INTRODUCTION

This paper describes how biological concepts assist an architectural space design through ongoing case-study project. The method was developed through the investigation of two embedded computational systems that take into account bioinformatics, environmental engineering and digital fabrication, which will be integrated into an architectural system. More precisely:

- Geometrical visualization of dynamical programming technic used for bioinformatics with open-source bank of genes constructed by collaborative genetic research.
- Natural light optimization as part of its energy management shaped by environmental engineering and bioclimatic multi-criteria.
- Structural optimization for digitally crafted geometry in association with light analysis to develop a new curved traditional timber system.
BIOLOGICAL DATA-MINING

The subject is illustrated by the example of a project inspired by the bio-mechanism of the immune system, Immunorium. The contemporary analogy between immunized organism/environment and the immunological concept of “self”/“non-self”, developed by the German philosopher Sloterdijk, is the theoretical framework of this project. This physiological concept is translated to geometrical motif of sunshade façade (Figure 1) system generated by pathogen searching algorithm (Figure 2), the basic bioinformatics technique of cloud DNA sequencing developed for human disease research. Such kind of medical information network infrastructure is actually a very discussed issue in the context of a rapidly aging Japanese society. The façade itself may work as photosynthesis-like receptor of sunlight and also filters natural sunlight for optimized passive energy system discussed in the next paragraph.

BIO-INSPIRED OPTIMIZATION

For the first stage, the author presents a general computational framework of automated structural and sunlight optimization (Figure 3 & 4). Here we display the heuristic optimization loop repeating the feedback between design and simulation: the immune-inspired algorithm, which will be carried out several times in order to improve the building’s details (wall, openings spaces in between, assembling components).

Subsequently, the author shows a different optimized treatment of natural light according to functional space. The thermal storage wall and floor of natural light coming into space through the façade will be shaped by luminance criteria related to physiological experience of light/shade, or by criteria of irradiance in relation with thermal comfort such as PMV or healthcare specifications.
Angle of facade: 32.29°
Average of Illuminance: 8676.87
Max displacement of beams: 0.000039mm

Angle of facade: 34.46°
Average of Illuminance: 7781.60
Max displacement of beams: 0.000065mm

Angle of facade: 37.28°
Average of Illuminance: 6798.72
Max displacement of beam: 0.0019 mm

3 Opt One – visualization of structural optimization
4 Opt Two – visualization of sunlight optimization
5 Detail One – drawing of Japanese traditional timber jointing system
MODERNIZING JAPANESE TIMBER SYSTEM

The project is also a case study on the usage of parametrized Japanese wooden traditional jointing system for the structural details (Figure 5 & 6) generated from free-form surfaces, optimized in the previous process. Re-conceptualization of these details was also inspired by the work of Henri Deneux, a French architect who reconstructed the roof structure of Notre-Dame Cathedral of Reims in 1924 (Figure 7 & 8). The current paradigm shift of architectural production from ready-made industry to custom-made one needs to modernize new craftsmanship models to better preserve the Japanese prototyping industry, and this is an additional challenge in this project.

NOTES


IMAGE CREDITS

All image credits to Mayumi Iitsuka (2014).

MAYUMI IITSUKA is an architect who has been practicing at several architectural firms in Japan and France. She holds a Master of Architecture from E.N.S.A Paris-Malaquais (France) after graduating in Architecture and Engineering at Chiba University (Japan). In 2012, she founded Immunorium, an architectural firm where she develops her research and works focused on architectural space for cure. This concept was finalized during her diploma project at E.N.S.A. Paris-Malaquais, where she developed her design process in association with applied computer sciences. Her main research interest consists in the relationship between medicine and architecture, biology and machine.