Integrated bio-inspired Design by AI:

Using cell structure patterns to train an AI model to
Explore topology design ideas

Namrata Baruah | 5326664

MASTER THESIS – REFLECTION

BUILDING TECHNOLOGY MASTER TRACK

Faculty of Architecture and the Built Environment

First Mentor: Dr. Michela Turrin, Design Informatics

Second Mentor: Dr, Charalampos Andriotis, Structural Design & Mechanics

External Supervisor: Dr. Alberto Pugnale and Gabriele Mirra, University of Melbourne

Student: Namrata Baruah | 5326664

TU Delft Delft University of Technology
Faculty of Architecture
and the Built Environment

REFLECTION

1.Relation of the thesis to the master track and master's program:

The intention of the master track of Building technology is to reduce the gap between architecture and engineering by integrating architectural design with technical disciplines. The methodology developed in this paper uses design informatics to combine associated disciplines of building technology to create integrated, data driven and exploratory design solutions which is complimentary to the aim of the master's track.

The built environment is developing faster than ever. The explicit computational tools available can lead to zoning in on a solution too quickly and compromise on certain aspects of the design. It is crucial that the designers have the proper tools to aid in computation as well as exploration of design spaces for a more sustainable development.

2. Effectiveness of the Process:

The stage of Artificial Intelligence in design is still in its infancy where there is a lot of scope for research and development. The process taken in this thesis was effective for the limited time available to complete the thesis. This approach allowed me to explore other fields such as data science, bio-medical engineering, cell structures for different problems. The dataset creation and training the AI were important stages of the design process. The results from the process were within expectation but due to time constraint, the study of the different domains was not as extensive as preferred. The integration of the AI in the conceptual design phase was only explored for one application process but further research can be carried out to expand the domain for application. This interdisciplinary development of the methodology in this thesis can lead to collaboration between the experts of the different domains thus aiding in finding efficient solutions.

3. Societal and Scientific Relevance:

Designers are producing more data than ever before. Using that data to understand the design intensions and providing information to expand the design spaces of the design can be helpful in exploration of ideas. This allows the designers to focus more on the intangible aspects of design. Being able to explore the design space can aid the designer in making more sustainable and economic choices by exploring more design options.

The use of AI in design is still a novel one. The availability of pictures of human faces and objects limited the expansion of VAEs to other domains (e.g., design) and were extensively trained on available data. The use of VAEs in design opens up possibilities of exploring unpredicted design solutions which would not have been possible through traditional methods. Using the power of computation to iterate through vast design spaces that encompass any architectural design solution leads to possibilities of generation and evaluation of solutions which were not manually possible.

4. Ethical issues:

The biggest ethical issue with any generative design is that if the tool developed would make the role of the human designers irrelevant? One of the major factors for design space exploration is that human designers can control the outcome of the process. The project was carried out to act as a tool for designers to have better access to directed, unpredictable solutions for better design exploration. The context and the intangible parts of the design should be left to the designers while providing solutions to tangible and non-intellectual tasks. The aim of this project and also future developments is co-design and not replacement of human designers. In fact, it makes their task more important in the design process.

5. Self-Development:

The project was built on python programming language, and throughout the process I was able to learn and improve my programming skills. It was a challenge to work with Convolutional Neural Networks (CNNs) and Variational Autoencoders (VAEs) but a major advantage of using programming language is that there are a lot of resources and libraries available online (e.g., TensorFlow) to expedite the process. There was also a significant development of my own understanding of python, Artificial Intelligence and its architecture.

6. Application in Practice:

Design space exploration can offer aid in design problems where the different considerations might conflict one another. The results from the thesis can aid in exploring design solutions while weighing multiple and diverse design ideas. The solutions are neither optimized nor unidirectional and thus provide a navigation-able design space. The designers can make the final solutions while weighing the different solutions.

7. Impact on Sustainability:

The decisions that are taken during the concept design phase of a design project accounts for 75% of the building cost. The structural design is incorporated later in the design process and is constrained by the experience of the designer and the performance driven computational tool used. This thesis explored the possibility of introducing structural design to the conceptual design phase through providing freedom of exploration of the design space. The designer can compare and analyze options without setting constraints that restrict the variety of options available. This can lead to sustainable and creative design options.