

Flexible, Interactive Structures for Future Visions: A Case Study

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Abstract

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, 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 and 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.

1. Introduction

In this paper we report on a PhD research which has recently started. The field of the PhD research project is Interactive Architecture. As such this research paper will focus on defining what is the phenomena of Interactive architecture and how could it be used in developing an object (building structure) within an urban organism, which could be both flexible and interactive with its users. The word "organism" is deliberately used to accentuate author's belief that interactive means responsive, flexible, changing and always moving. The aim of this research topic would be to find and develop an idea of a design by which architecture could become more interactive in the future. Such, it would achieve much better building functioning, being user friendly and communicative on both ends: user – building - environment. The whole logic of design has to be changed due to the rapid change of the technology and human demands.

2. Problem exploration

The world we live in today develops rather fast and with the lifestyle which speeds up its pace day by day, we are in urgent requirement for new type of architecture. This "new architecture" principle has to take into consideration the environment and become efficient and responsive to it and its users. In particular we are looking at public spaces which are abandoned and today represent so called "black holes" inside the city structure. Revitalization of such public spaces in form of new architecture forms which would be a symbiosis of flexibility and interactive design technologies, would not only give life to those specific locations but would also create new "breathing spots" for the city. We observe that cities are mostly concentrated on few main "hotspots" which are increasingly becoming overcrowded and therefore their quality degrades, thus influencing functioning of the city as a whole.

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We feel that for that reason, in addition to adapting to changing conditions, built spaces should at the same time pro-actively affect our lifestyles and activities. They have to actively negotiate with all external demands. In other words – they have to become interactive [1].

What is wished to be achieved is to make an interactive flexible module, which would serve as an individual object, or be a part of a bigger urban settlement. It would be a symbiosis of new digital technologies and design methods. Changing architectural form would have to be in relation to its also changing environment.

2.1. Problem as seen in Montenegro, the rising issues

When we look at the current situation in Montenegro we can see that there is a lot of pressure on cities at the sea side. We may be left with no more free spaces to build anything for the community in cities along the sea, such as: Budva, Kotor, Ulcinj, Bar, and Herceg Novi, given that a majority of the land there is sold to hotel chains and profit seeking foreign investors. Hotel Fjord in Kotor, is an example of such an object. Once a modern example of architecture of 20th century, having an amazing location on the edge of the sea and the mountains of the Bay behind, while today a ruin and a ghost building. However, the visionary surplus of this architecture, still tangible even in its ruinous state, should make us ask ourselves what visions we might have today for these structures and in what way we should build new ones. Whatever we would build in these locations would have to be more user oriented, not only now but also for the future. Rigid boxes, hosting one function, not applicable to change are no more an option, and every day growing cities cannot afford them. The same situation is found on the north of the country, cities like Zabljak, Rozaje, Mojkovac and Berane. None of them could offer what the people need – a vibrant space, with multitude of functions, options and events. After being used as originally planned, mostly built for at the time active and important companies in the country, these locations and buildings completely lost their purpose. After their main usage they were even hardly maintained, until being totally abandoned. In our research we intend to look at these places.

2.2. Subtitle

There are many architectural examples along with important locations, which once served as prominent examples or an important part of an urban settlement, but due to the changes in urban fabric, current requirements for given functions of these buildings, they have been cast aside. These buildings and locations today mostly stay empty, and the "space" in them was

wiped out. As said before - The space exists only if there is an event to "activate" it. The challenge presented by such spaces is the challenge and the question of use. What is it, that we as architects, could plan better and give the buildings a possibility to expand their lives even after the main reason of their existence is gone? How can we plan a building, or a space, or an urban settlement which can be many things at the same time, so we do not need to demolish it, or leave it abandoned after some years have passed to be replaced by a different building? Buildings are becoming multi-functional and have multiple meanings and readings. A sport's centre for example is not anymore just a hall where the sport is played. Now it is also the administration for the sport events, shopping places, entertainment places, cafes, restaurants. It is a small city in one.

Office buildings are not like they used to be, where people would just go to work. Now they have sport facilities, children centres for the employee's kids, restaurants, places for bigger gatherings, cocktail parties etc. What has changed is the EVENT, or better put human need for it. Today people do so many more things in one day, in one place, in one building. Cities find it difficult to accommodate mono-functional buildings in their areas which are under pressure, and inhabitants are also demanding multiple activities nearby.

