INTERCOM 2.0: A web-based platform for collaborative design processes

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Abstract. Next to the advantages of consistent 3D planning, the Building Information Modeling (BIM) method also places new demands on the actors and thus primarily causes a change in the way of working. Against this background the paper discusses the development of the web-based BIM platform INTERCOM for collaborative planning processes in academia and AEC that enables monitoring, processing and assessment in a location and time independent environment. In addition to the technical advantages, a deeper, active and flexible discussion is intended to be created, involving all project partners. As such, INTERCOM is based on the openBIM idea and provides open access for all participants with a high degree of networking for solving complex planning tasks. The research showcases a further development of a previously implemented prototype and discusses the findings from the first academic projects, focussing on the collaborative workflow and the decision making throughout the design process.

Keywords: Building Information Modeling (BIM), Collaborative Design Process, Common Data Environment (CDE), Architecture Curriculum, Open Educational Resource (OER)

1 Introduction

Building Information Modeling (BIM) is a method that integrates diverse aspects around the design, construction and operation of an architecture and is based on the idea of a continuous use of digital building data models over the entire life cycle of a project. In this sense, BIM stands for a strategic approach that describes a process. The entire planning information of a building is organized in a central data set, which is accessed by all project participants in order to enter their contributions and coordinate them among themselves. The use of a common data environment (CDE) that is constantly synchronized, as well as the immediate availability of all current and relevant data, leads to a significant improvement in the exchange of information and, in the best case, to all-round coordinated and optimized planning before construction activities begin (Borrmann et al, 2018).

Most importantly, BIM causes a change in the way of working, especially in the cooperation with other project participants. With the increasing complexity of planning and construction processes, the creation of clear communication structures and joint exchange platforms between the various project participants (client, planners, construction companies, authorities) is becoming an increasingly important factor. Particularly in the context of growing spatially distributed collaboration, this aspect of interdisciplinary interaction and the integration of different planning contents is becoming the central point for the success of construction-related cooperation (Daniotti, 2020).

Even though the computer provides an effective interface for the collaboration of various participants involved in construction, the success of a project depends decisively on the socio-cultural imprints and disciplinary boundary conditions of the people acting. In addition to the technological challenges of digitization, the different working methods, requirements and objectives often represent an obstacle to the successful cooperation and execution of construction tasks. The purpose of BIM is therefore not primarily to introduce digital tools into one's own work process. For BIM to be successful, the way in which the players involved are organized on the one hand and the project structure on the other must adapt. This inevitably requires that the people involved get involved in this process and understand the associated "new culture of cooperation" as an added value.

Figure 1. Conceptual diagram of the INTERCOM platform

Against this background, the development of the INTERCOM platform aims to provide a web-based infrastructure that enables all those involved in the planning process to exchange information independently of time and location. The core of the web-based platform is an open source application consisting of a fully modular software architecture. This enables different expansion stages and a demand-oriented configuration of the collaboration platform. Interaction with the model and exchange with other project participants takes place via an avatar presence in real time. In addition to the real-time representation of the current planning status via an IFC model viewer, various communication tools such as a model-related live chat, screenshot and comment functions as well as eLearning formats are provided. The collaborative platform should enable monitoring, processing and assessment in an interdisciplinary learning environment that is equally available to all participants. In addition to the technical advantages, a deeper, active and flexible discussion is intended throughout the progress of the project.

