MIXED REALITY ENVIRONMENT AND OPEN PUBLIC SPACE DESIGN

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Abstract

The text explores potentials of use of mixed reality in urban design, specifically in public open space design. Research presents the model that uses mixed reality environment, not solely as part of a process of computer aided design, but also as architecture design result or architecture itself. Model describes the design process of mixed reality open public space, a space in which user's perception is artificially modified so the user can see and use both real and virtual environments.

Mixed reality open public space can dynamically change appearance of its spatial elements and allow open public space to be the product of user centred design. Such spaces are made to be used in a way users wish or need to employ them instead of making users change their behaviour in order to adjust to them.

Keywords: mixed reality, urban design, user centred design, quantum architecture, constructor theory

INTRODUCTION

ICT development in cities providing and assuring low-cost Internet access at homes, offices and open public spaces, is an indicator of development and well-being of their citizens. Relationship between ICT, community and cities has been continuously analysed and elaborated emphasizing emerging topics. Furthermore, the role of digital networks and flows has been recognized in many fields of urban reality, urban planning and urban design (Pigg, 2001), supporting sustainable social, cultural and economic development of cities and their spaces.

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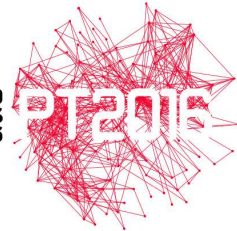
Nowadays, people interact in both physical and virtual realm, gathering formally or informally in order to exchange information and knowledge, disseminate practice and experiences, or erase different kinds of limitations (Stupar, Djukic, 2014). Furthermore, they become interactive participants in processes of collaborative planning and designing of the place. While the main role of open public spaces is to provide social contacts between people, thus remaining the place where they can rest, recreate and enjoy the environment, e-networks have opened additional channels of communication and diffusion and became a new tool for its continuous development (Stupar, Djukic, 2014). Users acting as consumers of places can participate as active contributors in the process of urban design or critics of open urban space using ICT.

Presented research shows how constructor theory, embedded in architecture and urban design processes, can increase and improve users' participation in the personal and public space design, which is achieved by simultaneous designing of both real and virtual environments on the same territory. With constructor theory, a new design methodology could be created so that a real space could be mixed with numerous layers of virtual space. A constructor enables incessant upgrade of environmental potential without losing original space potential (Aleksic, 2015).

MIXED REALITIES

Material and virtual spaces have always been inextricably linked (Firmino and Duarto, 2010; Graham et al., 2012; Nagenborg et al., 2010). Mixed realities are the new layer of space that replaces or merges with prevailing physical world. It is the space where the real physical objects and objects from virtual world are presented as common and unique experience. Its background philosophy supports the argument that virtual in interaction with physical and everyday human activities enriches the perception, potentials and activities in human life.

There are several reality domains that scale from the real to the virtual. There is the real reality, as a material physical space. There is also amplified reality that enriches the properties of physical objects. Augmented reality is providing additional virtual form based information about physical structures. Mediated reality is presenting space within human perception and is modified in order to deliberately diminish the user's perception of reality. Augmented virtuality presents the augmentation of virtual environment with real objects. It is registered in three-dimensions, real-time and it is interactive (Azuma, 1997; Aurel 2009). There is virtualised reality as a three dimensional virtual model of a real space that enables seeing the space from any angle. Yet again, there is virtuality as a completely virtual environment.

In architecture and urban design, domain of virtualised reality is used as a computer aided design for future, solely physical resulting world. The domain of augmented reality is used for obtaining additional information about physical objects. For the model presented in this research, the acceptable domain would be augmented and mainly mediated reality.

DIGITAL URBAN PUBLIC SPACE
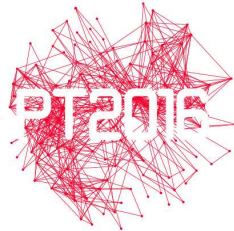
The present urban sphere is increasingly changing by the presence of digital media and technology. Physical city spaces are constantly merged with various virtual processes that are significantly changing the conditions for future urban design processes. Digital and coded information significantly influence everyday urban life and experience. Digital urban space contains the physical space as its basic element. Aspects of digital are in fact an upgrade or expansion of physical sphere. This extension gives new meaning to the physical space. It impacts the people in terms of how the use of space and also provides the greater freedom of choice with backward influence on the physical form.

