BIM Education in Landscape Architecture: The Rapperswil Model

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Abstract: In 2016, Switzerland decided to embrace digitization in every industry, in all sectors, and at all levels. Within the Landscape Architecture program at the OST University of Applied Sciences, teaching and research with strong emphasis on Digital Construction had already been carried out for years. In view of the country's vigorous drive towards digitization and being the only bachelor's program in the German-speaking part of Switzerland, Rapperswil Landscape Architecture is committed to partake and to aid in this digitization process. The paper gives an overview of Digital Construction in Landscape Architecture education in Rapperswil, status 2022.

Keywords: Digital Construction, Building Information Modeling, BIM teaching, digital grading, rainwater management

1 Introduction

In the coming years, the construction industry worldwide will undergo digital transformation. Building Information Modeling (BIM) plays a central role with the digital twin and with a clearly defined process. The strategy of the Swiss Federal Council from 2016 for digital Switzerland (SCHWEIZERISCHE EIDGENOSSENSCHAFT 2016) and the establishment of the framework "Bauen Digital Schweiz – Digital Construction Switzerland", the country chapter of buildingSMART International, gave the Swiss construction industry a big boost in the direction of digitization The Swiss government even went one step further and defined a clear time frame. By 2025, Switzerland will implement the BIM process not only in architecture, but in all infrastructure construction projects. The Swiss Federal railway company Schweizerische Bundesbahnen (SBB), a government-owned company, must apply it in all projects by then. SBB is also a big player in real estate architecture projects where greenspaces are always required. Therefore, this is not only applicable to engineers, but also landscape architects have to get ready for digital construction. As result, Rapperswil is consistently pursuing the goal of implementing "Digital Construction" in Landscape Architecture education.

2 Digital Construction

Digital Construction is the general term for using different digital technologies to build more efficiently. The below methods and processes belong to Digital Construction and are taught at Rapperswil.

2.1 BIM Construction

Rapperswil students work three-dimensionally from day one. In the first semester, the BIM architecture construction software (Revit) and the principle of a digital twin are taught. The

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students are required to build an existing structure (pavilion, pergola, water feature, etc.). This approach has the following advantages:

- Fast learning of architecture representation principles (floor plans, elevations, sections, 3D views),
- "One single source of truth" – the 3D model is the basis for all (representations, schedules/quantities, etc.),
- Object oriented construction only with 3D objects, which belong to building categories,
- Very structured modelling with parametric objects (standard families, external families and project families),
- The model has container function for fundamental construction data. It is used for structural engineering (formwork/reinforcement) and for MEP (Mechanical, Electric, Plumbing) modelling.

Fig. 1: The well-known Platzspitz Park Music Pavilion in Zürich was chosen by a Rapperswil student and modelled within the first seven weeks of the first semester

In the 2nd semester, the students integrate a building into an existing site based on GIS data with civil engineering programs (InfraWorks / Civil 3D). They locate driveways, parking lots, retention/infiltration basins in the project. Students get to know the 3D Global Navigation Satellite System (GNSS) excavator control system and learn what to look out for when preparing data for it. In principal students learn to use the correct tools for different challenges, as BIM construction in Landscape Architecture consists of tools for architecture projects and tools for civil engineering projects. The scheme BIM4RainWaterManament (PETSCHEK 2019) gives a good overview of the Rapperswil teaching in Digital Construction.

Before the students model the terrain digitally, they learn the craft by hand for one semester. In the construction course in the first semester, the students have to solve numerous small tasks on terrain modeling with elevation points/contour lines and prove their skills in a 1 ½ hour exam at the end of the semester. The exercises are based on U.S. grading courses, which are common at every north American landscape architecture program. Richard Untermann, with the book "Grade Easy" (UNTERMANN 1972), was an important pioneer for several textbooks on the English-language book market on terrain modelling and serves as the basis for the Rapperwil grading education.

