

EVIDENCE BRIEF

The **Social Sciences and Humanities Research Council** in collaboration with the **Future Skills Centre**

SSHRC's Imagining Canada's Future initiative mobilizes social sciences and humanities research to address emerging economic, societal and knowledge needs for Canada, and help guide decision-making across all sectors toward a better future. This evidence brief addresses the Future Challenge Area of: **Skills and Work in the Digital Economy**

Towards a modern Canadian engineering design curriculum: balancing artificial intelligence and human cognition

About the project

While computers have become extremely competent at cognitive assignments such as identifying faces and interpreting text, humans are still more effective than computers at many tasks, especially those that require creative reasoning and interpersonal empathy. The engineering design process requires not only fundamental subject matter expertise (in physics, chemistry, mathematics, analysis, etc.) but also problem solving and creativity. Despite recent advances in artificial intelligence (AI), computational systems are far from being able to use creativity, interpersonal empathy, intuition or persuasion for problem solving, or to coordinate and lead teams. With an envisioned future cooperation between AI tools and human engineers, these human-mastered skills will be increasingly vital in the process of engineering design, and therefore merit expanded emphasis in our engineering curriculum.

This report includes a focused literature review to classify the maturity of AI solutions for engineering design (ED), organized by steps in the engineering design process. Next, we review Canadian undergraduate mechanical engineering curricula to benchmark the current level of penetration of AI topics and engineering design topics, identifying gaps by comparing the themes previously identified.

The generated knowledge will guide curricula and policy change for engineering education decision-makers across Canada (accreditors, university deans), transforming the training of the 16,000 yearly Canadian engineering graduates. Ultimately, this will enhance Canada's innovation economy.

Key findings

- Our focused literature review revealed that engineering design research has recognized the potential for artificial intelligence tools and techniques to advance this important endeavour.
 - In particular, we found that conceptual design—a process step that leverages human creativity and collaboration—has been a focus for AIxED research.
 - Thus, our analysis reveals opportunities to explore AI application in other design process steps, and to continue to leverage the work towards human-AI collaboration in the conceptual design phase.
 - We analyzed 2,769 courses from 28 institutions from the list by the Canadian Engineering Accreditation Board (CEAB), under the “Mechanical” discipline to obtain the courses that signify the prevalence of AI in the engineering design field along with AI- and ED-focused courses.
- Using the keyword matching algorithm, we observed 11 courses—from nine institutions out of the 28 institutions—that highlighted the study and application of AI methods in engineering design courses.
- In addition, we detected 33 AI-focused courses from 12 institutions that were available for mechanical engineering students in these institutions.
 - 1,500 courses out of the 2,769 courses were specifically related to the field of engineering design, thereby reflecting the influence of design requirements set by the CEAB for accreditation of Canadian engineering programs.
 - The key result of this study is to highlight the limited but emerging prevalence of artificial intelligence teaching in engineering design education. We identified a number

of courses in Canadian mechanical engineering programs that can serve as blueprints for the continued expansion of state-of-the-art learning for our future engineers, to prepare

these graduates for the skills they will need to succeed in the digital economy. We are encouraged to see that Canadian universities have begun to formally introduce these topics in their curricula.

Policy implications

- We recommend that the identified courses that integrate artificial intelligence concepts with engineering design concepts serve as blueprints for the further establishment of such courses across Canada.
- These courses will require key instructor expertise that aligns with the increasing prevalence of engineering design research in AI applications.
- Given the strong prevalence of engineering design content in mechanical engineering programs, matching the CEAB's requirement, we identify a major opportunity for the accreditor to mandate some course content towards future skill building, such as artificial intelligence, for all engineering programs.
- This accreditation change may require coordinated lobbying from leaders of industry and academia, who can use our findings to support their case.
- We recognize that artificial intelligence and design concepts have been well integrated in courses outside of mechanical engineering and can be accessible to students via technical and free electives. We encourage university programs to exploit this interdepartmental strength as they ramp up their in-department expertise.

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FURTHER INFORMATION

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The Future Skills Centre (FSC) is a forward-thinking centre for research and collaboration, dedicated to preparing Canadians for employment success. As a pan-Canadian community, we are collaborating to rigorously identify, test, measure and share innovative approaches to assessing and developing the skills Canadians need to thrive in the days and years ahead.
