

From Moving Cube to Urban Interactive Structures

A case study

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When thinking about the future vision of a city, having in mind recent development in digital technologies and digital design tools we are inclined to expect new building structures which incorporate this technology to better help us manage the complexity of life, and to simplify our daily lives and tasks. The idea behind this research paper lies in design of such structures, which could be put inside an urban context and engage in creating a built environment that can add more to the quality of life. For us Interactive architecture is architecture that is responsive, flexible, changing, always moving and adapting to the needs of today. The world is becoming more dynamic, society is constantly changing and the new needs it develops need to be accommodated. As a result architecture has to follow. Spaces have to become more adaptive, responsive and nature concerned, while having the ability for metamorphosis, flexibility and interactivity. Taken as a starting point of this idea is a specific module from graduation project in 2014 "The Unexpected city", where it was possible to test out first ideas about interactive and flexible objects in an urban environment.

Keywords: *Flexible architecture, Interactive architecture, Responsive systems*

INTRODUCTION

In this paper we report on a PhD research which has recently started. The field of the PhD research project is Interactive Architecture. We explore what is the phenomenon of Interactive architecture, and how objects (building structures) within an urban organism may be both flexible and interactive with its users. The word "organism" is deliberately used to accentuate the author's belief that interactive means responsive, flexible, changing and always moving. We aim to develop a design by which architecture can become more interactive in the future. We hope

to achieve much better building functioning, being user friendly and communicative on both ends: user - building - user. We believe the logic of design has to be changed due to the rapid change of the technology and human demands. (Figure 1)

PROBLEM EXPLORATION

We can observe around us in society that it seems to develop more dynamically than before and that needs also have become more dynamic. The commercial lifespan of goods and products is decreasing because they quickly do not fulfill our needs. Unless

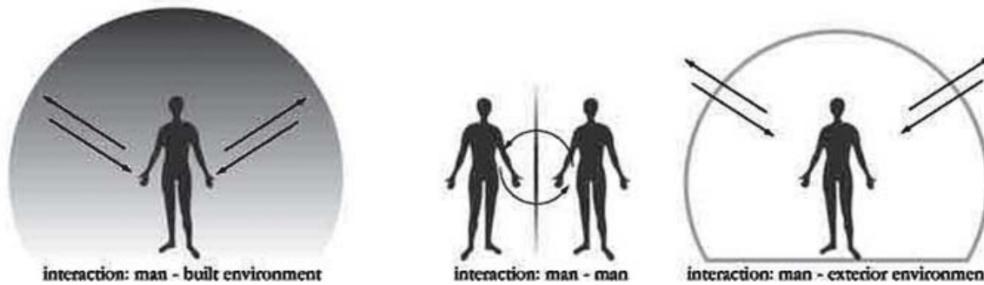


Figure 1
Interaction
relations.

they can follow and change with us, they become expendable. The challenge we are facing in this research is how to establish an environment that is part of developing human culture?

"The world around us is evolving. We are living inside an evolution. As a practicing architect I find nothing more natural than to look around me and implement relevant changes in to my own profession." (Oosterhuis 2012)

In our view, architecture is more than the physical realization of a space. Like for example Tschumi (1994) we believe that the events which take place in architectural space are as important as that space itself. We can observe a proliferation of events in contemporary buildings that are contrary to monofunctional types that have been favored in Modernist approaches. Peter Cook said that cities should generate, reflect and activate life, their structure organized to precipitate life and movement. In short, the cities should breathe together with the people, turning them into an alive organism. *"The pulsation of the city life is fast, so why not that of its environment? It reflects rise and fall, coming and going...change. So why not build for this?"* (Cook 1972)

50 years after Archigram's visionary Living City project we see proposals and prototypes that reference back to the ideas from the Living city and its way of above ground and diagonal transportation, such as in Elon Musk's ambitious 2013 whitepaper for Hyperloop [1]. Other examples are N55's "Walking

House" from 2008 [2], many examples of media/interactive facades, or the Spielbudenplatz in Hamburg from 2006 (Schumacher et al. 2010, 204-205). The future is happening. And it looks pretty much similar as the one drawn back in 60s on the images of the Living city.

