ENABLING KEY COMPETENCIES BY EDUCATIONAL PROJECT WORK EXEMPLIFIED BY TEAMWORK AND COOPERATION

Albert ALBERS, Norbert BURKARDT, Tobias DEIGENDESCH and Mirko MEBOLDT
Universität Karlsruhe (TH), IPEK – Institute for Product Development

ABSTRACT
Companies demand academic graduates with much more than only professional competence. Methodological skills, social competence or creativity are just some keywords that are mentioned often. Many years academic education concentrated on teaching professional skills, but in changing business environments with increased competition, shorter time-to-market, higher quality demands and high cost sensitivity, graduates have to face novel work contexts, e.g. working in interdisciplinary project teams. The Karlsruhe Education Model for Product Development (KaLeP) addresses competence development beyond pure professional skills. This contribution briefly presents the KaLeP approach and gives deeper insight to the project work of the integrated product development course being a case study. Further on the authors discuss how students can develop key competencies in a realistic project environment. Two examples are teamwork and cooperation support. The contribution points out, how those competencies can be addressed and improved during a four-month project task.

Keywords: kalep, blended-learning key competence key qualification, teamwork, project work

1 INTRODUCTION

Products and their corresponding development processes are of increasing complexity. Development engineers and designers are affected by increased demands to quality, time pressure and cost. Result of this change in development environments was the deployment of new processes and methods, e.g. interdisciplinary teamwork. Thus, recruiters and personnel managers expect graduates especially those from engineering programs not only to have professional skills. Beginners also are expected to bring along key competencies, such as the ability to work in a team, methodological skills, creativity, time management, frustration tolerance or the ability of bringing ideas into reality.

An inquiry of the German Chambers of Industry and Commerce (DIHK) in 2004 constitutes that employers were dissatisfied with the social and personal competencies of applicants (cp. [1]). 55% of asked employers identified social competence as deficient and 47% found fault with the personal competence. 39% complained insufficient professional and methodological skills. The main reason the answering companies addressed is a deficient or missing linkage of theoretical and practical

aspects during the course of studies. If employers parted with entrants, only in 13% of cancelation cases, a lack of professional competence was the reason.
Therefore, higher education has to draw the conclusion that novel approaches are necessary. The authors consider the duty of a university not only to educate specialists but to facilitate students to develop a general professional competence. Key competencies are seen as those competencies that are necessary to develop, employ, improve and extend professional competence and thus to enable operational competence.
To face this challenge, during the recent years the Karlsruhe Education Model for Product Development (KaLeP) [2,3] was developed, introduced and improved continuously. Elements of the approach are three course levels, different settings with changing teaching contexts and intense team-based project work.

2 THE KALEP-APPROACH

The Karlsruhe Education Model for Product Development (cp. Figure 1) comprises three elements, i.e. courses on increasing levels: Machine Elements (concerning systems), Methods of Product Development (concerning tools and methods) and Integrated Product Development (concerning processes). Both the machine elements and machine design course are mandatory and are attended by several hundreds of students (currently 750). Despite this number of participants, project work was introduced and observed as a successful means to enable students not only to develop competence regarding machine elements but also to learn how to cooperate and to coordinate in a design team.

Karlsruhe Education Model for Product Development **KaLeP Elements**			
	Systems	Methods	Processes
Course title	**Machine Design**	**Methods of Product Development**	**Integrated Product Development**
Setting	• **lecture** • **tutorials** • **project work**	• **lecture** • **tutorials**	• **lecture** • **tutorials** • **project work**
Key competencies: Level of acquisition	**high**	**medium**	**very high**
Course contents	• **team work** • **self organization** • **communication** • **idea transfer**	• **methodological skills** • **creativity techniques**	• **team leading** • **team development** • **project management** • **presentation** • **moderation**
Number of students	**~750**	**~400**	**30**

Figure 1 Elements of the Karlsruhe Education Model for Product Development

In the Machine Elements course the lecture focuses on theoretical contents, while tutorials concentrate on application of the given theory in concrete cases. For the workshop, students form teams of five members in order to fulfil a small, but complex

design task with project character. This accompanying design project is coached by faculty stuff and student helpers. Students receive individual feedback regarding performance and competence development to be able to evaluate their state within their own learning process. The workshop performance is assessed according to five fields of competence: professional, methodological and social competencies as well as potential of creativity and the ability of transferring ideas (cp. Figure 2). These fields of competence are based on case studies and the experience of the authors (cp [3]). Recent integral educational approaches (e.g. CDIO [4]) and publications (e.g. [5] point similar skills and competencies required for successfully working development engineers.
The Methods of Product Development course is not accompanied by team-based and coached project work. Thus, key competence development is not as intense as in the Machine Elements course.
The third element, i.e. the Integrated Product Development course addresses product development processes as well as tools and methods to manage these complex processes. At the example of this course, development of key competencies is explained in the following sections.
KaLeP as a teaching context for product development engineers also blends in to holistic approaches, such as the CDIO initiative (cp. [4]).

