A BODY-CENTRIC APPROACH TO SPATIAL ORGANIZATION

Designing through a new perspective on human body and local comfort

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ABSTRACT

Long established methods of spatial organization have had their tight grip on our thinking when it comes to constructing spaces for a long time but with technology advancing at a high speed, we are confronted with possibilities that have not yet been fully explored. These possibilities have the potential to lead us to a new direction that takes into account the human body and the movement in the most complex way possible. This project aims to demonstrate a body-centric design approach to constructing space by making use of some of the newest technologies available while establishing a new equilibrium between the old and the new.

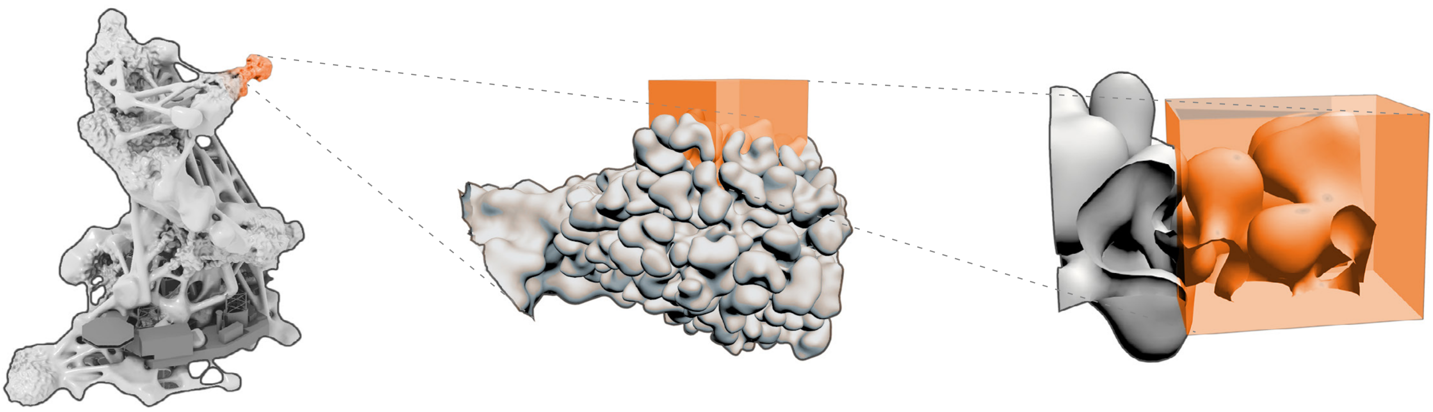
1. INTRODUCTION

The way we inhabit spaces is the result of a long process of making them suitable for our daily activities and our body. The height and width of floors, rooms and even chairs are a reflection of these operations. We can distinguish between two essential ways that are used to make a space fit to human proportions and necessities. The first method employs semi-generic spaces, composed of vertical surfaces, openings and electrical outlets that we then adapt to our needsby means of addition, such as furniture. This is largely the reflection of our methods of production, based on standardised and mass-produced components. Not only considering comfort but also efficiency, standardisation attempted at translating our body measurements into objects' heights, widths and depths. However, in the last decade we have arguably entered a new phase, in which we have shifted the systemisation from the product to the production, meaning that, with the same process, we can now produce very different results. This has allowed us to think of materials as more malleable and their application to be fluid and dynamic. Moreover, technological advancements and new scientific knowledge provided the opportunity to move away from traditional approaches for achieving thermal comfort. What we face now is the prospect of being able to provide comfort through localised heating and cooling, that we can depict as a thermal bubble that would follow us throughout our movements. This prospect would render useless the traditional practice of heating an entire building regardless of the time we spend in some rooms.