VISION OF RESPONSIVE AND CHANGING ARCHITECTURE

We as people change constantly. We are given free will and free movement. We adapt and adopt the spaces, thus why the buildings would not do the same? Leon C. Megginson said: *"It is not the strongest of the species that survives, nor the most intelligent. It is the one that is most adaptable to change"* (Megginson 1963, as cited in Seydel 2012).

Adaptability in architecture may be an essential component in creating sustainable architecture. Preserving and adaptive reuse of a building instead of demolishing it and erecting a new one in its place can contribute significantly to the environmental sustainability. However, adaptability comes as a cost (the whole sum of the system that is capable to change may be more expensive than a passive optimized system). Therefore the return of the higher cost of an adaptive building should lead ultimately to a better solution. Highly dynamic systems such as logistical nodes, places of events with large numbers of people, and so on may benefit in this way from adapt-

ability (Achten 2011).

"Intelligent building systems are used to create interactive architecture that responds to users' requirements in automatic or intuitive ways. It is architecture that is receptive to people's needs to alter their environment and has mechanisms in place to do so easily.(...)...sensors operate actuators that can trigger a wide range of actions - kinetic systems that physically alter space, services that alter the environment or materials that alter their state." (Kronenburg 2007)

With our idea of responsive structures architecture should become more self-conscious, and oriented towards all individual changes in urban matrix as well as in more private sector such as residential buildings. Technological advances are making such ideas increasingly feasible (see for example Schumacher et al. 2010 for a comprehensive overview of technologies applied in adaptable buildings).

"Public, the people almost always stand behind the traditional architecture, behind the traditionalists. In the public eye, architecture is about comfort, about shelter, about bricks and mortar. However, there is more and more of those for whom architecture is not necessarily about comfort, but is also about advancing society and its development" (Architecture and Disjunction, Bernard Tschumi, 1994).

PLACE OF INTERVENTION

In our research, we look at interventions by means of interactive structures on two levels: the urban environment and in the residential sector.

Urban environment

Author's belief is that the public space is the first point of action where these designs must take place, and where they must be tested. By observing people's actions we would be able to realize what is needed within an urban space, and to answer the questions around our design. In the first stage of the research this will be done in a virtual environment, in particular the Desk-Cave system at the Faculty of Architecture at CTU Prague. Following this step, more focused experiments will take place in real situations.

In particular we are looking at public spaces which are abandoned and today represent holes inside the city structure.

Architecture of industrial heritage is as well an interesting point of focus which could be a new field of action for this "new" type of architecture. There are many examples throughout the world where industrial buildings are being converted to cultural centers. Their flexibility gives an option for hosting multiple different functions, at various scales. Often industrial buildings are located in areas that have economically stagnated in cities, and which thus require revitalization. For this specific research industrial heritage is of importance in a way that it could be used as ground for technological and design improvements by the means of interactivity and flexibility in architecture. These types of buildings will be included in the research process from theoretical view, but also as a case study material.

Residential sector

In this research project we start in an urban context, and later in a residential one. The residential sector is different from urban sector in many obvious ways - scale, number of people involved, environment, context, and so on. However, we can apply a number of principles derived from experiences with urban context to residential sector. First, in both cases we start with an anonymous base of users. In urban environments this base may stay anonymous, whereas in residential context the system is more likely to get to learn the principal inhabitants. Second, in urban environments the number of actors involved with an interactive system can vary greatly from just a few people to large numbers of people. Deciding on the right interaction approach means reading and balancing out many inputs. Such decision making is also necessary in a residential context, although the number of actors is much more limited. Finally, by looking at the urban context we may get clues what people need from the urban context that they cannot get at home. These clues may be important pieces of information to improve the residential context.

