



Smart Building Engineering: Challenges and Opportunities of an Interdisciplinary Course Concept for Engineers in the Field of Technical Building Equipment

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Abstract

The share and sales of technical building equipment in construction projects is constantly growing [1], so that engineers for technical building equipment are increasingly needed for demanding construction and renovation projects. The classic engineering courses such as for example, civil engineering, supply technology or electrical engineering often only cover their respective sub-areas, although specialists are needed for these interface areas, especially for planning and design of technical building equipment. The bachelor's degree program "Smart Building Engineering" is successfully implemented in an interdisciplinary manner by the three departments of civil engineering, architecture and electrical engineering and information technology. Both in the organization and in the development of the curriculum, new challenges and opportunities arise for innovative training of specialized young engineers for technical building equipment. In particular, the different work and approaches of the trades involved in the construction process require a high level of interdisciplinary communication and knowledge of the different perspectives later in the job in order to realize a successful construction process. The methodology of Building Information Modeling (BIM) is also taught and directly applied during the course for getting the students used to this collaborative way of thinking.

Keywords: *Smart Building Engineering, BIM, interdisciplinary curriculum development*

1. New requirements because of more building technology

Buildings are not only made of concrete, steel and wood, but the proportion of technical components such as heating, lighting and information technology, the technical building equipment, is constantly increasing [1]. Here, water and air, energy and information move through structured pipe networks, creating good living and working conditions inside the building. The times when technical systems such as heating, power supply or control technology were largely planned and carried out independently of each other are now finally over. On the one hand, modern information technology links the individual trades with one another, and on the other hand, the increasing coupling of energy conversion processes (e.g. fuel cells, photovoltaics, solar and geothermal energy or heat pumps) lead to a much closer interaction of the components than before. In addition, the design of the buildings has a major influence on energy consumption and the level of building technology installed inside. The intelligent linking of technical components with one another is increasingly leading to "smart" buildings. So the planning and construction of such smart buildings requires, more than ever before, interdisciplinary collaboration between the classic disciplines of civil engineering, architecture, electrical engineering, information and energy technology as well as technical building equipment.

2. How can these requirements be implemented in a curriculum?

In order to be able to specifically implement these new requirements in a single degree program, the bachelor's degree program "Smart Building Engineering" (SBE) was developed at the FH Aachen and has been successfully implemented since 2018. For this purpose, a completely new concept was developed in which three separate and independent faculties at Aachen University of Applied Sciences (civil engineering, architecture, electrical engineering and information technology) offer and operate this course of study together and across disciplines. In order to be able to tailor the range of courses as precisely as possible to the needs of the construction industry and thus to future employers, industry representatives from the sector were asked for their opinion on relevant content and methods and the requirements profile was defined accordingly: In order to qualify new employees for complex issues in technical building equipment, the Smart Building Engineering course contains essential areas of building and supply technology, electrical engineering and modern control technology. It also includes classic subjects such as building construction and architectural history.



Modern planning methods such as BIM (Building Information Modeling) and working with various simulation tools are also taught and practiced during the course.

3. Career fields for Smart Building Engineers

In his professional life, the Smart Building Engineer has the task of understanding all the companies and actors involved in the construction as part of an interdisciplinary planning team made up of architects and specialist planners and of taking on the processing of interdisciplinary issues relating to design, construction, technical equipment and system integration. Technical, economic and ecological criteria must be considered and optimally implemented. This demanding task can be carried out both in a general manner in the area of concept development or system integration or in a more specialized manner in individual subject areas within the technical building equipment.

With the increasing introduction of BIM methodology into construction projects and planning, simulation and the comparison of different planning variants are becoming increasingly important in order to identify the best solution for a specific construction project and then implement it successfully. The development and optimization of products and technical components by the relevant manufacturers is also an interesting field of employment for Smart Building Engineers.

4. Support from industry

The “Smart Building Engineering” foundation has set itself the goal of supporting business and research in this area and of networking scientific institutions with companies in the industry. By providing financial resources for two endowed professorships for the course, the foundation has supported the SBE course at the FH Aachen from the very beginning. Every year it also presents the three best theses with the SBE Award.

Both the foundation companies and numerous other companies from the construction industry actively support the course and its students through lectures on the companies' activities as part of the course of study, with excursions to companies, with the supervision and implementation of internships and final theses.

In this way, students get to know potential employers during their studies and gain valuable insights into their future professional life.

The network “Aachen Building Experts” (ABE) also actively supports the SBE course through numerous events in the construction industry, specialist lectures, a job portal also for students and excursions to member companies [2].

