

Research Plan

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Introduction

This research plan is a reflection on the research methodology and structure adapted for the research during my graduation project at the ExploreLab Studio.

Human beings have always associated buildings with being something static, rigid and on many occasions nothing more than a shelter. My thesis aims to redefine this assumption of buildings and highlight them as something plastic that interacts and is aware.

“The future of Architecture will be soft and hairy”

- Salvador Dali to Le Corbusier

The research is intended to analyze and understand how spaces incite social behavior and how the integration of this dynamic nature into a static space can affect this behavior. Extrapolating this data, I would like to use soft robotics as a tool to incite new forms of social behavior. In this aim, my thesis project explores a way of research by design, “soft” environments that are not only soft materially but also soft dynamically thus being robotic in nature. This is to create interactive and responsive environments where there is a critical conceptual difference between interactive and responsive environments: interactive generates a certain dialogue and establishes a pattern between the user and the space associating a certain “alive character” to the space whereas responsive environments are limited to the response to a particular input.

This project is approached more from the angle of integration of a “**softscape**” into a rigid environment and an overlay of a digital environment over the physical [1].

In order to examine and help determine the possible scope of implementing soft robotics in activating spaces and promoting user engagement with space, my research will be carried out in a scenario redesign of an existing building, augmented with a few static interventions and few dynamic interactions.

Research Structure and Design Integration

“How can we integrate soft robotics into the built environment?”

The research questions are formulated along this problem statement looking into mainly four different directions which are:

1. Human Stimuli
2. Space deformation
3. Experiential Spaces
4. Hybrid materialization strategies

A synthesis of my research in these various directions can lead me to understand interaction in terms of soft dynamics. These interactions will then be extracted and catalogued as instances and preconditions to form a theoretical framework using which I will begin designing a soft robotic system.

The design method would be tackling the problem on two levels of a technological approach that is designing the soft robotic system and the spatial approach of choreographing spaces and movements to experience this correctly. Soft robotics will be explored as a form as well as a material integrated to perform.

Tools like grasshopper will be used for simulations to understand various phases of space deformation. The end goal will be to arrive at a space that functions more like one organism with some parts being “alive” and those will be the soft robotic system integrations.

The research by design will be used as a strategy for design integration.

Different instances of spaces will be studied with possible deformations using various principles of soft robots. Those individual cases would be used as a catalogue and a connected layout of volumes will be achieved by distributing them across the enclosed site creating a certain experience of circulation. This layout would be integrated with a uniform connected system of soft robots, to transform the interventions into a singular organism-like hybrid structure that functions as one huge network.

The design would like to represent an ever-changing alive environment where human social behavior not necessarily with the space dictates the plasticity of the environment. The soft robots would be used to highlight and explore how spaces could react to humans on a material scale.

The research connects three components for research to design integration:

Rigid
+
Soft

Space

Material

Material Behaviour
+
Human Behaviour

Interaction

Micro

Spatial deformation
+
Spatial experiences

Circulation

Macro

My focus here will also lie on exploring basic aspects of human behavior and types of human-interaction with space, and different typologies that are an amalgamation of **static** and **dynamic**. This layer of hybridity will induce a constant reconfiguration of the building elements, causing the space to be in a state of constant flux as an overlay of various phases. The design method adopted here would be exploring basic aspects of human behavior and interaction and how they can be influenced into decision making particularly movement through the structure enabled through a network of actuators and sensors integrated into the built environment.

Research Methodology Reflection:

Against earlier approaches that explored the more geometric aspects of forms and rigid materiality, the design of interactive environments requires to focus more on the co-constitutive behavior of human-environmental systems/assemblages [2]. Throughout the research, all the reference projects that were evaluated reached a similar conclusion, where for all the projects the assembly and system behavior was the main focus. Since the research is approached more from the side of technology and how it could be applied in design the research could also involve an in-depth study of alternative content such as keynote lectures, workshops, conference papers and other industry applications from biomedical and mechanical engineering domains.

