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Towards a sustainable future?

Citation for published version:

Vidmar, M, Fleck, J & Williams, R 2023, AI and data in engineering and innovation: Towards a sustainable future? in *Proceedings of the 29th International Conference on Engineering, Technology, and Innovation: Shaping the Future, ICE 2023*. International ICE Conference on Engineering, Technology and Innovation (Online), Institute of Electrical and Electronics Engineers, 29th International Conference on Engineering, Technology, and Innovation, ICE 2023, Edinburgh, United Kingdom, 19/06/23. <https://doi.org/10.1109/ICE/ITMC58018.2023.10332336>

Digital Object Identifier (DOI):

[10.1109/ICE/ITMC58018.2023.10332336](https://doi.org/10.1109/ICE/ITMC58018.2023.10332336)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

Proceedings of the 29th International Conference on Engineering, Technology, and Innovation

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AI and Data in Engineering and Innovation: Towards a Sustainable Future?

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Abstract—29th International Conference on Engineering, Technology, and Innovation (ICE 2023) touched upon the critical issues in engineering of the generative AI era. By looking at the key challenges in data-driven project management and sustainable development, the overarching theme emerging from the event was one of adaptation to AI and data tools as essential part of the work process and supporting new approaches in engineering, technology development and innovation and entrepreneurship. This points to a promising future ahead, where digital transformation reaches the extended engineering disciplines, which is the theme of the following ICE conference. Having said that, the use of digital tools also presents a number of problems, from data-driven biases to challenges of interdisciplinary, inter-organisational and inter-entity collaborations.

Keywords— ICE 2023, artificial intelligence, sustainability, data, interdisciplinarity

I. INTRODUCTION

The International Conference on Engineering, Technology, and Innovation 2023 (IEEE/TEMS ICE 2023) on the topic of *Shaping the Future: Data driven Engineering, innovation and Entrepreneurship* was held in Edinburgh from the 19th to the 22nd of June, 2023. Alongside five keynote presentations and a panel conversation *Shaping the Future: Will AI?*, 98 papers were presented in 24 sessions, organised in three broad parallel tracks — Engineering, Innovation and Entrepreneurship, and Technology. The collaborative and international nature of the conference was yet again reaffirmed, as papers brought together over 150 authors coming from over 35 countries from around the world, convened in partnership with IEEE's Technology and Engineering Management Society (TEMS).

The 2023 conference was held with the backdrop of generative artificial intelligence (AI) becoming the dominant technological change paradigm, fittingly in the year of celebrating the 60th anniversary of AI research in Edinburgh (<https://www.ed.ac.uk/c/60-years-computer-science-ai>). Moreover, Edinburgh is also the home to global innovation-driven unicorn companies, such as Skyscanner and Rockstar Games, and the University of Edinburgh leads the Data-Driven Innovation (DDI) initiative (<https://ddi.ac.uk/>), delivering a £660m investment in powering the city-region economy and make Edinburgh the Data Capital of Europe.

This future ambition is essentially linked to Edinburgh's history, from the philosophers of the Scottish Enlightenment (David Hume) to the pioneers in Biology (Charles Darwin), Geology (James Hutton), Chemistry (Joseph Black) and Physics (Peter Higgs), and trailblazing Social Scientists (Crystal Macmillan), Writers (Walter Scott), and Engineers (Robert Stevenson). With Mary Somerville's critical observations on the interconnections of natural sciences,

Edinburgh can be considered the home of interdisciplinary, too. This is particularly important in context of planetary crisis and the need for interdisciplinary solutions to issues of local and global sustainability, both technological and social!

Engineering has been taught at Edinburgh in one form or another since 1673 – in REF 2021 the joint submission from the University of Edinburgh and Heriot-Watt University to General Engineering was ranked 1st in Scotland and 3rd in the UK for quality and breadth of research. The conference host, The School of Engineering, also has a strong track record in producing more than 50 technology spin-outs and developing industry links that enable our graduates to build career-long relationships.

In particular, the Edinburgh University's staff and alumni benefited of the particular the collegiate culture which is a bedrock of our interdisciplinary innovation and enterprise. One of critical such efforts is a more holistic socio-technical understanding of emerging science and technology, having been home to one of world's first centres for systematic study of social dimensions of science and technology, the Science Studies Unit, established in 1966.

Since 2001, the wider research network bringing together researchers from across The University of Edinburgh who are involved in research, teaching and knowledge transfer on social and policy aspects of science, technology and innovation, has been convened by the ICE 2023 conference's co-host, the Institute of the Study of Science, Technology and Innovation – ISSTI (<https://www.issti.ed.ac.uk/>). This vibrant college of diverse expertise is critically engaging with the themes of how the development of emerging technology can help Shaping the Future.

