Engineers Ireland

Empowering Innovation.
Engineering The Future.

Engineering and AI

The impact of Artificial Intelligence and the role of the engineer in a new digital age





About Engineers Ireland

Engineers Ireland is the representative body for the profession in Ireland with a remit to advocate, educate, and regulate for engineers and promote professional excellence.

With more than 30,000 members, we represent engineers across all disciplines and sectors, and advocate for policies that advance engineering standards and technical innovation.

We collaboratively engage with government, industry, and the public to ensure engineers can make a lasting impact on society by helping solve challenges like climate change, energy sustainability, and infrastructure development.

Engineers Ireland leads the development of current and future engineers, and promotes excellence through accreditations, continuous professional development (CPD) opportunities, and a robust membership network.

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Executive Summary

Artificial Intelligence (AI) is rapidly reshaping the engineering profession, offering significant opportunities to enhance design, analysis, efficiency, and innovation across disciplines. As AI technologies such as computer vision, generative AI, and large language models become embedded in engineering workflows, they are enabling engineers to deliver more complex, sustainable, and data-driven solutions while accelerating project timelines and improving documentation processes.

Ireland is well positioned to capitalise on these developments, underpinned by strong capabilities in software engineering and a high-tech industrial base. Harnessing AI effectively will be critical to maintaining global competitiveness and advancing sustainable engineering solutions.

However, alongside these opportunities, AI introduces significant ethical, technical, and societal risks. These include bias in input data, lack of transparency in decision-making, security and privacy concerns, and the potential erosion of early-career learning opportunities for engineers. The widespread use of AI also raises broader concerns around employment disruption, public trust, and the potential misuse of advanced technologies.

Public attitudes in Ireland reflect this caution, with a majority of adults expressing more concern than enthusiasm about AI and strong support for tighter regulation and oversight. AI must be treated as a tool to augment not replace engineering judgement. Engineers retain ultimate responsibility for all outputs and decisions and must rigorously validate AI-generated work.

To ensure responsible adoption, ethical principles must be considered, particularly transparency and accountability, aligned with the Engineers Ireland Code of Ethics. Engineers must ensure that AI systems are explainable, safe, and deployed in a manner that prioritises the public good.

At a policy level, effective governance and regulation will be essential. While frameworks such as the EU AI Act and Ireland's National Digital and AI Strategy 2030 provide a basis for oversight, there is a need for continued regulatory development, investment in skills, and proactive planning to manage labour market transitions. In particular, the ability of AI to produce harmful images requires evolving regulation, while its potential labour market impacts must be modelled and planned for, with appropriate supports provided to those affected.

Ultimately, AI presents transformative potential for engineering and the wider economy, but its benefits will only be realised through responsible use, strong ethical frameworks, and coordinated action by engineers, industry, and government. Engineers Ireland calls for a balanced approach that supports innovation while safeguarding trust, safety, and the long-term development of the profession.

Introduction

The development of AI has presented immense opportunities for transformation, as well as industrial and societal challenges that must be successfully navigated. Engineering must also identify and seize applicable opportunities for AI in engineering workflows, harnessing the efficiencies that can be found in the use of the technology, while remaining conscious of its risks and drawbacks.

This report offers insights into AI's applications across engineering disciplines and provides ethical guidance for its responsible use. It is designed to inform members about AI's potential in disciplines like civil, mechanical, and electrical engineering, while equipping engineers and technology developers with practical principles for transparency, accountability, and risk management. The report also presents policy recommendations for Irish Government and regulatory bodies and includes case studies to illustrate real-world applications of AI in engineering practice.

Ireland has the potential to lead the way in innovative and sustainable engineering solutions that use AI, thanks to our strength in software engineering and high-tech industries. Embracing AI in engineering will be a key component of Ireland's future technological advancement and global competitiveness. Together, engineers and policymakers can shape a future where AI enriches Ireland's engineering landscape, while upholding the highest ethical standards.

Engineers Ireland recognises the potential benefits of AI in enhancing the quality and efficiency of documentation generation and engineering design work. It has been noted, however, that with the adoption of any new technology, a level of risk exists across a number of spectra. While AI may be used, for example, to improve language and grammar in documentation and accelerate design iterations, AI is capable of making errors, sometimes very significant in nature, and cannot, at least yet, replace human expertise, judgement, and supervision.

The governance of AI, not just in professional practice and workplaces, but across society, will become increasingly essential in the coming years.



