Bim as a Transformer of Processes

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Abstract: The use and implementation of BIM technology, BIM software and BIM processes are still new to the Architect, Engineering and Construction industry. Adopting BIM in a project involves more than just a software update. The processes used in a traditional Two-dimensional-environment is not necessarily possible to adapt in a Three-dimensional BIM environment. The use of BIM has the potential to radically change the structure and dynamics of a project. In our experience, we need to apply the same radical changes on how education for architects, engineers and BIM Technicians are applied. The BIM Technicians Education started up at Oslo Technical College in 2008. [1] The students are construction workers with a vocational certificate and practical experience from the building industry. On order to facilitate the transformation of these former construction workers into skilled BIM Technicians in the AEC industry, we have adopted teaching methods often referred to as “Situated Learning” and “Reflective Practice”.

Keywords: BIM, situated learning, learning-centred design, constructivism

INTRODUCTION

In Norway, most large building projects implement BIM at some level. Participants use the latest BIM technology and multi-disciplined models are used for clash control, quantity take-offs, and to calculate cost estimates. The use of BIM has proven its worth as an important cost-saving tool, not least when it comes to reducing the person-hours required to finalise projects. BIM also provides new possibilities to create holistic project planning and implementation. Still, established contractual frameworks and practises are limiting the optimal use of BIM software and processes. However, these established practises are being challenged. As we will explain below this entails that the participants not only share information, but also participate in an evolving process to find solutions before project start-up.

When the BIM technician programme was established in 2008, we believed that BIM could be a game-changer in the construction industry. Our ambition has been to educate BIM technicians that are able to provide their future employees with the competence necessary to fully utilise both BIM software and processes. [1] In order to do this, it has been crucial to realise that in the same way as the construction industry cannot fully utilise BIM by replicating old processes, it is not possible to educate fully productive BIM technicians by replicating old teaching methods. By adapting a learning-centred focus we aim to give our students the necessary skills and training, to develop and manage BIM processes in the field.

A learning-centred focus means that the perspective is on student learning outcome, rather
than teaching output. The student is the pivot point in the development of the curriculum and in the physical layout of the classroom.

NEW TECHNOLOGY IN THE EDUCATION SECTOR

A limited approach to new technology is also well-known in the education sector. Journalist David Raths has described what happened when one of America’s top universities established its first computer classroom.

“In the late 1980s, Stanford University’s (CA) writing program received a grant from Apple Computer to build a computer classroom and writing instruction lab. The facilities staff suggested putting the computers in rows, because that was the easiest way to hook them up, but the instructors had different ideas about how to arrange the classroom... It was one of the first computer classrooms designed by teachers instead of by the technologists and facilities folks,” recalled Richard Holeton, director of academic computing services at Stanford. But he remembers that the communication about the new space was a challenge. “The facilities staff has always thought in terms of things like square footage per person. We realized we had a situation where there was no common language, no standard for how you talk about group work.” [2]

The example from Stanford University is highly relevant when teaching BIM. As we will show below, adding computers and software to a classroom does not make the students able to fully utilise BIM on a construction site.

TRANSFORMING CONSTRUCTION PROJECTS

As mentioned above a clear majority of projects and construction companies use BIM software, but contractual frameworks and practises are limiting or delaying the process toward using the software to optimise the construction planning and implementation process itself.

Even in multi-billion projects, participants use BIM software, but are obliged to deliver drawings, often a pdf file, instead of models. Sophisticated and detailed models, containing a wide array of information, are reduced to Two-dimensional drawings.

As a result, in many companies, the implementation of BIM is limited to a replica of the processes developed for Two-dimensional “blue print production”. This can be compared to using your computer as a typewriter, without ever exploring the added possibilities available through word processing, hyperlinks, and file sharing.

