27TH INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
11-12 SEPTEMBER 2025, UNIVERSITY OF MALTA, MALTA

A STUDENT JOURNEY: TRANSFERRING HUMAN-CENTRED DESIGN EXPERIENCE TO A LECTURE EXERCISE INTEGRATING AI TOOLS

Marc NUTZMANN[1,2], Thorsten SAUER[1,2], Markus VOß[1,3] and Hulusi BOZKURT[1,3]
[1]IHB Institute for Education and Higher Education Research, DHBW, Germany
[2]DHBW Baden-Wuerttemberg Cooperative State University Ravensburg, Germany
[3]DHBW Baden-Wuerttemberg Cooperative State University Mannheim, Germany

ABSTRACT
Teaching the philosophy of Human-Centred Design (HCD) and Design Thinking, more so the application, in a two to three-hour lecture is challenging. The authors point out how Engineering Design students in their third semester of a Bachelor of Engineering programme are guided through typical phases of human-centred and user-integrated product development, discussing the main challenges, application and key values in an industrial context. The chosen approach discloses opportunities concerning collaboration, working in interdisciplinary teams in different stages of product development and the integration of customers, respectively users. A so-called HCD roadmap reveals major benefits in the learning process. To foster a transfer to own industrial development projects students were asked to team up, to find a product or service, to develop their own roadmap, to identify customer "gains and pains" in a profile map, fit it to a value map and to sketch or prototype the product or service. The transfer from the experience attained in industry to the lecture exercise facilitated the application of HCD perceptively.
An accompanying survey shows that the consultation of Artificial Intelligence (AI) raised student motivation in the exercise. In the study AI tools particularly delivered quick insights and have been used as a source of inspiration. The study also highlights experiences made with different AI tools along the Engineering Design and Product Development process.
In conclusion, the results of a survey that accompanied the participating students' HCD journey are analysed. The authors conclude on the findings on integrating HCD and AI in the lecture.

Keywords: Human-Centred Design (HCD), design thinking, customer and user experience (CX and UX), artificial intelligence (AI), engineering design, product development process, critical thinking

1 INTRODUCTION
Engineering Education has to keep step with rapid technological advancements and evolving industry needs. Human-Centred Design (HCD), teamwork, decision making on basis of requirements and innovative product features in context of global competition are increasingly important in product development. This study examines how integrating these approaches into higher education can enhance student understanding and motivation. It also focusses on how to prepare students for future challenges and skills, particularly for employing AI tools to typical tasks of the Engineering Design and Product Development process.
Trying to meet (and partially to exceed) customer requirements is already in the primary focus of Quality Management (QM) since the early 1990s. About three decades earlier, the Delphi-Method (1963, RAND) started a systematic and active exploration of the perspective of users, customers and experts. User Innovation (1976, von Hippel), the Lead User method (1986, von Hippel), Integrated Product Development (1994, Ehrlenspiel), Agile Project Management (2001, manifesto for agile software development), Open Innovation (2003, Chesbrough) and Design Thinking (2001, Kelley and Littman) are some of the approaches in developing strategies, respectively processes, for incorporating customers and users in Engineering Design projects of new products, processes or services [4]. This article explores an educational approach aimed at embedding Human-Centred Design (HCD) and Artificial Intelligence (AI) tools into the engineering curricula. Through a structured programme applied in Mechanical Engineering courses, the authors analyse how these methodologies impact student learning, engagement, and

innovation. Survey results indicate that a majority of students recognise the importance of integrating customer feedback in product development and are inspired by the possibilities AI offers. However, the findings also suggest that there are needs for more structured guidance in using AI tools in groups and training on HCD skills.

2 CONTEXTS IN ENGINEERING STUDIES AND STUDENT´S BACKGROUND

At DHBW Cooperative State University the module 'Engineering Design and Product Development' (EDD) is taught in 22 contact hours (eleven 90-min.-lectures) - over eleven weeks for Mechanical Engineering students in their 2nd year of studies. In the twelfth week students take a written exam on the lecture content. The cooperative studies at DHBW generally incorporate three months of theory in academia and three months of practical experience in partner companies per semester, cf. Figure 1. Thus, at the beginning of the lecture the students already have worked on engineering tasks. Some of them even have already some first experience on projects in Engineering Design and Product Development. One of the eleven lectures is on Human Centred Design (HCD), or more generally said on integrating user and customer experience into the different stages of engineering projects.