Categories of AI

AI is quickly becoming a part of everyday life, being embedded into more and more technology and devices. It is rapidly reshaping the engineering profession, offering transformative tools that enhance design, analysis, automation, and even decision-making across various disciplines. AI technologies such as computer vision, generative models, and large language models (LLMs) are increasingly being integrated into engineering workflows.

Computer vision

Computer vision has long been used in engineering applications such as robotics and automation. Developed in the late 1960s, computer vision enables machines to interpret visual data, supporting applications like structural inspection, autonomous vehicles, and quality control. Computer vision has been a pioneering version of AI, using vision algorithms to identify objects and edges which proved vital in the development of robotics and automation. The focus on automation was a driving force in the development into neural network architecture and has been used commonly in robotic control for years.

Generative AI

Generative AI or Gen AI is capable of producing new content such as design prototypes, simulations, or code, and is revolutionising how engineers approach creativity and problem-solving. However, Generative AI is a non-deterministic process designed to come to the most likely outcome. This means a generative AI system when asked the same question will often create a similar but unique answer each time.

Large Language Models

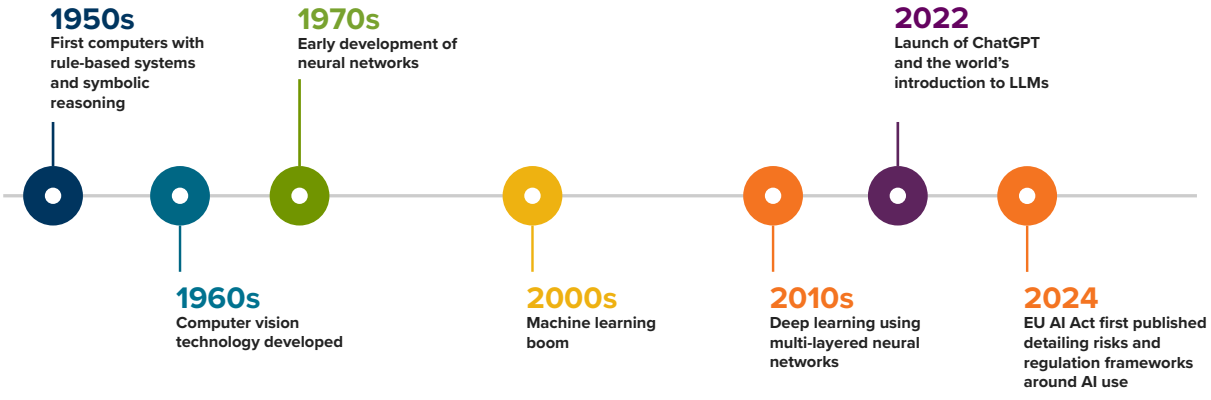
Large Language Models, LLMs are a type of generative AI trained on vast amounts of text to understand and generate human-like language. This facilitates more intuitive human-machine interaction, using human-like language to communicate and assist with documentation, technical writing, and even code generation.

The journey of modern AI began in the mid-20th century with rule-based systems and symbolic reasoning. Over time, the field evolved through the development of expert systems in the 1980s and the boom of machine learning in the 2000s. The last decade has witnessed an explosion in AI capabilities, driven by advances in computing power, data availability, and neural network architectures. Today, AI systems can learn from vast datasets, generate realistic visual content, and operate in real-time, ushering in a new era of intelligent automation.

Recent breakthroughs in generative AI and LLMs have captured public and professional attention, sparking widespread interest in their potential applications. In engineering, this surge is reflected in the adoption of AI-augmented design tools, predictive analytics for maintenance and performance, autonomous systems for construction and manufacturing, and digital twins for simulation and monitoring. In parallel to engineering applications, AI is becoming commonly used by members of the public. LLMs like Microsoft's Copilot and OpenAI's ChatGPT are designed to understand and produce human-like text to assist users with tasks. Indeed, AI systems are increasingly being run on local hardware instead of cloud servers, a practice often referred to as 'Edge AI'. These innovations can, if used properly, enable faster project delivery, improved writing quality and structure, and other benefits.

However, the adoption of AI also introduces significant risks. Bias in training data can lead to unfair or unsafe outcomes, while opaque decision-making processes challenge transparency and accountability. Engineers must also consider the impact of automation on employment and the ethical implications of delegating decisions to machines. Security and privacy concerns are paramount, especially when AI systems handle sensitive data or control critical infrastructure.

