly, contemporary architecture tends toward an infrastructure of flows, and infrastructure becomes a matter of architectural rethinking and design. New forms become more fluid, dispersed and reinterpreted, thus opening new potential for spatial design.

The results extend the findings of previous studies linking architecture and infrastructure to the phenomenon of fluidity by researching the position of the boundary in their interrelations. Although the research has shown that fluid spaces are expressed in diverse aspects of the dematerialization and loss of the architecture-infrastructure boundary, the number of examples analyzed is a limitation of this study. The original and significant scientific contribution of this paper is its identification and analysis of the concept of fluidity within clearly defined typological frameworks, which, with contemporary theoretical approaches to this issue, builds a platform for new design approaches and spatial interpretations. Future trends regarding this type of research and opportunities for future research can be found in the development of new principles and methodologies in architectural design.

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REFERENCES

- Allen, S. (1999). *Points + Lines*. New York: Princeton Architectural Press.
- Angelil, M., Klingmann, A. (1999). Hybrid morphologies: infrastructure, architecture, landscape, *Daidalos*, No. 73, pp. 16-25.
- Augé, M. (1995). *Non-Places*. London: Verso.
- Cairns, S. (2012). Flows. In G. Crysler, S. Cairns, H. Heynen (Eds.), *The SAGE Handbook of Architectural Theory*. Los Angeles: SAGE, pp. 451-464.
- Castells, M. (1996). *The Rise of the Network Society*. 2nd ed. Oxford: Blackwell Publishers.
- Corner J. (2006). Terra Fluxus. In Ch. Waldheim, (Ed.), *The Landscape Urbanism Reader*. NY: Princeton.
- Delalex, G. (2006). *Go with the Flow*. Helsinki: University of Art and Design Helsinki.
- Easterling, K. (1999). *Organization Space*. Cambridge. Mass.: MIT Press.
- Forrester, J. (1969). *Urban Dynamics*. Cambridge: MIT Press.
- Gausa, M. (2003). *The Metapolis Dictionary of Advanced Architecture: City, Technology and Society in the Information Age*. Barcelona: Actar.
- Goldblatt, D. (2007). Lightness and Fluidity: Remarks Concerning the Aesthetics of Elegance, *Architectural Design*, Vol. 77, No. 1, pp. 10-17.
- Graham, S., Marvin, S. (2001). *Splintering Urbanism*. London: Routledge.
- Koolhaas, R., Mau, B., Sigler, J., Werlemann, H. (1998). *Small, Medium, Large, Extra-Large*. New York: Monacelli Press.
- Kwinter, S. (1998). "LaCitta` Nuova: Modernity and Continuity," Zone 1-2. In M.Hays (Ed.), *Architectural Theory Since 1969*. London: MIT Press, pp. 586-612.
- Mossop, E. (2006). Landscape urbanism. In Ch. Waldheim (Ed.), *The Landscape Urbanism Reader*. NY: Princeton.
- Niković, A., Manić, B. (2018). A Possibility of Introducing the Concept of Form into Urban Planning in Serbia, *SPATIUM*, No. 40, pp. 18-24.
- Pawley, M. (1998). *Terminal Architecture*. London: Reaktion Books.
- Wigley, M. (2001). Network Fever, *Grey Room*, No. 4, pp. 82-122.

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