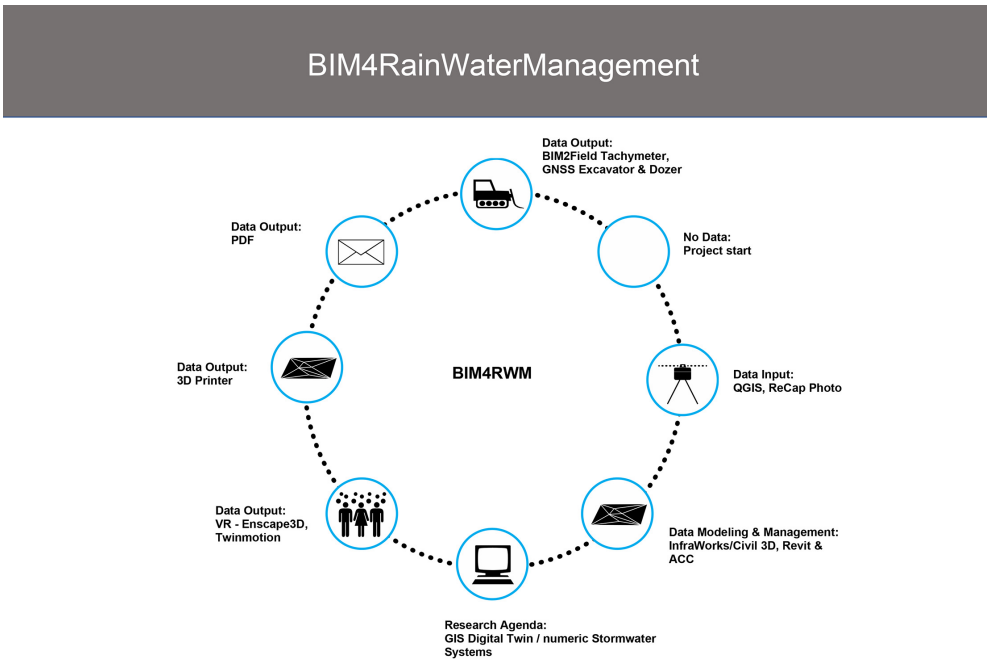

Fig. 2: The scheme gives an overview on data application in digital landscape construction, with a clear statement: BIM construction in Landscape Architecture needs to combine architecture and civil engineering tools

More complex architectural constructions, which serve as the basis for structural calculations, are the subject of the "Constructive Design" module in the 4th semester. This is also where the cooperation with the civil engineers of the newly formed School of Architecture, Civil Engineering, Landscape Architecture, Spatial Planning of the OST is practiced for the first time.

The previously often time-consuming visualizations are becoming a sideshow thanks to the BIM construction training. Software like Enscape3D or Twinmotion enables the virtual reality (VR) inspection of the model with a headset or on the screen. Individual images in different resolutions can be created from any point. Students can check out headsets and VR capable computers from a central IT service at OST.

2.2 Common Data Environment (CDE)

In addition to the 3D model, the management of processes and information is central to Digital Construction. Internet-based platforms, called Common Data Environment (CDE), are responsible for data exchange, collaboration on a model, costs, quantities, materials, delivery, testing and acceptance processes in all life cycle phases of the structure.

In the spring semester of 2020, like the other Swiss universities, all of Rapperswil's landscape architecture courses took place online. Since the first wave of the pandemic, Teams / Zoom conferences had been part of everyday life for all students. However, Rapperswil went a step further. It was made mandatory for all students to submit their BIM construction projects via the CDE Autodesk Construction Cloud (ACC). A project folder is dedicated to each course,

with student subfolders. There the students store their models, photos, sketches and text. The lecturers evaluate the work digitally, with the 3D model being the starting point.

