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– **Review thesis of MSc. Vasilija Abramović ing. arch.**

To whom it may concern,

This is a review of the thesis of MSc. Vasilija Abramović ing. arch. entitled “Artificial Life Approach to Interactive Architecture – Metamaterial kinetic environments at the edge of chaos”, submitted in September 2019 to the Department of Architectural Modelling, Faculty of Architecture, Czech Technical University in Prague.

– Vasilija’s thesis focuses on the domain of interactive architecture and in particular that of kinetic, non-verbal interaction between human and architectural agency. Arguing that interactive architecture today is still rather underdeveloped, Vasilija proposes that the field of artificial life might contribute to novel approaches. She further suggests to focus on the use of so-called metamaterial structures for their transformable qualities and tries to find suitable methods for their actuation. This approach highlights two significant issues, that today still prevent the large-scale application of “truly” interactive systems in contemporary architecture. First the lack of intelligent behaviors that could encourage a more diverse exchange between building and occupant and second the development of resilient (soft) actuators that create more natural, less mechanic (e)motions.

The thesis is structured into three core chapters, “Intelligent Kinetics”, “Softer Kinetics”, and “Edge of Chaos”.

“Intelligent Kinetics” focuses on two aspects. First it gives a historic overview on the evolution of kinetic/ interactive architecture with particular attention on Vasilija’s own Master thesis project “The unexpected city” from 2015. The second part of the chapter examines the development of smart or intelligent architecture, discussing two competing design models of intelligence. The analysis of historical examples could be more specific and broader, the selection of contemporary examples is interesting, yet also described rather briefly. Many of her references are lacking precise page numbers so it is at times hard to reconstruct her argumentation. Setting her personal student work into the context of prominent examples of dynamic architecture at first seems a bit bold (“The Unexpected City follows in the footsteps of similarly visionary ideas from the 60s and 70s,...”), however I believe it must be understood as an introduction and reason for her motivation to pursue further research in this area in the form of a PhD. The second part of the chapter discusses what she terms “Intelligent Architecture”, with a detailed analysis of the evolution of Cybernetics and artificial intelligence. Determining a number of shortcomings of artificial intelligence in respect to building, namely the predominant separation of the fields of computer science, robotics and architecture, she argues for a bottom-up approach towards the development of more resilient systems. This part is much more comprehensive than the first one and provides a thorough basis for her further argumentation, which is continued in the next chapter.

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“Softer Kinetics” is again structured in two parts, an overview of historical and existing soft kinetic actuators and detailed research into relevant metamaterial systems. Vasilija’s thesis of a necessity to develop more natural kinetic responses for interactive architecture to become publicly acceptable is funded in a comparison of contemporary examples in relation to radical ideas and experiments from the late 60s and 70s. Reviewing a broad selection of (commercially) available solutions and their shortcomings including cost and limited behavior she then turns towards the vastly growing field of open-source and DIY as a low-tech alternative. From this she shifts her focus towards the development of so-called metamaterial systems “that bring together programmable structures and soft actuation”. The research and analysis of existing systems is very comprehensive. Providing an overview of applied structures – both architecturally and more experimental - Vasilija continues with an in-depth analysis of commercially available soft actuators and the exploration of low-cost DIY substitutions. Her theoretical foundation is supported by a vast number of self-made metamaterial systems and their actuation using various types of soft kinetic systems, which were developed and continuously improved during different student workshops and courses. The description of these workshops is very detailed including both the process of making the materials and actuators as well as their control using diverse types of electronics and devices. She concludes the chapter calling for softer solutions that will encourage and enable more direct human-machine interactions as well as the uncompromised exchange and interdisciplinary discourse of architects, interaction designers and computer scientists. Promoting this idea to students and the scientific community marks one of the core contributions of Vasilija’s thesis.

Chapter four “Edge of Chaos” builds upon the conclusions of the previous chapters, “namely bottom-up approaches to computation, and material and morphological approaches inspired by nature”. The main part of the chapter focuses on describing an interactive installation called “Edge of Chaos”, which Vasilija developed together with Ruairi Glynn and Bas Overvelde, and which was exhibited as part of a European cooperation project by Cinekid Festival Amsterdam, the Gaité Lyrique Gallery in Paris and KIKK festival in Namur. Following a brief explanation of the context within which the work was produced, the chapter is then structured into four sections, narrative, metamaterial, control hardware and computation. Building upon Christopher Langton’s mathematical theory of the edge of chaos the project seeks for a poetic translation of artificial life concepts into the domain of the built environment, in this case in the form of an artistic installation. The work consists of three main parts, at its center a kinetic tree that symbolizes life, surrounded by a cloud-like structure, representing the vast unorganized matter of the universe and in between an interactive surface, which stands for the boundary in between the two – the edge of chaos. The installation is activated by the proximity and movement of visitors, resulting in physical transformations, light and sound outputs. The sculpture is driven by a custom-made cellular automata, which depending on the type and level of interaction produces different patterns and responses, navigating in between order and chaos. The scope, size, complexity and level of detail of this installation are very impressive.

Vasilija concludes her thesis with answering her initially posed research questions, arguing for softer approaches towards artificial intelligence and robotics. Yet she acknowledges that engaging humans into encounters with artificial life is rather delicate, since most people are not yet familiar with understanding complex systems where the resulting (re)actions do not directly correlate with a particular input. She also states that current commercial soft kinetic technologies are not yet adequately developed for interactive architecture, since they are either too expensive or restricted in their applicability. DIY solutions on the other hand allow for fast prototyping and the adaptation to specific scenarios, however don’t exhibit the necessary resilience and durability, which is also the reason why the installation featured “traditional” actuators such as DC and servo motors.

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The contribution of Vasilija's thesis to the field of architecture definitely lies in her educational approach, trying to bring together different disciplines and calling for more exchange among related stakeholders. From an artistic perspective she challenges the status quo in respect to both material system as well as computational strategy towards the implementation of aspects of artificial life. Despite the brevity of the thesis with just 138 pages and a strong focus on the description of realized projects and student workshops, I believe that Vasilija's work provides a relevant contribution to the still emerging field of interactive architecture. How her findings can be translated from an artistic context into real-world building scenarios remains however open. Parts of her work, especially from a theoretical perspective, could definitely have more depth, yet she manages to convince with her rigorous research on an applied, practical level and the successful implementation of these findings into publicly exhibited art. I therefore support the acceptance of the thesis.

Please do not hesitate to reach me if I can be of further service in this matter.

A handwritten signature in black ink, reading "Manuel Kretzer". The signature is fluid and cursive, with the first name "Manuel" written in a larger, more prominent script than the last name "Kretzer".

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