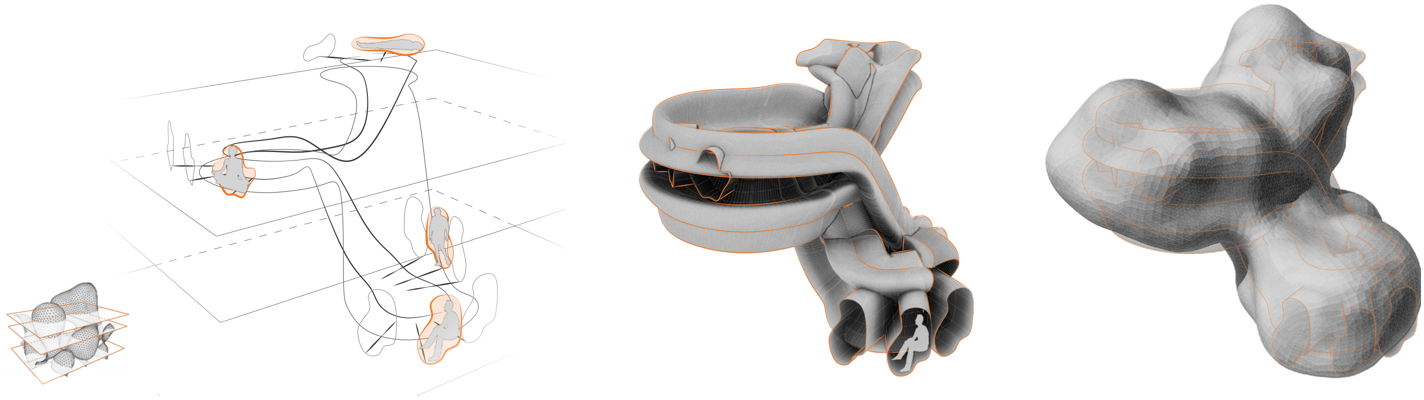
The project proposes an alternative way to the usual design-thinking by merging recent advancements in scientific-technological knowledge and production in order to create a body-centric design. Starting from the human body and imagining the creation of a dialogue between body and building for a new interpretation of comfort and efficiency.

2. THE FOUNDATIONS OF THE PROJECT

The physical context is derived from the graduation project of Benjamin Kemper, which envisages to build a new community on a former oil platform. The project, characterised by an intricate system that expresses different levels of spaces, was used to extract a fragment to be turned into a single-person dwelling. The selected unit is marked by a vertical evolution, an aspect that was to play a relevant role in the subsequent shaping of the geometry. Three main spaces-scenarios were identified following this orientation, from lower to higher: living-working, meditation-exercising and sleeping.



The project by Benjamin Kemper, from which a portion for a single-residential unit is extracted



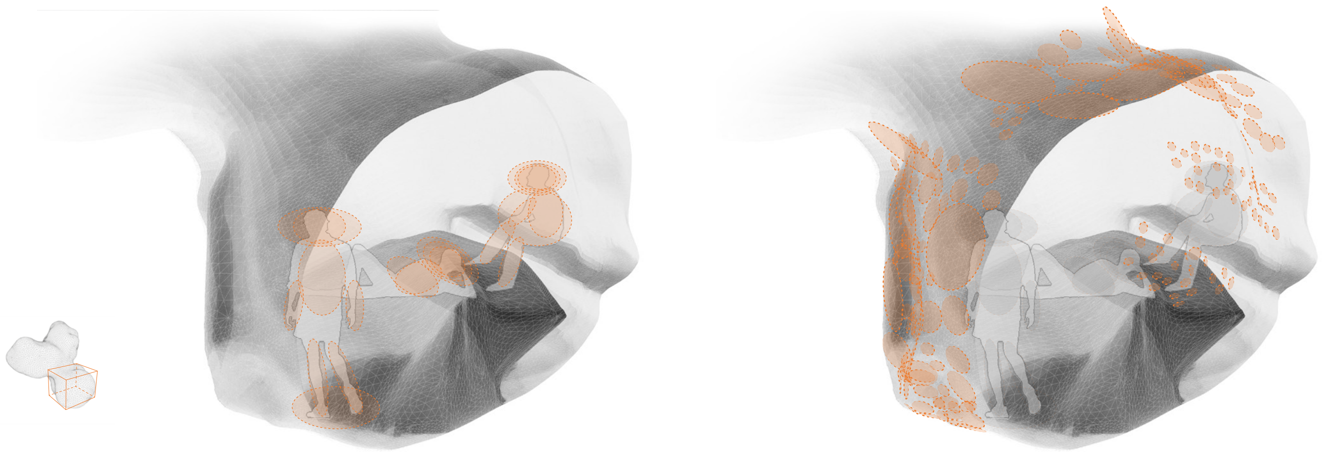
Synthesis of human activities into movements and body postures (left), which generate specific spatial configurations (centre) and the initial architectural skin (right)

3. BODY-CENTRIC DESIGN

The first step towards a body-centric design was to analyse the human anatomy in different scenarios, each representing the major daily activities within the unit: sitting, walking, exercising, laying down, studying/working and relaxing. Each of these activities is described through specific body positions and their minimum and maximum movements. The resulting profiles are then multiplied following the walking patterns and used for shrink wrapping the initial shape around them. However, in order to avoid a claustrophobic effect and provide a bigger visual comfort, a space greater than the immediate limits was enclosed. In this way, a building shape more respondent to the human body anatomy is created.
The use of the human body is maintained in the subsequent scales, specifically for creating furniture based on its anatomy and for identifying which areas need heating, cooling and lighting, according to the activity that is being performed. This results in new organic shapes and establishes a framework for an architectural skin that is directly derived from this mapping process. This allows us to identify on the skin where to locate the different devices and systems for thermal and visual comfort.