Thomas Putscher, lecturer at OST, writes, “I consider the submission to the Construction Cloud to be a good thing. The students found their way around quickly and it went smoothly. Meetings took place directly via Teams with the open 3D cloud model. The corrections to the model were very easy for me because I could do them directly online. I uploaded my evaluation sheets and informed all students via email about their grades. If necessary, there were debriefings online with the open 3D model. All in all, the construction cloud has saved me a lot of time.” For Rapperswil, the full integration of the Common Data Environment into landscape architecture training was the next logical step towards Digital Construction. From fall semester 2021, all students in the construction courses worked with the CDE platform right from the first semester. The cloud solution is now used for submission and evaluation in all construction courses up to the bachelor thesis. Paper plans are no longer used as submissions.

Fig. 3: Paper plans are longer part of the construction education. Rapperswil students use a Common Data Environment (CDE) construction cloud for project submission and evaluation

2.3 BIM4RainwaterManagement

“Climate change is leading to heavier and more frequent precipitation. In urban areas, where development means the total impervious surface area is increasing, there is a growing risk of flooding from surface run-off after heavy rainfall. In climate-adapted and risk-based urban development, there is an increasing need to manage rainwater resources sustainably. The concept of 'sponge cities', which focus on increasing evaporation, infiltration, retention, controlled temporary flooding and providing emergency waterways, is a planning solution to prevent damage from surface run-off and to reduce the effects of heat” (BAFU/ARE 2022).

Landscape Architects must take over a leading role in building 'sponge cities'. How can the principle of the sponge city be realized as part of Digital Construction? Although it belongs

to BIM Construction, this very important topic is specifically addressed under the title BIM4RainWaterMangement. It is taught in the construction course in the 5th semester. The basic goals of BIM4RainWaterManagement are:

- Return of clean rainwater to the groundwater,
- Optimization of a slow percolation,
- Usage of a digital twin.

When building the digital twin, the students apply the steps of the BIM4RainWaterManagement scheme (PETSCHEK 2019) and of course, they use digital terrain modelling. It is the basis for quickly testing precise alternatives of retention and infiltration and thus find the ideal solution for allowing rainwater percolation on site. The civil engineering software and the architecture software, combined with their respective strengths, are used to set up the BIM4RainWaterManagement project.

The 3D model has the following advantages:

- Proof of retention areas in the event of heavy rain events. All water from roof tops and surfaces percolates on site,
- Precise modeling of pavement surfaces and subsurface structures,
- Parametric inlets, sludges collectors, manholes and pipes are included in the digital twin,
- Clash detection between tree root balls and subsurface drainage elements,
- Precise stakeout of all elements using BIM2Field,
- Study of site grading alternatives with the help of automized grading (Grading Optimization in the civil engineering software).

In the next step, a link between the digital twin and numeric stormwater management software will be established to validate the model and integrate it into a larger GIS analysis context. Also extracting sustainability data from the digital twin will be an important topic.