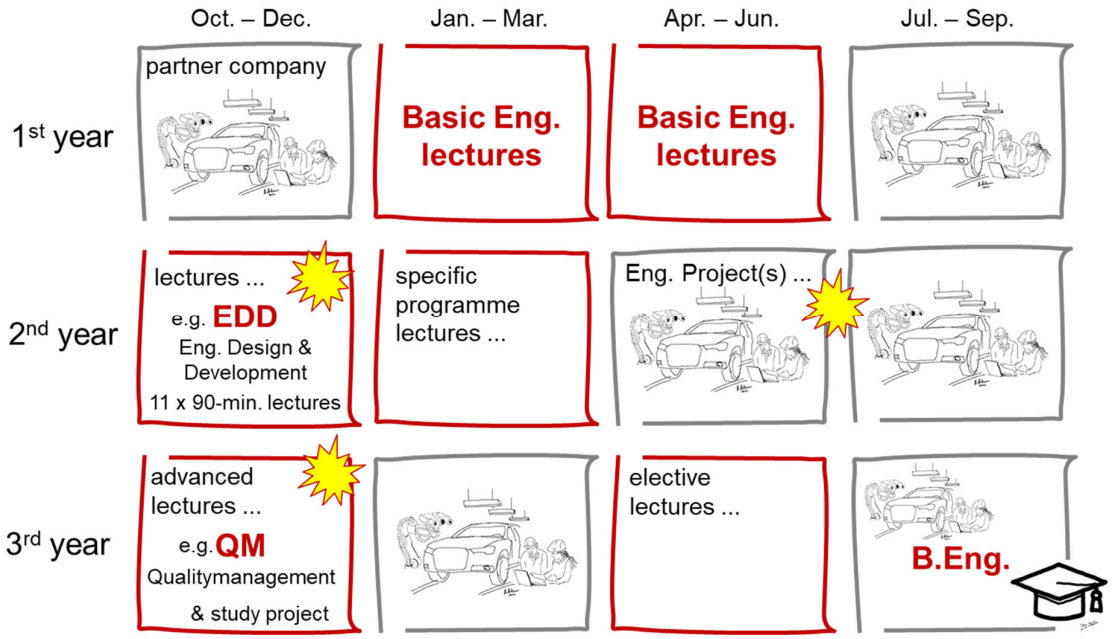

Figure 1. Three year study programme in Mechanical Engineering with 12 week-terms in academia (red) and partner companies (grey) per semester [3]

3 THE HCD TEACHING CONCEPT

In the lecture 'Engineering Design and Product Development' (EDD) students learn about systematic engineering design and product development, about processes, methods and engineering models before they experience how the perspective of users and customers can be integrated in engineering projects. The lecture on Human-Centred Design (HCD) is organised in three parts:

1. an introduction of 15 minutes on engineering models, customer and user integration in general, e.g. the concept of Design Thinking (DT).
2. a 30-minute journey through the major stages of a development project with a special focus on the integration of customers and users. This presentation includes results of every development stage from problem identification, user interviews, observation, workshops, ideation, prototyping to field testing. In this part students get involved as they are asked about challenges, product specifications which are discussed on basis of product examples, competitor products and user feedback.
3. an exercise of 45 minutes in groups with three to five students on a product of free choice. For getting started the students are asked to use the Value Proposition Canvas by Strategyzer [6], [7] and thus define the customer jobs and identify 'pains and gains'. After finding a creative (and

possibly innovative) product concept, they should identify so-called 'pain relievers and gain creators,' which are features in the new product. At this stage, students are encouraged to seek help by AI in order to 'encircle' the features of the product that are of highly competitive and innovative nature.

