The uptake of BIM

From BIM teaching to BIM usage in the design studio in the Bachelor studies

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This paper is about the uptake of BIM in the design studio in the Bachelor studies. In the current study year at our school we have the first cohort of students that have followed integral education of BIM from the very start of their study programme. We assess the usage of BIM in the final project work. The final data are not in yet, but we can observe a slight increase of the use of BIM in the design studio work.

Keywords: Building Information Model, Education, BIM Pedagogy

INTRODUCTION

At our institution BIM was introduced for the first time in 2004. Throughout ten years the course was offered to an increasing number of students. Because it was an elective course in the second year of studies, it did not have a firm anchoring in the remainder of the curriculum of the faculty. In the study-year 2014-2015 BIM was offered integrally to all first-year students. Right at the start of the year they can choose from three software packages: AutoCAD (no BIM), Revit (BIM), and ArchiCad (BIM). For the education at our school this was quite a large leap forward. First of all, it increased the number of students who got education in BIM-based software in contrast with previous years; second, it meant institutional acceptance of BIM as a subject; and third, it meant that BIM-skills could be reasonably expected as basic skill from students.

Figure 1 shows the options students have in their choice of software education at our Faculty, from the study year 2014/15 onward. Each course takes up one semester. Students have the possibility to take BIM for four semesters, leading them to “expert” level either in Revit or in ArchiCad. A decreasing amount of students choose AutoCAD and 3DStudio Max as their track, turning them into AutoCAD experts at the expense of BIM.

Figure 2 shows the changes in amount of groups (roughly 15 people per group) that take particular courses throughout the study program. From this graph we can conclude: Demographically there is a decreasing amount of incoming students (which happened after the transition of Czech Republic to democratic system), particularly notable since the year 2015. In the study year 2014/15 we can see a sharp change in trend what the students choose from the very start of their studies. General decrease of interest in AutoCAD, 3dMaxDesign and Rhino. Increased interest in BIM-based software Revit and ArchiCad.

The absolute amount of students are listed in Figure 3 and Table 1. We can observe an increase in the amount of students that choose a BIM-based software.

As can be seen from Figure 3, roughly half of the students choose the non-BIM approach through Au-
Figure 1
Schema of CAD education in the first 2 years (4 semesters) in Bachelor programme, since study year 2014-2015

toCAD as CAAD package. BIM adaptation is on the rise in Czech republic, starting from a low level of adaptation reported earlier in Vinšová, Matějovská and Achten 2014, compared with other European countries (Russell and Elger 2008; Boeykens et al 2013; Kocaturk and Kiviniemi 2013; Ibrahim 2014; Dieckmann and Russell 2014). An increasing amount of parties in the building process are able to produce BIM documents, but because these operate in a fragmented process (architect to documentation to permission to constructor, each with own fee system), there is no incentive to pass on BIM models between the parties. The large construction firms mainly operate on BIM, but many architects and smaller construction firms still make do with AutoCAD.

DEMAND FOR BIM GRADUATES
Table 2 shows in more detail the amount of students taking the BIM-courses at the Faculty.

Table 2 shows the amount of students that successfully completed the course (in WT: Winter Term the basic course on Revit and ArchiCad; ST: Summer Term the advanced course on Revit and ArchiCad). Where available, the data shows number of regis-
At the end of the summer term 2016 we had the first cohort of students that took all four courses on BIM during their Bachelor studies. To be more precise: 15 students following Revit, and 23 students following ArchiCad. The latest results we do not have at our disposal yet. BIM education has a long tradition at our Faculty; ArchiCAD from year 2004, and Revit from year 2006. In fact BIM education preceded the demand for graduates with BIM capabilities at Czech firms. This situation was different however for larger Czech firms that worked with foreign developers (for example the architect’s office of Cigler&Marani in 2010). Those offices eagerly welcomed graduates with BIM skills.