4. THE HUMAN BODY AND LOCAL COMFORT

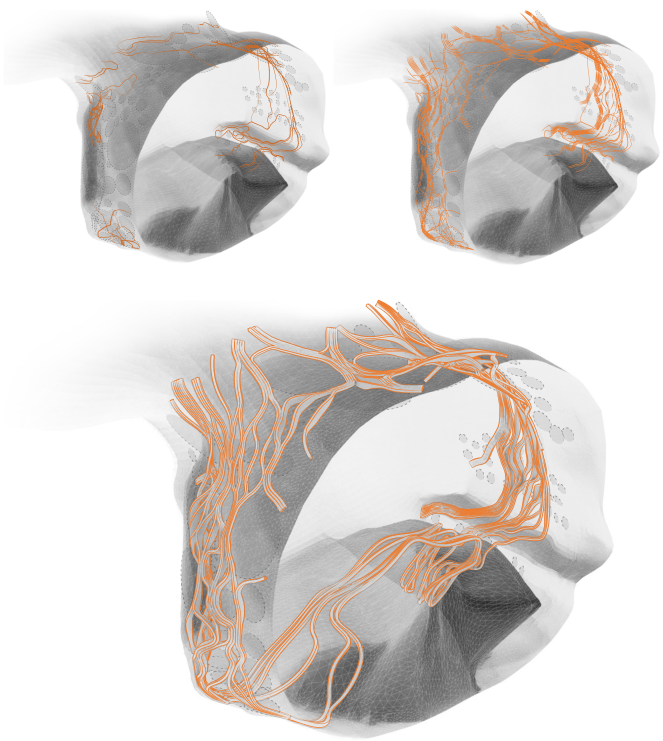
While the perception of temperature is relatively subjective, patterns can be identified that express a physiological relation between specific parts of the human body and comfort. Local thermal comfort describes the resulting approach, that aims at regulating each individual's well-being by addressing these physiological requirements on a small scale. Through localised methods, efficiency would improve exponentially in environments that are sparsely inhabited or rarely used. The starting point of this discourse is thermosensitivity, which asserts that the human body possesses distinct sensors for heat and cold, called thermoreceptors. Thermoreceptors are unequally distributed throughout our body, effectively creating areas of high density that are specialised in perceiving heat and cold. These principles have been recently refined and unveiled a hierarchical distinction among thermoreceptors (1). While the three areas are of highest concentration of thermoreceptors are located in the head, the abdomen and the extremities, their importance varies. Cooling is, in fact, the most effective when applied to the head and the extremities respectively, while little impact is perceived in the case of the trunk. This order corresponds to the levels of discomfort if additional heat is directed on these areas. Inversely, comfort in a cold setting will be highest when applied to the abdomen, the chest and the extremities respectively, while it will produce no difference if applied to the head. In thermal comfort, not only is the target important but also the orientation of the flow, especially when cooling is required. ____ demonstrates that a perpendicular direction is beneficial to sleeping (2).
Eventually, within a localised comfort logic, additional factors can be identified, for instance for visual comfort (lighting and view).



Local comfort mapping on the human body (left) and subsequent projection on the architectural skin (right)

5. DESIGNING FOR LOCAL COMFORT

The building skin would be equipped with a set of systems that respond to the physiological local requirements.
The project employs existing technologies to explore methods of integrating them into an architectural skin.
These would vary from heating and cooling devices, that would dynamically target a person in space and create a personalised climate bubble around them, to gradients of porosity for lighting and view.