As AI becomes embedded in engineering practice, it is essential for engineers to navigate these opportunities and be mindful of the risks associated with AI use.



Applications of AI in Engineering

In the past decade there has been a clear increase in the number of AI related publications as seen in Figure 1. [1] This is most notable in machine learning, as well as computer vision. These are vital areas for development for robotics and engineering applications. Though despite the rush to integrate AI into business models 95% fail to return predicted revenue acceleration.[2] This suggests that, while AI offers opportunities to increase efficiencies in work practices, it is unlikely to replace all tasks in the workplace.

As AI is increasingly being integrated into simulation tools and CAD packages, it offers a powerful design tool that enhances efficiency, precision, and innovation across disciplines. In design and simulation, AI enables engineers to explore complex geometries and optimise structures through generative design, where algorithms propose solutions based on performance criteria and constraints. This not only accelerates the design process but leads to more sustainable and cost-effective outcomes.[3]

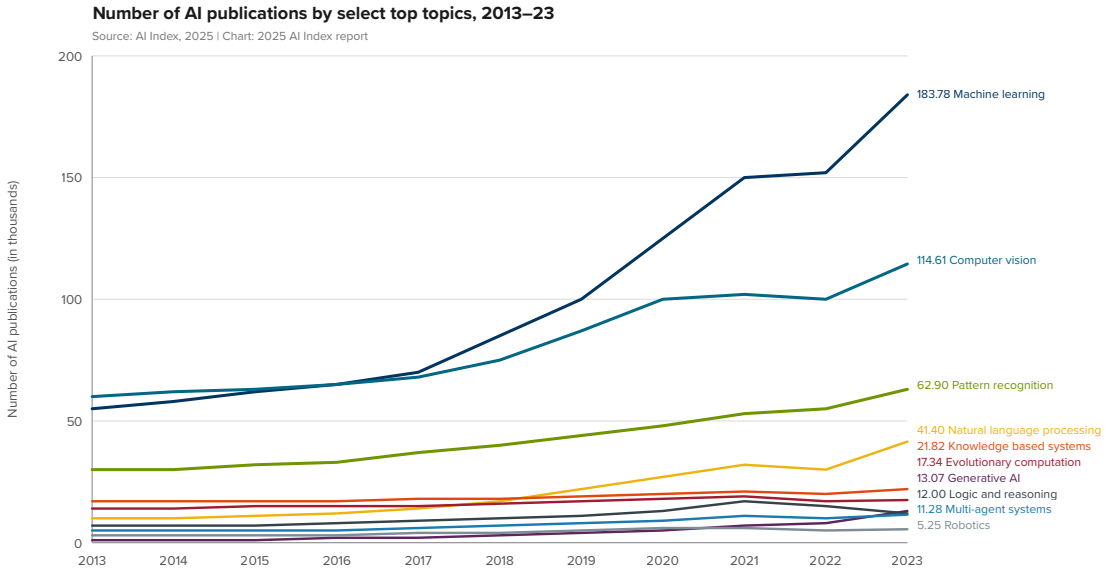


Figure 1 – Number of AI publications by topic

AI is both transforming how engineers solve problems and redefining the tools they use, the speed at which they work, and the complexity of challenges they can address. From design to documentation, AI is becoming a core enabler of innovation across all disciplines such as civil, mechanical, and electrical engineering. It is important to remember that "AI systems can be used very effectively to support decision-making rather than replacing it".[4] Some specific examples of AI applications are:

Generative AI in Computer-Aided Design (CAD)

AI is enhancing traditional CAD tools by introducing intelligent features such as automated constraint solving, design optimisation, and feedback. In mechanical engineering, AI-integrated CAD platforms can suggest alternative geometries that reduce material use while maintaining strength, or organic structures ideal for 3D printing. In civil engineering, AI can assist in site layout planning by analysing terrain, zoning regulations, and environmental constraints. Electronic engineers benefit from AI-assisted PCB CAD systems proposing layouts that optimise routing and component placement for performance and manufacturability. All these opportunities provide good starting options, but a human must critically review the suggestions.

Digital Twins Enhanced by AI

Digital twins and virtual replicas of physical systems. These can become more powerful with AI integration. In civil engineering, AI-enhanced digital twins of buildings or infrastructure can simulate structural behaviour under different loads or environmental conditions, supporting predictive maintenance and disaster resilience. In mechanical systems, digital twins of engines or turbines can be used to monitor wear and optimise performance. In electrical engineering, digital twins of power grids or substations help manage load balancing, fault detection, and energy efficiency. In predictive maintenance, machine learning models, powered by AI, analyse sensor data to forecast equipment failures before they occur, reducing downtime and improving safety in sectors such as manufacturing, transport, and energy.