Physical Sphere of Open Public Space Design

Design of open urban space generally comes as a result of an architect's interpretation of users' wishes and needs. Also, an urban space is designed based on previous designing experience, by coming to some general conclusions about a man and his needs. Constant upgrade of the relationship between a user and his surroundings and a higher level of participation is necessary for a lively, attractive and quality urban space (Stupar, Djukic, 2015).

Almost all studies of urban public space are focusing on its physical sphere, and open public space is mostly used for different types of physical social interactions and activities that can be seen as necessary, optional and social. Necessary activity is conducted on daily basis and implies activities that do not include leisure or free time. Optional activities include more or less random or common activities on streets, squares, parks etc. Social activities involve any line of communication between urban space users. Social activities are intertwined throughout the both necessary and optional activities and, in solely physical public spaces, they require physical presence of other people. The open public spaces serve as nexuses around which communities can gather (Carr, Francis, Rivlin, & Stone, 1992; Kent, 2000). The high proportion of public space as well as a good networking available in a city has been associated with an elevated quality of life for the city's inhabitants (Brown, 2009). It is also important to mention that high quality of physical environment includes larger amount of optional activities (Gehl, 2010; Hillier, 1996). Presence of high level optional activities is consequently improving social activities as well. Also, optional activities are offering more opportunities for users.

User and Cognition in Digital Urban Public Space

There are two prevailing scenarios of what will emerge as a result of digital media enrolment in open public spaces. The first one is dystopian, that will lead publics into more commercial, fragmented and estranged public environment. The second one is positivistic, and predicts emergence of new types of public space and new public role in a city (de Wall, 2014). A great thing about both scenarios is that choice of the option and in the extent in which it is about to come to life is going to be decided by the user. In digital world users have more choices of how to live than it is the case in purely physical environment. Thus, citizens with their knowledge and way of space usage determine the space itself.
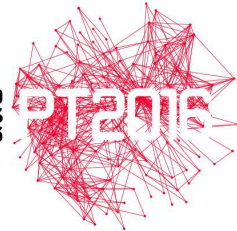
In order to use the digital media, one must grasp digital rules and must understand the space he is using. Knowledge must be significantly higher than when one is using non digital environment. In digital world user is faced with a lot of choices that eventually start processes inside its environment and in fact make its environment. Thus, user's actions driven by its cognition are beginning to appear as central factor for space definition. Model presented in this paper is guided by idea to create space that will, by its self-development and upgrading, eventually mirror the user i.e. its cognition - fully user centre designed environment.

## MIXED REALITY ENVIRONMENTS AND OPEN PUBLIC SPACE DESIGN

Since digital technologies for urban space are not yet fully incorporated in city life of every day users, there is a lot of space for creation of various models for design and discussion about possible outcomes of digital media involvement in urban sphere. This paragraph and the research in general, present open public space model of digital urban space that involves mixed environments as a main tool for design process definition.

Virtual and mixed environments in architecture are mostly used as a tool for realistic preview of a physical structure or an open space. Also, digital networks are used as system for data collection and interpretation of design concept development such as space syntax. Nevertheless, virtuality that is upgraded with mixed realities environments interlaced with digital networks and its supporting technologies have a greater potential than just being a credible information collector or representation and simulation for a future built environments.

This research is attempting to expand a role of mixed environments and digital world into open urban space. Public sphere merged with mixed reality environments can easily consist more than static virtual and real surroundings. Virtual spaces can be changeable, responsive and user canter animations that fit involved citizen's needs and choices. Virtual space can include live recording of distanced spaces and in such way virtuality can connect users from various locations on the planet via physical public sphere and on the internet as well. Such spaces, by its representation defy the law of physics and, by its flexibility and changeability potentials, can enable presentation of almost any user's visual and audio need or unusual wish. Mixed environments enable surroundings that involve active citizen participation, almost or completely equal as the participation in the real physical space. In such surroundings, users can have a prevailing role in shaping of their environment.