Karlsruhe Education Model for Product Development **KaLeP Fields of Competence**		
1. Professional Comp.	2. Methodological Comp.	3. Social Competencies
▪ mathematics ▪ technical mechanics ▪ machine elements ▪ IT ▪ foreign languages	▪ design methodology ▪ FMEA ▪ QFD ▪ DOE ▪ statistics ▪ CAD	▪ personal techniques of working ▪ communication and teamability ▪ visualisation skills ▪ presentation skills ▪ leadership
4. Abilities in transferring Ideas	5. Potential of Creativity	
▪ customer orientation ▪ awarness of costs ▪ systematic approach of working ▪ ability of decision making	▪ creativity techniques ▪ courage for new solutions ▪ bearing down the play for safety	

Figure 2 Fields of competencies

3 THE INTEGRATED PRODUCT DEVELOPMENT COURSE

The integrated product development course is the third element of KaLeP. The course addresses development processes and the necessary management tools and methods. Similar to the Machine Elements course, Integrated Product Development consists of lecture, workshops and project work. Lecture contents are innovation processes and management, simultaneous engineering, core team management, problem solving methodology, psychological aspects in product development, team processes and development, team leading, marketing, cost and quality management in product development and decision making. Due to the intense coaching in workshops and project, the number of participants is restricted to only 30 chosen students that can

attend the course. These students usually are just before graduation. The lecture is partly in ex-cathedra teaching style, partly an open dialogue between professor and students.
The project that is part of this course has a task from a partner from industry. This ensures realistic development problems and realistic decision scenarios. During the course of the project, the students attend additional workshops that both address professional and key competencies. Workshop aspects are scenario management, project management, presentation techniques, moderation, problem solving, TRIZ (a method for finding novel solutions), target costing, creativity & ideation, decision making and quality function deployment.
During the term 2006/07 the authors asked after each workshop, how helpful the contents seemed to be in order to solve the project task. Finally, after the term, the questions were asked again. While most the evaluation for most workshop topics pointed out to be almost constant, the students underestimated the relevance of decision making during the project (15%: helpful) in contrast to the retrospection (60%). Thus, the conclusion is drawn that students could not identify all relevant issues in theoretical lectures and practical workshops. Consequence is that project work with a realistic environment, as described in the following section, enables students to identify relevant issues for their professional career as design engineers and thus supports the individual development of key competencies.

4 PROJECT WORK

The project in Integrated Product Development begins with the early stages of product development, i.e. the identification of market trends and needs. Based on this information the students develop scenarios for future markets and create product profiles, which describe the customers and their demands without anticipating possible product solutions. After having passed several following milestones for ideas, concepts and designs, virtual prototypes and function prototypes are presented to an audience. The project work is supported by coaching through skilled faculty staff. Additionally weekly tutorials, respectively workshops are given. For doing the project the teams gain access to team workspaces featuring IT-infrastructure and relevant software, such as office, CAD or FEA. Further on the teams learn how team cooperation and knowledge management can be supported in design project by using a wiki system [6].
Teamwork, team processes and team leading are contents in the theory framework of the Integrated Product Development course. At the beginning of the course, students completed simple personality type indicator tests roughly classifying into three types of persons preferring implementing, deep thinking and creative thinking. Beside the educational reason, the tests come along with the secondary effect, that teams can be built that are heterogeneous in their type constitution. This way of composing team supports team development and prevents inapt teams. During the course of IP, the participants learn about team development processes and leadership. In this context, team composition once again is addressed. Thus, students have the chance to assess the preference types of the other team members and discuss their outcome with them.
After constituting the teams, the project task given by an external partner is released. Very important is the broad definition of the project task in order to have a wide space for solutions. A typical task definition would be, that “company X would like to enter a new market segment and thus needs innovative products with a high market potential”. From that point on, students develop product profiles, ideas and concepts, evaluate those according to weighted criteria derived from market and present those at several milestone meeting to the supervisory board, which consists of representatives from the

industrial partner and IPEK. These milestone meetings emphasize the serious character of a development project and provide the chance to practice the just developed competencies.

