Developing an Engineer-to-order Product Configurator of an AAC U-block Manufacturing Machine

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Aircrete Europe is a Dutch supplier of autoclaved aerated concrete (AAC) manufacturing equipment. AAC is a lightweight, porous building material (Aircrete Europe, 2015). Although the most wide-spread AAC product shape is a simple block (parallelopiped), some applications necessitate the so-called U-blocks (Figure 1). U-blocks are produced by post processing standard blocks and are characterized by a U-shaped cross section. U-blocks are applied in construction for pre-casting lintels that span door and window frames for additional strength or for pre-casting a so-called reinforcement ring around the whole building story.

Figure 1, an AAC U-block. Taken from udkgazbeton.com

For an upcoming turn-key plant supply, Aircrete is engineering a machine to manufacture U-blocks. This work explored how Aircrete can optimize the engineering of the U-block machine given that they plan to sell the product to more customers in the future. This exploration was tackled by first studying the state of the art of U-blocks manufacturing based on a specific customer situation. Second, by expanding from specific data and synthesizing a generalized system architecture. And, finally, by developing the approach to apply certain customer input with the synthesized architecture.

First part of prior research focused on studying the customer expectations, what U-blocks manufacturing is, how can U-blocks be applied and what are the existing solutions to manufacture U-blocks with their advantages and disadvantages. But gaps in understanding the customer expectations and existing solutions remained. Second part of prior research focused on understanding what is order processing, what are the strategies in order processing and what are product configurators within order processing strategies. The background research formed the structure for the main body of the work by focusing on closing the state of the art gaps and determining the direction for developing the order optimization approach for Aircrete.

Although filling gaps in the state of the art of U-blocks manufacturing and applications necessitated a few stakeholder interviews, main takeaways of this chapter were in an identified number of distinct ways to manufacture U-blocks, determined customer problem and identified existing solutions for U-blocks manufacturing.

The anticipated complexity level of the envisaged machine implies that the standard designing process might not be the most efficient approach. Although systems engineering might appear in different definitions, there seem to be some commonalities: it is an approach for large systems that requires more complete effort for defining system requirements (Blanchard & Fabrycky, 2013). The goal of the system architecture chapter was to use customer specific data gathered earlier in this work and create an architecture of a generalized machine. Main takeaway of this chapter was the most efficient system breakdown based on the conducted contextual and functional analyses. For example, see Figure 2.