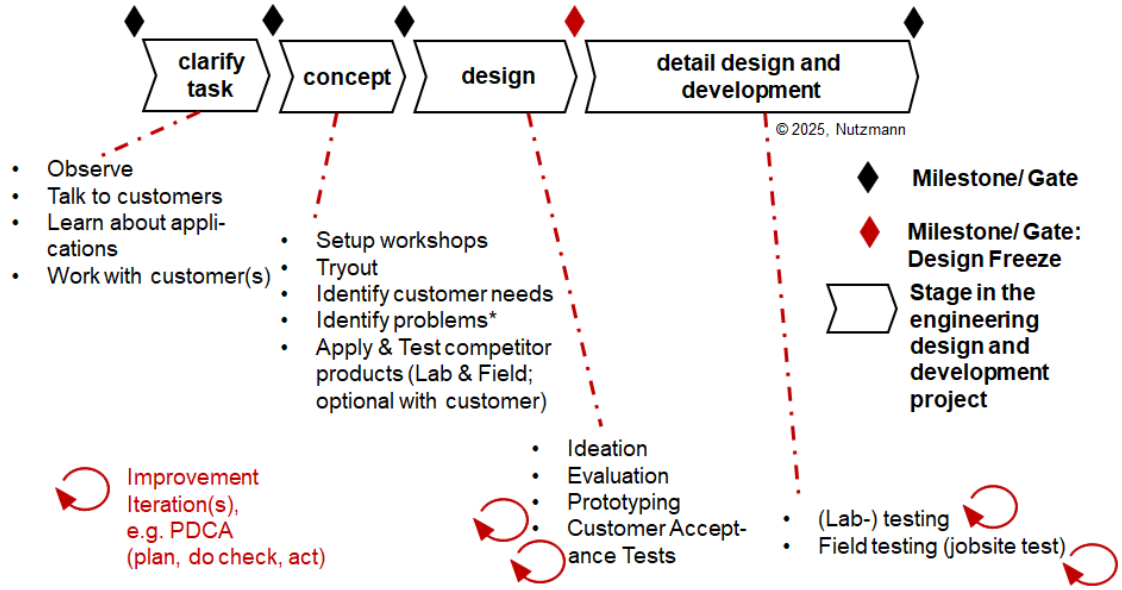

Figure 2. Integrating the perspective of customers and users in Engineering Design and Product Development [4]

The teaching materials are available on a learning management system (Moodle). They include the presentation slides, a video showing the product example used in the field and moreover a summary of the user and customer journey, cf. Figure 2, which can be considered as a 'HCD roadmap' [4].

4 SURVEYS ON HCD

Subsequent to the lecture and group work the students were interviewed in a survey on the experience they have gained on user and customer integration. Altogether 52 students from two Mechanical Engineering, specialised in Engineering Design and Product Development, working for 36 different companies participated in the study. The main results of this study are summarised:

- The students were asked if they thought that a strong focus on customers and users is useful to develop (or optimise) new products or services. On a Likert-type scale (reaching from the value 1, meaning 'very useful', to the value 5, meaning 'not useful at all') students graded it being very useful, in average with a value of 1.5.
- The broad majority of the respondents (77 %) affirmed the hypothesis that an integration of customers and users leads to more innovative products. Only 4 % rejected the hypothesis, while some (19 %) respondents expressed themselves with indifference.
- 98 % of the students in the course pronounced that they would integrate customers and users in their upcoming engineering projects (i. a. six months in the partner company follow, cf. Figure 1).
- 83 % stated that the company for which they work already applies human centred design or design thinking.
- 87 % of the students consented to the question if they had developed ideas of how their company could improve, optimise or innovate their products, processes, services or business models within this lecture. The distribution of the approvals is shown in Figure 3.
- Last but not least, the students were asked if they liked the lecture. 98 % answered with 'yes'. On a Likert-type scale reaching from the value 1 (being very good) to the value 5 (being very poor), students graded the lecture and exercise with a good result (1.8).