5. Challenges in implementation

There are diverse and sometimes new challenges for a course of study in which many different disciplines and perspectives come together. Basically, these can be grouped into technical and organizational problems:

5.1 Content specifics of the SBE course

When it comes to the technical characteristics, it should be taken into account that the many different specialist disciplines also bring in many different perspectives, terms and sometimes their own “technical language”, which are not always congruent. The sometimes very different roles in the construction process of the specialist disciplines involved also mean that role-specific experiences, prejudices and the weighting of individual subject areas are very different. The limitation to a curriculum with 7 semesters of standard study time, in which the focus is on an overview of the entire construction process, makes it necessary to narrow down and select from a large range of topics.

Since the construction industry is changing towards digital planning methods such as BIM and towards a further development of digital models into digital twins of buildings, a solid basis should also be provided in this area in the interests of future viability. In this way, the sometimes blatant planning and execution errors and massive communication problems between those involved in the construction can be avoided and converted into collegial cooperation.

5.2 Organizational specifics of the SBE course

A course of study that is implemented jointly by three independent departments requires a high degree of organization and coordination in order to be carried out successfully. Small differences between the departments that are not even noticeable in degree programs in a single department can become challenges: At the FH Aachen there are no uniform exam and lecture times, which greatly complicates the timetable and exam planning due to different time periods and deadlines. Due to the postponed lecture and examination times, many students on the SBE course felt very stressed, as there were



hardly any fixed times during which no courses or examinations take place. Planning vacations, external internships or work during the semester holidays could only be done spontaneously in the beginning of the course.

The sometimes completely different examination offerings of the departments involved (2 or 3 examination dates per year, examinations within two examination weeks, examinations over a period of up to 8 weeks) also contributed to this problem. In some cases there even was an overlap between lecture time in one faculty and exam time in the other faculty.

Due to the high coordination effort, planning a semester took longer than usual and students could sometimes only be informed late and often had to accept “special solutions” (recorded courses due to overlaps in the timetable, long breaks between individual courses, etc.)

Joint lectures with students from other courses such as architecture or civil engineering lead to couplings in the timetables because these courses are attended together. The use of teachers in more than one course also sometimes leads to overlaps in the timetable.

5.3 Optimization as a process

Some of the problems just became apparent during the course, so some adjustments were necessary to solve them and ensure that everything runs as smoothly as possible: In order to have clear responsibilities without duplication, the course is organizationally affiliated with one of the three faculties involved. This means, for example, that only one office is responsible for registering for examinations and there is a specific contact person for the students and less confusion. The supervision and organization of the SBE course is also supported by a research assistant, so that the information comes together centrally with one person, who can therefore better keep track of things and act as a contact person for colleagues and students.

In order to improve the exchange of information between the faculties, a contact person is appointed from each of the faculties involved who takes part in regular (digital) meetings and then informs colleagues in their own department.

In addition, the lecture and exam times are better coordinated between the departments, so that there are less overlaps and better planning for the students.

6. Conclusion and Outlook

During their studies, the SBE students gained their first practical experience in external internships in industry and made valuable contacts with future employers. This led to good networking in the industry right from the start, so that the first SBE graduates had no problems starting their professional lives with their first job successfully. The feedback from industry is consistently positive and the graduates are very satisfied with their degrees and the opportunities on the job market. The basic idea of training the most “suitable” engineers for technical building equipment in a practical manner and using digital planning methods seems to fit well with the needs of the construction industry and should be continued in an industry-oriented manner.

In the future, it would be desirable if the SBE bachelor's degree program could be supplemented by a thematically suitable master's degree program at the FH Aachen, so that students who are aiming for a master's degree do not necessarily have to change universities. The first coordination between the involved faculties has just begun.

Research is being further advanced by the Institute for Smart Building Engineering (ISBE), founded in 2023 at Aachen University of Applied Sciences [3]. In addition to student jobs and interesting topics for theses, the research projects there also provide input for the degree program via research partners from industry, from which students can benefit during their studies. There is now also the possibility of doing a doctorate in the field of Smart Building Engineering at the FH Aachen through the Doctoral College NRW. [4]

These good opportunities will certainly be interesting and promising for many students and will enable them to start a career in the field of technical building equipment successfully and sustainably.

References

- [1] <https://www.tga-fachplaner.de/meldungen/tga-marktdaten-haus-und-gebauedetechnikbranche-waechst-weiter>, 19.02.2024
- [2] <https://aachenbuildingexperts.de>, 03.03.2024
- [3] <https://www.fh-aachen.de/forschung/institute/isbe/>, 03.03.2024
- [4] <https://www.pknrw.de>, 04.03.2024