Through the expansion of technology we can note that things and services should become more user friendly and more responsive, so that they become more nature aware, surrounding oriented. In this way people can get fast and easy what they need while at the same time we preserve what is around and exploit the environment in a proper way. This is the point where smart houses and Internet of things come to the picture. These technologies can make architecture more user concerned, trying at the same time to host all kinds of events its users might need.

From here we can propose that basic elements of how we should start developing new way of thinking and designing the architecture should be (Figure 1):

- 1) USER (main player)
- 2) EVENTS (main action)
- 3) SURROUNDINGS (main place)
- 4) ARCHITECTURE (main host)
- 5) FLEXIBILITY (main option)
- 6) INTERACTIVITY (main way)

All these elements must be taken into consideration when making a project design, and these steps should be followed. User requires certain number of events, which are happening inside wider area – surroundings,

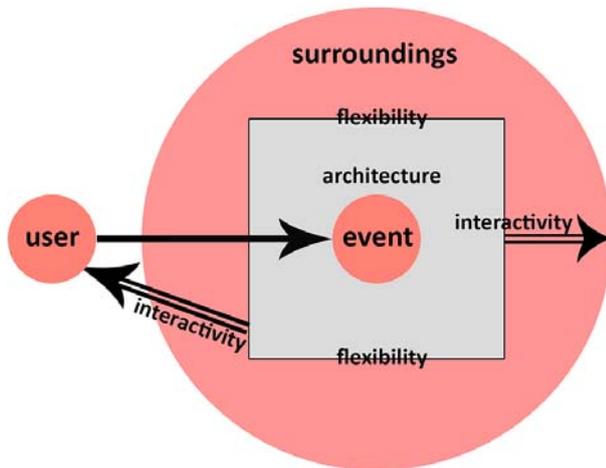


Figure 1. Basic elements proposal

and should be hosted by an object – architecture, or an urban settlement. This object should provide flexibility towards all elements around and inside of it. Moreover interactivity towards the user and the surroundings is needed for better user experience and better building performance. This diagram shows main relations of all six elements. The design of interactive architecture should involve a choice by the parties involved what kind of attitude(s) the building should have [2].

2.3. Efficiency of the built structure

Important matter is that the design has to be efficient as well. It has to deal efficiently with its surroundings, meaning that architecture of this advanced design would have to answer both to the user and the environment. Additionally, it is commonly acknowledged that architecture has to be sustainable. This means that it has to sustain itself by its own means, instead of being sustained by external forces. Environment in which architecture has to perform consists of numerous layers. Those layers; the natural, social, cultural and many others, form local and global ecologies of all possible kinds, creating very rich networks of dependencies and relations. If demands towards architecture, coming from any factor of such intricate ecologies, under certain conditions abruptly change, architecture may have to either adapt itself in order to accommodate those new demands, or it has to give feedback to its environment to reconsider its requirements. In either case, this means that buildings have to develop an ability to react to unpredictable and rapid changes in demands for specific functional qualities [3].

2.4. Goal

Architecture we build today, and for the future, should correspond to what has changed in the world itself. It is

not the same as 20 or 50 years ago. The needs of people, of city functioning and the city lifestyle have dramatically changed, and therefore architecture must follow. Events are the main triggers in the space nowadays coming from various sources such as work, living, public gatherings, or administration. People are the one who ask for them, and we – architects are supposed to create architecture, or urban settlements to host all of their needs. As an important step to achieving simplicity inside the complexity of today's lifestyle, interactive design would help the communication between the user and an object, by creating responsive objects. The user would give an input of information about its needs to the object – structure, which would be able to react and change based on them.

Architecture should not only sustain, but also needs to entertain, instruct, explore, and optimize performance in various degrees. 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.

3. Method of work

Author's belief is that the public space is the first point of action where these designs must take place, and where they should 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. Initially we will test these ideas in a virtual environment, where all possible interactive designs could be applied as well, in corporation with other engineers. This project plans to focus on discovering and applying chosen interactive designs into planned architectural urban structure, which would be the test prototype both of interactivity and flexibility in architecture.

Main questions this research poses to answer would be: "Where, and how could new technologies and structures be implemented inside an urban context?", "How should this structure look like, in order to satisfy main interaction goals?", "What kind of interaction and flexibility is needed inside the public space?" etc.

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 centres, since their flexibility gave an option for hosting multitude of different functions, with various scale incorporated. It

should be stressed that a flexible approach in such buildings is necessary so that programs can be suspended or changed in response to changes in priorities that might occur, which is one of the core points of this research. The industrial heritage is part of a country's culture and it reflects the degree of civilization reached at a certain point in time. 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. As an inspiration for future work, this will be an example of changes in architecture, with the important question of scale and wide range of possibilities for its development. These types of buildings will be included in the research process from theoretical view, but also as a case study material.

