Interdisciplinary Planning and Building in a BIM-oriented Manner

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Abstract: As part of a project for the further development of digital teaching, a 'BIM simulation' is being developed for integrative planning in a BIM-oriented manner. This enables students to understand the complex interrelationships of interdisciplinary planning processes. In this way, they learn about the advantages of BIM working methods and modern digital techniques and tools through 'learning by doing'. For the 'BIM simulation', planning principles and BIM models of building construction and open space were developed based on a construction project that is being realized on campus. The basis is the development of teaching modules along the BIM process chain. These were tested using a pilot teaching project. Students from different bachelor's programs worked together in an interdisciplinary way – with great commitment. Together, they developed an integrated 3D model and presented it visually. The results are available in the form of images and videos on the project homepage.

Keywords: Building Information Modeling, BIM, landscape architecture, interdisciplinary, planning

1 Introduction

Building Information Modeling (BIM) is an integrated planning and management method that covers the entire life cycle of buildings. It is characterized by close interdisciplinary collaboration based on a common semantic 3D model (BORRMANN et al. 2018). In Germany, the new planning method BIM is promoted and advanced by initiatives of the German government. The aim is to increase the productivity of the entire value chain of planning, construction, and operation. In building and infrastructure construction, BIM is already largely established. Since 2020, infrastructure projects with a construction sum of 5 million euros or more are required to be executed using BIM (BMI 2021, BMVI 2021).

Landscape architecture is still at the beginning of this development, but here, too, BIM is becoming increasingly important in the course of digitalization of construction (SHILTON 2018, BRÜCKNER et al. 2018, BRÜCKNER & REMY 2021). This process is changing the demand of the job market for landscape architecture graduates. In the future, the requirements for digital transformation training at universities will go far beyond software training. It is about networked working and thinking.

2 Project 'Open Space Planning Digital'

The Landscape Architecture department at Osnabrück University of Applied Sciences is addressing these challenges in the further development of its study programs. Support is provided by the funding program 'Quality Plus – Program for Good Teaching' of the Lower Saxony Ministry of Science and Culture with the project 'Freiraumplanung digital' ('Open space planning digital') over a period of 3 years from June 2019 to June 2022 (see Project Homepage, HOCHSCHULE OSNABRÜCK 2022).

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The six study programs of the study area reflect the entire process chain of the BIM life cycle with their different focal points (open space, landscape, building, construction operation). The aim of 'Freiraumplanung digital' is to strengthen and further develop the students' competences regarding new digital technologies and BIM, and to anchor corresponding teaching content in the curriculum of the degree programs. Along the BIM process chain, new teaching modules on digital technologies and planning tools are being developed and prepared for teaching (Fig. 1).

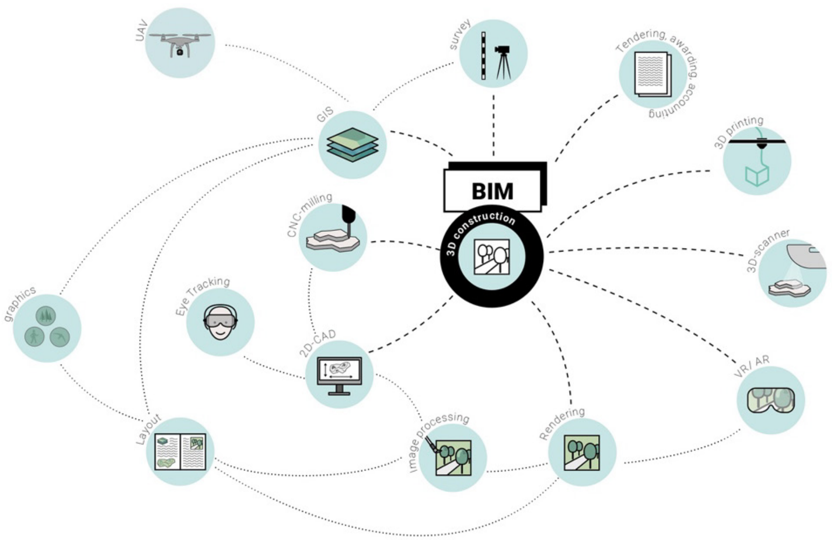

Fig. 1: Teaching modules on digital technologies and planning tools along the BIM process chain