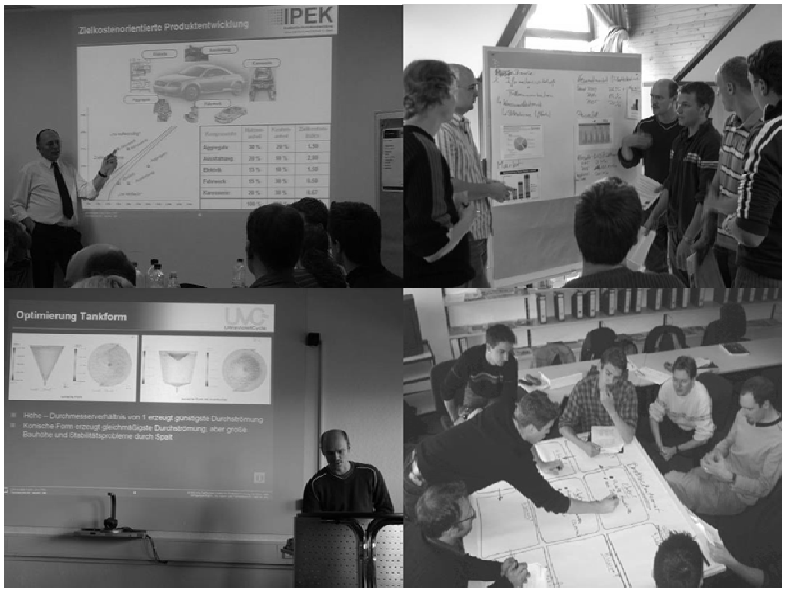

Figure 3 Impressions from lecture, workshop and project work

In the very beginning of the project time, the project groups complete a team-training workshop, in which a task can only successfully be fulfilled by intense teamwork – although the task is a very simple one. Team behaviour is supervised and observed by psychologists. In addition recording by a video camera enables the student teams to reflect their behaviour later on. Based on that experience the students derive measures in order to improve coordination and cooperation in a team for the subsequent project time. If teams or supervisors identify the necessity of further training on cooperation, team-specific coaching can be "ordered". Comparing studies with groups with intervention (team workshop) and without intervention (comparison group) were not conducted since all students must have same chances in competence development.

5 SUMMARY AND CONCLUSION

The present contribution pointed out in what way integration of project work into academic education can support the development of key competencies of coming development and design engineers. The shown Karlsruhe Education Model for Product Development is a threefold approach combining lectures, tutorials, respectively workshops and project work. It was shown that project work can sensitise students how relevant some issues are for daily design work, which cannot be accomplished by theoretical lectures or workshops with small case studies. Feedback from former students and from industry partners indicate that the project based approach being accompanied by workshops concerning soft skills results in development of competencies being expected by employers.

REFERENCES

[1] DIHK. Fachliches Können und Persönlichkeit sind gefragt – Ergebnisse einer Umfrage bei IHK-Betrieben zu Erwartungen der Wirtschaft an Hochschulabsolventen. June 2004 [PDF]. Available: http://www.ready-for-the-job.de/pdf/umfrage_hochschulabsolventen.pdf [Accessed on 2008, February 15th]. Compare also: Ingenieur Karriere, *VDI-Nachrichten*, No.3, 2004

[2] Albers, A. et al. Competence-profile oriented education with the Karlsruhe Education Model for Product Development (KaLeP). *World Transaction on Engineering and Technology Education*, Vol.5, No.2, 2006

[3] Albers, A. & Burkardt, N. The "Karlsruhe Model" – A successful approach to an academic education in industrial product development. Procs. 3rd *Workshop on Global Engineering Education* GEE'3; 18-20 October, Aachen, Germany, 2000

[4] The CDIO initiative. http://www.cdio.org [Accessed on 2008, February 15th]

[5] Jänsch, J. Akzeptanz und Anwendung von Konstruktionsmethoden im industriellen Einsatz. VDI Fortschritt-Berichte Reihe 1 Nr.396, Dissertation TU Darmstadt, 2007

[6] Albers, A. et al. Wikis as a Cooperation and Communication Platform within Product Development. Procs. *Int. Conf. on Engineering Design* ICED'07, 28-31 August 2007, Paris, France

Albert ALBERS
Universität Karlsruhe (TH)
IPEK – Institute of Product Development
Kaiserstraße 10
76131 Karlsruhe
albers@ipek.uka.de
+49 721 608 2371