AI for Report Writing and Summarisation

AI is also streamlining the documentation process in all industries and could offer significant opportunity in engineering to explain complicated designs and processes succinctly. Engineers often spend significant time writing technical reports, summarising test results, or preparing regulatory submissions. AI tools can now assist in drafting these documents, summarising large datasets,

1 N. Maslej et al., ***The AI Index 2025 Annual Report***, AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, April 2025, available at: https://hai.stanford.edu/assets/files/hai_ai_index_report_2025.pdf.

2 A. Challapally et al., ***The GenAI Divide: State of AI in Business 2025***, MIT NANDA, July 2025, available at: https://mlq.ai/media/quarterly_decks/v0.1_State_of_AI_in_Business_2025_Report.pdf.

3 Autodesk, ***State of Design and Make 2025***, April 2025, p. 23, available at: https://damassets.autodesk.net/content/dam/autodesk/www/pdfs/2025-sdm-report-final.pdf?_gl=1*1vx0ts4*_gcl_au*MTk1NjcwNDM1Ny4xNzc5NDYwMTU0*_ga*NjM1NjQ4MzI1LjE3Nzk0NjAxNTQ.*_ga_NZSJ72N6RX*czE3Nzk0NjAxNTMkbzEkZzEkdDE3Nzk0NjAxNTQkajU5JGwwJGgw

4 Department of Public Expenditure, Infrastructure, Public Service Reform and Digitalisation, ***Guidelines for the Responsible Use of Artificial Intelligence in the Public Service***, May 2025, available at: https://assets.gov.ie/static/documents/09fe3ad4/Guidelines_for_the_Responsible_Use_of_AI_in_the_Public_Service_20250918.pdf

and even translating technical content for non-expert audiences. This accelerates project timelines and frees engineers to focus on higher-value tasks. For example, a civil engineer might use AI to summarise site inspection data, while a mechanical engineer could generate a performance report from simulation results.