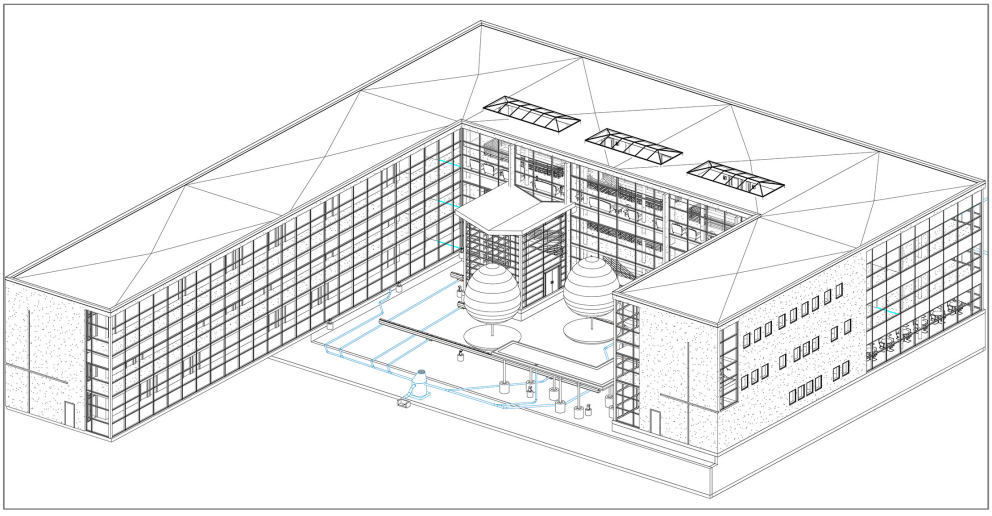

Fig. 4: Subsurface drainage student project

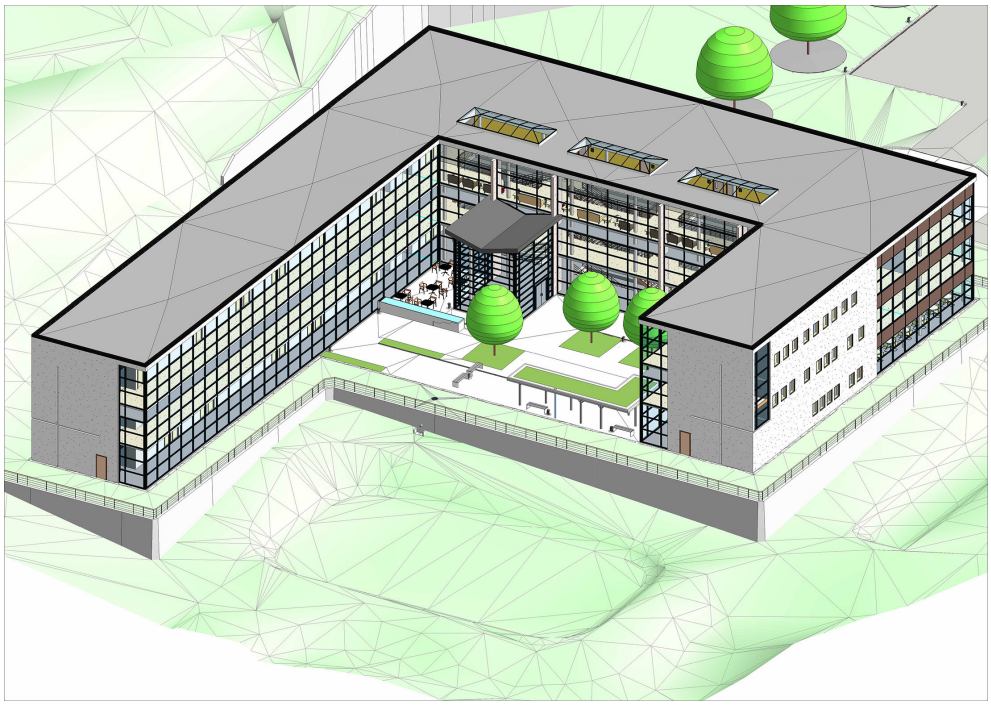

Fig. 5: All the water collected ends in a detention pond

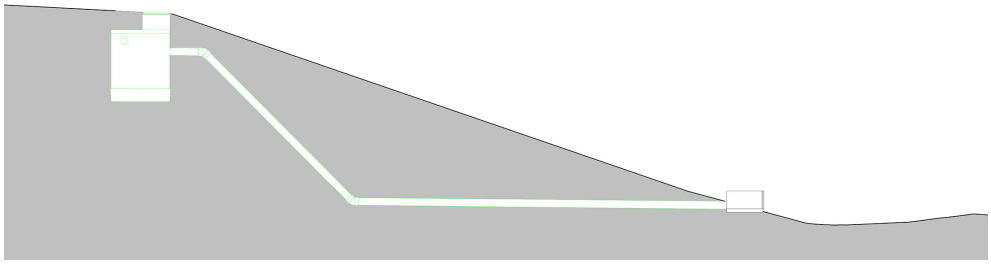

Fig. 6: Precise modelled subsurface structures for water percolation on site

2.4 BIM4Trees

Students "plant" as part of the course described under point 2.3 BIMTrees. The trees were developed by Andreas Luka Consulting in close cooperation with Rapperswil, and the Swiss landscape contractor association Jardin Suisse, in which the Swiss tree nurseries are organized.

