Factory of the future

Reflection on graduation – March 2018

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In this graduation project the Factory of the Future (FoF) is researched in the context of the present and near future. The goal is to formulate a design proposal for a factory building in Amsterdam. This plan is based on scenarios regarding the technological developments of the industry, new possibilities for distribution networks, and the relations between factories and urban and social fabrics.

Goals and research

Architectural research questions:

- The logic of the factory in itself, regarding inputs, processes and outputs.
- How technological developments could shape the factory of the future different than it is today.
- How a factory can be shaped to fit into the context of a contemporary western urban area, regarding the economic, environmental and spatial aspects.
- The possible connection and openness between life within a factory and human life outside of the factory.

Material, parametric and robotic research:

- The parametrics and calculations regarding double curved structures.
- The use of additive methods in the design process regarding methods obtained from maritime technology.

Automation in factories

The current trend in production is the transition from mass production towards a mass customized workflow (Oosterhuis, 2014). This means the use of 'intelligent' production methods to fabricate a variation of products at the speed and costs of mass production. "A mass customization system should possess a stable although still flexible and responsive set of processes, that are capable to deliver a finite number of customization options." (Boër, Claudio, & Pedrazzoli, 2013) Factories try to transform a raw material into a demanded product at a cost-effective competitive way. In the case of automation in factories this cost-effective aspect is commonly achieved by the reduction of human labor. To sharpen the scope in this FoF the focus will be on products related to the building industry.

Reducing human labor in factories generally includes both automatic transportation within the factory as the automated production of goods and the link between these two aspects. Automated transportation within the factory regards intelligent order systems that are translated to distribution systems that control orders throughout all the steps in the production process. To transform a raw product into a final product, usually several steps need to be taken to do so, though per final product the steps may differ. The routing of such a differentiated factory outline is an opportunity for the FoF.

Automated production is the use of variable and intelligent production methods, such as the robotic arm or intelligent CNC or printing machines. The economic opportunities are rather in the field of the creation of series of comparable objects rather than the creation of truly unique object. This way the errors in the processes can be researched and prevented, granting full use of possible machine time. The integration of the two processes is a key factor. Both automated routing and production grant the minimum use of human labor, but also grant the opportunity to enter human aspects to the process if a certain step in the production process can be achieved more straight-forward and cheaper than automated.
Both the automated routing throughout the steps of a production process and automated steps within this production process form the basics of the design of the FoF. These aspects are also supported by the Dutch government for further exploration in universities and industries (Team Smart Industry, 2014).

Relation of the factory to social aspects

The design of factories is largely determent by revenue. This is a combination of the costs of production (labor + machines), purchase of raw materials, transportation costs and sales of products. All the costs should be less than the price of a product. Over the last decades production flocked around spots with cheap labor in e.g. Asia, this effect was amplified by low costs of transportation. In a paradigm with automated factories, the influence of labor costs on the revenue decreases and increasing the share of transportation costs on the final product. This allows for and stimulates production closer to the end user and by that decreasing the need for transportation.
Other aspects that could decrease the distance between factories and the end users are that factories are getting cleaner and circular in their planning and that production on demand may ask for a fast delivery to the client for the reason no stock can be made producing unique products.

In contemporary urban design a new way of coping with factories is needed. In the pre-offshoring era the factories were at the outskirts of the city, mainly due to pollution. In the near future factories, when not polluting, may need to be closer to the client.
A way of looking at this is by creating a network structure of factories rather than a building - as an object - focused approach. In this approach, inspired by the network structures of Constant Nieuwenhuys (Wigley, 1998), the automated production facilities have a space that is separated but intertwines with the human world. The human world is focused on the celebration of free-time due to the decline of labor. This forms a framework for the social context of the FoF.

Design to robotic production

The studio track focusses on ‘design to robotic production’. This means the use modern production techniques and the research of it on the architectural project. Research is carried out on the practical, how to fabricate and make certain building components, and on the larger scale, how this influences architecture.

The focus of design studio is less on the automation of certain existing processes, but more on looking for new possible ways of production and looking for new ways to design with these. Certain possibilities in production technology lead to certain ways of architectural design and vice versa. The creation of large scale architecture doesn’t only rely on context, functional, architectural or designer driven arguments, but may also relate to the very tiny detail in the production process.

Throughout the architectural scales

A framework of working towards an integrated design project is the use of the macro, meso and micro scale. The macro captures the architectural towards the urban scale; the meso scale is the architectural fragment or focusses on the building components, while the micro scale focusses on the

production, the building product and it's specific characteristics. The integration between the scales, the influence of one scale on the other, grants the possibility for an integrated architectural project.

The macro approach of the FoF incorporates the use of swarm simulations to make both a functional and spatial layout on the level of the complete site. Internal parameters, based on the two main functions on the site, the factory and the recreation are taken into account. External parameters, such as lines of sight and global routing are taken into the model as well. This generates a rough geometry to work with in the project.

The meso scale focusses mainly on the structural and environmental aspects of the building. The forces in a building are roughly separated in tension and compression forces. The lines are taken to generate inner structure of the buildings shell structure. The spots of the window openings are determent by environmental aspects. Both rainwater flow and a sun model are taken into account.

The micro approach is based on additive manufacturing. Steel plates are bended into shape by a pin-bed system. Steel is printed on top of theses plates to create flanges according to the force-lines. This technique is describes by an extensive research on both the production process and the viability by a project by students of maritime technology (Bergsma, 2017; Zalm, 2016).

Reflection

Parametric design and robotic production should not be seen a substitute for human activity, but rather as an extension in possibilities. It grands new opportunities in design of architecture and building components. Parametric design in my graduation project is used in two distinct ways. At first the generation of certain layouts or rough geometry. These can be considered as certain underlying layers of information for the design, though it is up to the designer to transform these into architecture. It should not be considered an automated process, rather as an extension of the designers tools.
The second way parametrics are used in my design process is by the generation of geometry that has a close relationship to the production process. It doesn't mean there are no manual steps in this process, but here the relation between the design, the building-component and eventually the robotic toolpaths have link in the process.

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