The research methodology of research by design can be used to determine and examine the scope of soft robotics in a pre-existing building combined with a few static interventions and few dynamic interactions to study how they can be used to activate spaces and promote user engagement with space. The research method will further be divided into descriptive research followed by experimental research to help organize the collected data. For thorough research, existing robotic case studies will heavily be drawn from to gain a better insight into the topic since it required prototyping, but I have not been able to access the resources needed for the same. The research will primarily explore how to conduct simulations that verify with the studies already conducted before and these results would be logged in, in the form of screenshots from grasshopper along with the simulated model. This method can be efficient in my case because it enables me to understand the basic physics behind the movements and isolate that learning to apply elsewhere. Another advantage of collecting research data like this is to also understand and be able to calibrate softwares to the right parameters since the results were already known.

The soft robots used or developed in the aforementioned research can help me better understand the movement achieved, the type of structure and actuation that results in the movement and the materials used. This information will then be extrapolated in a design context, using existing projects in the architectural domain using soft robotics as a guideline [3][4][5][6].

While most of the ongoing research in the architectural field related soft robotics is around prototyping and producing a working model, my research will be more oriented towards developing a system of soft robots [7]. Thus, the method of research by design could be evolved from redesigning similarly conducted experiments at various scales and observing the parameters taken into consideration.

Ultimately by using research by design these results will be used to further explore different typologies that are an amalgamation of digital and physical as a new approach to topological research of spaces and exploit this layer of hybridity to incite a social behavior.

Conventional design research methods focus on arriving at a more extrinsic approach to the designing defining the aesthetics (the already formed space) whereas, with research by design strategy, I would like to involve the user as an active part of the design process and focus more on an intrinsic result that highlights the property of the space to reform.

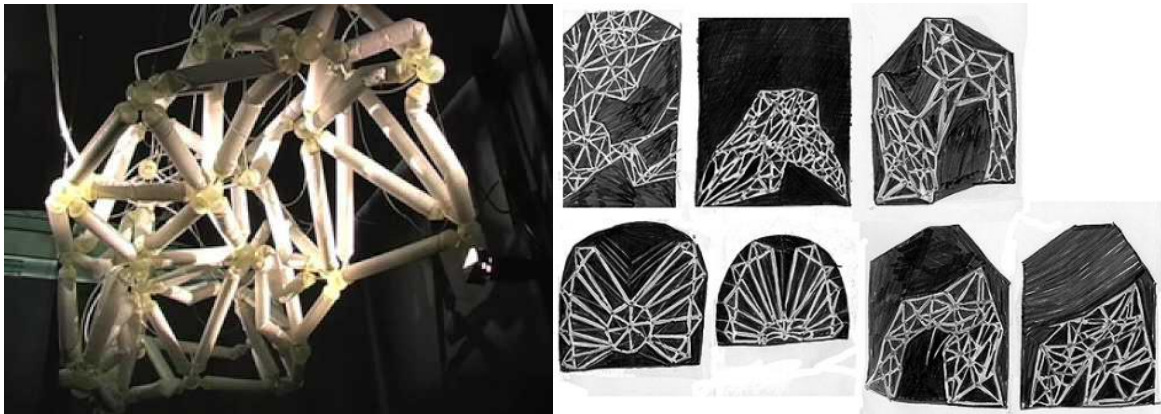
The relevance of this project

In the current times with the world context focused on trying to incorporate hybridity into various industries. There is a certain research gap between architecture and soft robotics where inflatable architecture has been implemented and architectural robotics has also been implemented but a combination of pneumatic robotics has not been explored much. In this aim, my thesis would like to explore the possibility of integrating using Soft robotics leading to the symbiosis of digital and physical.

The research can describe what a possible scenario of living and working with robots could look like with spontaneous environments and architectural actors that optimize and enhance experiences.