Vision of this research project would start in an urban context, and later in a residential one, which would be interactive in a way to respond to the needs of people using/living in it so it could completely follow up on lifestyles, "read" its surroundings and therefore also be more efficient in its life span. 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. This research will focus on the development of new ideas and practical applications for interactivity inside firstly urban and then private sector.

Our main methodology is research by design – in which we develop our understanding of interactivity and flexibility 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 analysing them: creating a prototype and observing the reactions by ways of videotaping, observing (professional observers), surveys, simulations etc.

4. 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 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. Such 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. 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.

4.1. Location

Project location is the city of Kotor, on the coast of Montenegro, situated in Boka bay. The urban core of Kotor is an intricate network of narrow streets and squares of irregular shapes. Complexity and irregularity of the urban matrix represent one of the main characteristics of Kotor. This place was chosen as project location for several reasons. In the author's view it has a lot of potential that has not been exploited enough. The project is set against a very powerful scenery of mountains and ancient walls. On the other side of the walls it's an entirely different sight and that is where this project is being used as a link of the old town, on one side, and the other part of the city, on the other side. In the project the focus is less on exuberant forms and materials but on actions in which people participate – the so-called events ("events" as a tool in architecture will be explained more later in text).

4.2. Case study design concept

Spatial volumes change and continuously redefine their relationship with the ground. This volumetrically chameleonic structure can accommodate multitude of

functions. The architecture is deliberately simple. No skew lines, distorted facades or structural acrobatics. Just a modular grid, sometimes occupied by volumes, sometimes left empty. The core is eroded and contains references to topographical features of Boka Kotorska. 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.

With the technical support of telescopic columns which enable these modules to elevate (rise up) or descend, this space is given a unique arrangement constantly making it possible to be a shade, an object, walking platform, a square, a place to sit on. These objects do not have a fixed purpose, fixed shapes and heights. The modules can appear and disappear any time as needed. They can unite and host bigger masses, or just descend and become something to walk onto. They can respond to the needs of an individual or be a place for bigger gatherings.

The project relies more on actions - on events, on setting a stage for happenings than on physicality of the built form. Projects like this need to generate considerable visitor's traffic. Proposed technologies are feasible even if they approach sometimes the cutting edge. This project gives a clear statement how we can add new layers of architecture in the historical context. Programming of the content comes from very deep knowledge of local situation where there is very limited space for extension of the public space. Last but not least is the fact that there is much thought through energy consumption, which is yet another topic architecture dwells around today. One can be critical about energy spent to the telescopic columns but if we would compare it with one installation of the stage in the public space which includes transport of all the equipment this starts to be not just energy but also money saving solution. This complex will never be something already seen before, and not something which one could ever see again, since it is constantly changing. One event replaces another, and so happens in circles, over and over again. Like this it is becoming a "hotspot" not only of the city of Kotor, but of the whole country.

4.3. Flexibility—approach

There are many different approaches possible in designing a structure that could answer all the mentioned requirements. The architecture has to respond to the environment. Question is how can we apply principles from nature back to architecture, without letting it be too artificial? The environment we create inside the building, has to correspond to the one outside. In finding practical ways of creating complex

systems, a lot can be learned from nature. In fact, every living being, seen as composed of countless smaller and simpler elements, is a complex system in itself. If we trace processes that form living organisms, it's obvious that none of them 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. Analogically, buildings can be designed and created in a similar manner [4]. 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 (Figure 2 and 3).

Also, zooming to a smaller scale (Figure 4), shown is the relation which was explained earlier in figure 1. Taking a modular cube as a graphic example, from the case study, the relation between previously mentioned 6 elements is demonstrated (user, event, surroundings, architecture, flexibility and interactivity). User, requires certain number of events inside of a building, which then communicates back to it, whereas both factors being affected by the surrounding, which has its own influence.

