

AI – A PROBLEM SOLVER IN ENGINEERING EDUCATION? OPPORTUNITIES FOR MORE INCLUSIVE PRODUCT DEVELOPMENT TEACHING

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ABSTRACT

Since the introduction of large-scale generative AI systems such as ChatGPT (GPT-3.5) in 2022, artificial intelligence has rapidly expanded across professional, educational, and societal domains. In engineering and product development, AI tools are increasingly integrated into engineering workflows, supporting tasks from early conceptual design to detailed development processes. However, their accelerating adoption raises critical questions: How can students be taught to use AI responsibly? How can ethical, democratic and societal values be preserved when intelligent systems influence decision-making? This paper investigates the application of AI tools within engineering design and product development education, with a particular focus on inclusive teaching approaches.

Through a structured survey among mechanical engineering students, the study evaluates the current usage, attitudes, and perceived usefulness of AI. The research identifies practical application fields - such as ideation, requirements engineering, concept evaluation, simulation assistance, and documentation, but also reveals a significant gap between informal academic use and structured professional application. Findings show that while students frequently use AI for research and text generation, domain-specific engineering tasks and critical evaluation skills remain underexposed.

The contribution of this work lies in its combined analysis of AI-augmented engineering methods and its framework for integrating inclusive, responsible AI education. The paper highlights the need for sustainable educational strategies to ensure that students become active, ethical decision-makers in an AI-augmented professional world.

Keywords: AI in engineering processes, education, inclusive opportunities, AI survey in engineering

1 INTRODUCTION

A new generation of students (Generation Z) is entering universities and engineering programmes. Having grown up with digital technologies and AI-based applications, these students are highly familiar with such tools. However, it remains unclear whether this familiarity translates into the ability to apply AI effectively and responsibly in professional engineering contexts.

AI is also reshaping educational environments. Recent studies show that students increasingly use AI tools for learning, research, and problem-solving activities [1], [2]. Consequently, engineering education must respond to these developments and prepare students for an AI-augmented professional world [3]. Based on this background, the following research questions define the scope of this paper:

- Which AI-augmented engineering methods currently exist?
- Is Gen Z able to use AI in a professional work environment?
- How do students use AI tools in their studies?
- For which tasks do students primarily use AI?
- Which competencies should be taught more intensively in engineering education than they are taught at the moment?

2 CONTEXTS IN ENGINEERING STUDIES

Mechanical engineering students encounter structured design and development processes early in their studies. They learn classical tools and methods such as creativity techniques (e.g. brainstorming, morphological box), CAD systems, and systematic product development methodologies.

Despite the increasing relevance of AI in industrial practice, these technologies are still only marginally integrated into many engineering curricula, resulting in a persistent gap between academic teaching and industrial application [4], [5], [6]. Educational research therefore emphasises that AI literacy should become a core element of modern education systems [3], [7]. Without structured learning opportunities, students tend to rely on self-taught and unsystematic use of AI tools, which may lead to uncritical or ineffective applications. To address this gap, AI integration in engineering education should follow principles of human-centred design and usability, ensuring that AI remains a supportive rather than dominating technology [8].

3 CURRENT RULES ON TEACHING AI USAGE

Universities within the European Union are required to ensure adequate AI literacy among students and staff when providing access to AI systems, for example through university-operated platforms or institutionally hosted AI services. This obligation derives from the EU Artificial Intelligence Act, with the relevant provisions becoming applicable on 2 February 2025. The specific implementation measures remain at the discretion of individual university administrations [7], [9], [10].

4 USABILITY OF AI IN ENGINEERING TASKS

Some typical and relevant use cases for applying AI are described in the following sub-sections.

4.1 Usability of AI while searching for literature

One of the most common academic applications of AI is the support for literature research. Large language models can help students to identify relevant keywords and research topics, summarise articles, generate structured overviews of research fields, and suggest potential sources.

Tools such as Elicit, ResearchRabbit, and AI-enhanced search engines provide faster access to scientific knowledge. However, generative AI also entails risks, particularly the generation of “hallucinated” references, i.e. non-existent or inaccurate publications. AI-conducted literature research can also be incomplete. Students must therefore be trained to critically verify AI-generated information using established academic methods [1], [2], [11].

4.2 Usability of AI while applying creativity methods and human-centred design

Creativity and ideation are core elements of product development. AI tools can be integrated into traditional creativity techniques to increase both the quantity and diversity of ideas [12], [13], [14], [15].

Possible AI-supported activities include:

- AI-assisted brainstorming (large numbers of initial ideas, alternative solution concepts)
- Morphological box support (filling matrices with solution principles).
- Analogical reasoning (solutions from other domains).
- Customer needs analysis (transforming interviews into structured requirements), including market and competitor analysis [14], [15].
- Concept evaluation (support for evaluation matrices and multi-criteria decision methods).
- Textual formulation of ideas (turning rough concepts into professional descriptions).