Secondly, in established contractual frameworks, income is generated every time there arises a need for revisions that are not covered in the tender document. In other words, the framework rewards the production of revised drawings and plans throughout the project. There is therefore no incentive to make sure that the original plan is as accurate as possible and that revisions are kept at a minimum. This can be described as a culture of claim. A contractor, who on a regular basis experiences that the actual cost of construction is far higher than described in the tender document, makes the claim. In his book Construction Law: From Beginner to Practitioner Jim Mason names this practice as Claimsmanship, and give the following description of its nature:

The bid price is frequently a long way removed from the actual cost of construction. The reasons for this can lie in poor planning and late design changes... The defence to the allegation put forward by the contractors would be that the ultra-competitive tendering procedures and focus on lowest cost to the exclusion of all other factors leave them no choice but to seek to make a margin by bringing claims. [3]

In the report popularly named as “The Egan Report”, or as it’s officially named; Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction, Sir John Egan concluded on the matter of competitive tendering:

The industry must replace competitive tendering with long term relationships based on clear measurement of performance and sustained improvements in quality and efficiency. [4]

The report was published in 1998, long before the existence of today’s high-level functional BIM software. None the less, the report pinpoints how the tendering process can be a limiting factor for the delivered quality and the collaborative processes in a project.
**BREAKING THE DEADLOCK**

By demanding open BIM formats, Norwegian public clients have been the main driver behind the transformation from Two-dimensional drawings to model-based information delivery. The Norwegian public contractor Statsbygg sets the use of models containing properties and relationships as a mandatory demand in their BIM manual; “A digital 3D building information model (subsequently denoted as “the BIM” or similar) based on object-based design (using objects with properties and relationships) and using open BIM standards/formats is a main deliverable.” [5]

This is an example of how governments can play an active and important role in making BIM the main deliverable platform of information in the project. This active role is described by Jim Mason who concludes on this matter in his book Construction law, from Beginner to Practitioner: The government is a major client of the construction industry and can clearly dictate policy in relation to public projects. [3]

**TAKing BIM A STEP FURTHER**

In the planning of the new regional public hospital for the county of Vestfold, this approach has been taken a step further. In this project, the governmental client also demands that all sub-contractors are jointly responsible for accurate planning and implementation. [6] Helse Sør-Øst (the Health Authority for Norway’s southern and eastern regions) has added additional demands when contracting for one of their new regional hospitals currently under planning. The hospital located in the city of Tønsberg, will comprise 40,000 square metres, and has an estimated budget of NOK 2.5 billion (approximately 250 million Euro). Hospitals are considered the most complex type of building project, but this has not deterred the client from setting ambitious goals.

The official objectives are to:

- Reduce costs with 10 per cent, compared with similar projects
- Reduce time from start up to completion with 50 per cent, compared with similar projects
- Keep the amount of construction related error at 0 per cent [7]

**KEY SUCCESS FACTORS**

In order to fulfil these objectives several key factors have been identified. One of the most important is to place collaborative BIM processes at the nave of every project decision. The project teams are therefore obliged to work at the on-site project village throughout the planning and building process.

Another key factor is that the client has decided that the quality of the BIM models must be at level with LOD 500 before start-up. LOD 500 has a level of detail normally found in “As Build” models. In other words, the sub-contractors must work together, foreseeing and solving possible issues prior to the construction phase. In addition, the different technical disciplines have to pass a practical modelling test before being accepted as qualified to take part in the project. The use of Four-dimensional tools like Synchro is mandatory, and gives the client a possibility to follow up progress and alterations at a new level, and finally IFC files cannot take longer than 15 minutes to export from their proprietorial program.

Setting these standards, means taking into account the BIM processes, the use of BIM software and also the challenges working with BIM.

**BIM DIDACTICS: ACTIVITY RATHER THAN BROADCASTING**

As shown above, optimal use of BIM processes involves a high degree of information sharing and willingness of committing to collaborative process. A BIM technician should therefore be able to, not only use the software, but also take active part in and develop BIM processes.

We therefore need to empower our students so that they have confidence in their own abilities to think holistically, contribute to problems solving, and carry out quality assurances. In our opinion, it is not possible to teach students these skills through lectures where the teacher broadcasts the curriculum, and the students are passive recipients.

We have therefore based our curriculum on Constructivist Learning Theories, which focuses on empowering students through constructing their own learning. In his article Rethinking Science Ed-
ucation: Beyond Piagetian Constructivism Toward a Sociocultural Model of Teaching and Learning, Professor Michael O’Loughlin quotes the Brazilian Constructive educator Paulo Freire on how learning emerges:
“...Freire argues that curriculum must emerge from the generative themes of people’s lives and that if education is to be empowering it must culminate in praxis.” [8]

Freire points to two elements, firstly, that the curriculum should emerge from generative themes in people’s lives, secondly that in order to be empowering education must culminate in praxis. We try to adopt this sequel of learning in our curriculum.

