Graduation Plan

Title
C.H.E.A.P – Cheap Homes Enabled by Automated Construction

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Studio
Architectural Engineering
Tutors:
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Rooij, Dr.ir. R.M
Argumentations of choice of the studio

The reasons why I chose this studio are the same that made me chose to further study beyond my bachelor. My personal experience of participating in the construction made me aware of some of the problems in the current state of the architectural design and building industry in China. Among these two are very severe.

One is that there is a huge gap between architectural design and production/construction. Architects, since their education in universities, usually know too little about actual building and construction. Too much time spent and training were on pure architectural design, not even including the details. The materialization of design often get out of control. This does not only lowers quality but also damages the efficiency of the whole project.

The other is that the general building construction is still in a rather primal state. On the one hand, large quantity of human labor is required, yet the working condition and production method is usually very poor. On the other, as the last generations grow old, the labor market is changing rapidly. The younger generations do not have as much endurance and are less willing to work too intensively. In a predictable future, it is no doubt that money spent to pay construction workers will grow, while the need to improve working environment will become stronger.

From my point of view, a “leapfrog development” would be a possible solution, which is the implementation of automated production in the building industry. The designers need to know more about manufacturing to develop their design. For the other side it is more obvious, since by doing so fewer but better educated workers will be needed in construction, either on site or in prefabrication.

Last semester I was in the Hyperbody studio doing Robotic Design to Production (RD2P). Yet personally it was not satisfactory enough for me, since we didn’t really get down to actual building, or so called traditional buildings, but had chosen a rather progressive and revolutionary way of design. I see an opportunity in the AE studio that allows students to focus and pursue their own interests in a better organized way and thus chose this studio.
Graduation Project

Problem Statement

Factory town is a contemporary phenomenon where workers gathered autonomously around their factory. With insufficient government intervention and organization in such area, in this case, Bandung, the living conditions can often be rather undesirable. Besides the lack of city grid and water supply and management, the building quality is also low because of unorganized constructions.

More detailed information is needed to further the research, but still I do see some similarities in Bandung that relates to the situation in China, and differences as well. The market in developing countries still require large amount of human resources in manufacturing and thus leads to manufacturing cities, such as China’s Dongguan, and Shunde. Though the policies and context would differ a lot, developing housing products for the population with relatively low income will long be an important issue. Bandung is not the very specific context that I hope to research and design with, but rather a representative for a more general social context.

Objective

How to develop a housing product which is able to be produced with high productivity and relatively low sales price that is affordable for low-to-middle-income population in Indonesia, while being possible to be customizable according to various customer needs?

Overall design question

Context:
What type of housing product and specific requirement would be needed for the relatively low income population living Bandung, or other similar manufacturing cities?
How to make the product attractive enough for the target group? (Quality, low price, and customizability, possibility of extension)

Program:
What would be the proper function, form, scale and configuration of this product, and also taking into consideration the possibility to be customizable and expendable?

Thematic focus:
How to design a housing product that meets these requirements and at the same time optimized for automated production and construction to gain its added value and become more competitive?
Thematic Research Question

How to use automation-oriented design to provide an affordable and productive product for the housing demand in Indonesia and alike emerging cities in developing countries, and at the same time being customizable?

Sub questions:

1) What kind of housing is needed in Indonesia for low-to-middle income households?
2) What is the proper price of the product?
3) What is typical site condition for the product?
4) What kinds of robots and robotic systems are there? And what are their characteristics?
5) What kinds of modular strategies are there, and how to make a choice?
6) What are the principles in designing with robotics?
7) How to estimate and control the cost of the system and eventually the product?

Methodologies

Literature study:
Including articles on ISARC (International Symposium on Automation and Robotics in Construction and Mining) proceedings, IEEE (The Institute of Electrical and Electronics Engineers) Robotics and Automation Magazine, and books on robotics which authors include Balaguer, Bock, Shoham, Vepa etc. Summary and discussion will be made through the study of these literatures.

Case study:
Precedents in automated construction, current modular housing products, and current affordable housing.

Research by design and experiment:
Rhino model, grasshopper codes, simulation of robot construction process, and real robot experiment if possible

Planning

See last page
Relevance

As is mentioned before, the research would use Bandung as a typical representative for manufacturing cities in developing countries, thus the outcome is in fact meant for a more general solution for this bigger social phenomenon, that the population with averaged or even lower income aggregate autonomously around their working place, where low-cost, recyclable, customizable, and massively produced housing products will be needed.

Literature

Book:

Article:

Precedent:
ABCS (Automated Building Construction System), Obayashi, Japan
BIG CANOPY, Obayashi, Japan
SMAS (Solid Material Assembly System), Science University of Tokyo
RCACS (Robotics & Crane Based Automated Construction System), Korea University
AMURAD Grow-up System, Kajima, Tokyo, 1994
Push-up System (Electric Powered Screw Jack Method) Plan, Kajima, Tokyo, 1995
Shimizu Manufacturing System by Advanced Robotics Technology (SMART), Tokyo, 1993

NB. Part of the graduation (especially in the MSc 4) is the technical building design. Therefore a Building Technology teacher will be part of the tutoring team from the P2presentation on. This should be taken into account when writing the Graduation Plan, in the time planning as well as in the relation to the content (e.g. statement, method and/or relevance).
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