AI as a Knowledge base for a Multi-disciplinary Team

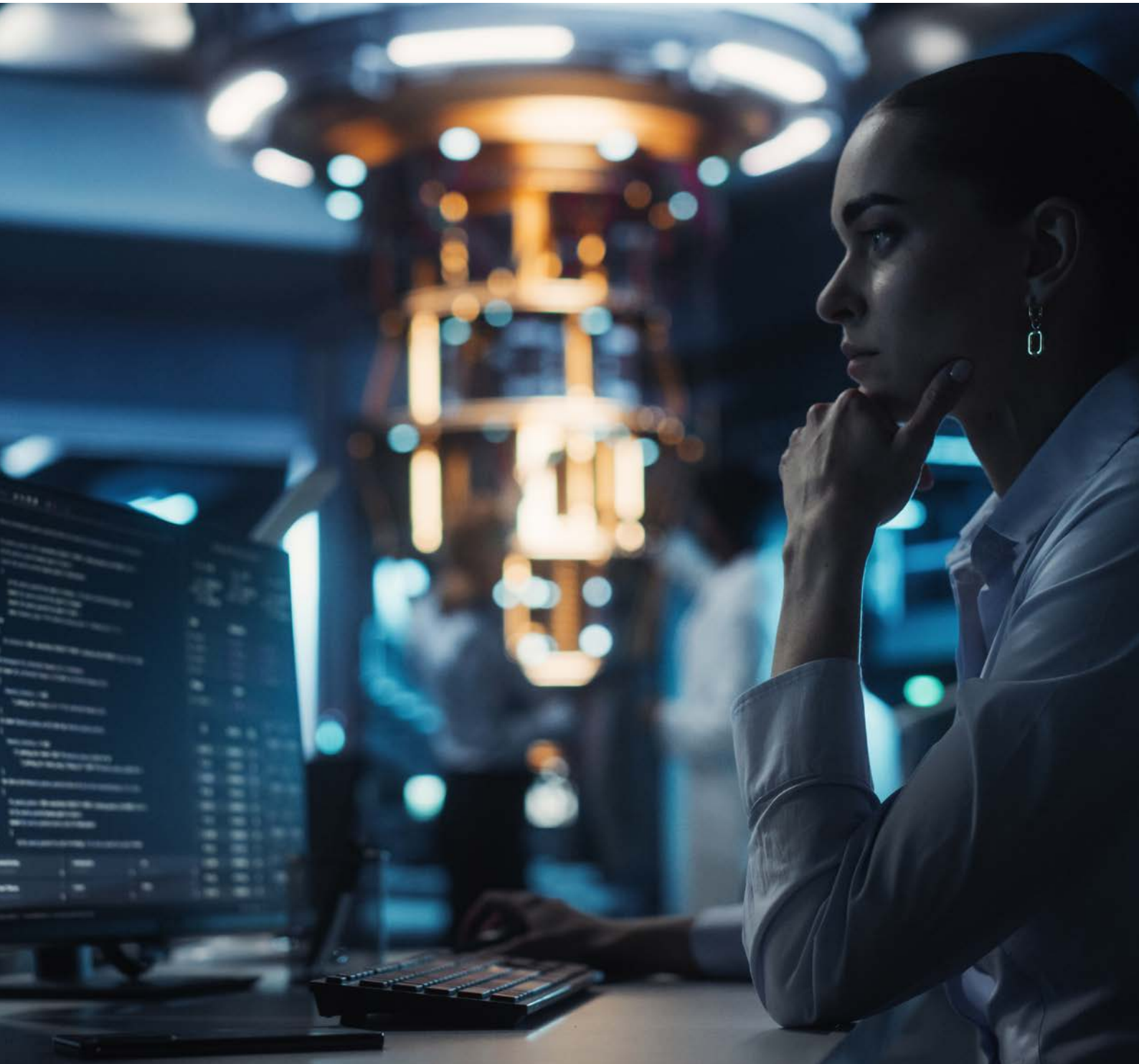
LLMs can act as a dynamic and comprehensive knowledge base, especially when an engineering team lacks a member from a key discipline and the hiring process is slow. For example, a company seeks to engage consultants to install solar panels that both offset its demands, and supply any excess excess into the the electricity network. Due to demand for solar panel installations, the firm lacks the electrical engineering resources, and hiring is slow. In this scenario, the team can use LLM to understand core concepts; generate problem-solving approaches to explore; translate and simplify complex documentation from vendors, all while waiting for hiring to complete.

These applications demonstrate that AI is not only a tool for automation as it was first developed, but a catalyst for innovation, enabling engineers to solve complex problems and deliver more resilient infrastructure. However, the integration of AI requires careful consideration of ethical principles, transparency, and accountability to ensure that its benefits are realised responsibly. AI cannot replace engineers, but it can support them in the same way as the calculator and computer have already done.

These opportunities for AI often replace roles that were done by junior engineers or graduates with oversight from more experienced engineers. This creates two major risks:

1. The pipeline for future experienced engineers will be damaged due to junior engineers missing opportunities for experience.
2. The output from AI will need to be thoroughly checked and confirmed by senior engineers to ensure no bias or hallucinations have been used in the building of the solution.

These risks must be considered carefully when engineers use AI solutions.



Ethical Practices for Engineers using AI

As AI technologies become increasingly embedded in engineering workflows, engineers must adopt a rigorous ethical framework to ensure responsible innovation. Two foundational principles, transparency and accountability, are essential in guiding the development, deployment, and oversight of AI systems. According to the Institute of Electrical and Electronic Engineer's (IEEE) Ethically Aligned Design framework, AI systems must be designed to respect human rights, be verifiably safe, and allow for traceability in the event of harm. [5] This means engineers must be able to explain how an AI system arrived at a decision, particularly in safety-critical contexts such as infrastructure, transport, or healthcare.

AI systems, especially generative models and LLMs, are known to produce outputs that are plausible but incorrect, a phenomenon referred to as hallucinations. Through interaction with a person the AI can be corrected repeatedly and tricked into generating a false positive. These systems are highly agreeable, often presenting information with confidence even when it lacks factual grounding. Such inaccuracies are not just issues in code generation, in which AI is widely used, but present very significant risks across the engineering spectrum, from infrastructural development to safety-critical software.

It is worth noting that some legal ambiguity may exist around work created through AI prompts and, while, section 21(f) of the Copyright and Related Rights Act, 2000, provides that, where computer-generated work is concerned, the author is "the person by whom the arrangements necessary for the creation of the work are undertaken", this has not been tested with regard to AI and may indeed be at odds with a growing body of EU jurisprudence on the matter, admittedly arising from other jurisdictions. New legislative provisions in this area to clarify the matter would be welcome.

