

**Title:****Challenges Associated with Teaching CAD/CAE****Authors:**René Andrae, rene.andrae@uni-due.de, University of Duisburg-Essen  
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**Introduction:**

In this paper, new teaching concepts for studies of mechanical engineering and plant construction are discussed, to prepare students result-oriented for the requirements of modern product development processes. Starting with basics in descriptive and constructional geometry, methods and information technology fundamentals will be taught in coordinated courses, which are required for mastering multidisciplinary product development processes. This includes internships and assignment papers, where a structured approach and the sensible use of various software tools (CAD, analysis, simulation, etc) must be demonstrated. This is accompanied by eLearning tools and multimedia teaching materials on the Internet.

**Main:***Chair Computer-Aided Design, University of Duisburg-Essen*

The University of Duisburg-Essen is one of the youngest universities in the Federal Republic of Germany. Almost 40,000 students are enrolled from 130 countries. The department for Computer Aided Engineering is part of the Institute for Product Engineering, which belongs to the engineering department. This year the chair can rely on a 20-year experience in research and teaching in the area of CAD / CAE.

*Use of CAX tools in teaching*

By using CAX tools far-reaching opportunities for product and process optimization are given. Figure 1 shows various stages of the design and manufacturing process. Below the respective CAX tools are assigned. An efficient and modern education of students with these tools is not only essential, but also required by the industry [3].

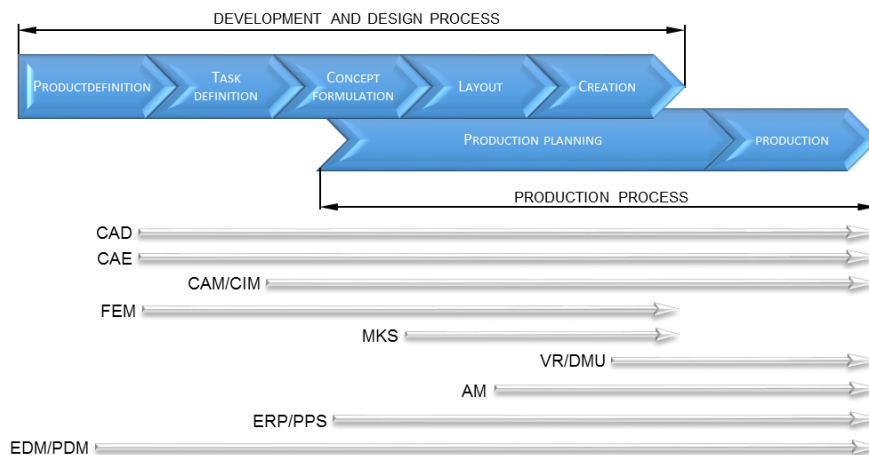


Fig. 1: Development, Design and production process with respective CAX tools.

In the course of changing the diploma degree program to the Bachelor / Master degree program all courses had to be re-structured, according to the objectives of this new system. The challenge here lies especially in the fact that even after the sixth semester of higher education, a professional qualified bachelor's degree should be achieved. Therefore, specific professional skills must be demonstrated earlier than before. In the field of construction technology education, a three-stage structure was chosen in the bachelor's degree program. First step is the training of spatial abilities and mastering basic techniques and standards for the production of technical representations of parts and assemblies. An introduction to working with CAD systems is done here also. In the second stage expiry strategies, design methodological approaches and boundary conditions (design for X) are treated for multidisciplinary product development processes. CAD techniques for the construction of part and assembly models and techniques and for the derivation of appropriate product documentation and information technologies for product data and project management will be deepened. In the third stage selected aspects of the geometry and product optimization are discussed. Above all interactions between functional and manufacturing-oriented modeling are the focus. In all three stages assignment papers are prepared by the students, which should contribute to the strengthening of skills.

Building on that, a three-stage approach to strengthen the competencies in the CAE area was also developed in the master's degree program. The focus of the courses is not exclusively in the field of construction, but also in the region of selected engineering process chains. In the first module problems are discussed which are important for multi-disciplinary product development processes. CAD techniques for building and analysis of cross-product and plant models will be addressed, as well as CAD-CAM-couplings and methods for quality assurance and product presentation. In the second module fundamentals of computer-aided product optimization are provided and deepened in the field of FEM, MBS and the flow calculation. In the third module information technology aspects of KBE (Knowledge-Based Engineering) are treated. This will have particular regard to opportunities for knowledge integration in the CAD environment. Components are the use of appropriate APIs (Application Programming Interface) as well as the Workflow Management in PDM systems.

#### *Use of modern teaching methods at the CAD teaching*

Due to the different abilities of students in terms of spatial ability and other skills and knowledge the use of modern teaching methods, from the beginning of the studies, is useful. The classic structure of a course of lectures and plenary exercise is therefore counterproductive. A concept that has prevailed at the Chair CAE, University of Duisburg-Essen in all subjects, is the combination of a conventional plenary exercise with self-editing tasks. In this case, one trainer and several tutors, usually advanced students care an exercise. In addition, tutorials or consultation appointments are offered so that students have more opportunities to clarify open questions. Because some of the assignment papers are processed in smaller groups, the team ability of individual members is strengthened at the same time.

The use of e-learning methods is state of the art in the field of engineering sciences [1]. With e-learning portals, students can consolidate the learned exercise material in self-study. There are various possibilities for the integration. A discussion and information platform accompanies and supports students during the respective course. In addition to the provision of teaching materials, also online training sessions are integrated here, such as test questions for repetition. The students can solve this in self-study.

The integration of videos to teaching content generally reflects a new trend in teaching and is accepted by the students [2]. For example, the students can access current instructional videos via a YouTube channel. The integration of 3D elements in presentations during the lectures promotes the fundamental understanding of the problem areas to be treated. Various software vendors provide possibilities to do that, but it is emphasized that most CAD systems have their own viewers, which can be integrated into presentations.

#### Conclusions:

This paper describes how modern CAX tools are integrated into teaching. The presented tools are state of the art for the industry and are more and more required by graduates. The distribution was carried out in six teaching modules. These are based on the development design and production processes and the respectively used tools and methods. Additionally, various options for integrating e-learning and other tools to support the teaching were discussed.

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