The Potential of Generative AI for Systematic Engineering Innovation

Pavel Livotov1, Mas’udah1,

1 Offenburg University of Applied Sciences, Badstr. 24, 77652 Offenburg, Germany

**pavel.livotov@hs-offenburg.de**

**Abstract.** The advent of generative artificial intelligence (AI) has opened new paths for innovation across various domains, including engineering. This paper explores the role of generative AI in facilitating systematic innovation and inventive problem-solving in engineering contexts. By leveraging AI's capabilities for automated idea generation and evaluation, the study explores its effectiveness in addressing complex engineering challenges and proposes frameworks for optimizing AI-assisted innovation processes.

The study employs a multifaceted approach to examine the potential of generative AI in engineering innovation. Using an automated prompt generation approach, including iterative problem definition and multi-directional prompting with numerous elementary solution principles, the study investigates the ability of AI chatbots to autonomously generate solution ideas and create and evaluate innovative concepts based on one or more partial solution ideas. The study encompasses a series of experiments with different Large Language Models (LLMs), assessing their performance in generating viable solutions and evaluating their practical applicability.

The experiment results reveal that generative AI can rapidly produce a substantial number of ideas, reflecting its potential to significantly accelerate the innovation process. However, findings also show that generative AI often overestimates the feasibility and usefulness of its proposed solutions. AI-generated concepts frequently exhibit a high degree of complexity, which can hinder their practical implementation. The performance of various AI tools varied throughout the innovation process, demonstrating that no single AI model consistently outperforms others in all aspects of idea generation and evaluation.

The variability in performance among different generative AI tools throughout the innovation process provides an opportunity to form mixed AI innovation teams, where different generative chatbots can complement, monitor and correct each other as needed. This collaborative approach leverages the strengths of different models while mitigating individual limitations. By integrating multiple AI systems, a more balanced and comprehensive evaluation of innovative concepts can be achieved.

Several case studies are presented to demonstrate the practical application of these findings, highlighting different strategies for generating and refining solution concepts using generative AI. These case studies demonstrate how various AI tools can be employed in conjunction to address specific engineering problems, offering insights into effective strategies for maximizing the impact of AI in the innovation process.

The research suggests that while generative AI holds significant promise for accelerating engineering innovation, there is a fundamental challenge in aligning AI-generated textual descriptions with practical implementation. The observed discrepancies between AI-generated solutions and their real-world applicability point to the need for enhanced human oversight and involvement. Determining the optimal level of human involvement in the AI-assisted innovation process is crucial for bridging this gap and ensuring that AI-generated ideas are both innovative and practically feasible.

The potential of generative AI to transform systematic engineering innovation is significant, yet it is accompanied by challenges that must be addressed. By exploring the capabilities and limitations of generative AI, this paper contributes to a deeper understanding of its role in engineering problem-solving. Future research should focus on refining AI models, improving their ability to generate feasible solutions, and developing frameworks for effective human-AI collaboration in the innovation process.

**Keywords:** Generative AI; Systematic Innovation; Problem-Solving; Engineering Innovation.