Design System Theory: Quantum Architecture and Constructor

Main theory that backs up the basic for user adjusted mixed environment space is found in constructor theory of David Deutch and in principles of quantum architecture presented by John Lobell. Trough decomposition of constructor elements, by means of mixed environment supporting technology, it is possible to create methodological frame for design of space that corresponds to principles of quantum architecture.
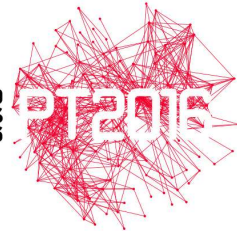
Quantum architecture is a space that exists only if it is being observed or turned on by the user. It is a space perceived by a user as both virtual and real, whereas multiple architectures can be perceived and exist at exact the same coordinates at the same time. It is the space that can transform itself through different parallel dimensions when used repeatedly. It is an environment that can consist of different spaces active and/or inactive trough parallel timelines and key frames. It is where each new user's experience in space is being used for development of spatial potentials for new parallel spatial dimensions. It is there that it is possible to walk on all paths inside one physically attached territory at the same time, and even to be at the two physically distanced places simultaneously. Each architecture reuse represents a new potential and development for new spatial dimension, where form can memorize user's experience and connect it with all other connected forms within any networked territory or event horizon (Flachbart, 2005 Lobell, 2003; Arida, 2002).

The constructor theory research is aiming to present spatial theories in context of possible and impossible transformations, regarding transformations that can and cannot happen. Constructor consists of input data, a programmable constructor and the program that runs it, and output data or temporary results. Programmable constructor is made of possible and impossible transformations, while the program manages transformations (Deutch, 2013).

Constructor is phenomenon that has ability to cause physical system transformation without reducing the original transforming ability (Deutch, 2013). In order to exercise constructor theory in sphere of mixed environments, it is necessary to slightly reconfigure the definition so that transformations can be not only material physical, but mixed as well, meaning that possible transformations could also have a virtual form.

Design Elements of Mixed Environment Open Public Space

Design elements consist of constructor's impossible transformation as a physical form, possible transformations as a virtual and changeable spatial layer and program that defines the relationship between transformations. Additional elements are: physical area or event horizon within which program operates the transformations and activities inside the open public space, input and output state that presents mapped information and resulting temporary manifestation of form/architecture and the matrix that defines the position of possible and impossible transformations. Also, all spatial options of possible transformations exist at the same time and can be experienced by different users at once. This applies to 'and/or' logic of post-Boolean principle (Aleksic, 2015).

When a user inhabits a single spatial option, that option is connected with all other options currently used by other users in the same event horizon. Thus, the connection is inevitable and controlled by the program. The experience of each user in the event horizon is recorded in accordance with the criteria by a 'seeing machine' and connected with all spatial elements, possible and impossible transformations, inside the same event horizon. Without the simultaneous connection between all active possible transformations, merged with impossible transformations, function inside event horizon would not be possible (Aleksic, 2015).
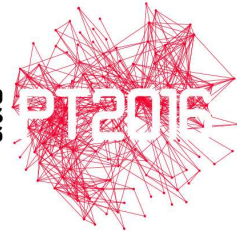
Design Process Model for Mixed Environment Open Public Space

General model for use of constructor theory in architecture and urban design is presented trough self-regulative and generative system. It consists of all presented design elements set in certain order which enables functioning of the required system. The essence of the system consists of the element presented through the constructor theory: input and output state and programmable constructor with impossible and possible transformations. Auxiliary structure is made of 'process-like' elements that make constructor alive. In order to explain how this system is functioning four layer or levels, with addition of fifth layer, are presented in a repetitive life cycle of the system. All layers are merged into one inseparable algorithm system, and their division is made solely for explanation purpose.