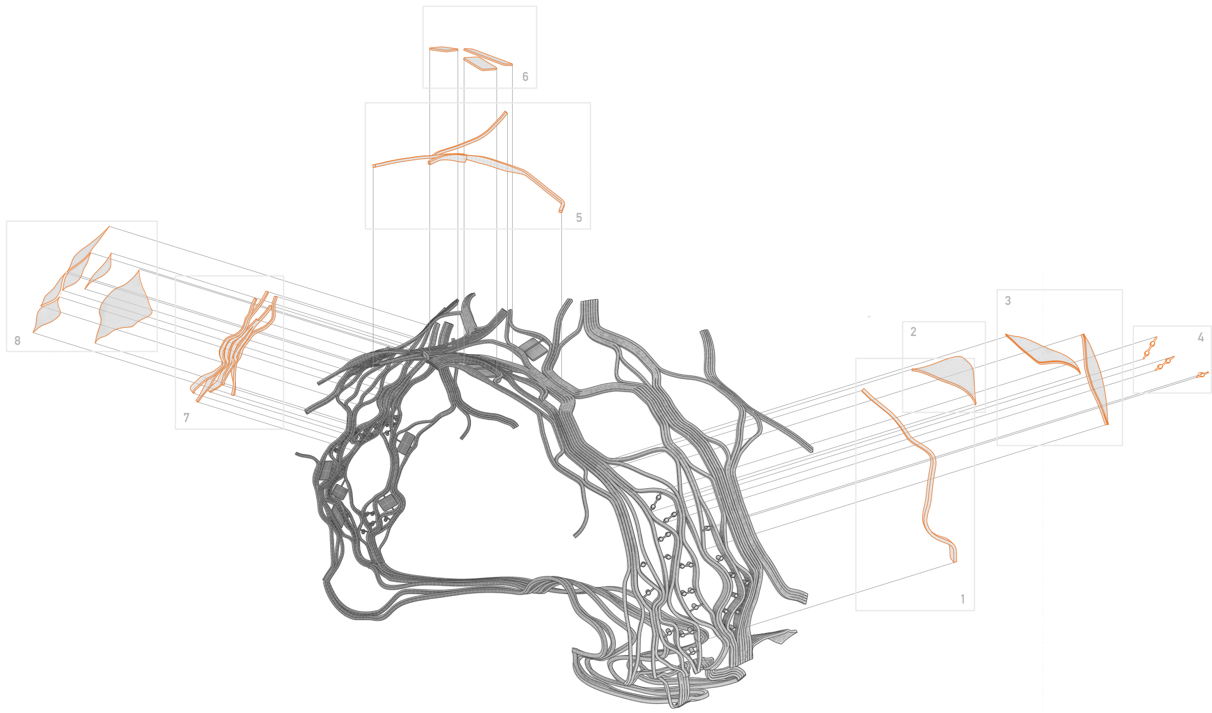


The projected local comfort requirements are implemented to define specialised cells (above,right) which, in combination with structural needs (above,left), define the materialisation of the architectural skin (bottom)

This is achieved by re-connecting the local comfort factors with the above-described profiles for each activity.
Subsequently, these physiological requirements are embedded into the architectural skin by means of separating it into specialised cells, each corresponding to a function and a type of device. These devices require cells of different sizes and density and directly affect the porosity of the skin. Heating devices consist of infrared lamps, whose energy is derived from sheets of solar panels on the outside, while the cooling process is broken down into different specialised cells. The biggest would collect water, which is then transformed into a vaporized stream and emitted into the internal environment. Both the devices are able to rotate in three directions in order to follow a moving person.

6. CONSTANT INTERACTION BETWEEN HUMAN BODY AND BUILDING

The dialogue between the human body and the design would not stop at the level of the conception. For a truly body-centric architecture we would need to directly reference and engage with the body in a real-time, durational communication. The framework of local thermal comfort demands that the building has the capacity to understand not only the location of the inhabitant but also their posture. This can be achieved through the use of sensors, that have to be carefully mapped and become part of the cell system. In this way, the devices are capable of creating an effective interaction with the user and follow them through their movements.



Devices and systems implemented in the specialised cells of the architectural skin

7. MATERIALISATION OF THE SKIN

Considering the varying sizes of cells, the materialisation would have to be able to accommodate these differences while maintaining a structural skin. The material choice to use wood resonates with its relative malleability and possibility of application of robotic fabrication methods.
The continuous beams that were developed create areas of different density in accordance to the porosity previously established, while maintaining an interrupted vertical direction. For structural reasons, additional beams were placed where the shell's forces were higher. Finally, their integration with devices entailed that their depths would vary in accordance to the component that was embodied.

8. CONCLUSION

With technology advancing ever so rapidly, the project aims to bring our spatial thinking up to speed by questioning the validity of long-standing means of constructing a space and offering a possibility of seamless integration between old phenomena and newly available methods.
Taking a project that deals with building a new community on a seemingly unlikely plot as the basis of the physical context allowed the project to explore relatively more innovative concepts including body-centric design.
Human body being primary factor of such design, the project aimed to demonstrate the fluidity and flexibility of spatial configuration that accommodates a wide range of users. One important aspect that was needed for such demonstration was the integration of smart devices for local comfort into an architectural skin. Newest technology available at the time of this paper being written has been considered and possible ways of integration including interaction between the human body and building based on real-time feedback have been explored.
The subject of materialisation of the skin has been carefully examined to accommodate the needs in terms of robotic fabrication methods and structural integrity.
The project has delved into multiple areas where further conversation is needed, however, creating a dialogue was exactly what this project had set out for.

9. REFERENCES

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