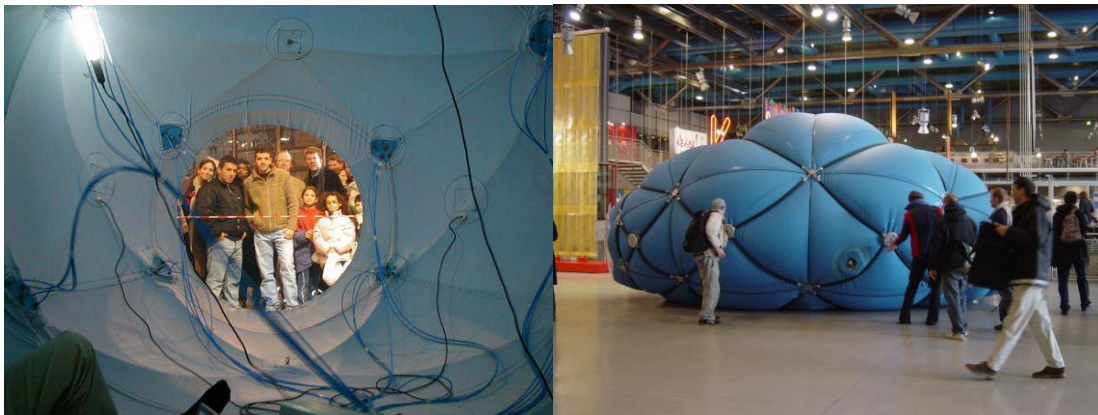
Reference Projects

Inflated Architectural Body



This project by Chico Macmurtrie is using a pneumatic system that creates an interactive interface that tries to create immersive environments for the viewer. The work explores the applications of pneumatics in a plug-and-play situation that is constructed using modular components equipped with a sensing system. The project will be used as a reference to understand immersive environments how these installations could become an active part of our regular spaces [8].

NSA Muscle



The Muscle NSA represents a programmable building that has seventy-two tensile actuating components. The actuation is initiated in the connections which behave like a muscle contracting and responding to the environmental input, the whole volume functioning is one organism that by deforming itself in real-time [9]. This structure reflects the methodology of trying to make a volume engage with consumers through an interactive environment.

Conclusion

Based on this approach, the methodology is evolved by studying various functions and finding out the most important property for it which could be integrated as a soft robotic component. This componential approach will then be put together in a logical manner by studying functional adjacency hierarchies and circulation patterns and experiences that could augment a user's quality of space.

The confluence of form, material and digital design in the research will help understand the "performative" quality of the space and the functions of spaces would dictate soft vs rigid material dynamic. The hybridity of the space would be represented through soft robots whose materiality governs its forms and would be an important contributor to the topological development of the space due to its distinct form. I would also like to remark a stark shift in the design methods from a supposedly rigid CAD geometry approach to an organic approach can be adopted for this research plan.

Bibliography

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Course Reflection

I strongly believe that a Graduation project consists of extensive research and it can stand to highly benefit from a research course running in parallel to the main project. While I enjoyed all the lectures and the masterclass offered by the course, the discourse was not completely clear on how it could be used to improve or develop new research skills. While a course like this is essential, and it helped me articulate and structure my research, much of that end result was a by-product of writing the research plan. In my case, I felt the lecture contents were too far from my research aims and I could not find clear channels to adopt them into my ongoing research trajectories.

Having said that, if the course could have been introduced sooner in the masters, it would have been much more beneficial to help us set up a research plan for our thesis since we would already be aware of the methodological approaches and scope of a plan.

The different themes for Thursday sessions did very little to contribute to my actual thesis study area maybe since it was very theoretical for a technologically intensive topic as mine. While the lectures were truly thought provoking, maybe discussions in smaller groups could have benefitted me more to determine how to apply the information of the strategy to my research.

The how-to sessions were beneficial but, in my opinion, too short to build on, and I could have benefitted more if they could be more frequent and slightly more inclined towards materialization into graduation projects. The weekly lectures did not have much of an impact on me since I felt very difficult to relate to them or use the discourse to formulate a research plan for myself. I also found that the practical research aspect was not addressed such as researching through prototyping or simulations rather than literature study.

Since the course's outcome is expected to be a research plan that is supposed to help us with our research paper, this output was not as such given emphasis during the lectures that did not directly mention or elaborate different researching or data collection patterns or how to analyze the same. Overall, the course could be restructured more to align with the graduation or could be taught earlier in the master's so that it does not form a tangent to the graduation project.