Today, mainly due to the pressure of large Czech developers (in particular Skanska a.s., Metrostav a.s. and HOCHTIEF CZ a.s.) and the application of BIM in large construction companies (e.g. VPÚ DECO PRAHA a.s., Metroprojekt Praha a.s., Obermeyer Helika a.s.) there is a high demand for graduates from Civil Engineering who are capable to work with BIM, while there seems to be a surplus of BIM-skilled graduates from Architecture. The reason for the latter surplus may be that in Czech Republic, the laws and implementing regulations for designing in preparatory phase in architectural firms do not require the use of BIM. Additionally, due to a number of inappropriate marketing campaigns, there have been several unsuccessful projects with BIM that disheartened undecided architects to go “BIM.”

**HISTORY OF TEACHING, EXPERIENCES AND RESULTS**

In 2015 we reported on our experiences of first time education of BIM in the first year of Bachelor studies (Vinšová, Achten, Matějovská 2015), and diverging from the standard approach of teaching AutoCAD in the first year. The first cohort of students who had four semesters of BIM education, are the ones that can apply their BIM skills in their graduation project. We feel that this phase is in particular important to assess, because it is in the integrated application of design studio that students learn to appreciate the advantage (and limitations) of BIM (Techel and Nassar 2007, pp. 635). The graduation project at our institution in the Bachelor studies has a particular setup. It runs over two semesters. In the winter semester the students make a design for a particular task. This is a regular task as can be seen over many schools of architecture - design a house; housing complex, offices, sports facilities, and so on.

The winter semester is dedicated to the concept design (so-called “study”). Students design the main volume, internal organisation, basic material decisions, and create visualisations of the project. In the summer semester they have to produce all the materials and documentation that are required to obtain the so-called “building permit.” This means that they have to produce plans, floors, sections, and details as in a realistic project, as well documents about structural calculations, HVAC systems, electricity, and regulation schemes as required by the municipality. The whole set of documents comprises the work that has to be handed in for the final diploma work. At the defence of their work, students typically show the results of their “study,” a scale model, and a projected presentation about the design and most significant results from the detailed documentation. Usually an architect from practice is assigned as external critic to detailed assessment of the diploma work.

It is precisely due to the character of the graduation project, that we were able to introduce BIM in
the first year of Bachelor studies. The school had obtained finances from a two-year OPPA grant that enabled us to offer extra-curricular workshops and lectures to educate students in the third year to work their graduation project (BP) as a BIM model. This was necessary as extra effort, because we found that due to high learning curve and time pressure, students ultimately reverted to AutoCAD to produce their documentation. Using BIM required more organisation and was more complex than in traditional production mode. The graduation project is not realistic, it does not undergo major changes, and it does not require coordination of many specialisations. Thus the normal advantages of using BIM were not applicable, and the use of BIM was seen as additional load. In order to ease the learning curve, it was decided to teach BIM from the first year, and offer four semesters of BIM-based courses. The model is limited to the architectural and civil part of the model. We do not have the ambition to model also technical installations, nor control of the structural design; students do need to check for collisions between parts of the building design - thus we are positioned somewhere between BIM level 1 and level 2, however with the requirement that the use of 2D software is out of the question.

Through the OPPA project we found it was easier to follow the students in their own individual design studios where they choose to do their graduation project, then to concentrate all “BIM students” in specialised design studios. Students have the possibility to consult their BIM model throughout the whole year for production of their graduation project. We do not have the final figures of the actual graduation projects, but it is already clear that there will be a large number of BIM models. The winter semester, in which the students produce the “study” concept model, 90% of the students who passed have done the “study” as a BIM model. For the summer semester, in which the students make their final graduation project, we estimate that it will be 70% (this number may actually change). In order to reward the students for their additional effort, we have set up for the successful students a so-called “BIM Ready Certificate.” To obtain this certificate, the model must pass a number of criteria “BIM rules,” which also acts as a motivation. We found that the students work the whole year and throughout the whole school with BIM, and that the supervisors of the design studios do not have an issue with this.

