Contributes to a Baseline for Interdisciplinarity supported by Engineers' Views on AI

Rosa M. Vasconcelos
2C2T-EEUM
University of Minho
Guimarães, Portugal
rosa@det.uminho.pt

Paula Urze
CIUHCT
NOVA School of Science and Technology
Lisboa, Portugal
pcu@fct.unl.pt

Emilia Araújo
CECS, ICS)
University of Minho
Braga, Portugal
era@ic.uminho.pt

***Abstract*— This work-in-progress research paper explores how the growing recognition of the social implications of artificial intelligence (AI) is prompting the need to revise engineering curricula. preparing engineers to promote social engagement, foster public participation, and enhance citizens' AI literacy. The paper is based on ongoing research that includes interviews with engineers working in AI, directors of engineering courses, and policymakers focusing on the identification of the main implications of AI for society. The preliminary results point out the relevance of debating engineering curricula in light of the new challenges imposed to meet citizens' and community expectancies and develop AI literacy**.

Keywords—AI, education in engineering, innovation, social engagement, participation, innovation

I. INTRODUCTION

This work-in-progress research paper describes the perspectives of engineers involved in AI research. It aims to illuminate how these engineers perceive and assess the broader impacts of AI and how engineering education can be enhanced by integrating a more comprehensive understanding of social issues, informed by three key theoretical approaches: social implications of AI, citizens' participation and social engagement in AI innovation. The social impact of AI is vast, encompassing areas such as power dynamics, health, work, the economy, sustainability, inclusion, diversity, and justice. While many of these implications offer the potential for important societal advancements, others remain uncertain and may be less favourable. For instance, AI and automation are associated with profound effects on democracy, governance, and social trust, with the potential to exacerbate social inequalities and create new technological divides. Given that AI is both disruptive and transformative, it is increasingly necessary to equip citizens with the knowledge required to ensure its acceptability and safe usage.

In this context, it is also essential to prepare engineers to cultivate deeper relationships with citizens and stakeholders before designing innovation. This approach enables accurate diagnoses of societal needs and ensures that these are integrated into the design and deployment of AI innovations. The United Nations' goal of using science to build futures that are desired ("wanted") serves as a strong motivation for this approach, which not only makes AI more socially and ethically responsible but also more desirable and participatory. There are many ways to improve AI literacy among citizens and to promote social engagement in the early stages of AI innovation. In this work-in-progress research paper, we focus on two key strategies: i) Increasing interdisciplinarity in research, bringing together social scientists and engineers to foster synergies that promote co-creation and engagement in AI solutions.; ii) Restructuring engineering curricula: Integrating social aspects of innovation into the curriculum, with an emphasis on two areas: train and learning in methods for engagement and participation, ensuring diverse stakeholder involvement during the creative and innovative process of AI development; and enhancing interdisciplinarity in curriculum design.

This work-in-progress research paper is structured into four main sections. First, we provide a theoretical introduction to the subject, emphasizing the importance of understanding the social aspects of AI as fundamental elements in the AI innovation process. In the second section, we outline the methodology used in our research on scientists' views and present key empirical findings regarding their perspectives. Finally, before concluding, we offer core recommendations for reforming engineering education to align with societal needs.

II. THEORY

Engineers and social scientists increasingly recognize that technologies, including AI, are sociotechnical phenomena that influence and reinforce each other. It has been assumed that his interdisciplinary relationship is essential for creating technologies that are not only less harmful but also capable of fostering positive social change [1-15]. In *Sciences of the Artificial* [1, p.3], the author distinguishes between natural sciences—focused on natural objects and phenomena—and what they term "artificial" science, which concentrates on artificial objects and phenomena [4]. Building on this concept, some researchers advocate for developing an interdisciplinary domain dedicated to the study of "intelligent machines," viewing these not just as engineering artefacts but as important players that influence practices, decision-making processes, and the social acceptability of AI. These studies argue that understanding the social dimensions of AI allows scientists and policymakers to anticipate and mitigate potential negative consequences for society. Thus, the interdisciplinary nature of AI practice benefits from approaches that integrate technical considerations with knowledge that anticipates social change [13]. However, identifying the social consequences of AI is only part of the equation; it is equally important to shape AI innovation in

