Boathouse ZHS

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Boathouse ZHS

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Our task is to build Boathouse for ZHS by the Sternberger lake which should also contain the function of workshop, offices, boat parking places, etc.

We had in the very beginning a research on the site. There we observed the existing buildings and daily activity in the boat center. The center now owns three buildings: one wooden workshop with tiny working space and storeroom for all type of boats; one steel store room by the lake which serves only als storeroom, and one multifunctional building contains diversified function such as classroom, kitchen and office. There is also a open field by the lake for training and outdoor activity. The existing site has perfect view to the lake, but the current situation can no longer meet the need of increasing staff and equipment. At the site we got the first impression that the new building should not avoid the nice view corridor.
Considering design a boathouse by the Sternberger lake, the form related to water came up to our mind. On the lake we observed how the water move smoothly when boats pass by. And we suddenly got an idea that the form of our building also could be smooth and look more like from the future.

By thinking of our basic need of the new boathouse, there should be one big workshop as big as 200 m² and storeroom for at least 6 boats. Since the storeroom does not have to be totally enclosed, we consider about combining these two space together.

After then we got an idea to use the form of waterspray which on one hand serves as the roof of storeroom in semi-open space, on the other hand meets the demand of height in the workshop.
Architectural Design

In the siteplan we chose the location where a small steel storeroom currently stays as our target place. In this way, the nice view corridor to the lake could be remained. Furthermore, the open field in the center is kept for training, outdoor activities and temporary storage of boats.
Architectural Design

1. Workshop 210 m²
2. Storage of Boats 300 m²
1. Office 102 m²
2. WC 24 m²
3. Multimedia room 120 m²
1. Office 90 m²
Architectural Design

Section 1-1

Southwest Fassade
Collaboration with BIM

The first challenge within the project has been the choice of the right BIM tools that work together to create a valuable and consistent model. Since the interoperability and the exchange of data between systems has been a main topic of discussion in the last years of BIM history, we decided to use the full potential of BIM tools that the Chair of Computational Modelling and Simulation so as the Chair of Architectural Informatics have offered access to.

The first ideas for the architectural design of the Boathouse at Stanberger See were realised in ArchiCAD, as a software that has been extensively used at the university. However, we quickly switched to another AUTODESK product – Revit 2017 to maximise the cohesiveness and minimise possible mismatches between BIM-supportive tools. Further we designed our structural model likewise within Revit 2017. The reasons lay above all in the possibility to import and export the model in further softwares such as Sofistik, So-libri Model Checker and RIB iTWO, without having major problems.

Nowadays data management in big projects is still exchanged using individual files (email, etc.). Copies are modified concurrently which arises the problem of inconsistencies and merging difficulties. A possible solution would have been a synchronous collaboration, offering simultaneous work on the same subject on a central database. Despite the possibilities, servers offering that are not completely mature and haven’t found place in the practise yet. A model server that enables this kind of “live” collaboration is BIM360, which we used to exchange data and ideas with local copies on users. Due to a very good communication and timing, there was no need of model merging and no data was lost as a result of the independent work of the participants.
The main task of the team in this phase is to analyze architectural concept and at the same time to further develop the structure.

After the geometric model is set up, the Revit model is analyzed and optimized for structural improvements. The final structural concept can be divided into three main parts: workshop area, office area and roof Structure System.

**Workshop area:**
The workshop offers large working space for the boat-repairs, the roof vertical loads were placed on 8 reinforced concrete columns. In order to build the boats inside the boathouse is clearance height 10 m required. Therefore, the height of the concrete pillar is also 10 m. As a consequence the columns have dimensions 40 x 100 cm. In order to build the boats inside the boathouse is clearance height 10m rec The foundations of the columns had dimensions 2,00 x 2,50 x 1,00 m. The workshop is closed by openable glass facade. The glass facade consists of a self-supporting mullion transom construction.

**Office area:**
The office area has a slightly different structural concept. The flor plate is made of steel reinforced concrete with a thickness of 20 centimeters, supported by 7 round reinforced concrete columns whit diameter of 25 cm (2,50 m distance between the columns) and 25 cm thick load bearing walls. The bottom plate is made of steel reinforced concrete with a thickness of 30 centimeters. The glass facade consists of a self-supporting mullion transom construction.
**Roof Structure System:**
The main supporting system of the roof contains 8 steel roof trusses. Every truss consists of an upper and lower belt (HEB240) and vertical and diagonal bars (HEB160). The entire length of every truss contains 13.80 m. The middle distance between the trusses is around 6.50 m.