The focus is on a cross-course integrated project 'BIM simulation'. Under the term 'simulation game' there is an inhomogeneous collection of different approaches and overlapping definitions of the term. In this context, it is understood to mean a non-computer-based learning game of the 'field' type (after LEAN et al. 2006). Simulations and games/role-plays are a form of experiential learning. When used as part of a course, they aim to mimic a system, entity, phenomenon, or process. They attempt to represent or predict aspects of the behavior of the problem or topic under study. Simulations can be used to conduct experiments in a fictitious situation to show real behavior and the results of possible conditions (UNIVERSITY OF TENNESSEE 2022). This is based on KOLB's (1984) theory of experiential learning. According to this theory, learning is most effective when it is directed and controlled by the learner and based on his or her own practical experience, i. e., when it has concrete meaning and significance for him or her. The chosen teaching approach thus supports active, interdisciplinary learning. The didactically sensible use of e-learning elements such as video recordings, teaching videos and e-assessment additionally contributes to the students' independence and motivation.

The project is based on a real construction project 'Research Center' on the campus, which is in the construction phase since December 2020. With the support of the Laboratory of Geoinformatics and Surveying, a drone survey of the project area was carried out as the basis for the digital terrain model. Other necessary basic data were supplied by the university's Department of Buildings and Technology. These were combined in the so-called existing facilities model as the data basis for the 'BIM simulation'. Both the planned building and an open space plan were implemented as semantic subject-specific BIM models and can be used in a variety of ways in future teaching projects. The digital teaching modules include, among others:

- The acquisition and processing of baseline data as part of the as-built survey, in particular the workflow from the point cloud (drone) to the terrain model.
- 3D visualization in the planning process using new digital technologies such as virtual and augmented reality.
- The workflow for converting a typical open space design into a BIM model is available as a self-learning program including e-learning elements.

Teaching modules represent so-called BIM use cases and are first developed individually and then combined as components of an overall BIM workflow. As a result, they are scalable, and can be used in different teaching/learning scenarios. They include introductions to the theoretical background knowledge, sample data and descriptions for the practical implementation of the workflows with common authoring software. The use of these materials is being tested in a pilot teaching project, which is presented below.

3 Pilot Teaching Project

3.1 Goals and Project Task

The project task is to develop an object planning across all courses of study. Starting with a design sketch, the students create a joint 3D geometrical model that is further developed into a 3D visualization. This represents the environment of the 'Research Center'. The open space planning includes paths, equipment items as well as areas for vegetation.

The participants are students from various bachelor's degree programs in the field of landscape architecture. There is no semester limit, students from the 2nd to 6th semester take part. Apart from basic 2D CAD drawing, no special digital knowledge is required for the course.

A fundamental goal is to promote the independent project-oriented work of the students. The teaching units described above are used for this purpose. Students receive a brief input on required basic knowledge. Various digital topics such as terrain modelling based on a 3D point cloud, immersive experience through virtual reality and the capture and scanning of real objects by a 3D handheld scanner are introduced. This is complemented by brief introductions to the software used.

Through independent practical project work with 3D modelling and 3D visualization software, the students are enabled to evaluate and classify these methods in comparison to conventional, analogue methods and to use them sensibly in the context of the respective task. The concrete task reduces the entry barrier when using digital tools. The examination of different interfaces and data formats is promoted.

Another overarching goal is to network the content-related references of the degree programs. The students do not learn to think solely in their familiar environment but must consider the views and working approaches of other disciplines and integrate them into their workflow.

This simulates the cooperation of the different trades in the planning and construction process.

3.2 Project Structure and Implementation

The one-week interdisciplinary course comprises five working days. It starts on Monday morning and ends on Friday afternoon with the final presentation.