PREVIOUS EXPERIENCE

Firstly, we have based the curriculum on the students’ previous knowledge and experience. Our students are former construction workers, including carpenters, steel workers, brick layers, plumbers, and electricians. This means that the student has a practical understanding of at least one building discipline and is familiar with on-site construction. We encourage our students to use this experience as a starting point when creating their own models. For example, a plumber is well versed in the difficulties related to finding solutions related to routing pipes above a suspended ceiling. Consequently, using his or hers former experience when using a Mechanical Electrical Plumbing (MEP)-tool in modelling proves to be fruitful. The ability to adopt previous experiences on to a new phase in a construction site, can be described as reflection in action. Donald Schön describes this process in his book The Reflective Practitioner, How Practitioners Think In Action. [9]

SITUATED LEARNING AND EMPOWERMENT

Secondly, we have found that empowerment is best achieved by drawing on the methods of Situated Learning, an element within Constructivist learning. Situated Learning was first projected by Jean Lave and Etienne Wenger as a model of learning in a community of practice. This type of learning allows an individual (students/learner) to learn by socialization, visualization, and imitation.
“The pedagogy of computer tutors echoes the apprenticeship model in setting individualized tasks for learners and offering guidance and feedback as they work.” [10]

In order to support a Situated Learning model, our classrooms were set up to facilitate workshops, instead of desks in a row, the rooms were designed as open office environments. We thereby transformed the classroom from a standard “knowledge reproducing environment” to a “knowledge sharing environment.” The layout of the BIM-Classroom itself encourages teachers and students to share experiences. Large oval tables give the students an opportunity to walk around and interact with one another. It also diminishes the teacher’s authority (which is good) and places the BIM teacher more on level with the students (which is even better). After all, we teach skilled construction workers, who often have more up-to-date experience from construction projects than we do.

Working in this environment, the students create multi-disciplined BIM models throughout the course. They find solutions and adopt changes in projects based on real-life scenarios, interacting with teachers and other students, or even consulting former students (see more below) as they to their tasks.

Picture 1: The picture shows how the students (sitting) and the teachers (standing) collaborating on a commons task. An example of learning-centred area design integrated with BIM.
IN REAL LIFE

In the same way as collaboration is a key factor in the Tønsberg hospital project, we have found that the use of Internet, file sharing and other collaborative platforms does not make the need for social interaction obsolete. In fact, more information, and more complex models increases the need for communication IRL (In Real Life).

The Tønsberg project demands that the different stakeholders are physically co-located from the design phase to the initial test phase when the hospital is operational. Why is this so important for the project? Files can be shared digitally, but the need to follow up on issues and establishing common ground is best solved through physical co-location.

A good example of how to promote collaborative processes can be found in the floor plan of the Tønsberg Site Village.

Note the blue area marked BigRoom. This area will host a multi-disciplined team. The area can be changed to an open meeting area where the BIM models will be the source and origin for the day to day planning. (ref Integrated Concurrent Engineering)

Finding solutions and resolving issues are at the centre of any BIM process. This is the reason why, in our curriculum, mastering BIM processes is equally important to mastering BIM software.

PRAXIS

Finally, we encourage contact and facilitate meeting points between students and members of the Architect, Engineer and Construction (AEC) industry.

- Former students are organised through an alumni network providing feedback to both present students and interaction between former students. This takes place through events and through an online forum.
- As part of the course, each student spend between two and four weeks as interns in an AEC industry company.

The AEC industry is also invited to evaluate our curriculum at regular intervals. This is to ensure that the curriculum stays relevant and up to the standards expected on site.
CONCLUSION
BIM has already altered the way building projects are carried out. BIM is in the process of radically changing established project structures. In the Tønsberg project, a much larger part of the overall project has been moved forward to the pre-building phase and sub-contractors are expected to collaborate earlier and closer throughout the project. This means that increasingly the BIM technicians need to be skilled in collaborative processes and digital, holistic quality assurance. In the Tønsberg project, BIM is not a “add on” but at the heart of the project design.

The same applies to the learning of BIM processes. Students need to implement, and actively taking part of the process itself, in order to be able to fully master the curriculum.

Learning-centred area design and learning-centred curriculum does not limit its use to topics involving BIM, but our experience is that Information Technology and BIM profits from the use of these methods. Both the student’s previous experiences and training best described as Situated Learning, are key elements in the transformation that leads the former construction worker to play a vital role in a collaborative BIM project.

REFERENCES