The importance of risk management in AI use cannot be overstated. Engineers must assess risks not only in the outputs of AI systems but also in the input data, assumptions, and parameters that shape the model's behaviour. Poor-quality or biased data can lead to unsafe or discriminatory outcomes.

Real-world examples illustrate the consequences of poor oversight. A 2022 case involving Air Canada's chatbot offering an unauthorised bereavement fare led to a legal dispute, with the court ruling that the airline was bound by the AI's promise.[6] This highlights the need for clear accountability structures when AI systems interact with the public or make decisions on behalf of organisations.

To manage these risks, engineers should implement safeguards such as validation protocols, human-in-the-loop review processes, and traceability mechanisms. For instance, logging AI decisions and maintaining audit trails can help identify the root cause of errors and support legal and ethical accountability. Transparency also builds public trust, especially when AI is used in public infrastructure or services.

The Engineers Ireland Code of Ethics (2023) requires members to act with fairness, courtesy, and good faith, and to prioritise the public good above all else[7]. These principles are directly relevant to the deployment of AI systems, which can influence public safety, environmental sustainability, and social equity. For example, when using AI to design infrastructure or automate decision-making, engineers must ensure that the technology does not compromise human welfare or introduce bias that could harm vulnerable populations.

The Code also states that a member's obligations to a client must never override their responsibility to the public good. This is particularly important in AI applications where commercial pressures may encourage rapid deployment without sufficient testing or oversight. Engineers must resist such pressures and advocate for transparency, fairness, and accountability in AI systems.

Moreover, the Code's emphasis on truth and honesty supports the need to address AI's tendency to produce hallucinations that appear correct but are factually inaccurate. Engineers must critically evaluate AI-generated content and avoid presenting it as authoritative without proper validation. This aligns with the principle that engineers should not enter undertakings that compromise their ethical responsibilities.

Finally, the Code encourages safeguarding human life, welfare, and the environment. AI systems used in engineering must be assessed for risks related to safety, data privacy, and environmental impact. Engineers should implement robust risk management strategies, including reviewing both the inputs (e.g. training data, assumptions) and outputs (e.g., design recommendations, predictions) of AI systems.

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5 Institute of Electrical and Electronic Engineers, *The IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems*, 2016, available at: https://standards.ieee.org/wp-content/uploads/import/documents/other/ead_general_principles.pdf

6 L. Cecco, 'Air Canada ordered to pay customer who was misled by airline's chatbot', *The Guardian*, 16 February 2024, available at: https://www.theguardian.com/world/2024/feb/16/air-canada-chatbot-lawsuit.

7 Engineers Ireland, Code of Ethics, February 2023, available at: https://www.engineersireland.ie/LinkClick.aspx?fileticket=0L3VSJJG_xY%3d&portalid=0&resourceView=1



Guidance for Engineers

As AI technologies become more integrated into engineering practice, it is vital that engineers approach their use with professionalism, ethical awareness, and technical diligence. The Engineers Ireland Code of Ethics remains a foundational guide, emphasising truth, honesty, and a commitment to the public good. These values are especially important when working with AI systems that can produce outputs that are convincing but incorrect, and that may reflect biases or limitations in their training data.

Practitioners should familiarise themselves with useful tools. The US-based National Institute for Standards and Technology's AI Risk Management Framework is recognised globally as an operational blueprint for AI risk management, based on a set of core characteristics of trustworthy AI, which can be of benefit in assessing AI systems.

Engineers must recognise that AI is not infallible. Like an inexperienced colleague, AI tools are eager to assist but can make mistakes. Both the colleague and the AI lack contextual understanding, judgment, and accountability. Therefore, any output generated by AI, whether it's a design proposal, a simulation result, or a written report, must be reviewed, validated, and confirmed by the engineer before it is used in practice or shared with stakeholders. Engineers must remain the final decision-makers when using AI. By embracing transparency, accountability, and rigorous risk management, they can harness the power of AI while upholding the integrity and safety of their profession.

Additionally, AI is trained on broad datasets, rather than individual inputs, requiring vigilance to protect company-specific data and ensure that safeguards to protect data are observed.