A second group of beams, mainly steel tubes with a profile of 168.3 x 10 mm, bears not only roof loads but also supports the main truss.
Next to the dead loads of the building components, the dead load of the roof is estimated with 1.00 kN/m² in general. Additionally, the following variable loads are applied. The site lies about 587 meters above average sea level and the height of the building is in the range of 10 to 25 meters. The climbing hall is located in snow zone “2” and wind zone “2” referring to DIN 1055. Because of the round, partly curved shape DIN 1055-5-4 could not be used for wind load determination. Therefore, 2.50 KN/m² as maximum wind load are applied on the roof. In addition to that 2.80 kN/m² are applied to the floor and the bottom plate in the office area as payload (traffic loads) referring to DIN 1055-3 (office + aggregate (separating wall)). The following table shows all loads:

<table>
<thead>
<tr>
<th>dead load</th>
<th>surface load</th>
<th>line load</th>
</tr>
</thead>
<tbody>
<tr>
<td>snow load</td>
<td>base value:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>snow zone 2;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$A = 587 m^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$s_k = 0.25 + 1.91 \times \left( \frac{A + 140}{760} \right)^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$s = \mu \times C_e \times C_l \times s_k$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\mu = 0.8; C_e = C_l = 1.0$</td>
<td></td>
</tr>
<tr>
<td>wind load</td>
<td>wind zone 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>round shape</td>
<td></td>
</tr>
<tr>
<td>payload</td>
<td>Kat. B1 (office)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>aggregate (separating wall)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Trennwandzuschlag)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>dead load</th>
<th>surface load</th>
<th>line load</th>
</tr>
</thead>
<tbody>
<tr>
<td>snow load</td>
<td>1.00 kN/m²</td>
<td>7.00 kN/m²</td>
</tr>
<tr>
<td>wind load</td>
<td>1.60 kN/m²</td>
<td>11.20 kN/m²</td>
</tr>
<tr>
<td>payload</td>
<td>2.60 kN/m²</td>
<td>2.80 kN/m²</td>
</tr>
<tr>
<td></td>
<td>0.80 kN/m²</td>
<td>—</td>
</tr>
</tbody>
</table>
When first exporting the analysis model to SOFiSTiK, some components are not appearing. The team could solve this by deleting and redrawing those parts in Revit. However, a second problem could not be solved and requires a workaround. The payload was recognized by SOFiSTiK as dead load. One possible solution was to define the payload in Revit as 'snow' and later manually convert the coefficients into the load case combination. As an alternative, the load case Q (as snow) had to be reprogrammed directly in the SO-FiSTiK input file. The next problem was that the roof was not a load-bearing object. However, trying to apply area loads to these floors was not successful in Revit because of the round geometry. As a solution, instead of the area loads, line loads are applied to the girder structure.

\[
\text{line load} = q \times e
\]
\[
e = 7,00 \text{ m}
\]
Analysis

The most unfavorable load case occurs for the weighted sum of the individual loads which is $1.35G + 1.5Q + 1.5*0.5S + 1.5*0.6W$. Considering this case, the strongest deformation arising is about 10.8mm in z-direction. Nevertheless, this movement is smaller than the maximal admissible deformation of 25.5 mm at this point ($f = \text{length}/500$).
In order to work productive, it is necessary for all the participants in the project to be aware of what kind of different information should be exchanged or at which point of the project timeline diverse assignments should be completed. A certain methodology has been established to keep track on the associated information that has to be exchanged between parties. Using the graphical language (BPMN) typical for describing the data exchange processes, we were able to assign diverse work packages to participants, create an estimated timeline of the project so as a raw strategy on which key points we should put more effort and time.

At the end of the project a brief feedback between the participants concluded that the foreseen work effort and time management were estimated correctly. The key points of our co-work have been the 2 loops before and after the interim presentation, where the most of the project progress is done so as the excessive teamwork between architects and civil engineers.

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Process Management Map according to BPMN

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BIM-derived estimating has been believed to be the most promising and useful future of BIM. Using the database behind a BIM model, the user is able to make an accurate quantity take-off and further precise cost estimation and scheduling.

Products such as RIB iTWO software allow the building information model to become more integrated by containing information for the quantity of the building components (3D), schedule (4D) and cost (5D).

