

Responsive digital design - interactive interior architecture

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ABSTRACT

The research topic is based on the desire to align the architecture and design related responses to the current environmental, social, cultural conditions. Regarding all architectural proposals that are as complex, as they are “petrified” in time and space, we analyze the principles, according to which they should constantly auto-correct themselves depending on the exterior stimuli and the relevant occurred changes. Hence, architecture would become an interactive, live, responsive mechanism, which would meet users with the best solution, configured depending on the parameters that influence it in a particular moment in time.

Keywords: parametricism, responsivity, interactivity

I. INTRODUCTION

“In a decaying society, art, if it is truthful, must also reflect decay. And unless it wants to break faith with its social function, art must show the world as changeable. And help to change it.” [1] Next, we will analyse the principles that give birth to contemporary and interior architecture, drawing on the ideas of continuous change, flexibility, responsivity and interaction with the user. We will also outline the theories based on the constant improvement of the response given by architecture according to the versatile exterior environment; then, based on how people develop as bio-psycho-social beings in an ever changing environment, which constantly influences their reply, we will outline a possible direction of thought towards the development of interior architecture as living, interactive, real time responsive entity.

II. ARCHITECTURE AS FUNCTION, SPACE, SHAPE, FIELD – ANALYSIS

Architecture, in its complexity, develops due to human activities, to needs and requirements resulted from peoples’ choices. It represents “petrified” points – a space, a place, a shelter – within the infinite matrix of the human paths. However, it has been regarded less as the sum of a series of activities and as materializing itself even in this continuous and infinite spirit. General and interior architecture are born from activity, which develops function, which then sets the tone for shape... Although these seem like the natural chronology and causality, it is exactly the complexity of this equation that has generated not only many solutions, but different interpretations, which led to possibly infinite approaches.

We firstly recall the functionalist approach of architecture through the famous phrase “Form follows Function” [2]. Taken from Greenough, for Sullivan, this was “distilled wisdom, an aesthetic creed, the only <rule to which no exception will be allowed>.” [3]. This concept was then adopted at the end of 19th century – beginning of the 20th century, when technology, esthetics and economy intersected violently, generating the necessity of an approach different from the past centuries. Alongside “ornament is crime”

[4], this functionalist approach would decisively influence modernist architecture and, thus, great architects such as Le Corbusier, Walter Gropius, Mies van der Rohe, Gerrit Rietveld or Alvar Aalto.

Next, viewing architecture from another point of view, we notice a deviation from the patterns, in the second half of the 20th century, with the Sydney Opera, in which form and esthetic choices respond to some needs, but not to the classical individual needs as before. The concepts of landmark-buildings, brand, flagship projects, star-(ar)chitects appear throughout the years as a response to global tendencies in the context of an acerbic economic competition. Thus appear emblematic projects intended to draw attention to a certain spot on the global map. They will push the technological solutions to extremes unseen before, bringing often shape to the forefront, and then resolving the functional needs within the spectacular envelope.

Finally, we recall the Rolex Learning Center designed by SANAA (Fig. 1.), the landscape-gradient, landscape-tactical architecture [5] and the tendency to deviate from the idea of activity that defines architecture. This gives birth to fluxes, paths, communication and transport networks, human activity, architecture being a node within a complex matrix or, on the contrary, being able to “extend” in the physical urban framework or only as influence, giving up its characteristic of punctual implant in favor of an ensemble of activities, areas, spaces, places, etc.



Fig. 1. Rolex Learning Center, SANAA, 2010 <http://www.archdaily.com/50235/rolex-learning-center-sanaa/> (last visit: 5.04.2015)

Last but not least, the “parametricism” introduced by Patrik Schumacher pleads for an “unifying style maintained and guided by a theoretical unifying edifice, which can integrate

several partial theories: a theory of the societal function of architecture, a theory of the self-demarkation of the discipline, a theory of the avant-garde, a theory of esthetics, a theory of media, a theory of process, etc. The theory of architecture's <autopoiesis> presents such an integrated theoretical edifice. It is nothing else but the rational reconstruction and systematization of the discipline that evolves discursively, explicitly materialized as unifying theory, open to critic and constructive elaboration". [6] Elaborating the idea of an architecture resulted from the sum of all parameters that characterize the implant, Schumacher proposes, through a fluid virtual field (Fig. 2.), which will unify all information, the constant improvement of architecture based on the relevant changes from the environment, as can be seen in the movie "Parametricism", section "Urbanism". [7]



Fig. 2. One North Masterplan, Network – Fabric – Buildings, Singapore, Zaha Hadid Architects 2001-2003 <http://www.patrikschumacher.com/Texts/Parametricism%20-%20A%20New%20Global%20Style%20for%20Architecture%20and%20Urban%20Design.html> (last visit: 5.04.2015)

III. UNDENIABLE INTERIOR GENETIC INFORMATION OR CONSTANT CHANGE BASED ON EXTERNAL STIMULI?

The myth of the irreversible passage of time materialized through the constant changes undergone by nature, by people and things, is found in the major literary themes of most cultures; in a time where speed and efficiency govern us, we came, paradoxically, to forget that time never stops, that we are in a continuous change and transformation. How could, thus, a piece of furniture, an architectural development, an urban implant, in their "petrification", static and "silence" in an ever communicating environment

completely satisfy their users' needs, when they are living organisms, constantly submitted to stimuli that influence and transform them?