ways that reflect people's desires, aspirations, and choices. [11,12] emphasizes the necessity for AI developers to collaborate with social scientists, affected stakeholders, and communities to ensure fairness in AI applications. This ongoing debate suggests a need to rethink engineering curricula and create opportunities for collaboration between social scientists and engineers from the outset [5, 6, 7, 8]. A recent paper [9] suggests that AI engineering education should cover several key social science-related topics, including lifelong learning, transdisciplinary education, sustainability, resilience, human-centric design, data fluency, and human-machine interaction. Other studies [10] present a model for teaching and learning in a transdisciplinary manner, underscoring the need for scientists and decision-makers to initiate this debate and drive change within academic institutions. Research highlights also the need to consider the diverse understandings of AI among stakeholders from academia, industry, and policy groups, emphasizing the need for greater awareness and interaction among these groups [16]. As AI continues to evolve, there is a growing need to enhance understanding of its ethical implications among engineering and computing students, who will play pivotal roles in future AI advancements across society.

The integration of AI in various domains requires engineers to develop social engagement skills and collaborate with diverse stakeholders. The Institution of Civil Engineers has developed principles for community engagement to guide best practices across infrastructure projects [17]. Authors claim that engineering education should prepare students to integrate social elements into their work, either through specialized training or by teaching "regular" engineers to consider social aspects, as community-engaged learning in engineering education promotes sustainability and helps students understand their future role in society [18,19]. To effectively prepare socially engaged engineers, changes in engineering culture and student support are necessary, both inside and outside the classroom, to challenge traditional conceptions of engineering identity, knowledge, and practice [17,18,19]. In fact, despite the increasing number of studies about the relevance of the topic, there are some difficulties to overcome, especially as regards the methods and ways of intervening in engineering.

III. Methodological notes

This paper summarizes key insights from ongoing semi-structured interviews with prominent AI experts to whom we asked about the methods of improving social engagement and participation in AI. These interviewees were selected based on specific criteria: they are active AI researchers within the country, maintain strong connections with both global academic and commercial sectors, and represent organizations that significantly influence public discourse and policy on AI. Their combined experience in academia and institutional leadership provides a unique perspective on AI's implications, particularly within higher education. This research project is still in development, with plans to interview more engineers from different universities. For this work-in-progress paper, we draw on content analysis from five interviews, with results that should be regarded as exploratory. The interview guide focuses on three main topics: the important social implications of AI development, the role of engineers and scientists in addressing these implications, and the relevance of social engagement and participation in AI development, along with its potential impact on engineering curricula. In addition to the interviews, this paper includes a literature review on the subject and considers specific studies from various engineering fields that increasingly discuss the need to create better synergies between engineering education and societal challenges.

IV. Contribution for Good Practices

A. Identification of social implications of AI

The engineers interviewed agree that AI represents a significant transformative force within society, impacting all domains of work, private life, health, and education. They recognize AI's capacity to enhance decision-making processes by enabling the anticipation of events and allowing for proactive measures to mitigate undesirable outcomes. There is a shared acknowledgement among engineers that AI may produce unforeseen effects with considerable social implications. For instance, concerns were raised about the application of AI in military contexts, where the delegation of decision-making to AI systems could lead to serious consequences, such as inaccurate predictions of enemy locations.

- *"For example, we use AI to predict order allocations to machines. However, when we consider AI in military contexts, where some decisions are transferred to AI to speed up processes, we may face serious consequences, such as incorrect predictions of enemy locations, among other challenges."*

Engineers identified several critical challenges associated with AI, including the potential for its misuse in negative contexts such as warfare, the erosion of human relational capabilities, ethical and privacy concerns, and the control of access to AI data. These challenges are seen as "side effects" of AI development, requiring both proactive regulation and corrective measures such as increased public literacy and informed political decision-making.

- *"Most people are not aware that when they use social networks, they are targeted by algorithms designed to keep them engaged for as long as possible".*

Concerns were also raised about the potential reduction in human capacity to critically evaluate AI-generated information, as illustrated by the challenges posed by deepfake technology and the increasing difficulty in distinguishing between human and AI-generated content. The use of AI in autonomous systems, such as self-driving

cars, also prompts questions about responsibility in the event of accidents.