A computer room at the university with the following equipment is used:

- Computer workstations,
- VR glasses,
- 3D hand scanner

The following software is used:

- 3D modelling tools: Autodesk AutoCAD, Autodesk Revit and SketchUp
- Coordination software Autodesk Navisworks
- 3D visualization tools: Enscape and Lumion
- Video editing Camtasia

Three thematic subgroups are formed, each containing students from different programs.

In the first step, a joint design sketch is created based on the planning of the different subgroups (see Fig. 2). The design sketch is then digitized into a 2D drawing. The digital design sketch serves the subgroups as a basis for their technical planning. The individual tasks for each group offer the opportunity for creative design.

Fig. 2: Development of the design sketch

The terrain model and the BIM model of the 'Research Center' are provided as a data basis. Building on this, the groups convert their planning topic into a geometric 3D model. These are finally combined into a common geometrical aligned 3D model. For joint planning, it is important that all subgroups use the same local coordinate system. For this purpose, the stored project base point of the 'Research Center' is assumed to be the origin for the partial plans. One person is designated as the BIM project coordinator. This person moderates the communication in the whole group and makes sure that the designs fit together with their coordinates and heights.

The thematic focuses of the subgroups are:

- Project Group Equipment (see Fig. 3)
  The project group is creating recreational areas with self-designed seating furniture. They are also planning shelters, platforms, a pond, and storage areas for bicycles.
- Project routing (see Fig. 4)
  The project group is developing the routing to and around the 'Research Center' as well as the car parking spaces. The challenge lies in adapting the different heights of the various path areas such as pavements and roads. This requires good coordination and agreement with the subgroups. The assumed heights had to be well agreed with the other groups, and the models had to be coordinated with each other.
- Atmospheric Design Project Group (see Fig. 5)
  The project group will place flowerbeds at different heights around the 'Research Center'. In addition, furnishings complement the atmospheric appearance. For this purpose, own ground spots and lanterns were constructed in 3D.