4.4. Review of case study

This module is well suited for public situations in which a city would be in need of a flexible space that could host multitude of events depending on the need. It could be any functions such as: artist's installations, exhibitions, galleries, public fairs, book fairs, open shopping days etc. In urban environments of today people are not offered with changing, inviting structures but rather with ones which are supposed to be observed or walked by, but in no way to be interacted with. We do not see a public space around us, which is engaging people in some activity with itself. Architecture which is not created just to impress, but rather to respond, to react and to work with people. Author strongly believes that the future of architecture lies in such a principle. Mentioned module, is however not perfectly suited for intimate and private situations or events, which would not concern open and accessible public space. Positive side is that if we presume that the idea would lie around the modular cube, which is not too big and could be easily moved, then we are inclined to believe that these modules could be moved wherever wished, and therefore could become many different things. 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 analysed throughout the public sector and we can know what the criteria is. "What kind of interaction technologies are good for the

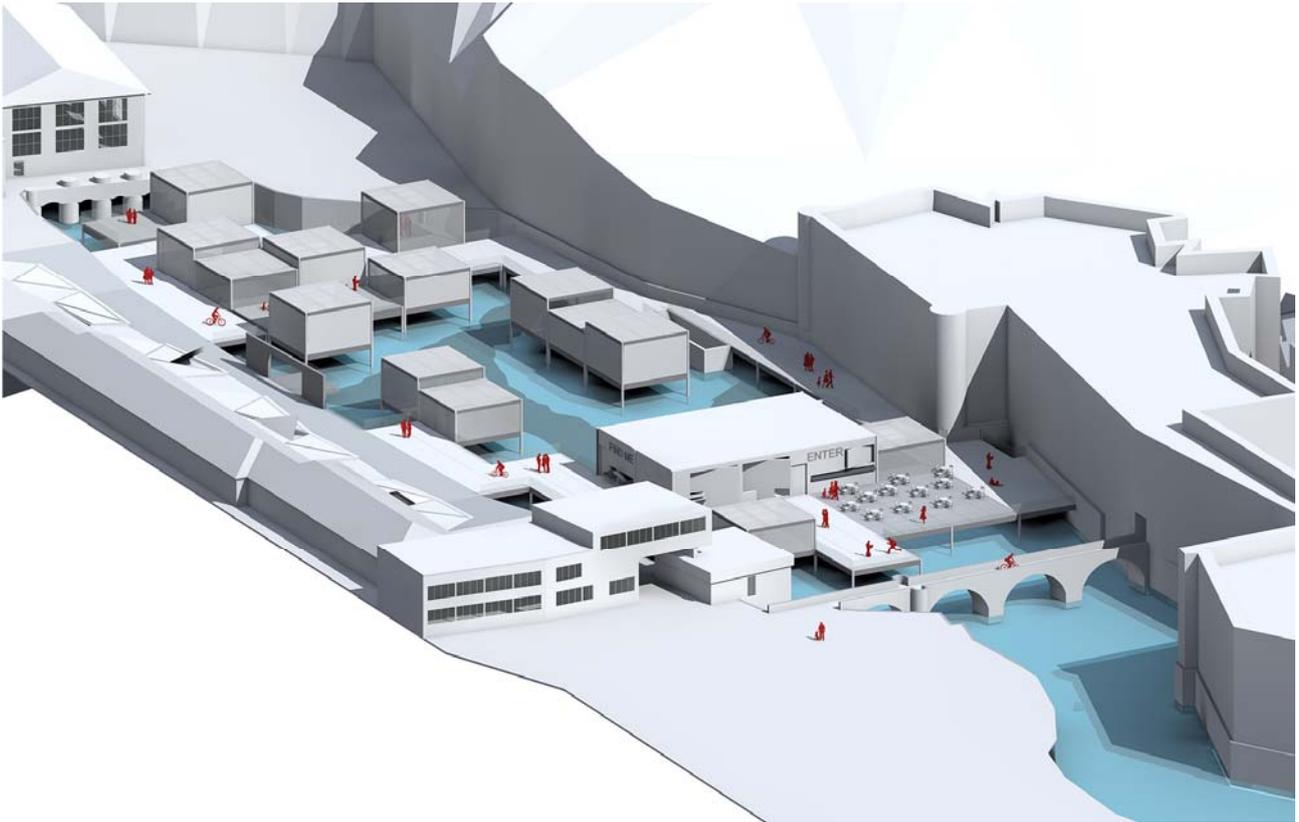


Figure 2. Urban setting 1 (modules from graduation project)