UNIVERSAL OR LOCAL?

The question after determining the place of intervention would be whether it should start as something more universal - as a structure that has no connection to where it is being built, or rather as something more local, with respect to a specific location. Both approaches have different implications. Something local would have to inherit cultural and local elements, thus respond to them, while something universal should be able to be utilized and put anywhere in the world. To establish something interactive that makes sense globally has the risk that the interactions are reduced to lowest common denominator. This could lead to rather banal and simplistic interactions, of which additionally it would be difficult to prove the universality as we cannot test a system everywhere. As we stated before, an interactive architecture would have to be responsive and interactive not only to the users but also to the surrounding - this surrounding then also plays a significant role. We might even argue that different locations inside the same city, or a country differ enough for the structure not to be designed specifically for one - *"no more locating in a fixed place, but a new heterotopia"* (Tschumi 1994). Therefore we need to strike a balance between generic and specific interaction strategies.

This is a matter of concern for spatial urbanism as well. The idea of the nomad, of mobility, of the transformable and permutational became one of the main obsessions of the spatial urbanists in 20th century. This was a function both of prospective thought - the desire to predict the change, or at least to be prepared for an unpredictable change. What is unclear in this happening is whether this is a condition or a remedy. If man were being liberated to wonder, or if they were only displaced (Busbea 2007). Probably both is the answer, since we have witnesses of the first case on an everyday cycle, and the second one can be connected to the current world crisis and with refugees being nomads out of need. Here we refer back to the original proposed solution - building flexibly and in an interactive manner, so people can find their place in whatever environment they feel

like, being nomads out of need or wonder.

ETHICS CONCERNS

Our perception of what is comfortable, of how the building should behave at the moment, is not going to be the same in the future. With ever-changing perception of us - architects and creators of living space, the main question we need to ask ourselves is "How to design a building that easily changes with us in the future?". A building that can be "upgraded". Without such changes the building becomes rapidly old and unsuitable, in need for replace

Another important point is how compelling should the interaction become - we should avoid that the building dictates our lives, and habits, and pushes us - users, to comply with its performance. In fact, we could say that in such an overbearing situation there is no case of interaction, but rather one-way communication or even control.

Interactive architecture absorbs inspiration from other industries, such as for example car manufacturing, user interface design, and aero-spatial design. Developing technologies contribute to the possibility of new and better constructional and operational strategies. Principle is creation of spaces which are able to maintain a dialogue with their users, not only responding to their demands, but pro-actively engaging themselves in all kinds of featured spatial activities. There are however many problems how to reach true "interactive architecture". The least of them are of the technological nature, but the most difficult once to overcome relate to theoretical, cultural and social questions. Important questions are what to design, and how to design those interactions - a lot of this is being tried out without established theoretical or methodological frameworks (Achten and Kopřiva 2010).

These problems should not be only concerning the "machine", but the identity as well. Similarly as in Mass-customization flexibility and client-orientation is desired, we should "mass-customize" interactions so that they best fit user-needs and desires. The physical part of interactive systems (sensors, actuators,

and material components) are less flexible than the software part, which can employ learning strategies to adapt its behavior. In all cases, some kind of user-adaptable behavior and identity needs to be established.

Overall mass production has its influence on the city's image as well. Global corporations and business trends tend to make cities look more like one another so the success and individuality gets lost. The fear which Archigram shared was that architecture alone cannot be enough to give this feeling of a place, to give identity.

"I have a desire for
The built environment
To allow me to do
My own thing."

What happens with nature?

There are social groups which are troubled with technological advances discussed above and who have the fear to lose touch with nature, while making this world a fast and a dynamic machine. The poem "All Watched over by Machines Of Loving Grace" by Richard Brautigan (according to [3] published in 1967; according to [4] published in The Realist, 1968, Issue 81, August, p. 11) explains it very well in just a few lines.