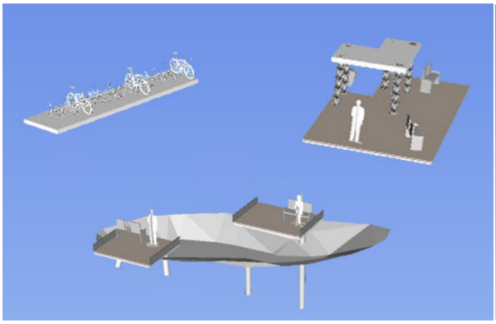

Fig. 3: Model Equipment

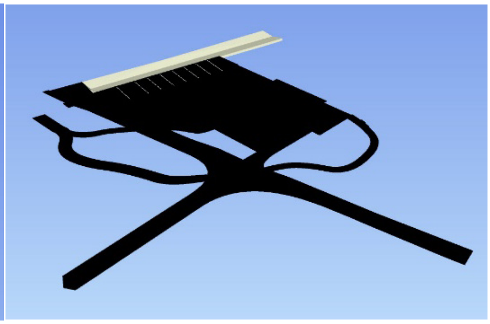

Fig. 4: Model routing

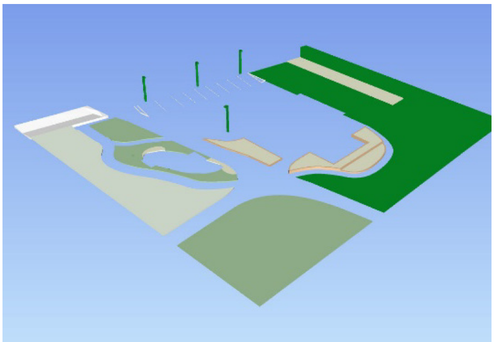

Fig. 5: Atmospheric design model

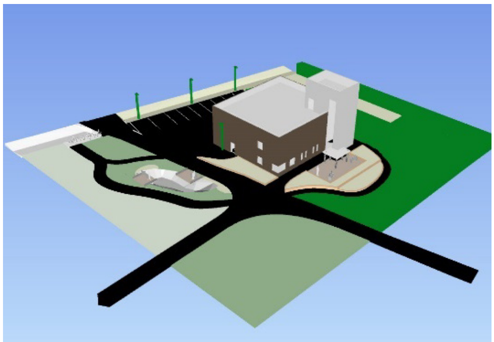

Fig. 6: Collaboration model

Merging in the Collaboration Model

All sub models are exported as IFC models and loaded into the coordination software. Here, the IFC format served only as an exchange format between the programs. An assignment to specific object class definitions is not relevant for the task and is not made. In this way, it is checked whether all planning contents required for further planning have been exported and transferred correctly. Afterwards, the partial models are merged, and a collision check is carried out (see Fig. 6).

After that, it is exported to the FBX file format. In addition, 3ds Max acts as an auxiliary program. By importing the FBX file and exporting it as a 3ds file, the design hierarchy for material assignment is preserved in the visualization software.

The project groups each visualize the overall model in their own style, resulting in three individual designs of the outdoor facility planning. The main visualization is done by the three groups with Lumion. In addition, the model is prepared in Enscape to enable viewing in VR glasses. The students create renderings from their models edited in the visualization software. Presentation videos are created from the generated images and videos. The entire workflow from sketch to visualization is shown in Figure 7.

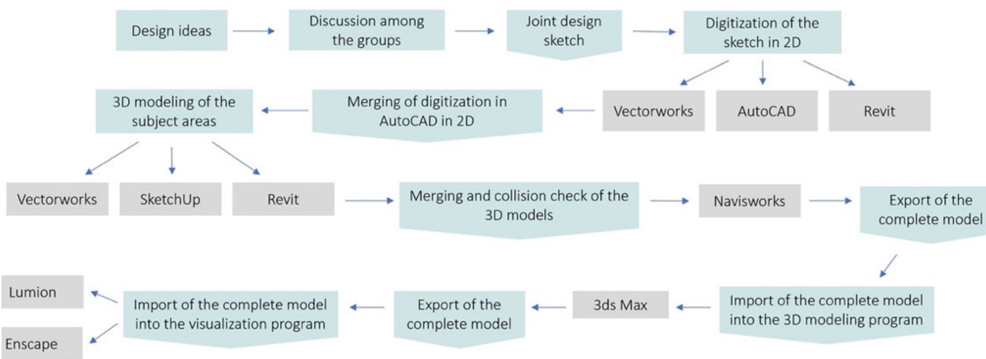

Fig. 7: Workflow for the development of the project results

3.3 Results

Presentation videos were created as the final examination guide. In an individual three-minute video, the groups summarize and present the workflows they followed, their experiences and the render results (see Figs. 8 and 9). The outcomes are available on the project homepage (HOCHSCHULE OSNABRÜCK 2022).

Fig. 8: Render result with Lumion group atmospheric design

Fig. 9: View of the 'Research Center' rendered with Enscape

In Order to assess the success of the course, an evaluation is carried out with the students at the end. The results of this survey are consistently positive. The evaluation includes general questions about the project structure and organization as well as questions about content-relate aspects and the assessment of learning success. The concern of overburdening the students with the abundance of new topics and programs was not confirmed. The level of requirement was appropriately chosen for the interdisciplinary course. According to the students' assessment, the concept of the interdisciplinary 'BIM simulation' was implemented successfully (see Fig. 10).