An open question gave the students the opportunity to give feedback on the lecture. To some really appealed the hands-on example of a 'real' project. Others liked the sharing of user experience and knowledge transfer by the interactive 'journey' through the development process. On the contrary, the

feedback on the group work exercise was rather mixed. Some did not get the meaning and intention on using the value proposition map. On the other hand, some of the solutions created with help of the Value Proposition Canvas showed rather innovative approaches for improved products, e.g. improvements on a spray gun, a dish washer, a secure gas container fixation, a broomstick, a plug for electric cars, and electric lights.

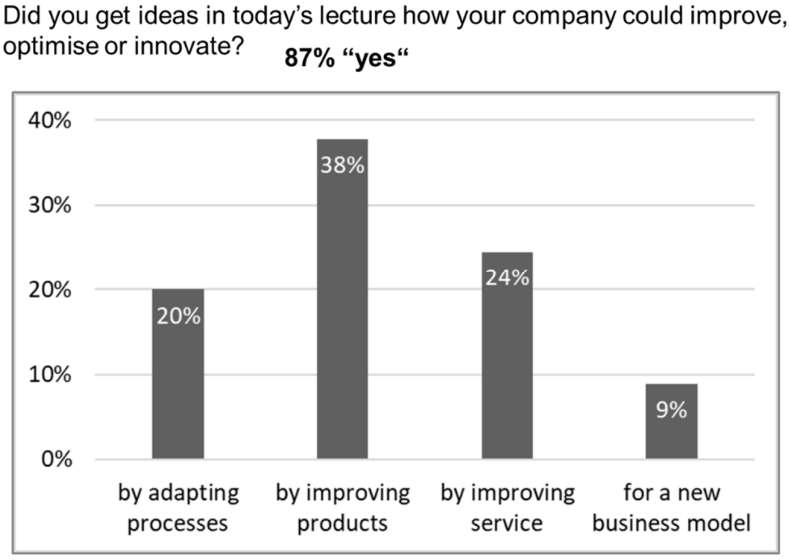

Figure 3. Distribution of students' ideas to improve their partner company

5 APPLICATIONS OF AI DURING THE GROUP WORK EXERCISE

To all appearances, the students were intrinsically motivated to use AI tools while they worked in groups. They were assigned to find a product, a process or a service of their choice and to analyse customer and user needs and requirements. The value proposition map was used to guide, assist and document findings. It could be observed that some groups got really engaged, found suitable products and innovated or improved existing solutions. One group invented a storage box of gas containers for camper vans. One of the students working for a company in that business sector had already experience and played the role of the 'lead user' in the engineering group. This resulted in a very good value proposition map with a prototype picture and new ideas. Only two out of nine groups stated that they used AI at this stage. None of the documentation, i.e. the Value Proposition Canvas, declared on what AI was used for, nor could an advantage be identified if AI were used. The lecture exercise seemed to support creativity and focus on customers and users, or at least on their views. But AI hardly played a role. The question is: why? Before this is answered in sub-section 5.2, some general findings on AI usage are highlighted in the sub-section 5.1.

5.1 AI application – general findings

Survey results on the usage of AI are shown in Figure 4. This year's group is referred to as 'Eng. Design students 2025' and is compared to former student groups. Engineering students in 2025 claimed to use AI regularly. Compared to the previous study the AI application gap of engineering students to their fellow students in Automation studies has been closed. The spectrum of application in the current study is much more differentiated. This is also recognisable in the answers. The students stated that they used AI to find information, help to understand e.g. complex tasks, ideation, inspiration, summarisation of texts, imaging, orthography, literacy. The most obvious difference between the groups is that nearly all Automation students also mentioned AI usage for programming (coding). The students were also asked if AI should be regulated, respectively if AI needs rules. In 2023 87 % of the students declared the necessity of AI rules whereas in 2025 the percentage has even grown to 94 %. This suggests that critical thinking and reflexion has increased as this is a dominating and repetitive issue in society, e.g. in discussions on faked news and biased posts in social media [2].

