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Practical engineering theses under pandemic conditions: challenges and new approaches

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Abstract

Bachelor and Master Theses are important elements at the end of engineering studies. By independently working on a practical topic, the students should prove that they have learned all necessary tools to deal independently with typical problems from everyday work of an engineer with support from a supervisor in a given time frame. Usually, the students either work on a specific question from the industry in cooperation with an industrial company as a partner or they work on a partial aspect of a research or development project at the university. Due to the corona pandemic and the resulting restrictions such as contact restrictions, difficult access to laboratories at the university, entire companies working in home office mode for several month and paused research projects, new ways for Theses had to be developed spontaneously [1,2]. Unfortunately, since it can't be foreseen when normal operation at the universities will be possible again in the long term and in a predictable manner, new concepts such as remote support and working on a project from home with the students were tried out. Questions often had to be modified in such a way that they can be processed meaningfully from home using simple tools and without a lot of technical equipment. In most cases, the implementation was a success: the students were happy to be able to successfully complete their studies without any further loss of time or financial problems, and the companies were pleasantly surprised by the often creative solutions and remote support for the projects, also from the university. Many interesting ideas for future projects and theses have emerged, which also include e.g. further distant industrial partners can be carried out in the future. So new methods of remote project team cooperation can be used in future.

Keywords: *Engineering courses, Bachelor and Master Thesis, Remote-Supervision, industrial partners, Corona-Pandemic*

1. Situation of students under Corona pandemic conditions

The global corona pandemic has also changed the situation of students and studying in general since it emerged in Europe at the beginning of 2020: Due to the contact restrictions imposed during the lockdown, many courses suddenly had to be held completely digitally instead of on site. The students had little contact with their lecturers and fellow students, and many struggle with loneliness. Those who started their studies during the pandemic usually hardly know their fellow students or the otherwise normal everyday life at the university. Postponed and canceled exams and the frequently changing rules lead to further uncertainty. In addition to poor planning and a lack of prospects, this circumstance often causes a delay in the entire course of study. In addition to the psychological problems, many students have financial problems, since many part-time jobs, e.g. in gastronomy, disappeared because of business closures and lockdowns and no alternatives available [1,2].

2. Special situation graduation

Bachelor and Master Theses are important elements at the end of engineering studies. By independently working on a practical topic, the students should prove that they have learned all necessary tools to deal independently with typical problems from everyday work of an engineer with support from a supervisor in a given time frame. Usually, either the students work on a specific question from the industry in cooperation with an industrial company as a partner or they work on a partial aspect of a research difficult or development project at the university. In most courses, the final thesis also accounts for a large proportion of the overall final grade and the thesis often is a topic in job interviews with graduates when they start their career. Therefore, it is also of great importance for the students.

For those students who are about to finish their studies the situation is extremely challenging because of the pandemic effects: Even if they have successfully completed all the necessary exams and

courses, new problems arise in connection with the thesis due to the pandemic situation. The procurement of literature is made more difficult by partially closed libraries. Access to laboratories, workshops or test stands at the universities is severely restricted [3]. Many universities have extended submission deadlines and hardship regulations for theses to compensate for the problems and delays, but many students have great difficulties to even find a suitable topic for a thesis [4]. Many research projects at universities, which often also offer interesting questions for theses, are delayed because the scientific staff work in the home office and can hardly carry out experiments. Theses in industry are hardly supervised or not offered at all due to the home office activities of the employees and financial bottlenecks in companies because of short-time work. Here, the poor ability to plan due to the pandemic plays an important role as well, since many companies find it difficult to agree to supervise a thesis for a period of several months and put off candidates instead [5]. Many students ask themselves whether it makes more sense to complete their studies somehow and struggle with an uncertain job market with application problems, or whether they should study longer and hope for better times after the pandemic. [6]. They suffer from this disorientation and the universities often do not know exactly how to proceed as well [7,8].

3. Making the best of it

Since it can't be foreseen when normal operation at the universities will be possible again in the long term and in a predictable manner, new concepts were tried out. It was stuck to the general concept, that the students were given real questions as a topic for a thesis e.g. from ongoing research and development projects. Industrial projects were supported also as far as possible under the changed conditions by the university and companies were encouraged to provide topics despite uncertain times.

Due to the contact restrictions, support had to be contactless and digital as far as possible. It has turned out to be useful to enable each individual student to have a regular digital meeting with the supervising professor and the scientific staff or industrial partners involved in the respective question. In this way, questions can be directly asked, answered and discussed, and at least a certain professional exchange is possible. This also creates a certain commitment when the students have to present their progress briefly every week. Since many students find it difficult to continue working on their project in a concentrated and structured manner at home, it helps them if there were still fixed appointments in the digital sphere despite the lockdown. In urgent cases, there was also the option of communicating by telephone and e-mail, as is otherwise possible with direct contact on site.

In most cases, the topic also had to be worked on completely from home: In the case of planning and conception topics, this was possible without any major problems as long as the technical equipment (PC, software, Internet access, etc.) was available. Even a thesis, for which research was carried out with various industrial partners, could be carried out completely digitally with little additional effort: The request to the industrial partners was made by email and by telephone. Since the interviews that were actually planned on site could not be carried out and arranging appointments with the employees in the home office also was more difficult as usual, a questionnaire was developed. The industrial partners surveyed were able to respond at any time when it suited them.

Other practical questions had to be modified in such a way that they could be worked on from home as far as possible. Since laboratories and workshops were not available, there were several approaches to lead the projects to success: In some cases, students could borrow the parts they needed and take them home to work on the projects. Programming a microcontroller like Arduino [9] could be done from home without any problems. Projects with larger individual parts, such as e.g. the design and construction of a test stand for a flow switch, the individual components had to be assembled in such a way that assembly at home is possible with simple tools. Then the assembly was started in such segments that the complete system could later be assembled quickly in a test hall in order to carry out the measurements. To do this, the individual segments had to be transportable easily and prepared for an assembling procedure as simple as possible. This required completely new aspects in the conception of the system and a certain technical talent on the part of the students. If that was not possible either, individual projects were not implemented actually, but analyzed using appropriate simulations. Here the questions had to be modified as well in some cases or the conditions had to be precisely defined so that complex projects could also be processed sensibly within the given time frame.

4. Outlook

In most cases, the implementation was a success: the students were happy to be able to successfully complete their studies without any further loss of time or financial problems. Many students also saw it as an opportunity to adapt a project to the actual conditions and make some progress instead of

waiting for the pandemic to end. In this way, they have learned a lot about problem-solving strategies, which is an important skill for aspiring engineers who will have to react to changing frame conditions in ongoing projects in their future professional careers. The involved companies and industrial partners were pleasantly surprised by the often new and very creative solutions and remote support for the projects, also from the university. Many interesting ideas for future projects and theses have emerged, which also include e.g. newly acquired distant industrial partners who urgently need new engineers used to project management. These extra skills and fresh experiences will definitely pay off for both employers and young professionals or start-up founders as well.

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