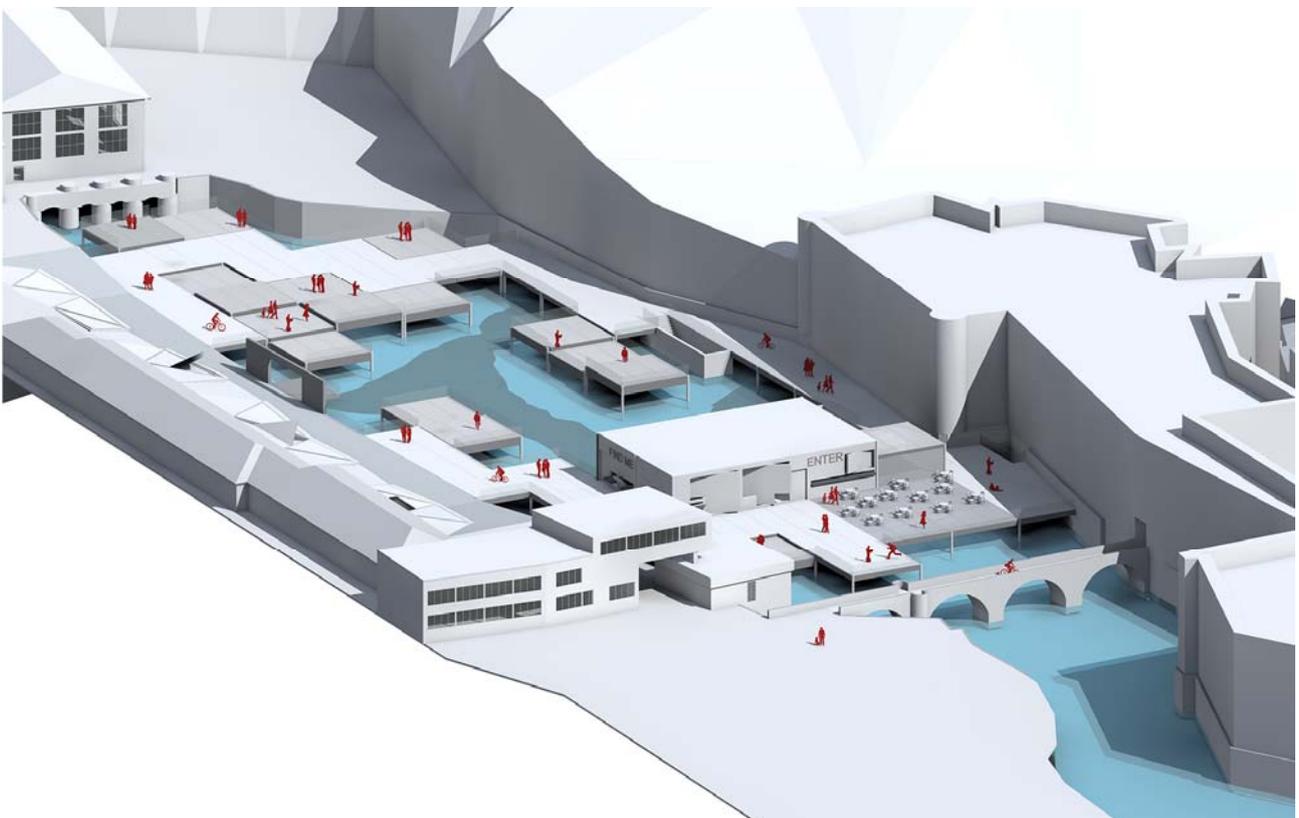


Figure 3. Urban setting 2 (modules from graduation project)

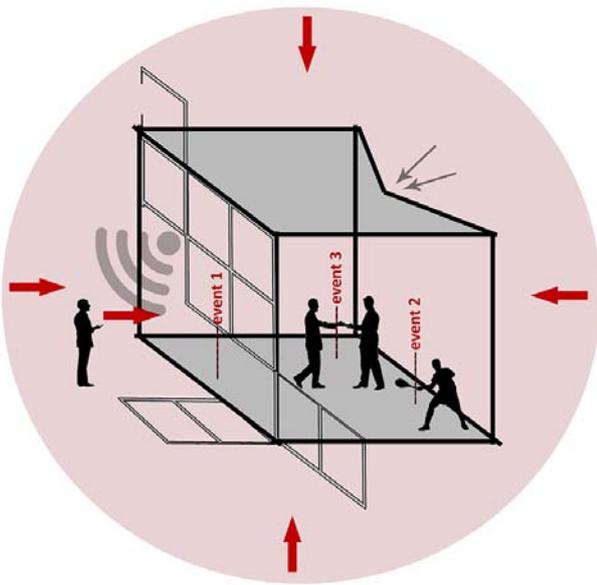


Figure 4. Module cube, 6 elements

people in 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?”, “Who should be able to control these modules in the public spaces?” etc.