2 Methodology

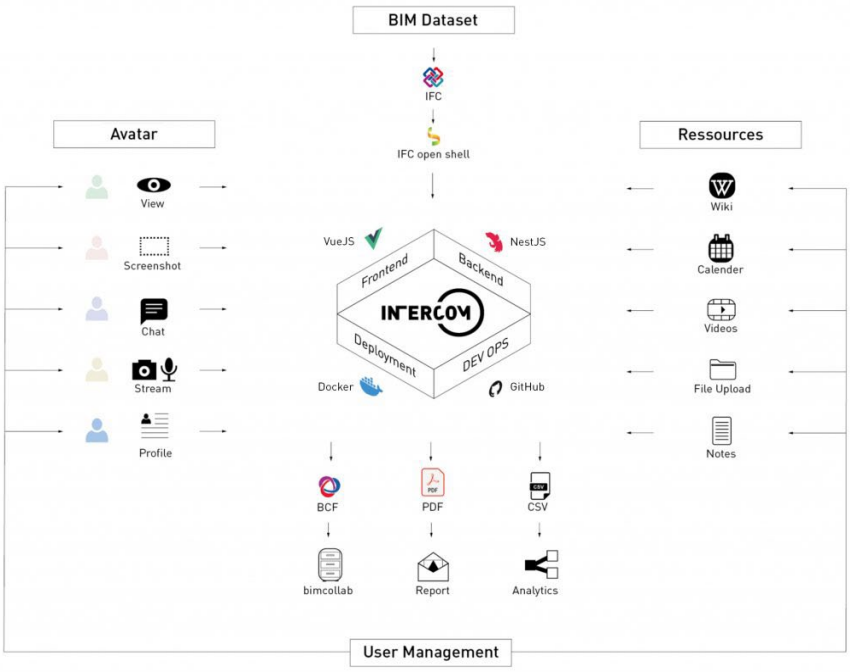

Figure 2. Technical architecture / system environment of the web-based platform.

The research showcases a further development of a previously implemented prototype that was realized based on the Unreal Engine (Edward, 2015). During the development of this first prototype it became apparent that the integration of communication technology (e.g. chat, tutorials, eLearning modules) had become increasingly difficult. Moreover, the scalability of the platform and modular extension had been quite limited (Hemmerling et.al, 2020). Since the communication and interlinking modules of the INTERCOM platform are essentially core web technologies, a move to an entirely web-based version form the starting point of the research presented in this paper.

The project is based on the openBIM idea and is intended to provide open access for all participants with a high degree of networking for solving complex planning tasks. The core of the web-based platform is an open source application consisting of a fully modular software architecture. This enables different expansion stages and a demand-oriented configuration of the platform. Interaction with the model and exchange with other project participants takes place via an avatar presence in real time – similar to a video game. In INTERCOM it is possible to meet with other project participants directly on the digital model. In this way, questions can be discussed very specifically and visually supported in real time and decisions can be made together. The option to take the point of view of other participants who are in the scene supports the interaction in the team and also promotes a common understanding of the project. A model-related chat with a screenshot and comment function supports direct exchange within the team. In addition, an integrated issue management, including BCF-interface (BIM Collaboration Format) and various eLearning modules complete the collaboration platform.

In architectural design we are dealing with a complexity, which can be characterized, according to Rittel and Webber (1973), as a series of wicked problems. The nature of these problems is based on a non-linear process, which is unique for each project and doesn't follow a well-described solution path. Hence, the decision-making process is hard to cope with, as there are multiple solutions, depending on the various interests and points of view of the stakeholders involved. In order to manage this kind of complexity collaborative approaches are key to arrive at a design solution, where the different perspectives are negotiated in open source and open-ended feedback loops where every output generates an input for the next step to improve, re-appropriate and reshape the design. A similar approach of iterative reflection has been proposed by Donald Schön (1983), focusing on a continuous conversation, confronting the designer's idea with others.

On this basis, a teaching format (Case Study – Borneo Sporenburg) was conceived that combines the development of an own design idea with a collaborative approach and requires as such an intensive exchange with other planning participants. The aim was to establish a working context that allows for the creation of collective knowledge in an environment of reciprocal support. In addition to the technological constraints (different proprietary software and CDEs) and the use of the newly developed INTERCOM platform, the focus was placed on the decision-making process and the associated design coordination

between the poles of "unity" and "difference". Or to put it another way: How much individuality can be mapped in a participatory and collaborative design process and vice versa? Referring to this question the following three operational levels were considered in parallel during the course of the project, evaluating their interdependencies:

- Individual design approach.
- Collaboration with direct neighbors and the overall urban context
- Decision making, communication and data exchange