We will underline next the human nature as a versatile, bio-psycho-social interface.

"(...) The dichotomy constructed around nature as major determinant of life's causality, through DNA, the code of codes (...) that conducts all, and around the social-scientific perspective according to which we are social organisms (...) completely detached from biology (...), is a nonsense. However, we notice that it is practically impossible to understand how biology functions outside the context given by the surrounding environment" (Dr. Robert Sapolsky). [8] Hence, we notice certain predispositions of human behavior, which can manifest fully or not at all, depending on the exterior factors that activate them or not. Human behavior will be, thus, influenced by these exterior parameters, transforming itself through them, as well as through interior predispositions, in a matrix of infinite possibilities. And so, we reach to the conclusion that nothing is only programmed genetically (behaviors, diseases, etc.), but results from a complex equation, that contains certain predispositions, but also the sum of external, environmental, social, cultural, economical or political factors.

The genes outline certain possible directions of response, but, depending on the totality of the exterior parameters, they can be activated in different proportions or can remain fully inactive.

In direct relationship to such organisms of infinite complexity, with a cumulus of multilateral and endless natural factors, how can architecture communicate in optimum manner? [9] And even taking into account the theories concerning its interactivity and flexibility, as well as the known parametric architecture examples, which seek the materialization of these directions, how can man communicate with a liquid space, which is part of a fluid field, when the latter only imitates movement, expansion, growth, in the end still being a petrified image in a development stage, with roots in the present, petrified to the spot?...

IV. RESPONSIVE, INTERACTIVE, LIVING INTERIOR ARCHITECTURE - PROPOSAL

Taking into account all the factors of this analysis, we will project this concept on interior architecture.

It is susceptible to change according to the user's needs. The user, having control over the elements of furniture and interior ambient by the fact that their dimensions are close to the human scale, can easily materialize the transformations. More than that, there are many examples which propose versatile developments that

enies these interactive projects in the common search of the possibly "living" nature of architecture, interiors and pieces of furniture surrounding us.

A. Interactive Wall - Responsive to Movement

The first experiment of this type consists of an unconventional piece of furniture, intended to transform external influences into own language elements, which it prefigures on itself, in a matrix of action-reaction, stimulus-response, open to transformation in real time, according to the following diagram (Fig. 3.)

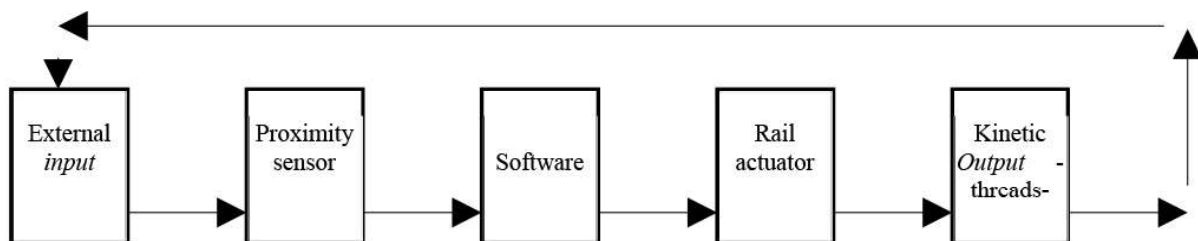


Fig. 3. Functioning diagram - Interactive wall. Concept and materialization Sinestezia.Studio (2014)

can be personalized based on the inhabitants' number and needs, changing function, configuration, place, details, textures, material, etc.

However, the purpose of this analysis is to seek for new directions of interaction between the user and furniture; the latter, after being designed and implemented, will become a self-standing piece of furniture, as well as a receptor of external stimuli, which it will perceive and transform in relevant information, processed then and materialized as self improvement, in real time. Thus, this entire communication network will constitute a multidirectional system of software-hardware constant dialogue. Thus, to illustrate the proposed direction through some basic tests, we will describe the functions and characteristics of an ongoing experimental project, based on the general idea of this analysis. The applicative part of a theme as vast, variable, complex and profoundly conceptual as this one, which is prefigured in the speeches of the great contemporary architects, has a similarly large range of implementation possibilities. Starting from the big urban experiments of parametricism supporters and reaching to contemporary fluid, flexible and organic furniture, we propose a small scale experiment that accompa-

The interactive wall is made of a series of fine and repetitive vertical elements, placed rhythmically along two rails at lower and upper level. These rails allow the gliding of all verticals. Therefore, the interaction with the surrounding environment takes place through the movement filter; the ensemble's processor perceives the external stimuli through a movement sensor, transmitting them then in real time to the vertical elements network, which transforms the information in a manner of expression characteristic to its own vocabulary.