- *"AI has a huge impact on society, in many ways. But the decision on how these impacts are managed, cared for and treated is a technical problem, it has technical aspects, but it is also a political problem, of political economy, of decision-making and of how society organizes itself. What society do we want? And this is a political problem, and politicians must be aware of this and must have proposals on the table"*

Engineers emphasize the risk of AI introducing bias and discrimination, leading to potentially unfair decisions. They stress the importance of robust ethical safeguards, particularly in areas concerning privacy and the handling of sensitive data. Despite these concerns, they recognize AI's potential to address societal challenges, such as reducing school dropout rates and absenteeism, while acknowledging the growing complexity and range of social implications that accompany AI's widespread adoption. However, while they emphasize the critical need for policymakers to have a clear understanding of their objectives and the role social sciences can play in amplifying people's voices within AI research projects, and in developing strategies to manage its broader social impacts effectively, they appear to be expecting and searching how engineering education can effectively address the social implications of AI. The interviews reveal however that there is still difficulty in developing practices of social engagement and participation that equip engineers to create socially acceptable AI solutions that meet societal needs.

B.Enhancing engineering education

Citizen participation and social engagement are crucial issues for engineering education when it comes to tackling with social implications of innovation [2,4]. Considering that yet existing difficulties in making bridges and opening engineers to communities and citizens before innovation takes place, we propose to put forward a preliminary synthesis of key suggestions issued by interviews and a literature review [2-19] for improving engineering curricula for better integration between AI and society, as presented below.

1) Fostering engagement with socially driven research

- Encourage students and faculty to engage with research topics that address societal challenges within engineering fields.
- Implement this approach through coursework, conference participation, and collaborative projects to enhance understanding of how engineering intersects with social dynamics.

2) Developing an AI-centric project on social implications

- Introduce a project that explores the social implications of AI.
- Train engineering students to engage with contemporary debates surrounding AI's integration into society, examining its impact on various domains such as health, the economy, finance, industry, and the environment from a cross-disciplinary perspective.

3) Other examples

- Training and preparing engineers for ethical and social issues, equipping students with the competencies needed to handle complex decisions in real-world scenarios. Emphasize understanding the risks of implementing AI.
- Exploring the application of AI through case studies in key sectors such as health, finance, and transportation.
- Promoting participation/development/co-creation by mapping and involving stakeholders in decision-making to ensure a broad vision that incorporates diverse perspectives and fosters consensus-building. Specific courses can be organized and offered to discuss the importance of stakeholder involvement and to explore the roles of companies, academia, and civil society in AI governance and the co-creation of solutions.
- Debating responsible AI to focus on issues of regulation, transparency, and trust. Address the challenges posed by the uncertainty, unknowns, and complexity of AI, particularly in the context of regulatory frameworks.
- Discussing the uncertain future of AI, which will depend on factors such as human values, regulation, ethical limits, and public policies.
- Projecting scenarios that consider the ethical implications inherent in AI design and implementation, emphasises the need for assessing the social and ethical impacts of AI.

V. CONCLUSION

This research working-in-progress paper aimed to explore the viewpoints of engineers engaged in AI research and innovation regarding its social implications. Despite the exploratory nature of this ongoing study, it underscores the relationships between technology and society, which leads us to claim that a dialogue and collaboration between engineers, policymakers, and societal stakeholders is imperative for the responsive development of AI, and to advocate that research institutions and universities need to open new avenues for that collaboration to get stronger. Currently, engineering education must transcend beyond traditional technical skills, embracing a broader

understanding of the social implications of engineering work. While engineers have long been viewed as problem-solvers focused on creating efficient, functional systems, there is a growing recognition that the solutions they design profoundly impact society, and the environment, and alter substantially social and human values. This recognition calls for a more global and holistic approach to engineering education—one that equips future engineers with the skills to face the complex social challenges that AI is now already enclosing.

ACKNOWLEDGEMENT

This work was financed by the Centre for Textile UIDB/00736/2020). We acknowledge the funding of FCT (Portugal), by UIDB/00264/2020 (CECS), and by UIDB/00286/2020, CIUHCT _ Interuniversity Center for the History of Science and Technology, NOVA University, Lisbon.

REFERENCES

[1] H. A. Simon, *Sciences of the Artificial.* MIT Press, 1969.

[2] M. Natarajarathinam, S. Qiu, and W. Lu, "Community engagement in engineering education: A systematic literature review," *Journal of Engineering Education*, vol. 110, pp. 1049-1077, 2021.

