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INTERDISCIPLINARY, BIM-SUPPORTED PLANNING PROCESS

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Abstract

Along with the rising technical capabilities of modern BIM applications, the performance requirements on interdisciplinary data and information exchange interfaces increase drastically. The planning practice reality demonstrated a number of upcoming problems with BIM implementation on technical- (heterogeneous data, interfaces, large data volumes) but even more so on process-level (question of responsibilities and work-load distribution, lacking standards or conventions on building-representation).

This paper will present the first results of exploratory research carried out at Vienna University of Technology in cooperation with seven BIM vendors and market-leading software developers. Project aim is to evaluate the practical suitability of interdisciplinary data exchange interfaces and -methods offered by the current BIM tools and to point out preferable BIM-software combinations at the current state of development to potential users. Also, insights are aimed to be gained on an optimal way of modeling building elements within an interdisciplinary context.

Simulating a BIM-supported planning process with students of architecture, structural engineering and building physics, the students were assigned to design a sustainable office building in interdisciplinary teamwork. Architectural, structural and ventilation models had to be created as well as an energy certificate and thermal and structural simulations. Each student group was assigned to work in a different, pre-defined software constellation and thus forced to handle interdisciplinary data exchange through the given interfaces. Thereby the data on technical issues (interoperability, usability) and process-related issues (efficiency, communication and coordination effort) were collected by the means of protocols and time-sheets.

Evaluating both the primary BIM data and the according process documentation produced by the student groups, first findings are that an integrated, BIM-supported planning process in a heterogeneous software environment remains a big challenge due to interface limitations, regardless of which software constellation is chosen. Anyhow, first improvement solutions concerning both modeling conventions and technical interfaces have been identified.

Keywords: Open BIM, Collaboration, Integrated Planning, Exploratory Research, Experiment

1. INTRODUCTION

With upcoming requirements for sustainable buildings, the need for more integrated planning practice, which would enable simultaneous collaboration of various disciplines in order to share and create new common knowledge, arises. BIM (Building Information Modeling) has often been recognized by research and practice as a suitable tool for support of collaborative planning, facilitating communication and information exchange between diverse planning process participants; and eventually to leading to maximization of efficiency- and quality and reducing time effort (Sebastian and van Berlo, 2011). Especially promising seems BIM in terms of life-cycle oriented planning and optimization. BIM is largely understood as object-oriented digital representation of a building or built environment that enables interoperability and data-exchange in digital form (Kiviniemi et al 2008). In this context BIM addresses primarily the process of model-building and information exchange (Succar, 2007). BIM is believed to bear large potential towards integrated design (Prins and Owen, 2010) inducing a shift from AFC fragmented practice that still largely dominates the AFC industry (Fellows and Liu 2010). Rekkola et al (2010) argue that "integrated design" is still handled rather loosely in the practice – often is the creation of BIM model sufficient for the project to be referred to as "integrated project", regardless of actual interdisciplinary data sharing and model use. BIM, in our understanding, is much more about how (design of design process), that about what (building model and its properties).

Since the AEC industry is project-oriented, the small markets are characterized by high fluctuation of the employees and of the related know-how loss. Owen et al (2010) point out the need for enhancement of skills of project members, which are often highly specialized in own fields of expertise, but seldom trained to work in integrated project environment. The organizations also seldom support this kind of professional development. The introduction of the new BIM-tools therefore mostly means more than simple CAD-tools shift, since the adoption is mostly related to the reorganization of the processes and management strategy of the project-based organization.

In the practical BIM operation and use a number of problems on different levels can be met. On the technological level the questions of the interfaces in the data transfer of the interdisciplinary models arises, as well as of the heterogeneous data-structure of the different software the art of model building and management of ever larger data-volumes. On the semantic level, it can be noticed that each discipline needs individual information; the professional languages differ strongly as well as the means and methods to represent a building (Bazjanac and Kiviniemi, 2007). The spectrum reaches from diverse lists for project management and quantity surveys, over reduced slab model for structural engineering for earthquake simulation, to complete spatial representation of architectural model in the full geometric complexity.

The optimal management, filtering and reliable synchronization of these very differentiated information in the context of in the building industry still dominant heterogeneous software-structure requires high effort in organization, administration interdisciplinary communication and know-how. A standard solution offering the complete software package for this large spectrum does not yet exist, and it is a question if such solution is viable for every building and consequently every design process is of prototypic nature.

