Summary of discussions at the 17th SEFI Mathematics Working Group Seminar, Dublin, June 2014

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The first group discussion in Dublin was concerned with the question **"What are the important topics in the mathematical education of engineers?"**. The discussion was preceded by a presentation of the steering committee of SEFI's MWG on current offerings and future tasks (cf. the seminar proceedings at http://sefi.htw-aalen.de). The contributions by the participants of the discussion session can be summarized as follows:

- The first issue is concerned with the "content" of mathematics education for engineers in a broad sense. It was stated that the competencies presented in the group's Curriculum Framework Document need more detailing. Moreover, the lists of topics to be taught need rethinking when we want students to deeper engage in specific topics in order to enhance understanding. The split of time between different learning scenarios like lectures, exercises, projects, labs, etc. is a further crucial issue. If we spend more time letting students explore and apply concepts, less contents will be covered.
- Close interaction between mathematics lecturers and lectures of application subjects taught in parallel or later on was also stated as crucial issue. The choice and organization of contents requires cooperation. Moreover, this is also necessary for using a "common language" regarding mathematical concepts since otherwise students will not recognize these concepts when they are needed in an application subject. In addition to cooperation with colleagues, contacts with industry would be helpful in order to spot topics of relevance for daily work.
- The involvement of students in the learning process was seen as a further important topic. Students should become independent, active learners and for this they need motivation that the mathematical education is useful within the context of their engineering study course and later work environment. Approaches for providing this motivation stated during the seminar (see seminar proceedings) include the activity by Goold who gave the students the task to find practical applications of the mathematical topics dealt with, and the project course used in Chalmers University (see contribution by Jahan). The common goal is to let students develop a positive attitude towards mathematics as useful language and tool for their future life in engineering. This could also help against the sometimes bad attitude in society towards mathematics.

  Growing heterogeneity in the student population adds to the problem. Dealing with this phenomenon without excluding weaker students and boring brighter students is still a major challenge.
- Finally, the difference between officially stated learning outcomes in school and university on the one hand and "less exciting" reality on the other hand is also an issue to be addressed. This is related to the problem of missing sustainability. Even if the learning outcomes matched reality at some point in time, in later stages of the educational process when they are needed again, many concepts and procedures have been forgotten.

The second discussion was concerned with the question "**How can technology be used to improve teaching and learning?**". This discussion was preceded by the keynote lecture by Sangwin on 400 years of educational technology. He introduced a very broad notion of technology including the usage of symbolism. The main question he posed was on the understanding of mathematical

concepts and procedures that is still necessary for making adequate use of available technology (like the log slider in earlier times and CAS today). The contributions by the participants of the discussion session can be summarized as follows:

- The following new opportunities provided by technology were recognized:
    - better visualization of mathematical concepts by using mathematical programmes
    - large data manipulation in more realistic projects
    - easier assessment
    - use of smartphone facilities like acceleration sensors for practical applications
    - use of smartphones for activating students by voting (www.mentimeter.com)
    - usage of videos for flipped classroom scenarios (lecture becomes tutorial).
- Modern technology also creates some new challenges and tasks in the mathematical education of engineers that must be addressed for technology to really improve teaching and learning:
    - One large new challenge is to strike the right balance between work with and without technology in a blended learning approach. Some participants advocated an approach where concepts come first and their application using technology comes later.
    - Learners should discuss and experience an adequate use of technology. They should for example see that there is no need for technology when it comes to computing cos(0). Students should also experience the limitations and pitfalls of mathematical technology (for example: are all possible cases covered in a computational procedure?) such that they develop a critical attitude towards technology and can make goal-oriented use of technology.

Technology will be there and cannot be ignored. This is also taken into account in the competence-oriented Curriculum Framework Document where the competency of using aids and tools addresses the issue explicitly.