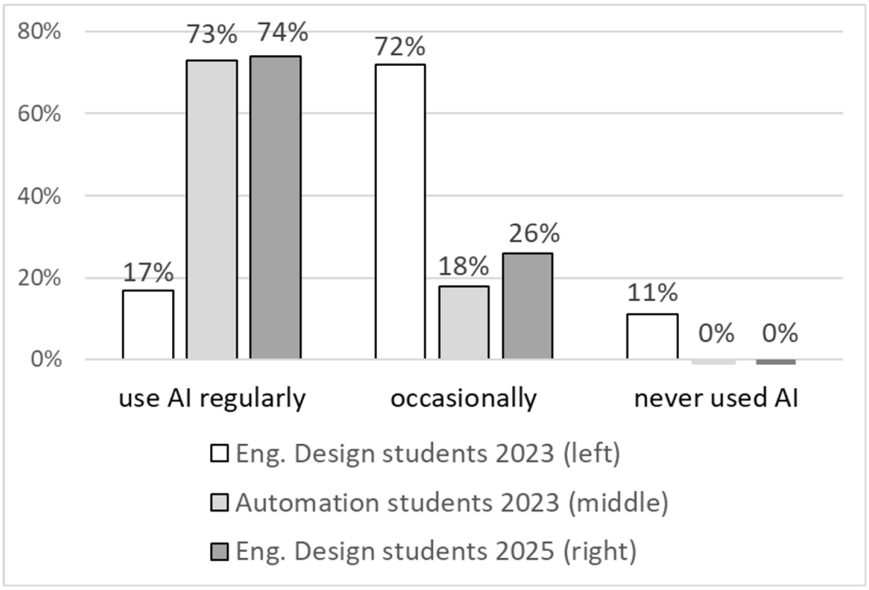

Figure 4. Survey results on usage of AI tools

5.2 AI application – a comparison between HCD and QFD

Trying to answer above question from the beginning of chapter 5, why AI was not widely used in the HCD exercise, although animated to do so, an explanation may be found by a comparison to another lecture, in which all groups used AI (=100%) with promising results. Approximately half of the students of the cohort that took part in the HCD exercise participated in another lecture and study on Quality Function Deployment (QFD), an engineering procedure, part of the module 'Quality Management,' referred to QM in Figure 1. The procedure was published at last year's E&PDE2024 conference [2]. -Now being the following year's student cohort, AI application can be compared between HCD and QFD. Some groups used the same product for QFD as in the lecture on HCD in Engineering Design and Development (EDD), the year before. The difference between the HCD exercise and the application of QFD is that QFD guides students through typical tasks in engineering, and thus helps them in defining customers' needs, in defining specifications, in weighting and evaluating and in analysing competitive products in a structured order. This set of interrelated tasks, but generatively applied, seems to be ideal in connection with AI tools, e.g. with ChatGPT or with Microsoft Copilot which were used for searching customers' needs, defining specifications for products and identifying innovative features. The conversational search engine Perplexity AI was used to find innovative features by searching for competitor products and directly asking for innovative features. Perplexity AI delivers photos and other sources that made product research easy, even with rather unknown products and technology. Step by step the tasks can be prompted using AI in the same manner as the QFD method is structured and applied.

But why was AI used by all groups applying QFD and not by those working with HCD? An answer may be found simply in the fact that students possibly earned more experience in applying AI in this one year between the module on 'Engineering Design and Development' (EDD) and the module 'Quality Management' (QM), cf. Figure 1. AI has become a widely applied tool. Some of the students may have been animated to use AI by the lecture on HCD in the module 'Engineering Design and Development' (EDD). In one known case, a student applied AI in an engineering project during the half year he spent in the company in the fourth semester, after the EDD module, respectively the HCD experience. Thus, the answer may be more complex: The answer may lie in the fact that engineering students are not particularly skilled and educated in observational and interviewing techniques that are required to understand customers and users, required in Human Centred Design (HCD). HCD requires an open, diverge mindset and approach, empathy with the user, along with creativity and experimentation skills. This is also referred to in an experimental comparative study by Meinel et al. differentiating results from Design Thinking projects and QFD applications [1]. Seidel and Fixson find limits of novice multidisciplinary teams adopting Design Thinking in performing brainstorming, rather suggesting to combining different methods, and reflexive practices, depending on the stage or process, divergent or convergent phase, in

which better performing teams are aware of a transition between more- to less-reflexive practices [5]. All these skills are also needed to prompt and reflect on AI applications. Referring to these findings, suggestions are derived to observe following student cohorts taking the lectures and possibly include training on typical skills needed for HCD application.

