Rebecca Lopes Cardozo
Theona Kessaris
Oscar Borgström
Andrea Costa

Architectural Design through D2RP&O

"*... the relevant question for the future is not whether robotic building will be implemented, but how robotic systems will be incorporated into building processes and physically built environments in order to serve and improve everyday life.*" (Bier, 2016)

Introduction

Approaching design from a robotically driven perspective allows for the creation of architecture which is a product of the interaction between users and their environment. Through the design of a pavilion-sized public furniture project (consisting of two main components; an organic, continuous ribbon, and rigid ribs), the parametric relationship between human and non-human agents in design is examined. Driven by the context, the human body and juxtaposition, the dockside project of contrasts addresses the application of generative and simulation scripting in the design process. Production and manufacturing scripting are explored during the workshops to further develop the design at the meso and micro scales via the examination of a fragment. The culmination of these processes is the generation of an architectural design which through the use of robotic systems has emerged exclusively from the connection between the users and the site.

Generative scripting

Within the generative scripts, a set of parameters are applied as driving factors. These parameters, based on the selected viewpoints of the Euromast and the New York Hotel, and a set of four to five curves which are derived from the ergonomics of the human body in a sitting and lying position, supply data to the scripts. These scripts support the designer in the search of a complete and comprehensive form constructed from the spatial experience and juxtapositional ideas defined in the concept. The design is further influenced by both an analysis of the various material options and the movement on site.

The scripts are arranged into macro, meso and micro scales. The macro scale relates to the major parameters of the site; approach, water to dock relationship, weather and viewpoints. The meso scale is defined from the size and shape of the human body, and the micro scale determines tectonics, material properties and the interaction between human and form.

Simulation scripting

The simulation scripts produced follow the form generation of the object whilst simultaneously informing the designer and providing feedback data for future designs. Moreover, simulations of the production process are made. These highlight the efficiency of the production and feed-back potential errors, which in turn can further inform the designer and potentially call for changes at earlier stages of the design process.

Production scripting

In order to run the robotic production, the geometry is translated into readable data. This data is organised in a way in which the utilised tool can follow a specific path and produce the desired shape. A large part of this translation (especially when it comes to robotic arms) has to do with optimising this path. The process from digital geometry to a manufactured shape is simpler if the means of production are taken into account at an early stage in the design process. Thereby, the geometry can be adapted to the tool, the translation straightforward and the manufacturing efficient.

The Dessau workshop focused on the design and production of a selected fragment of the urban furniture. The arsenal of tools on site established a first design guideline, defining the limits and possibilities for the design and production process. The production focused on the subtractive method of wire cutting for the shape, and milling for the porous pattern.

The Delft workshop concentrated on the assembly and production process. The componential logic led to a specific joint detailing: the fork joint and ground pinning for the wood elements, and a complex T-joint for the EPS. These joints allow the two materials to be interlocked in a sequential way, creating stabilisation for the entire structure, and locking it in place with the insertion of the final piece.

Discussion

The practice of designing from a process-oriented rather than object-oriented approach shapes architecture in a generative fashion. Process-oriented design allows for the configuration of architecture to emerge from the needs of the users and thus become a reflection of the relationship between the users and the environment, highlighting the idea that “architects design increasingly processes” rather than just objects and forms (Bier, 2016, p. 2). The design of the urban furniture at all scales (macro; meso; micro) has been shaped through these interactions, the parameters of the design generated by taking into consideration the passive behaviours of the user (the comfort level encountered within various areas of the object to generate the sitting/lying curves), and the active behaviours

of the user (the interaction with user-responsive lighting and movement through the space). The interaction between parametrics and users at the production level results in a targeted design with a gradient of experiences to attract people; demonstrating a consideration of the user experience throughout the entire journey, from anticipation, to experience and interaction with the object, and the final reflection on the experience as a whole. This generative method of designing results in an architecture which has been optimised to the user, producing a unique object and thoroughly considered experience.

Simulation

The use of simulations allow for the understanding of materialisation possibilities within the project. Connecting the design and production processes, simulations ensure the achievement of high quality results to the advantage of the users. Rather than being just a tool, simulations act as the element which closes the feedback loop in the design process, and more specifically "establish a feedback loop between…architectural production and the operation of the architectural system in time" (Bier & Knight, 2010, p2). The role that simulations assume in the design process become fundamental in defining the design guidelines which give the designers a clear understanding of the assembly and production process. This feedback loop correspondence highlights how materialisation and design aspects inform each other through simulations, leading the designers to the development of specific details in relation to material and structural optimisation.

Production

The focus of the second workshop on materialisation and assembly facilitated the development of the design in terms of buildability; stimulating an adjustment in the approach to the design to determine how the object could be put together whilst keeping in strong consideration the tolerances required to translate the design from a digital model to a physical prototype. This conversion leads the designers to an understanding of how "at [a] physical level, the robotic production system explores physicality that cannot be fully modelled inside the digital design platform in order to inform the design." (Bier & Mostafavi, 2015). The use of robotic production also drove the development of the interlocking connection details, allowing for the generation of custom components to realise the prototype, whilst also optimising the material and the assemblage. Adapting the design to suit the methods of assembly and more closely align with the strengths of the selected materials clearly shows this play of the feedback loop in the design process.

Conclusion

As examined through the urban furniture project at the Fenix Factory dockside, robotic processes provide a significant advantage in the design of responsive and considered architecture. The use of robotics allow for informative design; design which has been generated directly through the influences of its users and its surrounds via the information obtained from a feedback process between the human and the robotic. As such, the integration of robotic systems into building processes can create an architecture in the future which is highly refined and specific to both its users and its environment.

References

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