In practice, this wall of fine threads that define a complex organic area, with the two beams in the lower and upper having the shape of two special curves, retires in the immediate proximity of people, creating an airy island of vertical elements with movement along them. On the rest of its length, the wall maintains a rhythm as intense as possible, creating thus a gradient between the airy area that "reflects" in real time the presence of an individual in motion, regardless of the direction in which he is moving, and the rest of the wall, which does not perceive the dynamic, making a dégradé between presence (apparition of the user) and absence (its absence along the wall) through the increasing / decreasing distance of the threads constituting the wall.

This way we have made the first experiment related to the possibility of a wall to communicate with the surrounding environment, to perceive its motor characteristics, to appropriate them and to respond in its own manner, through a permanent dialog with the user in motion. It becomes a novel communication platform between the user and the architectural panel, based only on dynamics and movement.



Fig. 4. 3D Draft – Interactive wall. Concept and materialization Sinestezia.Studio (2014)

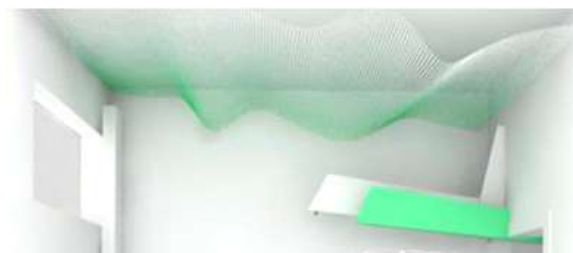


Fig. 5. 3D Draft – Interactive wall. Concept and materialization Sinestezia.Studio (2014)

B. Reflective / Responsive Wall - Mirroring the Surrounding Environment on a Dual Scale

Next, we sought to deepen the analysis of this possible trait of an interior decorative panel to interact with its users. In the next experiment we doubled the multidirectional relationship through the material we used. The responsive wall is formed this time by a large number of small mirrors that function on one hand as pixels that convey the image in front of them and, on the other hand, as a surface that reflects the environment due to the characteristic of the material itself. The functioning diagram (Fig. 6.) is, this time, a little different due to the fact that the wall does not only perceive the notion of

motion in its proximity, but also receives the entire “moving” image, which it reinterprets and renders then through its constitutive elements – a matrix of small size mirrors.

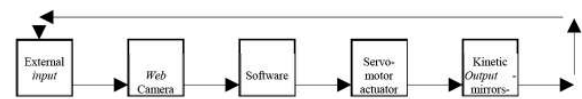


Fig. 6. Functioning diagram – Responsive wall

Concept and materialization Sinestezia.Studio (2015)The types of responses offered by it can vary according to the software, the possibilities being endless: from rendering the surrounding image to different independent animations and static positions of the mirrors, representing the desired images or certain directions (Fig. 7, 8).

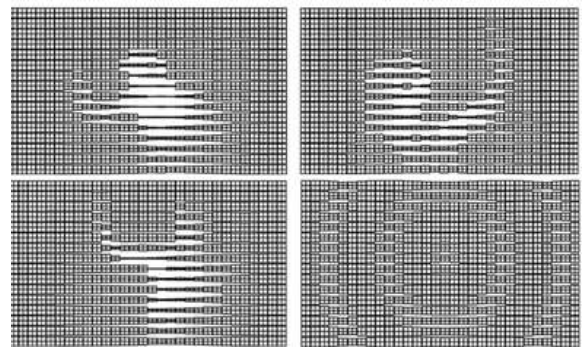


Fig. 7. 2D Draft – Reflective wall. Concept and materialization Sinestezia.Studio (2015)



Fig. 8. 3D Draft – Reflective wall. Concept and materialization Sinestezia.Studio (2015)

This way, the second experiment presents a small scale element of interior architecture that

capitalizes the very premises of this study, managing to capture stimuli from its exterior, to reinterpret them and to transmit a response in real time, in its own formal vocabulary. Through the dual scale of the reflection, by means of both the walls' pixels' movement and the material of the pixels (mirror), the experiment of a possible communication platform between an individual and interior architecture has been thus taken to another level.

The successful result of this second experiment is underlined also by the complete materialization of the concept and the certainty of the responsive panel functioning (Fig. 9, 10).