"I like to think
(right now, please!)
of a cybernetic forest
filled with pines and electronics
where deer stroll peacefully
past computers
as if they were flowers
with spinning blossoms."

Similar as in the poem, the author feels that the face of the city of tomorrow should be the integration of the natural with the artificial.

CASE STUDY

Many of the ideas presented above have their origin in a case study for the design of an interactive and flexible module. This study is the author's graduation

project in 2014 "The Unexpected city", which was also part of an international competition given by Daniel Libeskind. The proposed interactive structure in this project is a cube of 7m x 7m, which would serve as an experiment model. The module can be moved up and down thanks to four telescopic columns which are part of its construction. These columns expand and descend when needed. The ceiling is attached to the columns and therefore rises and descends along with them. Walls are made of special textile waterproof texture. As such they are stored in the compartment attached to the ceiling, and they can roll out, or roll in based on the need. This structure would already give a starting point towards the research being flexible and able to change : 1 *able to go up to 4m of height and therefore become an object, or 2 able to go down to -0,4m and therefore become either a platform to walk on/sit on, or used as a stage for an urban setting.* It can provide seating elements, light sources, atmosphere creation, ambient and direct communication, active monitoring, acoustic control, access control and many other. Spatial volumes change and continuously redefine their relationship with the ground. This volumetrically chameleonic structure can accommodate multitude of functions. This is where all simplicity ends and the whole set of complications and technical tricks enter the scene. These cubic modules, represent the idea of architecture of transformation or so called metamorphosis.

Mentioned structure is just taken as a proposal - starting point, whilst it will probably be changed during the design process and moved towards a different solution/strategy. The main research questions which are proposed are originating around the notion "interactive" itself. Research question number one would be: "What types of interaction technology do people in public places prefer? ". That is something that can be tested and analyzed in the context of the public sphere. More specific formulations of this question could be for example "If provided a choice set of various interaction technologies, which do people choose in a particular public situations?";

"What is the acceleration speed at which the walls of the module should move so it can be pleasant and interesting for people?", "How is the shift of control of such modules perceived by the public?"

Another important factor is the building skin since this is the most common interface between public-private space between building and urban space, and also one of the most dominant elements that makes up the visual boundary of urban space. Thus the building envelope is not anymore just something which is closing the inside space. What if the envelope, the façade could be changing in such a way that when needed it could be invisible? Or if we could make the building skin react to people, for example based on the occupancy within? Also since the starting idea is to work within the public spaces, it would be as equally important if the object/building envelope could react based on the public activity in the outdoor space.

Flexibility - approach

If we trace processes that form living organisms, it's obvious that no organism had initially been shaped in all its intricacy. They always start with a single cell which multiplies itself numerous times. When a critical mass is reached, cells start to differentiate; they begin to form tissues and organs. This process is called cell differentiation in biology, and leads to autopoiesis of stable natural systems. Analogically, buildings can be designed and created in a similar manner. In the case study we can see the same principle: a simple modular cube which was then multiplied several times until the needed number and area for that particular location was reached. Later what gave the required "shock" to this complex was the juxtaposition of the events behind the façade.

From here we can propose that basic elements of how we should start developing new way of thinking and designing the architecture should be (see Figure 2):

- 1) USER (main player),
- 2) EVENTS (main action),
- 3) SURROUNDINGS (main place),

- 4) ARCHITECTURE (main host)
- 5) FLEXIBILITY (main option)
- 6) INTERACTIVITY (main way)

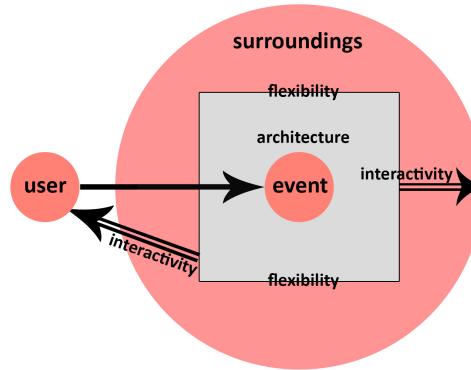


Figure 2
Elements of
interactive
architecture.