6 CONCLUSION AND OUTLOOK

The study highlights the benefits and challenges of embedding HCD and AI into Engineering Education. The lecture and exercise on Human-Centred Design (HCD), or speaking generally, integrating customers and users in engineering, is part of the lecture on 'Engineering Design and Product Development' in the Bachelor curriculum. This study shows that the understanding of HCD, customer integration, and the practical use of AI in product development is enhanced. Surveys conducted among the participating 2nd-year students, prove that a majority support the need for customer-centric approaches and are inspired to innovate within their companies.

These studies will be extended to 3rd-year students in order to investigate the benefits and challenges of embedding HCD. Initial results are already available from a seminar event. Students were asked to teach design thinking in the form of a flipped classroom concept. For this purpose, a team of five students prepared an introduction of approx. 60 minutes and developed an exercise of 120 to 150 minutes. The exercise concept incorporated teams of each four to six students and was guided (moderated) by the students that prepared the seminar. After completing the flipped classroom seminar, the students were asked to describe their experiences in a reflective report. The lessons learned with this group of 3rd-year students showed how important it is to consider the customer perspective in product development. All participating students emphasised the benefits of HCD and the 'Customer Journey.' However, for a transfer to a development project, the participating students noted, that the implementation to different framework conditions are to be considered, e.g. depending on product and business organisation.

The authors suggest on basis of the findings of these lectures and exercises, that while students are eager to integrate user feedback into projects, there is a need for more structured guidance and curriculum adjustments to incorporate HCD and AI. Recommendations include extending exercise duration, offering advanced lectures on HCD, including projects with companies or institutions with 'real' users and providing structured guidance. These changes aim to better prepare students for technological and industry shifts, cultivate a customer-focused and innovative mind-set, incorporating AI, reflective and critical thinking.

REFERENCES

[1] Meinel M., Eismann T. T., Baccarella C. V. et al. Does applying design thinking result in better new product concepts than a traditional innovation approach? An experimental comparison study. *European Management Journal* https://doi.org/10.1016/j.emj.2020.02.002; Elsevier Ltd.; Feb. 2020.

[2] Nutzmann M., Sauer T, Voß M. and Bozkurt H. Old procedure - new approaches: QFD with ChatGPT - Comprehensive product and process understanding in engineering design education. DOI: 10.35199/EPDE.2024.64. *Proceedings of 26th International conference on engineering and product design education*. E&PDE2024. Institution of Engineering Designers, The Design Society, Glasgow, United Kingdom, 2024.

[3] Nutzmann M. Old procedure - new approaches: QFD with ChatGPT - Comprehensive product and process understanding in engineering design education; presentation. *E&PDE2024 International conference on engineering and product design education*. Institution of Engineering Designers, The Design Society, Aston University, Birmingham, United Kingdom, 06.09.2024.

[4] Nutzmann M. Product Design and Development (Entwicklungsmanagement). Script. DHBW Ravensburg Campus Friedrichshafen. Baden-Wuerttemberg Cooperative State University, Friedrichshafen, Germany; 2019.

[5] Seidel V. P. and Fixson S. K. Adopting "design thinking" in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. *Journal of Product Innovation Management*. 01.01.2012.

[6] Osterwalder A. et al. The Value Proposition Canvas. strategyzer.com. Strategyzer AG also in [7]; download 19.11.24.

[7] Osterwalder A., Pigneur Y., Smith A. et al. Value Proposition Design. ISBN: 978-1-118-96805-5. John Wiley & Sons Inc. Hoboken, New Jersey, USA, 2014.