The high fragmentation of the design and construction process disables the management of complexity the linear planning process of highly specialized disciplines proves as not suitable for the achievement of sustainable buildings. The necessity for change in the way the buildings are designed, constructed and operated is being continually reported by the practice. The emerging of highly developed BIM tools together with maturing of promise a paradigm change from the linear, fragmented process towards more integrated practice that would not only bring benefits for the planning and construction but even more so for the optimization of operation. A life-cycle oriented approach brings whole-life value enabling knowledge management and -transfer form life-cycle phase to phase and integrating building services and automation systems (Owen et al, 2010).

The BIM-based software-packages that would fully support and enhance the integrated, interdisciplinary planning practice and holistic life-cycle oriented data integration are still rather seldom. One-stop architecture and structural engineering, MEP (mechanical and electrical engineering), energy optimization, cost- and life cycle cost calculation are not available for the needs of central European planning practice and building policy. Caused by the different project-constellations and mostly changing project-stakeholders with each new project, new combinations of software tools are to be met with each new project.

For a successful implementation life-cycle oriented planning and management strategies, enabling smooth data exchange without information losses, standing in close relation with further development of open formats for data-exchange is a pre-requisite.

The BIM research was mainly focused on the problem-solving of the software-interoperability and efficient data exchange, only recently has the academic community realized that the successful BIM-adoption towards more integrated design and delivery is not only related to the handling of technical, but even more over so of the issues related to the need for the re-organization of the design process itself (Succar, 2010, Pentilää 2008). This relates to the inter-organizational organization and standardization of the work-flows, role descriptions and related responsibilities of the stakeholders, as well as to the general commitment towards collaborative planning attitude. Rekkola et al (2010) argue the lack of knowledge beyond technological issues, in domain of workflow and business practices, where actual benefit of BIM is. In their case study of university building project, they identified problems and benefits of BIM-supported integrated process by creating categories: people (competence or knowledge problem), process (work-flows, timing, contracts, roles) and technology (software). They argue that a) for enhanced integrative practice a participative process is necessary and b) that the slow BIM-adoption in the practice is caused by the difficulty of interrelation (triangulation) of the people-process-technology problems.

Therefore, the greatest challenge either for holistic concepts such as Building Life-cycle Management (BLCM) (von Both, 2011) or Integrated Design and Delivery Solutions (IDDS) Modell (Prins, Owen, 2010), remain with the people (planning process stakeholder) and process – the process of model building of an integrated, interdisciplinary building model requires close cooperation and coordination of the planners, contractors, industry and facility managers, a high level skilled project team as well as detailed conventions on inter-organizational level (Sachs et al, 2010; Plume and Mitchell 2007; Arayici et al 2011).

2. EMPIRICAL RESEARCH THROUGH EXPERIMENT

The experiment is a part of an on-going research project "BIM-Sustain: Process Optimization for BIM-supported Sustainable Design", involving three institutes of Vienna University of Technology and seven BIM-software vendors. This interdisciplinary collaboration of academy and industry enables development of customized strategic concepts for the individual BIM-settings within multi-disciplinary planning environment. The final aim of the project is the development of a framework for BIM-supported planning process (conventions for efficient data-exchange, recommendations for the software vendors in terms of interoperability improvement, recommendations for practitioners for the design of BIM-supported design process), serving as road-map for the standardization process at Austrian Standardization Institute. Through exploratory research – an experiment within an interdisciplinary design class involving 40 students, the collaborative, multi-disciplinary BIM-supported planning for an energy-efficient office building is simulated. The multi-disciplinary teams consisting of architect, structural engineer and building physicist (BS) were formed by the means of a pre-questionnaire, which questioned skill-level, experience and preference of the software. Upon the results of questionnaire, a matrix of software-combinations used by each team was compiled (Table 1).