3 Case Study - Borneo Sporenburg

The Borneo Sporenburg site, two peninsulas in the eastern part of the Amsterdam docks, served as an urban context to establish the desired collaborative design process. The masterplan tied together two seemingly opposing ideas. On the one hand the potential of the largescale dockland area was to be exploited for water-related activities, on the other hand the brief called for 2500 low-rise dwelling units, with a density of 100 units per hectare. Taking these points of departure presented a fascinating and unique opportunity for an urban experiment. West 8 sought the solution in developing a new typology of three-storey, ground-accessed houses deviating from the usual terraced house in being strongly oriented to the private realm, in this case by incorporating patios and roof gardens (Machado, 2006).

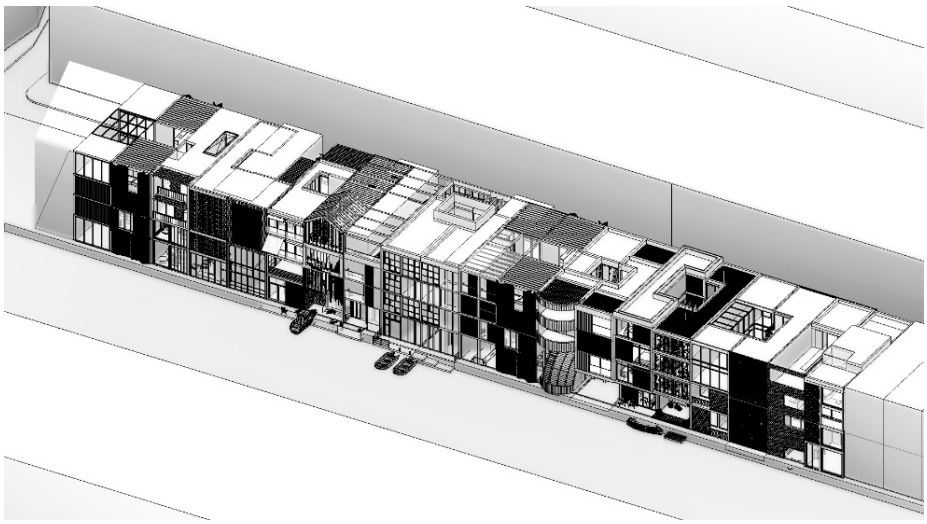

Figure 3. Collaborative design for the Borneo Sporenburg site (CDE).

The design task for the students demanded the development of individual houses for the peninsula within the pre-defined framework and design rules given by the West 8 masterplan. The participants of the course were supposed to carry out individual architectural designs for each single row house, as an integral part of the entire waterfront. An important aspect of the process was the coordination of each individual design with the adjacent canal houses and the urban context. The coordination and design decision making within the overall composition was organized via the INTERCOM platform.

At the beginning of the course, the participants' objectives and initial ideas were discussed in a design thinking workshop and agreed upon in the group. In addition, binding project goals (including a mix of functions, sustainability goals) and common planning principles (e.g. a uniform planning grid) were defined for further work. Throughout the course of the semester, meetings in presence alternated with video conferences and hybrid teaching formats, in which the design development was coordinated both in the entire group and in smaller teams. The INTERCOM platform was used in the process mainly to bring about and document the design decisions. It was essentially used outside the course itself to conduct asynchronous (time- and location-independent) coordination and to make the project evolution and outcomes visible to all participants in the planning process.