5. Future work

5.1. Vision statement

Through flexible and interactive architecture we hope to increase and diversify the lifespan of locations, spaces and buildings. Even though the idea started in Montenegro the plan is to generalize these findings to other countries.

New digital technologies and design methods offer exciting opportunities for architectural design. 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.

Another important factor is the building skin. It is one of the first building elements which distinguishes outdoor from indoor. The inside realm from the surroundings and nature around. This is one of the very first steps where the transformation are already starting, and new ideas are being presented. Nowadays it is important to see a building envelope from another point of view. It is not anymore just something which is closing the inside

space. Now it is a point of interaction. Since the main idea is to work within public spaces, it would be as equally important if the object/building envelope could react based on the public activity in the outdoor space. These aspects are something on what we plan to work further more with a goal of developing a specific design, which will live up to expectations of both interactivity and flexibility in a building.

5.2. Ethic concerns

As said earlier in the paper, main problems to overcome are concerned with social and ethical aspects. Here we want to address just some of them, as something we have to be aware of and come to an understanding in the future, in order for this new visionary type of architecture to be successful. Our perception of what is comfortable, of how the building should behave at the moment, is not going to be the same in 5 years from now. 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?”. 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?

These problems should not be only concerning the “machine”, but the identity as well. Mass production is something what has been introduced to people for already quite some time now, and we are mass producing more and more now. Despite the fact that our own lifestyle changes urge and ask for such production, we are also all individuals which feel the need to intervene with the design, to make it unique. Mass-customization aims to address parts of this question by producing (inter)changeable parts depending on individual needs and preferences. Advances in Rapid Prototyping technology are making it possible to produce highly individual and “one-off” pieces with same quality as mass-produced or mass customized products. Finally, turning away from the physical realm we can expect and even demand from our buildings individually tuned behaviour to us as inhabitants. In this way the problem of identity could be surpassed and turned into an opportunity.

Overall mass production has its tool on the city's image as well. They are all starting to 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."

When discussing these ideas of new age and futuristic architecture people are half amazed, but half is afraid how our world will look like if the future looks like this. There are certain social groups which are troubled with these concerns and with the fear not to lose the touch with the nature as well, while making this world a fast and a dynamic machine. A poem "All Watched over by Machines Of Loving Grace" by Richard Brautigan 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.

6. Conclusion

The world is changing, and so is architecture. Since the world is evolving its communication and manufacturing methods drastically and with increasing speed, architecture will never be the same [5].

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 actively engaging with its users and the surroundings, while adopting to constantly changing conditions. 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 analysed 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 - by giving to the end user the opportunity to intervene in the design.

This work will be a symbiosis of theoretical approach followed by case studies and prototype designs when applicable.

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References

- [1] Oosterhuis K., Cook P., Architecture Goes Wild, 010 Publishers Netherlands, 2001.
- [2] Achten H., Buildings with an Attitude. In Stouffs, R. and Sariyildiz, S. (eds.), Computation and Performance – Proceedings of the 31st eCAADe Conference – Volume 1, 2013, Faculty of Architecture, Delft University of Technology, Delft, The Netherlands, 18-20 September 2013, pp. 477-485.
- [3] Jaskiewicz T., Process driven architecture, ASCAAD 2007 conference proceedings, 2006.
- [4] Jaskiewicz T., Dynamic Design Matter[s], First International Conference on Critical Digital: What Matter(s)?, 2008.
- [5] Oosterhuis K., Simply complex, toward a new kind of building, Frontiers of Architectural Research, 201.

Thesis

- Acharya, LA, *FLEXIBLE ARCHITECTURE FOR THE DYNAMIC SOCIETIES*, Master's Thesis, Faculty of Humanities, Social Sciences and Education University of Tromsø, 2013.

Books

- Seydel, ER 2012, *Veerkracht. Rede uitgesproken bij het afscheid als hoogleraar Communicatiewetenschap en Psychologie aan de Universiteit Twente op 12 september door Prof.dr. Erwin R. Seydel*, Universiteit Twente, Twente, 2012.

- Schumacher, SM, Schaeffer, SO and Vogt, VM, *Move*, Birkhäuser Verlag, Basel, 2010.
- Ota, KO (eds), *Project Japan. Metabolism Talks...*, Taschen, 2011.
- Fox, Kemp, MF, MK, *Interactive architecture*, Princeton Architectural Press, 2009.
- Jenks, CJ (eds), *Theories and Manifestoes of contemporary architecture*, Academy Press, 1997
- Cook, PC, *Archigram*, Princeton Architectural Press, New York, 1972.