CONTROLLED AUTO-ADJUSTMENT OF CONSTRUCTION DETAILS VIA BIM-ENVIRONMENTS AND PARAMETRIC MODELLING

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INTRODUCTION

Building Information Modelling (BIM) is commonly understood as a holistic approach to support the generation and management of digital (and semantically enriched) representations of physical and functional properties of (parts of) the built environment. As compared to conventional CAD (Computer-aided Design) environments, a fundamental feature (and a key advantage) of BIM applications is that the representations are modified and controlled via property settings, not via mere drafting-oriented geometric views (e.g., wireframe line models). However, BIM objects of constituting building parts, which are sorted in so-called families, possess only a limited set of degrees of freedom where and how they might be situated in a building representation. Adapting an object to a construction or installation context still has to be performed by a human user. It this context, it is important to realize that there are normative rules for many building constituents that might be integrated in BIM-environments via algorithms. The present contribution illustrates a case study pertaining to windows and their representations in a common BIM modelling tool. Thereby, the coupling of a parametric modelling environment with BIM is explored in view of an automated approach to context-responsive object attribute adjustment.

WINDOWS AND PARAMETRIC MODELING

As (transparent) parts of the building envelope, windows possess specific characteristics in terms of light and energy transmittance, operability, and thermal and acoustic characteristics. Moreover, in the timeframe and construction logistics of building envelopes, windows hold a special position: They interface to both building shell and to the interior construction. Thus, windows require special attention in the building planning process. In contemporary BIM tools, windows and their components come as families, and thus can be conveniently positioned within a BIM model. However, there is regularly a certain amount of manual adaptation work needed in the BIM-environment to fulfil the requirements of different standards pertaining to structural stability, thermal performance, thermal bridge mitigation, water proofing, user comfort and safety, and maintainability of the windows. In many cases, different windows in the same building share a number of attributes, but differ in others. Human planners are thus forced to check these components manually one by one, even if copy and paste or multi-copy routines exist. Changes in the properties often are caused by different window sizes and orientations. If families are not properly interlinked, it might be required to not only change the properties of a window, but also the characteristics of connected components, such as connected foils, dimensions of window sills, or water proofing components in the window/wall joint. As many of these changes follow standards (e.g., window frame dimensios, which are influenced by different window sizes), partial automation of the related processes could provide effective support for planners.

A PARAMETRIC MODELLING APPROACH

Many BIM and CAD environments offer support for parametric modelling plug-ins (e.g., Dynamo in case of REVIT). To facilitate (partially) automated window properties adjustment (and properties of adjacent components), it was required to first identify the properties that are prone to modification in case of a change of window size, orientation, or positioning. Thereby, the focus was on size-related property changes. In a second step, the dependencies of properties were identified and sketched. Subsequently, these dependencies were modelled in DYNAMO. These algorithms were then subjected to extensive testing. For any BIM model with window families, these algorithms can be connected to the basic model. The relevant workflow for planners is illustrated in Figure 1. Figure 2 illustrates the graphic overview of the dependencies in the DYNAMO-file.

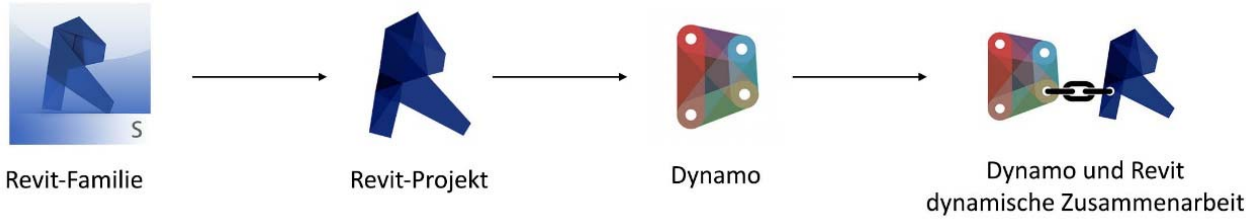

Figure 1: Principle workflow for planners to adopt the parametric change of routines regarding window properties in REVIT/DYNAMO.

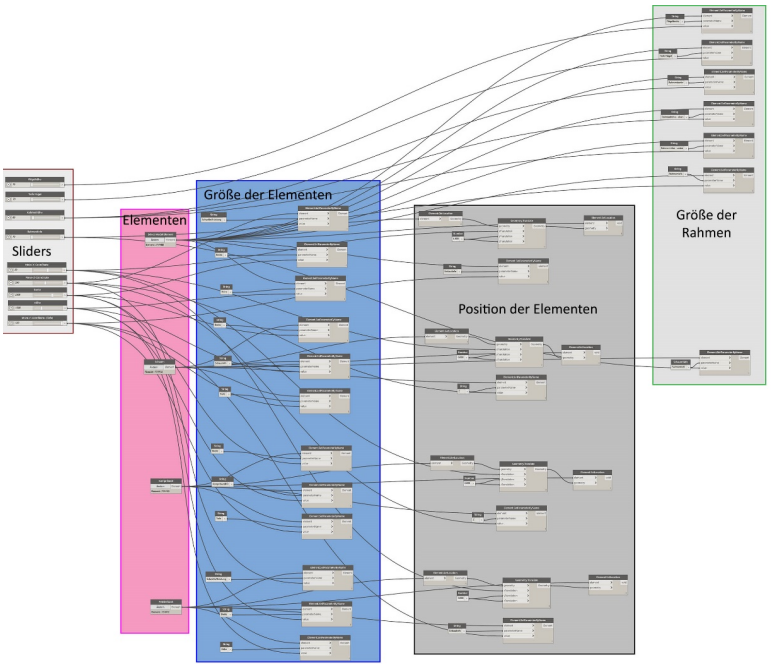

Figure 2: Dependency model in the DYNAMO environment (elements, size of elements, position of elements, size of frame properties).

CONCLUSION

The approach explained above represents an initial attempt to automate the cumbersome change management in BIM models as routinely experienced by the so-called BIM managers. Needless to say, it requires substantial additional work. Nonetheless, it illustrates the large potential of the coupling between BIM tools and parametric modelling environments as applied to the configuration of complex building components such as windows. The next steps include full-fledge modelling of typical window joints and usability testing with interested stakeholders and domain specialists.