II. GENERATIVE AI IN ENGINEERING AND INNOVATION

As often cited on the annual conference website(s), the ICE conference developed from an early focus on the engineering method of concurrent engineering to the general organisation of the engineering process and its organization within the corporation and in networks. The ICE conference, therefore, discusses systems engineering as a socio-technical task focusing on the design of products and services, and the entrepreneurial innovation process for its adoption in society and the economy.

The ICE 2023 focused specifically on how the future will be made and how the world will be impacted by developments in data-driven engineering, innovation, technology, and entrepreneurship, especially the growing prominence and ubiquity of AI. Covering socio-technical issues in engineering and how these shape the design of products and services, as well as the innovation and entrepreneurial processes involved, the conference was to look more closely to the development of the data-intensive economy.

The keynotes (not included in the conference proceedings) reflected several of the themes which surfaced in the paper presentations now collated into the conference proceedings. The keynote presentations ranged from initiatives encouraging research and development into data exploitation, through to investigations into wearable devices for health monitoring, to a project on the processing of data in satellites (“brainy satellites”) to improve the efficiency of their use.

The conference demonstrated clearly that data is an extremely pervasive resource, and its sophisticated exploitation is beginning to percolate into every area of human activity. As a consequence, standard engineering management techniques such as logistics and supply chain management, process control, and lifecycle/ maturity model analysis are now being imported into arenas not traditionally subject to conventional engineering attack. These arenas include education, consumer responses, health management and even banking, which are all now being radically informed through data-driven techniques.

A particularly prominent (and topical) theme in the conference was the exploitation of AI and machine learning across all areas of human activity, with at least a dozen papers explicitly addressing this. A major concern—the topic of one of the special sessions—is the challenge of explainability. As AI is potentially very powerful but works in an obscure black-box manner, the development of systems to track and explain the immanent logic is crucial to underpin trust for the future of these approaches.

The panel session on AI which concluded the conference, recognised the considerable current hype and attendant fears over this data technology. However, this hype was refreshingly absent from the practical issues and pragmatic methods that featured in the conference papers. Indeed, one such paper, *Effectiveness of AI in Drug Discovery*, won the “best paper” award, and detailed the limitations as well as the promise of AI data analysis in coming up with effective new pharmaceutical formulations.

III. DATA, AI AND SUSTAINABILITY

Another prominent theme was the equally topical challenge of sustainability and managing climate change issues more generally. One paper illustrated how far pertinent techniques (like supply chain management) could be applied to address such issues. It considered the potential of grass cutting maintenance along road verges in France for utilisation as a source of sustainable biomass for electricity generation. Other papers considered strategic planning and life cycle analysis of the carbon footprint for transport technologies as wide ranging as shipping, high speed rail, and electric cars.

As noted above, the data-driven approach is percolating into a wide range of arenas. Very obvious among these are education and healthcare, both of crucial importance for the effective operation of any economy and social system.

Advanced technologies are rapidly gaining ground in education, with some discussion at the conference about the current concern over ChatGPT and its consequent challenges to student assessment among other issues. More prosaically, as well as the direct, almost routine, contributions to the design and delivery of educational content and the evaluation of educational operations, conference papers also described how data-driven techniques are being applied to related aspects as far removed as optimising the design of the airflow in educational establishments, or the fostering of student engagement or “attachment” in the learning process.

Healthcare is another area in which data is creating major disruptions. As well as the drug discovery example noted above, other papers addressed wearable health monitors, the potential for the use of IoT (the Internet of Things), telemedicine, medication management, and the monitoring of home care.

Many other arenas are also being, or will be, affected by data-driven techniques. Papers at the conference commented on some of these. They ranged from the application of living labs, banking and financial services, drone delivery systems, government initiatives, industrial workplaces, concrete production, and VR and social inclusion. And of course, these techniques are directly affecting mainstream engineering management itself, with industry 4.0 being a focus for several papers.

Support for knowledge generation and innovation was noted as critical, with particular coverage of the opportunities and problems created by the data-driven approaches. These include cyber and information security, the emergence of new business models, and the challenges involved in the protection of new intellectual assets. Of course, entrepreneurship is associated with new knowledge generation, and here the issues considered included gender inequality, the developing countries context, effective support for those new business models, and the popular focus on ecosystems.

Overall, the conference (the keynotes, the papers included in these proceedings and the many conversations during the three days) clearly demonstrated the terrific potential and recognised some of the likely pitfalls of sophisticated data management for shaping a more sustainable future.

ACKNOWLEDGMENTS

As always, the ICE community is inherently relying on its members and we are extremely grateful for their invaluable contribution. Many of them have not only offered papers, but also reviewed peer’s submissions and have been supporting the chairing and other aspects of the smooth delivery of the conference. We would also like to specifically thank our colleagues at the ICE Board / Programme Committee and the dedicated work of our administrative staff, who made the logistics of the event possible.