To support responsible and ethical use of AI, engineers should consider the following recommendations:

- **Prompt Design:** Variations in prompt design can achieve different results, so consider how questions are phrased to AI systems and integrate the output with follow-up prompts.
- **Manage Input Risks:** Poor quality or biased data can lead to flawed outputs. Ensure that inputs to AI systems are accurate, representative, and ethically sourced.
- **Review All AI Outputs:** Never accept AI-generated results at face value. Validate them against engineering standards, codes, real-world constraints, and experience.
- **Understand the Source Material:** Know what data or models the AI is trained on. If the source is unclear or unverifiable, treat the output with extra caution and use first principles to confirm work where appropriate.
- **Maintain Transparency:** Be prepared to explain how AI was used in your work, including its role in decision-making and any limitations it may have.
- **Ensure Accountability:** Engineers must remain the final decision-makers. Responsibility for outcomes cannot be delegated to AI systems.
- **Implement Human Oversight:** Use human-in-the-lead processes for critical decisions, especially in safety-sensitive or public-facing applications.
- **Document AI Use:** Keep records of how AI was used, what decisions it influenced, and how outputs were verified. This supports traceability and accountability.
- **Engage with Stakeholders:** Communicate clearly with clients, regulators, and the public about the role of AI in your work, especially when it affects safety or public welfare.
- **Stay Informed:** AI is evolving rapidly. Engineers should pursue continuous learning to stay current with best practices, environmental impacts, risks, and regulatory developments.
- **Adhere to Standards:** Review all relevant standards, including ISO 42001, and others within the ISO 42000 series, that may impact specific requirements for establishing, implementing, maintaining, and continually improving artificial intelligence applications.

By following these guidelines, engineers can harness the benefits of AI while upholding the integrity of their profession and protecting the public interest. The use of AI should enhance engineering, not replace the judgment, responsibility, and ethical standards that define it.

Attitudes Towards AI in Ireland

Among Irish adults, there is considerable worry about AI and its potential impacts, as well as widespread awareness of the technology's attributes.

According to research conducted for Engineers Ireland by Ipsos B&A, a representative sample of just over 1,000 Irish adults* report a relatively high degree of knowledge of artificial intelligence. 65% say that they are either very or somewhat familiar with AI, while just 15% state that they are either somewhat or very unfamiliar.

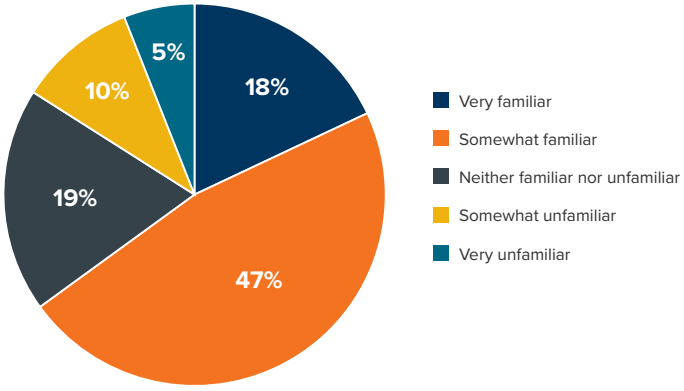


Figure 2 – Public Survey: How familiar are you with Artificial Intelligence (AI)

*fieldwork conducted in November 2025.

Despite this high degree of familiarity, however, AI use amongst Irish adults remains fairly low. Only 5% say they use it several times a day, with just a further 19% using it daily. While this implies a reasonable level of penetration of AI into everyday life few, seemingly, rely on it significantly in the course of their work or personal lives.

There also exists a clear distrust of AI and concerns about how it may be misused.

57% of Irish adults say they are more concerned than excited about AI's potential for increased use in daily life, with only 15% stating the opposite. 59% do not believe that AI will ever get to a point where they would trust it to make important decisions for them, with only 17% answering in the affirmative.

There was also a high degree of anxiety expressed about the various impact AI may have in a range of areas. Respondents were somewhat or very concerned about AI's potential to: impersonate

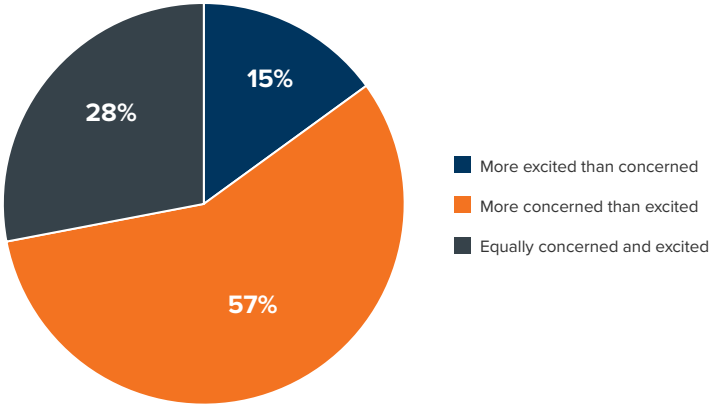


Figure 4 Public Survey: Would you say the increased use of artificial intelligence in daily life makes you feel...

people (77%), result in people's personal information being misused (74%), and lead to job losses (73%).