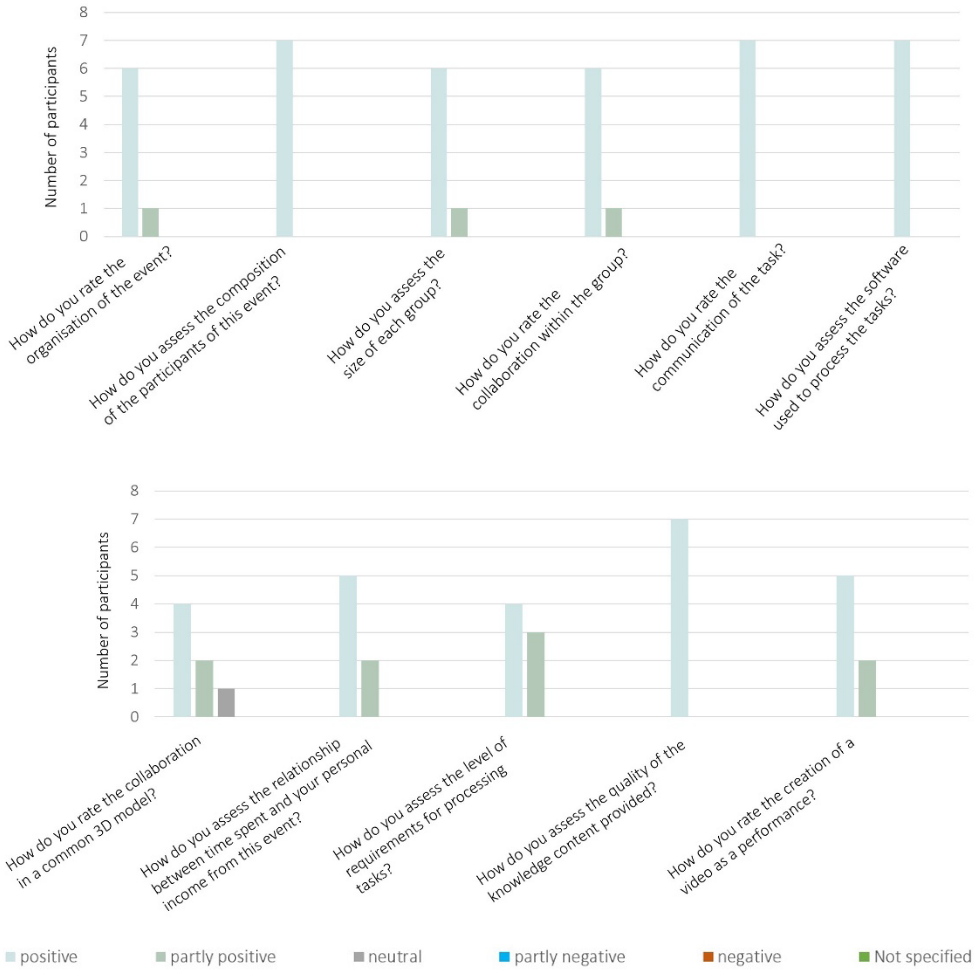

Fig. 10: Evaluation

4 Conclusion and Outlook

The advancing digitalization demands new teaching concepts also for landscape architecture. SOLNOSKY et al. reported already in 2010 about 'Integrated Design Courses Using BIM' for students with advanced BIM basic knowledge. PETSCHECK (2019, 2021) reports on Digital Grading Education as an access route to BIM in landscape architecture. A pilot teaching project on Mixed Reality is presented by FRICKER (2018) as part of a multidisciplinary research project 'Landscape in Transition'. A broader exchange on education in digital transformation would be desirable to mutually benefit from experiences.

There is great agreement about the benefits of simulation games also for higher education teaching (HOLZBAUR 2012, KAMPMANN & KNOCH 2015). However, their use is largely in the fields of 'business' (managing games) or in political education (BPP 2022). The results of the pilot project show that the approach is also very well suited for teaching integrated digital design and BIM in landscape architecture. Within only one week, the students learned to work in interdisciplinary teams in a BIM-oriented manner. They were confronted with various planning difficulties, which they solved independently. They know the basics and technical background of the modern digital tools used and can apply the methods for 3D modelling and visualization of terrain and planned open space. It became clear that the teaching concept promotes students to think outside the box to grow with new challenges. The concept enables the experience of the importance of constant and clear communication during the entire process. The concept of 'learning by doing' encourages students to find their solutions to efficiently solve problems arising in digital planning processes.

Parallel two course-specific BIM modules with the thematic orientations 'Landscape Architecture' and 'Civil Engineering' were expanded or redesigned. Here, too, the developed teaching modules could be used profitably. The integrated planning was successfully tested in the pilot project. This is going to be the basis for a more complex master module in which the integrated approach is pursued further across several courses.