3D trees are a major challenge for BIM in Landscape Architecture, as their geometry and properties change significantly over the entire life cycle (LUKA & GUO 2021). Existing solutions did not adequately meet this challenge and could only insufficiently exploit the potential of BIM. Rapperswil therefore, supported the implementation of dynamic BIM trees with a research project.

The focus on the outer shells for crown, tree trunk and root, which are important for BIM, and their representation as solids allow both efficient clash detections and the extraction of volumes and masses for further analyses (structural engineering calculations and shadow casting). The tree size can be predicted interactively and quickly within the BIM software using initial values for size when planting and growth functions for any point in time after planting, complete with root in species, variety and age-specific shape and size. By simply linking the very technical looking trees with Enscape3D, convincing visual representations of tree planting are created.

The feedback from independent study and bachelor projects flows directly into further development. There are currently 80 species/varieties with the shapes and sizes according to the Swiss quality regulations and the catalogue of a large German tree nursery.

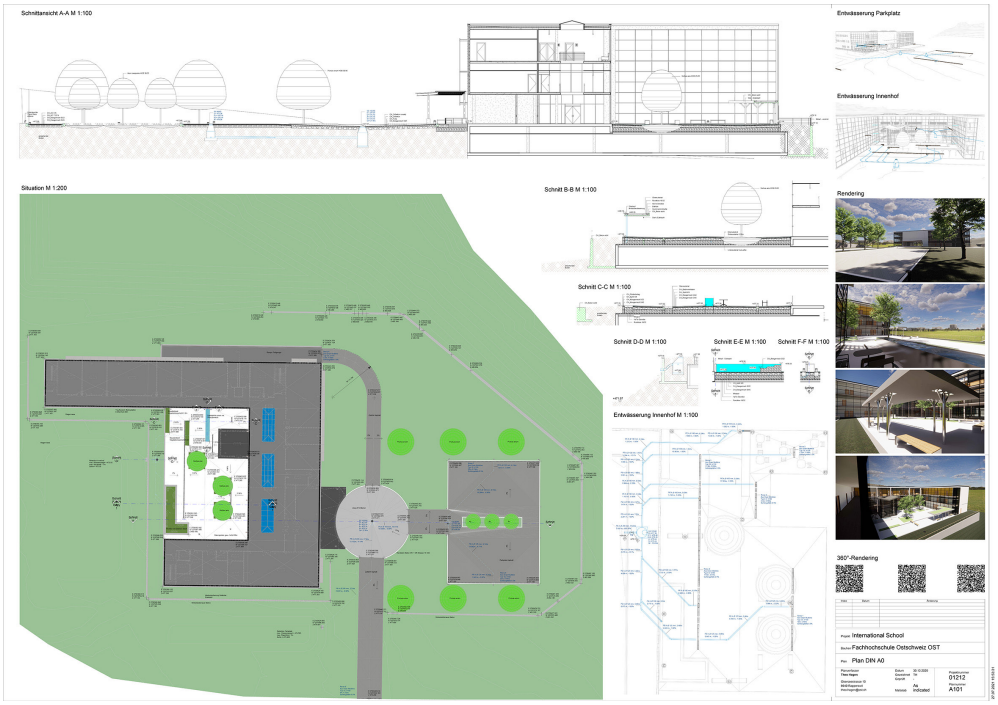

Fig. 7: The ALC BIM Trees with their root ball play an important role in the Rapperswil BIM models

