INTERFACING ARCHITECTURAL DESIGN AND INDUSTRY 4.0 CONCEPTS: A CASE STUDY

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INTRODUCTION

This contribution describes a TU Wien teaching and research activity pertaining to the relationship between architectural design and Industry 4.0 concepts (such as intertwining ICT and production processes, digital modelling for prefabrication, etc.). Thereby, interdisciplinary student teams from the graduate programs Architecture and Building Science and Technology were given the task to develop and evaluate the performance of new façade solutions for the envelope retrofit of an existing building in Vienna. This building – situated in a prominent location at the Danube channel – can be considered to be a representative of reinforced concrete skeleton buildings of the 1950 – 1970 period. Buildings of this period, influenced in part by the rationalist paradigm, often provide good interior qualities. For instance, they display good daylight availability, given large window areas. Likewise, functional solutions benefit from simple configurations. However, other properties, such as the thermal performance of the original envelope, do not meet today's standards. Given the strict rectangular and repetitive forms of both ground plan and envelope, such buildings appear to be good candidates for the application of industry 4.0 concepts for retrofit planning, such as parametric design, rapid prototyping and individualized prefabrication of façade elements. The majority of design concepts developed by the students participating in the course adopted these ideas. In this contribution, we illustrate some of the retrofit concepts developed in the framework of this design course and discuss their connection to industry 4.0 principles.

THE CASE STUDY BUILDING

The case study building was designed by the architects Wörle and Doskar [1] and was completed in 1961. It is situated in Schwedenplatz within the city centre of Vienna and facing the Danube channel. Figure 1 shows the building (as of 2017) within its urban surroundings. The building possesses three street facades. It and features a ground floor area with commercial functions, plus nine upper floors with mixed office and residential usage.

Figure 1: Case Study building (taken from google earth –

RETROFIT IDEAS

Six different retrofit concepts were conceptualized in the first step of the course and subsequently subjected to an intensive and iterative review, evaluation, and development process. Thereby, different aspects were taken into consideration, including the aesthetic implications of the interventions, their compliance with building codes and standards, their general usability, construction time, and cost, as well as the thermal, visual and acoustical performance of the façade and the overall building. Some of the concepts integrated original approached, such as adding a moveable layer in front of the existing façade, or attaching a new façade in front of the existing one, prior to demolishing the older envelope layer (thus protecting the interior of the building from the outside elements in the course of building retrofit). Figure 2 illustrates these six concepts.

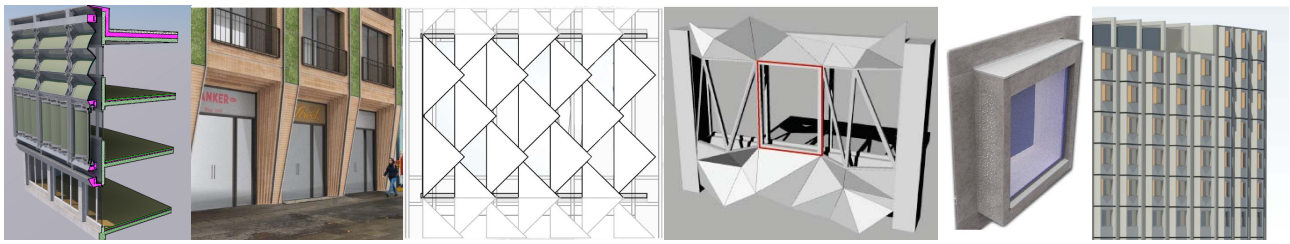

Figure 2: Six different concepts toward façade retrofit for the building at Schwedenplatz, Vienna

INDUSTRY 4.0 ASPECTS IN THE DIFFERENT RETROFIT CONCEPTS

The students were asked not only to provide the design of the new façade, but also consider aspects of building construction, building performance, and construction time. The latter is of crucial importance at the specific location of the selected building and its spatial constraints. Thus, all of the concepts employed factory prefabrication and rapid on-site-mounting. To achieve this, multiple issues had to be considered, including the module sizes (for transport), the mounting process, the interfaces of the modules to each other and the existing construction, as well as the requirements pertaining to the craftspeople involved in the mounting process. Some of the groups employed parametric concepts in their design. Toward this end, parameters such as shading properties and insulation were used as input data for digital and generative design processes. The resulting design vocabulary was then used to configure individual modules, adapted to the requirements of the target mounting position in the façade. Subsequently, the prefabrication process and the transport and mounting procedure were modelled. This approach allowed individualizing the façade modules without giving up the advantages of prefabrication.

RESULTS & CONCLUSION

All six façade designs were repeatedly subjected to a multidisciplinary review by different domain experts to identify strengths and potential weaknesses. Generally speaking, in all proposals, a theoretical decrease of the on-site construction time on site could be achieved as compared to traditional façade retrofit processes. It can be concluded that such design and construction processes, once established on a broad basis, has the potential to fundamentally change approaches to building and retrofit planning and corresponding construction processes. To validate the proposed approach, it would be of course necessary to apply it in a real world façade retrofit project involving building planning and construction professionals.

REFERENCES

[1] Wörle and Doskar (1961) – Design Plans of the residential/office building Schwedenplatz 2

[2] Google Earth (2018) - https://www.google.com/intl/de/earth/