Figure 3 shows the relations introduced earlier in Figure 1, applied to the modular cube from the case study (user, event, surroundings, architecture, flexibility and interactivity). The user causes a certain number of events inside of a building, which then communicates back to the user, whereas at the same time both factors are being affected by the surrounding as well.

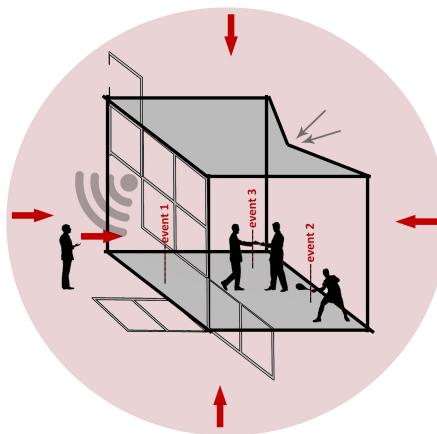


Figure 3
Relation between
six elements
applied to module
cube.

GOAL

Architecture should not only sustain, but also needs to entertain, instruct, explore, and optimize performance in various degrees (Achten 2013). While some of this may be achievable through passive means, it is evident that the future of architecture is a design which would be simple for use, but changeable due to the rapid change of the lifestyle today. Changeable design is perceived as a flexible architecture incorporated with interactive design technologies, and new design principles. In this research we aim to develop and test one or more simple structures which offer multitude of functions, while at the same time being responsive and user active.

"Since contemporary ways of life are so rapidly evolving in all their aspects, there is an urging necessity for architectural spaces to be enhanced in ways that would allow them to perform an active dialogue with their fluctuating content; to dynamically deal with changing needs of social groups, as well as to directly serve particular individuals. This trend forces architects to design flexibly, to take into account potential emergence of new spatial requirements that cannot be anticipated before the actual building use comes to place and which can dynamically change over time." (Jaskiewicz 2008)

In the first stage of the research, we expand the theoretical literature review. Based on this we identify a number of interactive urban case studies that are first tested in a virtual environment (CTU Desk-Cave) and after fine-tuning implemented in a real situation. As stated earlier, we first aim at urban environments and then make the step towards the residential sphere, where we aim to apply the lessons learned from the urban environment. This research project plans to focus on this specific problem - **How an interactive urban structure should look like and how can it be implemented inside an urban matrix? What would be its abilities? How could it serve to people?** Our main methodology is research by design - in which we develop our understanding of interactivity through a sequence of designs. By analysis, we would be able to improve the design and

make it each time a step closer to our goals. Several ways would be possible in achieving such results and analyzing them, such as: creating a prototype and observing the reactions by ways of videotaping, observing (professional observers), surveys, and simulations.

CONCLUSION AND METHODOLOGY

The world is changing, and so is architecture. We have to figure out a way for architecture to follow these changes, by designing complexity with simple methods. This research aims to develop architectural solutions capable of sustaining themselves in its dynamic spatial, social and natural environment. At the same time these solutions should actively engage with its users and the surroundings. Cities should be designed in such a way that they can breathe along with the city life. By this we would be creating solutions which can become interactive and flexible while adding quality to our lifestyles, and to cities in general. The ideas which were analyzed and mentioned in this paper will be used to help developing this philosophy further more in this research, which can contribute to better designing of an interactive and flexible structure in the future.

Metamorphosis and transformation of the space are the qualities which we must seek. Flexibility is the main component an object needs to demonstrate. If we want to build in a more flexible and varied manner, the architect must design at a higher level of abstraction - to allow the end user to fully engage with the final design product.

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