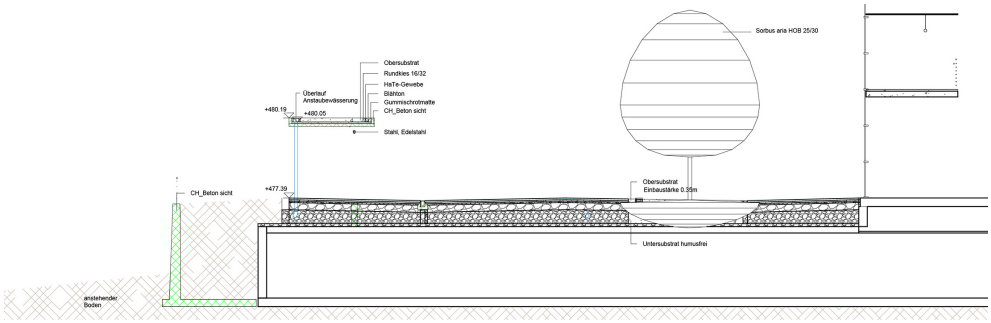

Fig. 8: The ALC BIM Trees help with clash collision and structural engineering of structure underneath

2.5 BIM2Field

Digital Construction is based on digital data. In addition to the existing GIS data, one often needs to collect his/her own data. Point clouds from drone flights are a possibility. However, landscape architects need height information below the tree and shrub layer. Drones cannot be used here. The mobile laser scanner BLK2GO (LEICA Geosystems) is the latest generation of mobile laser scanning. A stationary device no longer has to be set up as before as the scanner can be used while walking through the site. This flexibility is extremely important in Landscape Architecture. The created point cloud is then post-processed and prepared for the BIM construction. The OST students use laser scanning as a regular tool in their projects.

Since the fall semester of 2021, the surveying course has been renamed “BIM2Field”. The application of one person tachymeter stations is taught. The six robotic stations use the georeferenced model loaded on the Construction Cloud directly for stake out without any intermediate steps. GNSS machine control systems in addition are presented in class by commercial companies.

Fig. 9: The robotic station is central for stake out and site construction

Fig. 10: Rapperswil students use handheld laser scanning devices as a regular tool for site surveying

Fig. 11: Rapperswil students working with a 3D GNSS excavator on a construction site as part of the BIM2Field course

2.6 BIM2Cost

The central topics of the Landscape Architecture training in Rapperswil are cost calculations and construction specifications (specs). The 5th semester course, described under 2.3. is also

pioneering in this area. In Switzerland, the basis for efficient construction costs is the element-based classification eBKP-H, which was developed by the Swiss Central Office for Construction Rationalization CRB. The cost-relevant quantities are collected directly in the digital twin. Automatically calculated dimensions and volumes result in more precise cost estimates. Due to clash detection, errors in the construction are detected early and thus increase cost certainty. In the future, construction schedules will be displayed as 4D simulations using the Common Data Environment ACC. In this way, the planned construction process can be checked visually by the students and any contradictions can be solved.

2.7 YouTube Channel

The YouTube Channel "Landscape Architecture Rapperswil" is the medium for the presentation of student independent study projects, thesis work and lectures on the topic. The following posts on building digital can be found on the constantly updated YouTube Channel:

- BIM2Field, laser scanner and robotic tachymeter: https://youtu.be/icjaM3AoRa0
- BIM2Field, 3D GNSS digger: https://youtu.be/2MTnb7rV58o
- BIM Student *independent study* project: https://youtu.be/q2SMcJ2knjg
- BIM Bachelor thesis: https://youtu.be/0X8VUk-FyUM

3 Conclusion and Outlook

Digitization in the Swiss construction industry is taking big steps forward; Landscape Architecture is not unaffected by this. Education in design, planting design, ecology and construction are the foundation of future Landscape Architects. In addition, skills in Digital Construction must be integrated today. The next step is the switch to Bring Your Own Device (BYOD). From fall semester 2023, students are required to use their own devices in all Rapperswil courses. Computer labs will be no longer in use. It is also planned to integrate the digital twin topic in the GIS teaching. In conclusion, OST Ostschweizer Fachhochschule in Rapperswil acknowledges the challenges of Digital Construction and is riding along the digital wave.

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