First layer is the input state. Its role refers to selection of information based on designed criteria. Each information or information group are intended for triggering certain behaviours or actions of possible transformations. Information selection domain is within the event horizons. The second layer is the programmable constructor that consists of the program and possible and impossible transformations. This layer is making the architecture or open public space functional, i.e. when a user interacts with the space and turns on one of the possible transformation options. All complexity of model lays in structure of the relationship between possible and impossible transformations and users. This relationship can change in every following cycle. Its ability to change is allowing the users to apply their knowledge and manner of space usage as well as to determine the space itself. Third layer is the output state: the information about resulting space. Its role is to map users' spatial selection option and its behaviour within the selected space inside the event horizon. All information gathered in this step, such as: real form of impossible transformations, changeable or virtual form of possible transformations, behaviour of users within the space together with mapping and analysis of that behaviour, are actually the architecture of open public space, the resulting architecture of the constructor's output state. Space created in this manner goes beyond the form and function, and it can involve all of the processes that make up the form and function of the architecture too. Layer four and five are making the architecture, created out of elements and principles of constructor theory, being generative and alive. After the third step is finished or even while it still lasts, a new design process is starting. The fourth step is evaluating everything that happened in previous steps. Analysis can result in creation or selection of new sets of criteria, i.e. designing and adding new spatial options to possible transformations, or designating potential new areas of the event horizon followed by a matrix redesign that can include creation and determination of new or different, non-changeable structures or impossible transformations. It's mandatory, completely new design upgrade, based on the previous users' experience gained in steps one, two and three (Aleksic, 2015).

Elements of the constructor theory, using the presented layers, make a circular system with self-regulating intentions. Since the system is predesigned to upgrade and adjust itself throughout the cycle, the overall process can be seen as iterative. The model is further presented with five iteration design steps. The first one is determination of event horizon three dimensional borders. The second one is matrix design with purpose to separate space of possible and impossible transformation. The third step is mapping of buildings of
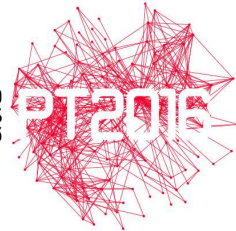
impossible transformations and/or building of new impossible transformations structures. The fourth step is new matrix redesign to define the area for various spatial options within possible transformation territory. The fifth step is the program design.

Open Public Space Upgrade: User Centred Design

New spatial layers of mixed environment, specifically augmented and mediated reality, are additional optional activities in open public space, with the potential to continuously upgrade the social activities in urban sphere. Social activities improvement potential is further more increasing when two or more physically distanced territories (event horizons) are overlapping into one space which enables users from different parts of the world to socially interact in mutual mixed environment.

There are various ways of how user can interact with presented mixed environment model of open public space. Each one is involving active or passive interaction where user is directly choosing the options of virtual layers' options of possible transformations or where layers are being assigned to user by program that runs the space. Either way, user must understand and perceive the mixed environment open public space in order to use it with the level of knowledge that is higher than when he is using only physical environment.

In each stage of design process or in each iteration circle of life span of mixed environment open public space model presented in the paper, user is involved as the space creator or the one choosing his own space. The whole system is designed to make the user the central element of public space design. User-centred design is a process in which end-users influence what shape the design takes. They can be involved in design process in different ways. Furthermore, user-centred design is based on the physical and psychological needs of the human user. Considerable attention is given to user's wants and needs throughout ever-present design process. The extent of users' satisfaction with the environment they reside in, depends entirely on the spatial option type and ways of the allocation of options. Spatial option types and methods of assigning them to users represent the quality of the architecture and thus open public space upgraded with mixed environments.

CONCLUSIONS

The role of user centred design addressing public user needs in activating open public spaces is a relatively covered under research area of urban design as a discipline and it is not enough explored. Moreover, research and review of literature indicate that the needs and desires of public space users are often unpredictable, overshadowed by the implementation of a macro-level design approach, complicated by the different goals of various stakeholders and the large-scale logistical and political complications involved with developing public spaces.

Human needs are dynamic and demanding in the way that individuals will continue to reach for better, more enjoyable and more meaningful situations (Utterback, Vedin & Alvarez, 2006). This demands re-making of spatial experience and interactions with the space and place as well as the constant changing of the open public space over a course of time. In

order to achieve better design for open public spaces that appeals to user's functional, emotional, and social comfort and constant changing of the needs and experiences, Pilloton (2009) it is suggested that urban designers must reorient public priorities to deliver value to design solutions that fit users' needs.

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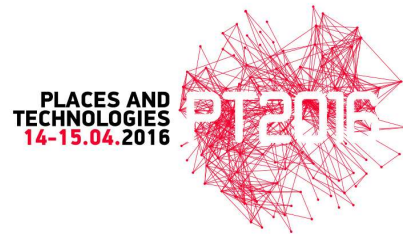
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