<table>
<thead>
<tr>
<th>Year</th>
<th>AutoCAD</th>
<th>Revit</th>
<th>ArchiCAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-2015</td>
<td>168 (58%)</td>
<td>43 (17%)</td>
<td>72 (25%)</td>
</tr>
<tr>
<td>2015-2016</td>
<td>120 (45%)</td>
<td>49 (18%)</td>
<td>96 (37%)</td>
</tr>
<tr>
<td>2016-2017</td>
<td>108 (47%)</td>
<td>52 (21%)</td>
<td>72 (32%)</td>
</tr>
</tbody>
</table>

Figure 3
Distribution of first-year choice of students of CAAD-package.

Table 1
Distribution of first-year choice of students of CAAD-package.
FURTHER CONSIDERATIONS
The greatest obstacles in BIM education are found in the established practices of drafting building structures. Although the drafting regulations are taken as recommendations (some of which are even not accepted in practice), the school insists on strict adherence to these standards. For students this means additional work, because Revit is not yet fully localized for Czech situation. A standard stumbling block in case is the depiction of staircases, which yields problems for all students. We did find that supervisors and reviewers of the graduation projects done in BIM greatly appreciate the ability of BIM software to create 3D axonometric sections, as well as 3D worked out details or shaded axonometric sections through the floors.

We also found that with increasing knowledge of BIM, the overall level of the design studio work becomes even better. There is a growing number of shared student’s models, in particular when multiple people in a design studio are working on the same location, as for example in creating an urban block with shared underground parking. We can observe team collaboration through the creation of such shared models, with the students using Dropbox, BIM server, and transfer of IFC-models. Thanks to this, the models of the individual work are more explorative in shape and material. Students have access to more advanced technologies already at the start of their study, as they start to use 3D printing and Virtual Reality more easily. So far we have not been able to extend the application of BIM to other areas, such as sustainable design, analysis and simulation, and in general all other kinds of calculation that are possible on the basis of a virtual building model. We decided to focus on intensive teaching of BIM software Revit and ArchiCad, as for the basic production of a 3D model. We are aware that this is
only a prerequisite for further use and development of BIM and the design. A high quality 3D-model that is well prepared for working together with other BIM project parties does not yet guarantee a high quality process or result during the design, realisation, and ultimate use of the building. Throughout the Bachelor programme, (additional) BIM education has to compete with the rather high amount of obligatory courses (Table 3).

The introduction of a separate course dedicated to principles of BIM is in this context highly unlikely. Therefore we are looking rather at an option to offer existing courses additional lectures on BIM, and thus to update their curriculum. This concerns in particular:

- Construction
- Structural systems
- Building materials
- Installations and HVAC
- Management and economics of buildings.

We have found that it is important to set up and maintain a systematic and steady terminology for the BIM education. Thus BIM is also something that should appear in foreign language teaching. We can state that general introduction of BIM in education is something that effects the whole curriculum. Through the CAD education, students learn the basic alphabet for architectural design. At our Faculty, the graduation project needs to be worked out on the level comparable to obtaining a “building permit.” If they are able to realize this project using Revit or ArchiCAD, then the Faculty for sure will appreciate this. BIM in practice is a long-term practice that is difficult to approximate or simulate in the semester teaching at our school. For this reason, students have difficulty grasping the practical advantages of using BIM. We are currently preparing practical workshops outside regular curriculum workshops, that would allow combination of various branches within the university, so that architecture students can work together with for example students from structural engineering, building construction, HVAC, economics, and realisation, so that they actually verify the realism of their projects. In practice we see clear trends at successful architecture offices an increased effort of all parties involved to work together. This collaboration already starts in the early phase and continues to add quality and functionality later in the process as well. We see a definitely positive contribution of BIM to these processes.

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REFERENCES