[3] W. Marshall, M. Tang, and S. A. Durham, "Integration of Science, Technology, and Society (STS) Courses into the Engineering Curriculum," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2012.

[4] I. Rahwan, M. Cebrian, and N. Obradovich, "Machine behaviour," *Nature*, vol. 568, pp. 477-486, 2019.

[5] E. Subrahmanian, E. Eswaran, T. T. Odumosu, and J. Tsao, "Engineering a Better Future: Interplay between Engineering, Social Sciences, and Innovation," in *Interplay between Engineering, Social Sciences, and Innovation,* E. Subrahmanian, E. Eswaran, T. T. Odumosu, and J. Tsao, Eds., 2018, pp. 1-15. doi:10.1007/978-3-319-91134-2.

[6] M. Thürer, I. Tomašević, M. Stevenson, T. Qu, and D. Huisingh, "A Systematic Review of the Literature on Integrating Sustainability into Engineering Curricula," *Journal of Cleaner Production*, vol. 181, pp. 608-617, 2018. doi:10.1016/j.jclepro.2018.01.144.

[7] E. Fisher, "Engaging the Micro-foundations of Responsible Innovation: Integration of Social Sciences and Humanities with Research and Innovation Practices," in *International Handbook on Responsible Innovation,* 2019. doi:10.4337/9781784718862.00020.

[8] E. J. H. Spelt, P. A. Luning, M. A. J. S. van Boekel, and M. Mulder, "A Multidimensional Approach to Examine Student Interdisciplinary Learning in Science and Engineering in Higher Education," *European Journal of Engineering Education*, vol. 42, no. 6, pp. 761-774, 2017. doi:10.1080/03043797.2016.1224228.

[9] D. G. Broo, O. Kaynak, and S. M. Sait, "Rethinking engineering education at the age of industry 5.0," *Journal of Industrial Information Integration*, vol. 25, 2022. doi:10.1016/j.jii.2021.100311.

[10] O. Kelly, P. White, F. Butera et al., "A transdisciplinary model for teaching and learning for sustainability science in a rapidly warming world," *Sustain Sci*, vol. 18, pp. 2707-2722, 2023. doi:10.1007/s11625-023-0.

[11] M. Sloane and E. Moss, "AI's Social Science Deficit," *Nature Machine Intelligence*, vol. 1, pp. 330-331, 2019. doi:10.1038/s42256-019-0084-6.

[12] S. Lindgren and J. Holmström, "A Social Science Perspective on Artificial Intelligence: Building Blocks for a Research Agenda," *Journal of Digital Social Research*, vol. 2, no. 3, pp. 1-15, 2020. doi:10.33621/jdsr.v2i3.65.

[13] L. Sartori and A. Theodorou, "A Sociotechnical Perspective for the Future of AI: Narratives, Inequalities, and Human Control, *Ethics Information Technology*, vol. 24, no. 4, pp. 1-4, 2022. doi:10.1007/s10676-022-09624-3.

[14] A. Trotta, M. Ziosi, and V. Lomonaco, "The future of ethics in AI: Challenges and opportunities," *AI & Society*, vol. 39, no. 3, pp. 15-30, 2023. doi:10.1007/s00146-023-01579-2.

[15] G. S. van der Vegt, P. Essens, M. Wahlström, and G. George, "The ethical implications of artificial intelligence (AI) for meaningful work," *Journal of Business Ethics*, 2024. doi:10.1007/s10551-024-05019-8.

[16] K. Hooper and T. Fletcher, "An Analysis of Engineering and Computing Students' Attitudes to AI and Ethics," in *2022 ASEE Annual Conference & Exposition Proceedings.*

[17] S. Bell, E. Boyle, J. Canton, Z. Khan, R. Quinn, E. Rollason, K. Tully, S. Ward, and P. Xavier, "Establishing a statement of principles for community engagement with civil engineering," *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 2022.

[18] D. J. Gilbert, M. L. Held, J. L. Ellzey, W. T. Bailey, and L. B. Young, "Teaching 'community engagement' in engineering education for international development: Integration of an interdisciplinary social work curriculum," *European Journal of Engineering Education*, vol. 40, pp. 256-266, 2015.

[19] S. Niles, S. L. Contreras, S. Roudbari, J. A. Kaminsky, and J. L. Harrison, "Bringing in 'The Social': Resisting and Assisting Social Engagement in Engineering Education," in *2018 World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC),* 2018.