However, research shows that while AI increases idea quantity, human judgement remains essential for assessing originality and feasibility [12].

4.3 AI in Computer Aided Engineering (CAE)

Beyond text-based applications, AI is increasingly embedded in professional engineering software environments. These applications directly influence technical design activities [13].

The authors identify the following as particularly promising AI-supported activities:

- AI-supported CAD modelling (geometry generation from functional requirements).
- Generative design and topology optimisation (optimised geometries for given loads and constraints).
- Simulation assistance (proposal of boundary conditions and mesh settings).
- Error detection in models (design rule violations, manufacturability issues).
- Code generation for engineering tools (scripts for MATLAB, Python, ANSYS).
- Data analysis.
- Tutor bots that assist applying engineering tools and support learning in general.

5 SURVEYS ON AI USAGE AMONG ENGINEERING STUDENTS

Recent publications on AI integration in engineering lectures - covering areas such as engineering design, quality management, and scientific writing, have reported positive trends and introduced new teaching concepts [14], [15]. However, these studies focused on one special aspect or sub-disciplines of mechanical engineering. A comprehensive study capturing general AI usage among mechanical engineering students at DHBW Ravensburg has not yet been conducted. To address this gap, a structured survey was carried out to gain empirical insight into AI use in both academic and professional contexts, assessing frequency of use, attitudes, perceived usefulness, application fields, and cohort-specific differences.

5.1 Survey Design, Methodology and Demographic Overview

The questionnaire was distributed to two consecutive cohorts: TMK23 (47 third-year students) and TMK24 (57 second-year students). The questionnaire covered demographic data, AI usage behaviour, perceived usefulness, application fields, use within partner companies, specific tools employed, and attitudes toward AI-supported CAD/PLM systems, with the aim of obtaining a comprehensive overview of current AI usage across academic and professional environments.

Participants represented typical dual-study mechanical engineering cohorts, alternating between academic studies and industrial practice every three months. Most respondents were aged between 19 and 26 years. Partner company sizes ranged from small enterprises (<100 employees) to large corporations (>100,000 employees), with company size strongly influencing access to AI tools and digital infrastructure: students from larger organisations more frequently reported access to internal AI solutions, while those from smaller companies often indicated a complete absence of structured AI tools.

5.2 General Attitudes toward AI

One central element of the survey was the question of whether students perceive AI as useful in engineering contexts. Across both cohorts, the majority of respondents rated AI as at least moderately useful. However, opinions varied significantly:

- Some students expressed strong enthusiasm and curiosity about AI tools.
- Overall, 89.7% use AI (TMK23: 91.7%, TMK24: 87.7%).
- Overall, 52.7% see AI as extremely useful or useful in engineering design (TMK23: 44.7%, TMK24: 60.0%).
- Others remained sceptical or indifferent (overall 47.3% see AI as only partly useful or useless - TMK23: 55.3%, TMK24: 40.0%).
- Despite of regarding AI usage sceptical, 33% of those use AI (TMK23: 23.1%, TMK24: 42.9%).
- A small group rejected AI usage entirely, arguing that “traditional thinking” or “human intelligence” should remain central. Some addressed fear of losing understanding for parts of the results (overall 4.1% address such fears - TMK23: 6.4%, TMK24: 1.8%).

5.3 Actual Usage of AI Tools

A gap emerged between positive attitudes and actual usage. While many students believed AI could be useful in engineering design, only a portion reported regular use applying typical engineering design tasks, ranging from daily to occasional; a considerable number did not use AI tools at all. TMK24 students reported slightly more frequent use than TMK23, pointing to a possible timing effect.

Students who reported using AI tools were asked for which tasks they mainly applied them. The answers show a clear pattern. In academic contexts, AI was mainly used for research and information retrieval, understanding complex technical topics, summarising texts and lecture materials, exam preparation, and writing or improving academic texts (literacy). Students primarily viewed AI as a learning and knowledge-support tool, not as a direct design tool.

In professional contexts, many students stated that their companies do not officially use AI tools or that they were unaware of any usage. Around 35% mentioned specific tools, with Microsoft Copilot and internal AI solutions being most common, mainly for calculations, documentation, information search, and support in design-related questions. Structured AI integration into engineering workflows (e.g. AI-supported CAD or simulation) was rarely reported. In some cases, this may be the result of a lack of awareness or knowledge, presuming that especially the second-year students haven't yet worked on

larger projects in their companies. This indicates that, at least in the companies represented in this survey, AI in engineering is still at an early stage of adoption.

5.4 Comparison between Cohorts TMK23 and TMK24

One explicit goal of the survey was to compare two cohorts at different stages of their studies. Table 1 summarises the key results and differences identified between TMK23 and TMK24.