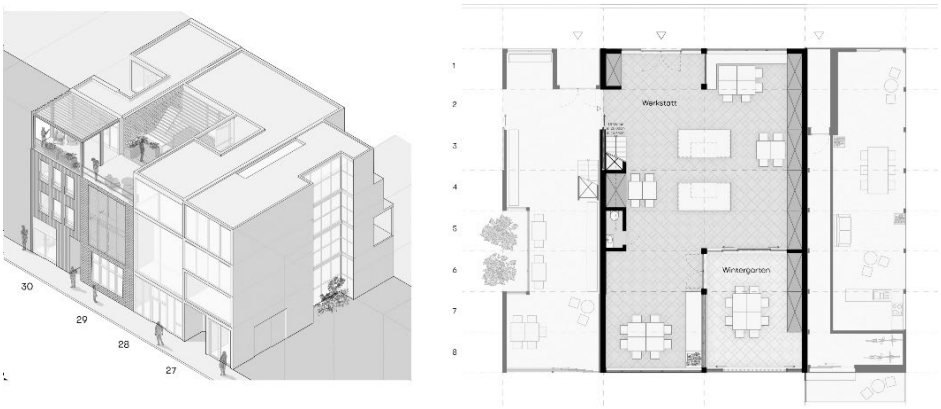

Figure 4. Example of adjacent houses with individual and common design features.

It should be noted that groups of two to three students formed quite quickly to move forward together on the design development. Coordination with the other adjacent properties then took place in a second planning step, so that there are stronger and weaker links within the overall urban design. This clustering can be clearly observed and is particularly prominent in the formation of atriums, programmatic definition of use, and façade design. Beyond that, however, there are design and content connections that establish a relationship between the designs across several plots. The resulting density of content and diversity of design within a common framework of action can be understood as a reflection

of the aforementioned complexity. In this respect, the process certainly represents the greater findings compared to the design results.

4 Results

Due to the fact that a large variety of authoring software was used for the planning of the respective houses, the challenge in the coordination, apart from the discussion of the design content, was mainly the data exchange and the synchronization of the individual models. Thus, bilateral interfaces between the programs were tested as well as the IFC interface in order to be able to view the individual buildings in entire and neighbouring context. The IFC export/import to the INTERCOM platform worked without any problems, only the positioning of the buildings in relation to each other had to be partially corrected due to the different positioning in the coordinate system of the authoring software. The majority of the students worked with Autodesk Revit and were able to use the CDE cloud service BIM360 for the synchronization of the models without any problems. Models created other programs (e.g. Archicad, Vectorworks, Rhinoceros, Nemetschek Allplan) were loaded into BIM360 via bilateral interfaces or IFC import. Although this worked in different ways for all models in the end, the BIM360 platform was hardly used for decision making and exchange in the group due to the lack of communication and interaction tools.

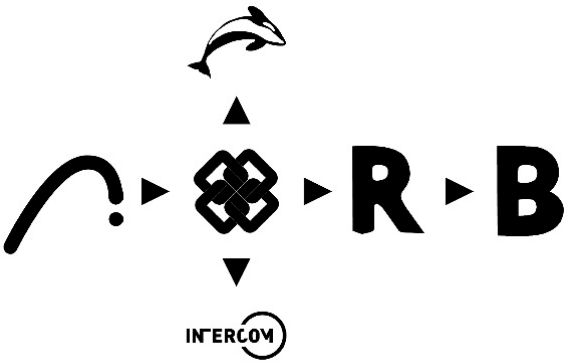

Figure 5. Work- and data flow example:
From Archicad via IFC to INTERCOM, Revit/BIM360 and Orca.

In addition to the INTERCOM platform, other media and formats were used for coordination in the process (messenger services, video conferences, break-out sessions, telephone). Direct exchange and face-to-face workshops at the university also contributed significantly to the success of the project. In this respect, the web-based collaboration platform is currently still to be seen as a supplement and not as a replacement for existing communication systems.