Fig. 9. Materialization – Reflective wall. Concept and materialization Sinestezia.Studio (2015)



Fig. 10. Materialization – Reflective wall. Concept and materialization Sinestezia.Studio (2015)

V. SELF-DEVELOPMENT. SELF-RECONSTRUCTION.SELF-REINTERPRETATION

Taking the concept of continuous reiteration of architecture based on external relevant stimuli, which would start as being a basic static space – the shelter –and would become a constantly evolving information system – the field / the matrix – we could accept the idea that this entity observes the changes of the surrounding environment; we could also accept the idea of storing selected information; we could accept that this entity would examine all relevant stimuli; however, how could we imagine it to be capable of transforming the analyzed information into a real model as a response to this ever changing infinitely complex equation?

A. Software versus Hardware

Contemporary state-of-the-art technology and the constant innovation allow nowadays the production of unprecedented structures of great complexity, developed through the capabilities of algorithm-based software. However, from the point of view of the present analysis, they still have a lack of substance: the chronology of their nativity.

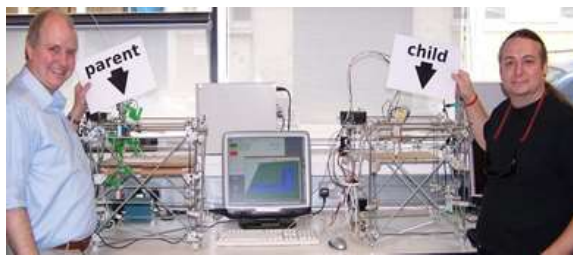
The stages of this type of architecture's creation, independent of its fluidity, start from an initial virtual model, that takes all relevant factors into consideration, thus molding the final solution. Then, this virtual project, which actually imitates the real conditions with varying grades of accuracy, is being materialized in an existing environment. The direction of this evolution can thus be sketched through a one-way type of relationship: software – hardware, virtual programming – real representation, creation – materialization. However, in the context of the present analysis, this relation should evolve into an interdependent constant dialogue, where the virtual proposal becomes construction, which perceives all relevant external stimuli, transmitting them to the central software that processes the information and proposes an improved version of the existing model; this complex entity should then be able to materialize the proposal and transform it into reality every time opportune stimuli come to influence it. Thus,

a functional relationship of reciprocity is born between the virtual and the existent, where the virtual is being materialized and the material is being transformed into virtual information, constantly rematerializing itself on the basis of the equations it develops. Therefore, the project chronology grows from being a unidirectional temporal vector into a communication matrix of temporal and spatial impulses in continuous multidirectional movement.

In conclusion, the “form being communication that frames and the function being the actual framed communication” [10], the basis for the answer for this great unifying and infinitely versatile project would have to be defined by the design of its infrastructure – the communication networks between the virtual model and its real representation. [11]

B. RepRap Functioning Concept

RepRap, although from a related field, represents the above mentioned concept, but most of all, the complex idea of its implementation. It is “humanity’s first general-purpose self-replicating manufacturing machine”. [12] It is therefore, an entity that can 3D-print plastic elements; but because it is made out of these types of elements itself, it can continuously replicate itself, constantly multiplying the initial in-



formation (Fig. 10).

Fig. 11. First RepRap Replication (2009) http://en.wikipedia.org/wiki/RepRap_Project#/media/File:First_replication.jpg (last visit: 5.04.2015)

To sum up, the possibility of self-construction already exists in related domains at substantially lower scales than those of architecture and urbanism, having infinite possibilities of further development.

However, an open question still remains regard-

ing the potential real-time transformation of a building as a result of all significant exterior stimuli that should cause major changes in this possibly never-ending process of rethinking and reconstruction of the structure itself.

Nevertheless, the concept of self-reinterpretation and self-development derived from the RepRap project can still open doors to further analysis regarding this subject matter. [13]

VI. CONCLUSION

Taking the present analysis and its proposals into consideration, the drawn conclusion would be that the method of perceiving information in architecture and of expressing the proposal resulted from its processing, through a unique artistic vocabulary, deserves to be aligned to contemporary technological progress; but this endeavor should not only be made through chronology and regular causality, but through a virtual unifying system, which includes all the parameters and can suggest solutions for the equations resulted from their analysis in real time, too.

From here to an interactive, responsive, living architecture, with a “self-healing” capacity and possibility of self-reinterpretation to the good of its inhabitants, of the environment and of used resources, lays an open, difficult and unknown experimental path. But interior architecture, through accessibility and its small scale, could successfully capitalize empiric interpretations of this concept. And they could form the basis for future personal studies in the field of the present analysis: namely architectural flexibility, interactivity and responsivity, all of which are features that emphasize the possible dialogue that could be created between architecture and its users.

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