Quantity Take-Off plays a major role in the planning and execution in every construction project. Therefore, an important goal for our project was to make a detailed quantity calculation so as an exact cost estimation. The components of the building model are geometrically described as surface of triangles. Each geometric body has specific geometrical properties through which lengths, areas and volumes are calculated. The process of quantity calculation starts with checking the BIM data quality of the exported CPIXML file form Revit into RIB iTWO. We started with a medium quality which later resulted in some errors or the inability to estimate exact quantities of components.

Using direct dynamic filters or model attributes we were able to link most of the building components to a recognisable group of segments in RIB iTWO. However some constructional component weren’t able to be recognised by the software as such.
Bill of quantities

1. *Trusses were not linked to any type of component*
   Problem: By the exporting of the data exchange file, the roof construction of trusses was not identified by the software as any type of constructional component. A possible reason could have been that they are custom made families in Revit.
   Solution: Manually adding the components to a dynamic filter
   Result: The linking was unsuccessful therefore the trusses were not included in the bill of quantities

2. *Excavation works were not estimated correctly*
   Problem: Terrain was not calculated correctly
   Solution: Calculate the excavation works directly through Revit by creating two terrains and their interface.
   Result: We didn’t manage to use fully RIB iTWO’s futures and had to find a workout through another tool.

Furthermore, we aimed for a detailed compilation of specifications, which gives the user information of the unit prices of each component directly linked to a database with costing records: However, our model-based estimation still lacks useful cost information for key building components such as the concrete beam and triangular glass facets of exterior façade or the trusses. A major upgrade in the cost databases and processes used to estimate the BIM-derived information should be a priority in the future.
Clash Detection

Model coordination and especially the analysing of 3D models against each other based on predefined rules is the base of a successful building information model. Solibri Model Checker is software that allows a team to share, combine, review and correct a BIM model using a 3D viewer. The main idea of generating clash reports is to coordinate the model throughout whole process of modelling and exclude clashes before executing process.

During the design process we tried to resolve all of the issues marked in the clash reports on different stages of the project. We started resolving the model conflicts in a “macro to micro” way. First me focused on resolving the larger systems, such as rooftop units or overlapping of components such as walls and façade and others which could have been impossible to change or move because of their size or support structures.

Further the deficiency detection showed some poor modelling practises that included missing or misplaced components. Most of them were logical in their consistency and we resolved them on a later stage of the project where the level of detail was more advanced.

Component check insured that multiple types of component and their various dimensions are checked allowing us to be certain the components are modelled within reasonable and realistic boundaries. Clearance in front of section rules set insured that the required space in front or behind the component is there.

However some of the collisions were not applicable fully for the purpose of this project such as some oversized components – beams and steel trusses. Those clashes were statically proved and approved as reasonable.
## Modell Check for 2. BIM Presentation