Table 1. Key results and differences identified in student cohorts

Aspect	TMK23	TMK24
Average age	21.64	21.11
Reported AI usage in Engineering design (e.g. creativity methods)	37.5%	49.1%
Reported AI usage in other contexts	87.5%	86%
Openness/ trust toward AI (scale 1: very positive to 5: very sceptical)	M=2.69 (more sceptical)	M=2.34 (more positive)
Awareness of AI in companies (see below)	limited	slightly higher
LLM in companies	31.3%	33.3%
Knowledge of CAD/PLM with AI	2%	12.3%

Interpretation

- TMK24 students appear more open and accustomed to AI tools. They reported using AI more frequently for engineering design tasks and for tasks like learning and problem solving.
- TMK23 students tended to be more cautious, especially in tasks where they are liable for the outcome. Some of them expressed doubts about the reliability or necessity of AI.

This suggests a cohort effect: as AI tools become more common in schools and everyday life, new student cohorts integrate them more naturally into their workflows. The timing between AI-acquaintance cohorts may be very small. However, despite these differences, both groups shared one common feature: formal training on AI usage was almost completely absent or with no major perception.

5.5 Critical Perspectives and Concerns

Several students expressed concerns regarding the reliability of AI-generated results, over-dependence on AI, ethical implications, data protection, and restrictive company policies. Statements such as “I have no idea how to use AI properly” highlight the need for structured guidance, transparency, and ethical reflection in AI education.

5.6 AI in CAD and Engineering Software

A specific question addressed whether AI-supported CAD or PLM tools are used. Here, the results were very clear. Almost all students answered “No” (48.4%) or “I don’t know” (31.4%). Only a very small number reported actual use of AI features in CAD environments (14.4%). The remaining 5.8% of respondents did not answer this question.

This shows that, although AI in engineering software is a growing industrial trend, it has not yet reached everyday practice for most students. However, it cannot be determined if there is no usage or just missing knowledge. Here the question arises, if students are not aware of the usage of AI tools, if the usage is not communicated or if the students are not trained in the usage of the tools.

5.7 Implications for Engineering Education

The survey results lead to several important conclusions:

1. AI tools are already part of students’ daily lives, mainly for learning, literacy and research.
2. Usage is largely informal and self-taught.
3. There is a significant gap between potential applications and actual structured usage.
4. Students lack guidance on how to use AI effectively, how to evaluate AI-generated results and knowledge about where AI can be meaningfully applied in engineering tasks.

Therefore, engineering education should introduce systematic AI literacy courses, teach critical evaluation skills, integrate AI tools into project-based learning and show concrete engineering use cases rather than only general-purpose applications.

This raises the question of whether universities should require students to take such courses. During the “Long Evening of Literacy” at our campus, students were given the opportunity to attend voluntary workshops. However, participation fell short of expectations (10-12%). This leads to another important question: Is it possible to encourage greater engagement in voluntary programmes, and if so, how can this be achieved?

5.8 Limitations of the Survey

The survey has several limitations: it is limited to one university, relies on self-reported and subjective data, and captures a rapidly changing field at a single point in time. The time difference between the two cohorts (TMK24 in early February, TMK23 in late December) further restricts comparability. Nonetheless, the findings provide a useful starting point for AI-oriented teaching concepts.

5.9 Summary

The survey shows that while AI is widely known and used by engineering students, its application is largely limited to academic support tasks. Professional engineering applications remain rare, and structured AI education is largely absent. These findings underline the need to systematically and responsibly integrate AI competencies into engineering curricula.

6 CONCLUSION AND OUTLOOK

AI technologies are rapidly transforming engineering practice and education. This study indicates that AI offers considerable potential to enhance learning processes, support creativity, and foster more inclusive product development teaching.

The survey findings address the research questions outlined in the introduction. A broad range of AI-augmented engineering methods already exist - spanning literature research, ideation, and CAE - yet Gen Z students, despite their digital familiarity, apply these methods largely informally and without structured training. Usage remains predominantly limited to academic support tasks such as research and text generation, while professional engineering applications remain rare. In company contexts, general-purpose tools such as Microsoft Copilot dominate over engineering-specific AI solutions. These findings reveal a clear competency gap: critical evaluation of AI outputs, prompt engineering, and domain-specific AI application in engineering design require more systematic and intensive coverage in future curricula, alongside clear guidelines for academic integrity and didactic concepts that keep human judgement central.

The formerly performed surveys mentioned in the introduction of Chapter 5 underline the survey observation of this paper in the general AI application, but the above survey additionally points out a lack of AI skills in engineering design applications, assessed in the actual cohorts. Due to this observed deficit of AI skills in engineering design applications, it is highly recommended to counter steer and develop a sustainable and integrative AI educational strategy, e.g. “train the trainers”, respectively lecturers, and students in more additional lectures, exercises, use cases, workshops and trainings.

Future work will focus on developing concrete teaching modules and best-practice frameworks for AI-supported product development courses. Long-term studies are needed to evaluate how AI influences learning outcomes and professional competencies.

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