Transformation of architectural heritage through adaptive modular systems

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1 INTRODUCTION

Most towns and places have their own character and identity, and the architectural heritage is often a carrier of this identity in local communities (Proshanky 1983). Many of these are today challenged by changes in demography and production, where the original buildings are abandoned in order to meet new needs within agriculture, industry and housing (Hansen 2013). The result is that the heritage buildings are in decay and demolished, while new more functional buildings are being built, leading to a loss of history and cultural heritage. A solution to this problem could be to promote adaptive reuse of the historic buildings, which will be both more sustainable and preserve a part of the place identity and history. This is both difficult and costly compared with building new, and it can seem more rational to demolish them and build new according to modern and industrialized construction methods.

The Aarhus School of Architecture entered into a partnership with Faaborg-Midtfyn Municipality to develop a method and conduct a pilot project. The task of the demonstration project is to develop and construct a housing project in an existing factory building from 1905 in the small Danish town Ryslinge, which will be able to compete with corresponding conventional housing construction.

2 METHOD

The first step of the method is to conduct an analysis and value assessment as a basis for the transformation project. This aims to highlight particularly valuable elements that should be protected during transformation, while showing where, in the building(s), there is the possibility of intervening with major transformations without detracting from the overall architectural and cultural value of the building(s).

The next step is to produce a data set that holds detailed and concise information about the existing architecture and where it is possible to extract geometric information for the project development in an easy way. A 3D laser scanning of the entire building is carried out, producing a 3D point cloud that can be used as a source of precise information where specific parts are extracted.

As part of choosing a transformation strategy, ways for implementing a modular principle are analyzed. Digital fabrication technologies give the opportunity for customized production and adaptation to an existing building. Joined with a modular system, the new technological tools can be used for a more economical and sustainable adaptive transformation of the architectural heritage. The module can be seen as either a spatial room-size module or a wall. We have developed a strategy for implementing a wall module in existing buildings, where the periphery is fabricated with CNC-milling to make a precise connection to the existing building tissue. The center of the wall is made of standard size wall modules, thereby limiting the number of customized components to a minimum.

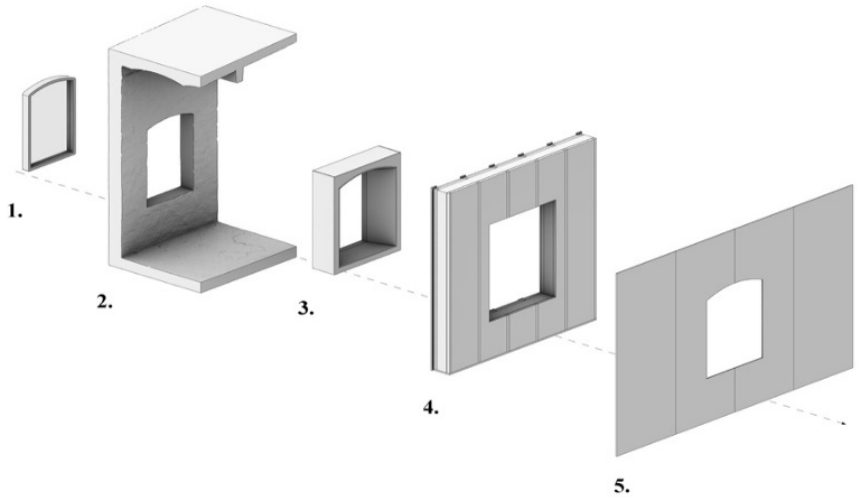

Figure 1. 1. New window, 2. 3D scan of existing wall, 3. Bespoke Digichalk module, 4. New woodfibre backwall, 5. New internal cladding.

3 CASE

A factory building that only recently had lost its original function as part of *Fabers Fabrikker* should be transformed into an affordable housing complex containing five different size apartments. To make the apartments accessible and to get access to fresh air and sunlight, it was essential to connect the independent structures with the existing building complex around windows and doors. These connecting modules had to adapt geometrically to both the old building on the outside and the rigid new structure on the inside, as shown in Figure 1. To achieve the necessary precision without having to rely on expensive manual labor time on site, a digital workflow was developed to parametrically design and digitally fabricate the modules that connect the existing building and the new structures as singular bespoke pieces.

4 CONCLUSION

Even though the laser scanning allows detailed design decisions at an early stage, which permits a precise implementation, the project showed that the increased amount of data required being able to do so turned out to be a big hurdle for some of the collaborating parties. The modular strategy requires a certain digital know-how, which currently cannot be presumed, as well as a highly digitalized industrial manufacturing partner.

The setup as an interdisciplinary demonstration project has been a challenge in terms of readiness for innovation both within the digital development of the system and the digital fabrication of the modules. However, as a completed building project the case demonstrates the possibility, to a certain extent, to implement the described method and digital technologies into the building industry and transformation of heritage buildings. In this project, modularity both refers to a modular building system of multiple identical pieces and a digital process and digital fabrication of bespoke individual modules. The methodology leads to a set of principles that can be used to determine the approach and modular system in the specific case.

REFERENCES

Hansen, J.Z, Stephensen, P. & Kristensen, J.B. (2013) *Modeling Household Formation and Housing Demand Forecasts*. Copenhagen: DREAM, Danish Rational Economic Agents Model, pp. 115-122.

Proshanky, H.M., Fabian, A., Kaminoff F. & Kaminoff, R. (1983) Place-identity: Physical world socialization of the self. *Journal of Environmental Psychology* 3, pp. 57-83.