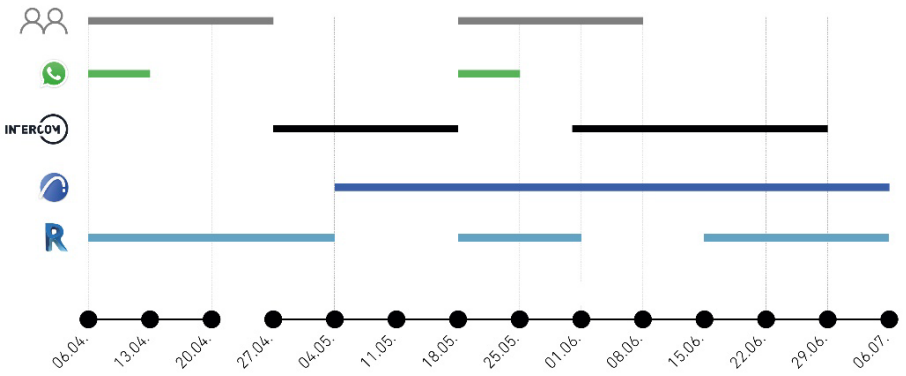

Figure 6. Example of a time-based use of communication and planning tools.

A Questionnaire that was conducted by the participants every week during the semester showed that the platform was appreciated as an added value for the collaboration and the design decision process from the beginning on. The basic modules of the platform that were used most included the IFC model navigation, the chat and screenshot function as well as the Avatar option. In INTERCOM it was made possible to meet with other project participants directly on the digital model. In this way, questions were discussed very specifically and visually supported in real time. As an avatar, one could explore the model, similar to a video game, and view it from different angles. The option to take the point of view of other participants who are in the scene supported the interaction in the team and also promoted a common understanding of the project.

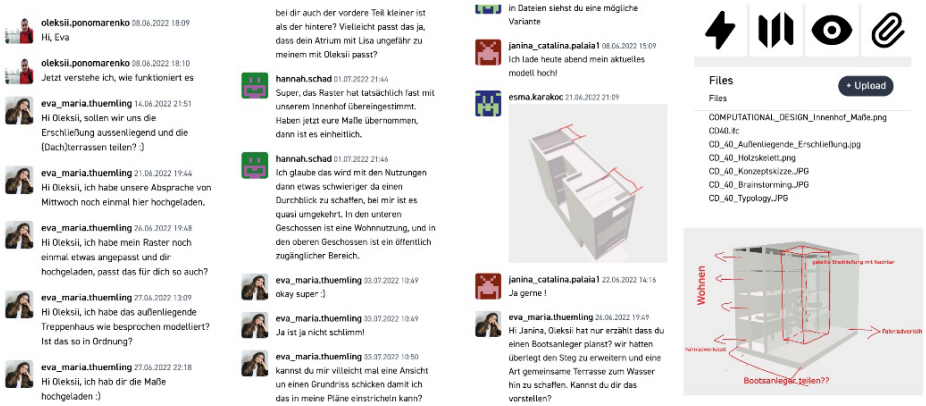

Figure 7. Example of design coordination using chat, screenshot and file documentation within the INTERCOM platform.

So far, the platform was mainly perceived as a pinboard that documents design decisions and the project evolution. Amongst the desired functions a group chat, push messaging as well as an audio and video streaming were mentioned to improve the functionality and interactivity level of the platform. Extensions, such as the BCF interface, the issue management as well as the knowledge database and the extension towards eLearning modules (Tutorials, MOOCS etc.) are intended to be implement in the next development phase as well.

Figure 8. INTERCOM platform with IFC viewer, avatars, project chat and screenshot function.

5 Discussion

Professional orientation and motivating support form the basis for the students' learning success. Phases of trying out, repeating and practicing as well as reflecting, discussing and evaluating alternate in the learning process. Different methods of teaching and the use of various media modules enable broad access to the content and are intended to meet the needs of different learning types. The profile of this teaching innovation is therefore characterized by conveying a comprehensive approach to solving complex planning tasks with a high degree of networking.

An essential prerequisite for the success of the teaching innovation is the willingness of all participants to engage in a comprehensive process change. Working on a shared data set in the cloud requires not only technical training but also, indispensably, the teaching of a different social approach - from "I" to "We". The INTERCOM platform offers the appropriate learning space for this, which promotes exchange by defining a common action space for all participants from the very beginning. However, the success of the whole depends on the contribution of each individual. This applies to students as well as to lecturers. In the best case, this creates a conscious sense of community

and responsibility among all participants, which makes a decisive contribution to the success of the project and to learning success.

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