References

BMI – BUNDESMINSTERIUM DES INNERN, FÜR BAU UND HEIMAT (2021), Masterplan BIM für Bundesbauten.

BMVI – BUNDESMISTERIUM FÜR VERKEHR UND DIGITALE INFRASTRUKTUR (2021), Masterplan für die Digitalisierung im Bundesfernstraßen-Bau.

BORRMANN, A., KÖNIG, M., KOCH, C. & BEETZ, J. (2018), Building Information Modeling: Why? What? How? In: BORRRMANN et al. (Ed.), Building Information Modeling – Technology Foundations and Industry Practice. Springer, Cham, Swizerland.

BPP – BUNDESZENTRALE FÜR POLITSCHE BILDUNG (2022): Planspiele. https://www.bpb.de/lernen/angebote/planspiele/.

BRÜCKNER, I., MAẞLING, N., WOZNIAK, M. & THIEME-HACK, M. (2019), How to Develop a BIM Workflow for Landscape Architecture – A Practical Approach. Journal of Digital Landscape Architecture, 4-2019, 122-130.

BRÜCKNER, I. & REMY, M. (2021), BIM Model Landscape_Open Spaces: An Approach for Landscape and Environmental Planning in Infrastructure Projects. Journal of Digital Landscape Architecture, 6-2021, 344-352.

FRICKER, P. (2018), The Real Virtual or Real Real: Entering Mixed Reality. Journal of Digital Landscape Architecture, 3-2018, 414-421.

HOCHSCHULE OSNABRÜCK (2022), Project Homepage Freiraumplanung digital. Qualität Plus in der Freiraumplanung – Curriculumsentwicklung vor dem Hintergrund der Digitalisierung in der Landschaftsarchitektur. https://www.hs-osnabrueck.de/qualitaet-plus-in-der-freiraumplanung/ (28.02.22).

HOLZBAUR, U. (2012), Spielend lernen – spielend lehren. Planspiele in der Hochschullehre. In: BERENDT, B. et al. (Ed.), Neues Handbuch Hochschullehre (Medieneinsatz Simulation D4.2). https://www.nhhl-bibliothek.de.

KAMPMANN, E. & KNOCH, J. (2015), Wir spielen Wissenschaft. In: BERENDT, B. et al.(Ed.), Neues Handbuch Hochschullehre (Medieneinsatz Simulation D4.3). https://www.nhhl-bibliothek.de.

KOLB, D. A. (1984), Experiential learning: Experience as the source of learning and development (Vol. 1). Prentice-Hall, Englewood Cliffs, NJ.

LEAN, J., MOIZER, J., TOWLER, M. & ABBEY, C. (2006), Simulations and Games: Use and Barriers in Higher Education. In: Active Learning in Higher Education, 11-2006, 227-242.

PETSCHEK, P. (2019), Digital Grading Education as an Access Road to BIM in Landscape Architecture. In: Landscape Architecture, Beijing Foretry University, Beijing, 8-12.

PETSCHEK, P (2021), Erfahrungen aus der Schweiz. BIM-Ausbildung an der OST Rappersvil. BIM in der Landschaftsarchitektur. Ed. FLL, Conference Proceedings FLL-Fachtagung BIM in der LA 14./15.9.21, 85-94.

SHILTON, M. (2018), Digital Futures – BIM in LANDSCAPE Design: A UK Perspective. Journal of Digital Landscape Architecture, 3-2018, 236-240.

SOLNOSKY, R., HOLLAND, R., PARFITT, M. K., PHILAK, M., POERSCHKE, U. & MESSNER, J. I. (2010), Integrated Design Courses Using BIM as the Technology Platform. EcoBuild America Conference. Pennsylvania State University, 2010.

UNIVERSITY OF TENNESSE KNOXVILLE (2022), Experience Learning. Teaching & Learning Innovation. https://experiencelearning.utk.edu/about/types/ (28.02.22).