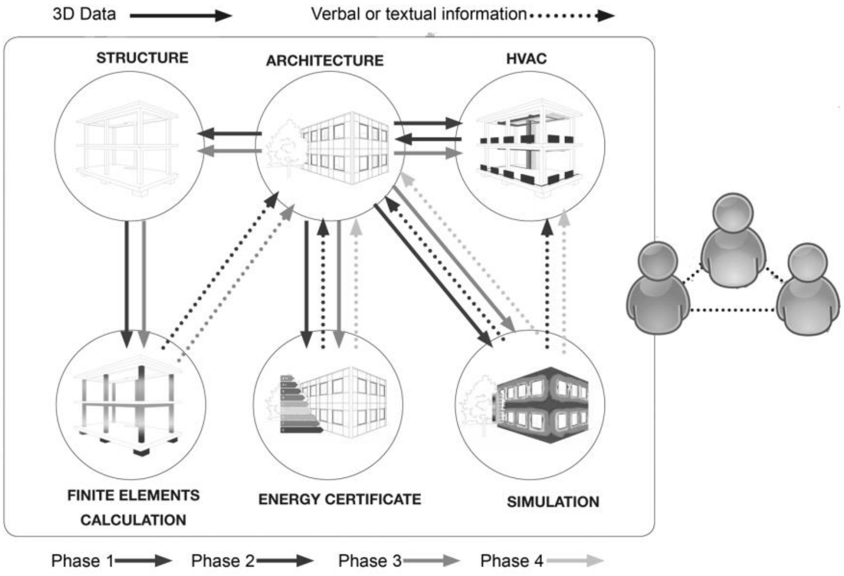
#	Architect	Structural Engineer		Building Science (Simulation in TAS)	
	CAD	CAD	FEM	CAD	Calculation
1	Allplan	Allplan	Scia Engineer	Allplan	Allplan
2	Revit	Revit	Sofistik	Revit	Plancal
3	ArchiCAD	Tekla	Dlubal RFEM	Plancal	Plancal
4	ArchiCAD	Allplan	Dlubal RFEM	Plancal	Plancal
5	Revit	Allplan	Scia Engineer	Plancal	Plancal
6	ArchiCAD	Allplan	Dlubal RFEM	Revit	Plancal
7	Allplan	Tekla	Sofistik	Revit	Plancal
8	Revit	Tekla	Scia Engineer	Allplan	Allplan
9	ArchiCAD	Revit	Dlubal RFEM	Plancal	Plancal
10	ArchiCAD	Allplan, Tekla	Dlubal RFEM	Revit	Plancal
11	ArchiCAD	Tekla	Sofistik	Revit	Plancal

Table 1: Software Constellation within the student groups

In the course of the experiment (design class) basically two work-flow models can be identified: One-Platform BIM (proprietary) and Open-Platform BIM.

The Open-Platform BIM (Fig. 1, Groups 3-11) uses different, for each discipline relevant (typical, custom) software and works with central architectural building model, exchanging the data using the IFC. The One-Platform BIM (Fig. 1, Groups 1 und 2) work with one software family Nemetschek Allplan (2012) or Autodesk Revit (2012) using proprietary standard.

The teams are producing the architectural-, structural, thermal and ventilation (as representative of MEP) models, as well as thermal simulation and energy certificate in collaborative manner. The groups were given an assignment consisting of a functional program, site-plan with orientation and set origin, layer-structure and color scheme for latter room-stamps. The time-schedule of the design-class is strictly organized, the experiment is taking place for one semester. We have organized three presentations, where in the first one the architectural model is presented, in the second presentation the structural and thermal and in the final presentation the optimized, full model containing all the information. Between the presentations the crits as well as tutorials provided by software vendors are taking place. The experiment is examining the efficiency of the two BIM-models, communication effort, and work-allocation (work-flows) as well as satisfaction and conflict levels. Through the mandatory protocols and time-sheets the problems related to the technology (data transfer inconsistencies or losses, semantics) but also to the process-people related problems (conflicts, communicational difficulties, lack of work-flow definitions or responsibilities etc.) can be tracked. Additionally an e-learning platform has been set up, with a forum for tutor feedback as well as for student-communication, scheduling and posting of tasks is taking place.



3. FIRST FINDINGS

Here comes the rest of the sections. The full paper should be minimum 6, maximum 10 pages long.

All tables and figures should be referred to in the text. The figures have to be inserted in .jpg format.

Table 1: Title

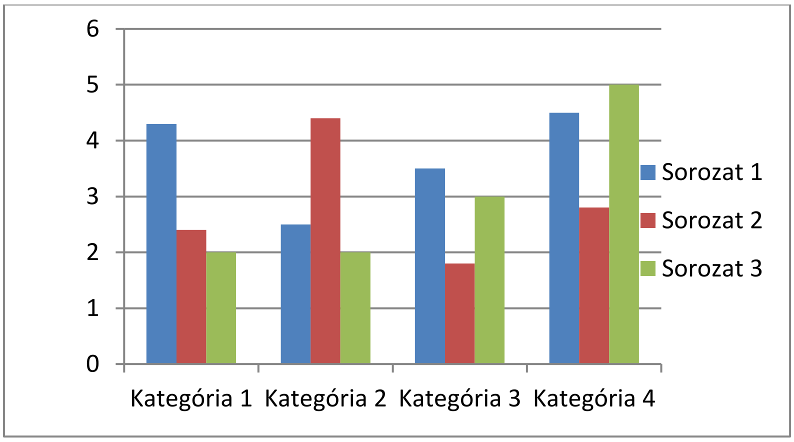


Figure 1: Title

3. CONCLUSIONS

Here comes the conclusion of the paper.

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