<table>
<thead>
<tr>
<th>Nummer</th>
<th>Id</th>
<th>Standort</th>
<th>Titel</th>
<th>Bild</th>
<th>Beschreibung</th>
<th>Komponenten</th>
<th>Kameraposition</th>
</tr>
</thead>
</table>
| 1      | 6  | Ebene 4  | Falscher Wert der Eigenschaft - Dicke: 2,76 m                        |      | Dachdicke  
Dach Komponente(n) mit einem falschen Wert. Der tatsächliche Wert der Eigenschaft: Dicke ist 2,76 m ± 1,00 m.                                                                                                                                  | Dach.4.3    | X: 15,30 m  
Y: -8,43 m  
Z: 16,00 m |
| 2      | 1  | Ebene 4  | Falscher Wert der Eigenschaft - Länge: 50,27 m                       |      | Balkenlänge  
Balken Komponente(n) mit einem falschen Wert. Der tatsächliche Wert der Eigenschaft: Länge ist 50,27 m ± 20,00 m.                                                                                                                   | Balken.4.5  | X: 11,56 m  
Y: -9,76 m  
Z: 16,63 m |
| 3      | 6  | Ebene 5  | Falscher Wert der Eigenschaft - Profilbreite: 60 mm                  |      | Balkenabmessungen müssen innerhalb sinnvoller Grenzen liegen  
Balken Komponente(n) mit einem falschen Wert. Der tatsächliche Wert der Eigenschaft: Profilbreite ist 60 mm ± 100 mm.                                                                                           | Balken.3.3  
Balken.3.1  
Balken.3.4  
Balken.3.5  
Balken.3.2  
Balken.3.7  
Balken.3.7.1 | X: 23,37 m  
Y: -21,81 m  
Z: 22,40 m |
| 4      | 5  | Ebene 2  | STB 40 x 100                                                         |      | Komponenten oberhalb von Säulen  
Ähnliche Komponenten, die Komponenten Oberhalb selbst nicht berühren.                                                                                                                   | Stütze.2.0  
Stütze.2.2  
Stütze.2.1  
Stütze.2.5  
Stütze.2.6  
Stütze.2.4  
Stütze.2.7 | X: 11,08 m  
Y: -12,90 m  
Z: 11,90 m |
| 5      | 10 | Ebene 0  | STB 40 x 100                                                         |      | Komponenten unterhalb von Säulen  
Ähnliche Komponenten, die Komponenten Unterhalb selbst nicht berühren.                                                                                                                   | Stütze.0.8  
Stütze.0.7  
Stütze.0.4  
Stütze.0.5 | X: 4,83 m  
Y: 7,67 m  
Z: 0,76 m |
| 6      | 12 | Ebene 5  | 60 x 140                                                             |      | Komponenten unterhalb von Balken  
Ähnliche Komponenten, die Komponenten Unterhalb selbst nicht berühren.                                                                                                                   | Balken.3.4  
Balken.3.1  
Balken.3.8  
Balken.3.5  
Balken.3.2  
Balken.3.3  
Balken.3.11 | X: 6,67 m  
Y: 12,77 m  
Z: 14,05 m |
| 7      | 13 | Ebene 0  | STB 25.0 WÖ 12.0                                                     |      | Komponenten oberhalb von Wänden  
Ähnliche Komponenten, die Komponenten Oberhalb selbst nicht berühren.                                                                                                                   | Wände.0.3   
Wände.0.90  
Wände.0.7   
Wände.0.6   | X: 3,77 m  
Y: 10,13 m  
Z: 14,74 m |
| 8      | 14 | Ebene 0  | 2.00 x 2.50 x 1.00 und STB 20.0                                      |      | Platte-Platte-Überschneidungen  
Ähnliche Komponenten, die Komponenten Oberhalb selbst nicht berühren.                                                                                                                   | Decke.0.2   
Decke.0.3   
Decke.0.1   
Decke.1.1   
Decke.0.4   | X: -0,75 m  
Y: -2,27 m  
Z: 2,05 m |

Interim Clash Detection
Overall the workflow of our team was fluent and trouble-free during the whole project. At the beginning we had some difficulties with lack of coordination and time estimation. As the project was consolidating we found our way out how to keep progress going and deliver profitable results.

Throughout the project the main difficulties occurred by the application of the different and until that moment unknown BIM tools. The following problems appeared:

- Minor problems with families in Revit and BIM 360
- BL1 was not recognized as payload by Sofistik
- RIB iTWO: Problems with linking the trusses to any type of component, not enough unit price information for variety of components.

Other challenges emerged out of model inaccuracy, no proper data integration or modeling without understanding the functions of the software. These difficulties can be avoided by focusing on the need of better interaction between tools and achieve interoperability on every stage of planning and modeling.
Project Progress

The changes undertaken were made mainly to optimise the project value and functionality. Our first concept for the architectural design was the form of an ellipse, which represents a water drop and is a suitable form for the surroundings of the terrain. However, a better choice was to change it into a circle to maximise the utilisation of the building as a workshop and to gain a better access of the boats.

Additionally, after running the structural model and optimising it in Sofistik, we removed the beams which were surrounding the columns on level 3. The result is a lighter, but a stable construction using less material and opening more space for light to come in the workshop.
Conclusion

Overall the project went smoothly, and both the design and engineering members of the team have been very cooperative at all stages. Both, architects and structural engineers worked on the same project, which kept the risk of losing valuable information but also enabled a quick and exact review, compare and change of the two designs. With the external help of the tutors and software experts, so as the valuable remarks of our professors the final product shows creativity, functionality and nevertheless combines the intellectual work of the team with the correct implementation of different BIM tools.

There is a lot of room for improvement especially on the level of details of the model, team communication and creation of documentation. Furthermore, a platform to host the output data from different BIM tools would be essential to future success. This information basis of BIM together with standards and interoperability would determine the future of BIM and its role as a modifier of the construction industry.
### GRUPPE A

<table>
<thead>
<tr>
<th>Name</th>
<th>Semester</th>
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<tbody>
<tr>
<td>TSVETELINA ILIEVA, 03632921</td>
<td>4. SEMESTER</td>
</tr>
<tr>
<td>ZHIWEI MENG, 03692844</td>
<td>3. SEMESTER</td>
</tr>
<tr>
<td>GERGANA POPGAURIOLOVA, 03652406</td>
<td>1. SEMESTER</td>
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