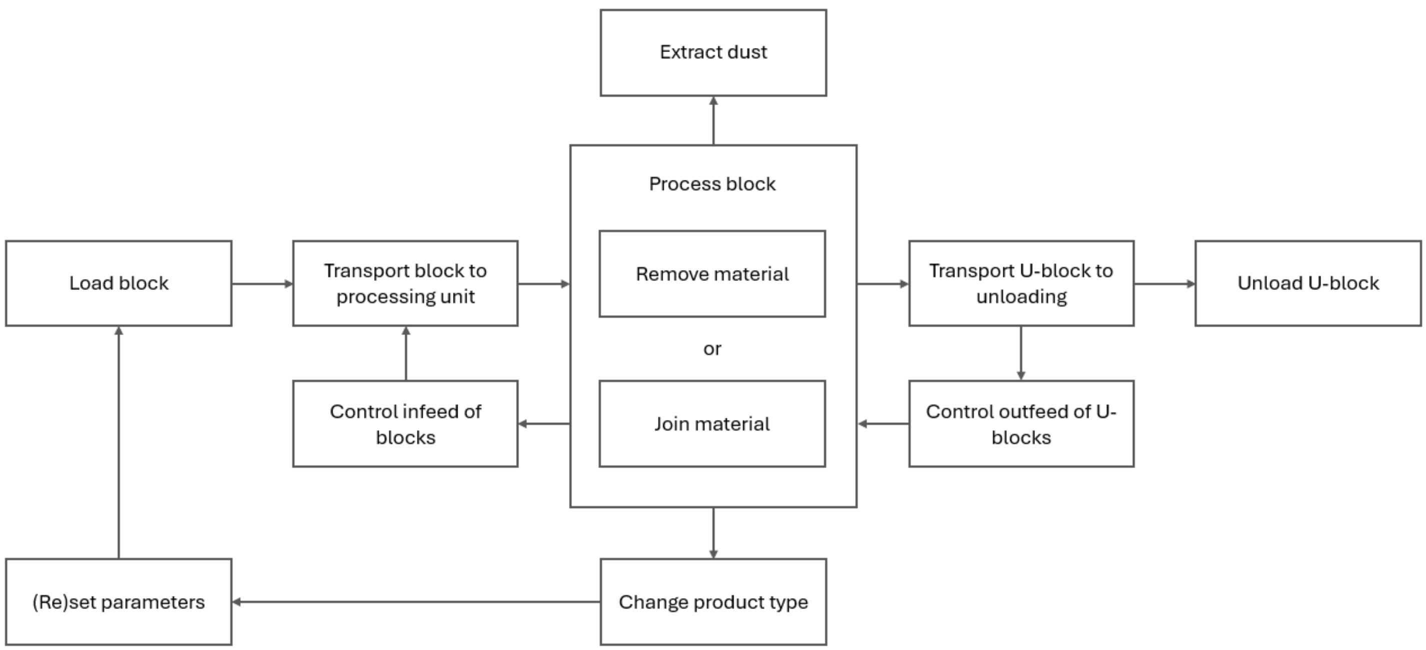

Figure 2, functional behavior of the generalized U-block machine

When processing an order, there is a point where the customer no longer has influence over the project. It is called customer order decoupling point, or CODP (Olhager, 2010). Depending on where that point is in the material flow of the project, there exist a number of strategies to process an order. Engineer-to-order (ETO) strategy has been identified to be the most suitable order processing strategy for Aircrete's U-block machine. Product configurators are tools that are capable of generating possible product variants (Blecker, Friedrich, & Abdelkafi, 2004). They provide added value by optimizing the order processing (Myrodia, Kristjansdottir, & Hvam, 2017). Developing an ETO product configurator has been chosen to be the order optimization approach for Aircrete's U-block machine. The developed product configurator is aimed at internal use by the stakeholders and is capable of taking certain customer input and transforming it into a to-be engineered solution concept (see Figure 3).

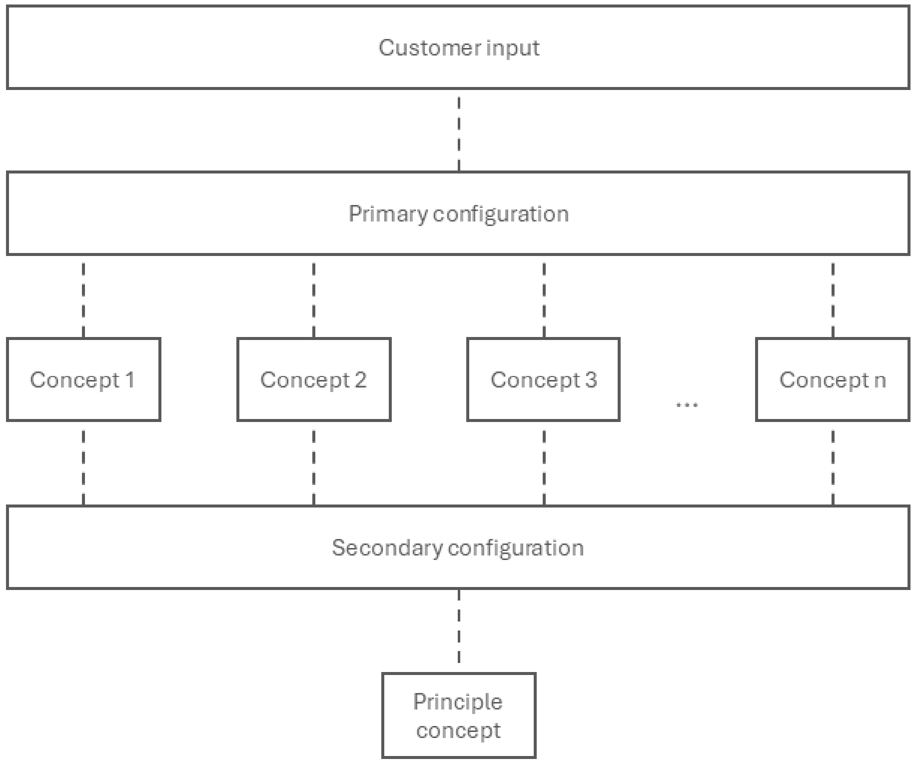

Figure 3, configuration logic outline

The developed configurator was evaluated by conducting a case study and a user testing. The case study tried to replicate the creation of the very first machine concept that was developed for the turn-key customer, and the results demonstrated significant time savings while getting the same outcome. The user testing featured a participant from each stakeholder department: engineering, project management and sales. The user testing proved the developed configurator to be a beneficial approach in general.

Upon completing a number of U-block machine projects, more design standardization can be introduced into the material flow and, thus, the order processing strategy can be further optimized into make-to-order which would offer even more time savings for Aircrete. In turn, the product configurator itself would have to be redesigned to be capable of generating new, more specified U-block machine solutions.

References

Aircrete Europe. (2015). *Flat-cake technology*. Retrieved from Aircrete.com: https://www.aircrete.com/unique-technology/#flat-cake-production-process

Blanchard, B. S., & Fabrycky, W. J. (2013). *Systems Engineering and Analysis.* Pearson Eduacation.

Blecker, T., Friedrich, G., & Abdelkafi, N. (2004). Product Configuration Systems: State-of-the-Art, Conceptualization and Extensions. *Eighth Maghrebian Conference on Software Engineering and Artificial Intelligence* , (pp. 25-36). Sousse. Retrieved from https://www.researchgate.net/publication/24114368_Product_Configuration_Systems_State_of_the_Art_Conceptualization_and_Extensions

Myrodia, A., Kristjansdottir, K., & Hvam, L. (2017). Impact of product configuration systems on product profitability and costing accuracy. *Computers in Industry*, 12-18. Retrieved from https://www.sciencedirect.com/science/article/pii/S0166361517301355?via%3Dihub

Olhager, J. (2010). The role of the customer order decoupling point in production and supply chain management. *Computers in Society*, 863-868. Retrieved from https://www.sciencedirect.com/science/article/pii/S0166361510001156?via%3Dihub