57% strongly agreed that AI should be more tightly regulated by governments, with a further 24% somewhat agreeing with this sentiment. Only 6%, in total, stated that they somewhat or strongly disagreed with this position. Furthermore, 53% of Irish adults said that clear regulations would make them feel more comfortable about the use of AI in engineering, while 46% said they felt independent oversight should be pursued.

Among Irish businesses, data collected by the Central Statistics Office found that about 20% said they used AI in 2025, compared with 15% in 2024.[8] Among large enterprises, 58% said they used AI, with 35% using AI for data mining and 29% using it for automating workflows or assisting in decision-making.[9] AI was used by only 17% of small enterprises, demonstrating the unevenness of AI adoption.[10]

8 Central Statistics Office, *Information Society Statistics - Enterprises 2025*, February 2026, available at: https://www.cso.ie/en/releasesandpublications/ep/p-isse/informationsocietystatistics-enterprises2025/

9 Ibid.

10 Ibid.



The Coming Wave

In late 2023 Mustafa Suleyman, co-founder of DeepMind and now CEO at Microsoft AI, authored The Coming Wave: Technology, Power, and the Twenty-first Century's Greatest Dilemma.

The evocation of a wave metaphor encapsulates what many feel best describes AI; an overwhelming and powerful force, uncontrollable by man, threatening to sweep away all in its path and reshape society in its wake.

The dilemma at the centre of the book is how the enormous positive potential of AI can be harnessed, while containing its potential negative impacts. Suleyman argues that this new technology has the capability to greatly enhance economic growth and scientific enquiry, yet "threatens to empower a diverse array of bad actors to unleash disruption, instability, and even catastrophe on an unimaginable scale." Many go further, arguing that, even in the absence of bad actors, a sufficiently advanced and autonomous AI may be independently capable of wreaking disaster on humanity.[11]

The kind of AI that forms part of public consciousness today, large language models (LLMs) that produce information in human or computer languages, are not the end goal for AI companies. Instead, they are a waypoint on the journey to artificial general intelligence (AGI) – an artificial intelligence that matches the intelligence demonstrated by humans across all domains – and even superintelligence.

AI that evolves to the level of AGI, it is believed, would be capable of recursive self-improvement; AI that redesigns itself continuously, without human intervention, to expand its capabilities until its cognition vastly exceeds that of humans.

There is broad disagreement on whether LLMs, even those supplied with considerably more compute and data than they currently have access to, will ever be capable of reaching recursive self-improvement. Dario Amodei, the CEO of Anthropic, the company behind the Claude LLM, believes this development is possible and has recently stated that AGI will likely be reached within the next three years and certainly within a decade. Meanwhile, Yann LeCun, former Head of AI at Meta and a Turing Award winner, has claimed that LLMs will never be capable of reaching a level of general intelligence and that another breakthrough development would be required to enable AI to attain this milestone.

Indeed, such disagreement characterises almost all predictions about how AI will continue to evolve and what the effects of this evolution will be. Few, however, contend that our society is anywhere other than on the precipice of extensive and irreversible change, reshaped by a transformative new technology. Only the exact extent and the nature of that reshaping remains open to debate.

Economic Effects

In his 1987 review of Cohen and Zysman's work 'Manufacturing Matters' in *The New York Times*, economist and Nobel laureate Robert Solow famously quipped that "[y]ou can see the computer age everywhere but in the productivity statistics".

Here Solow was highlighting that, despite widespread adoption of computers by businesses across the 1970s and 1980s, productivity had not increased, in fact, it had slowed. From 1948 to 1973 US labour productivity had grown by almost 3% per annum, but after this period it had averaged just over 1% a year.[12] This presented an apparent productivity paradox; despite investment in technology that should increase efficiency, productivity slowed, rather than accelerated. The phenomenon, which has been dubbed 'Solow's Paradox' has been intensively studied by economists, but not fully explained.

Earlier this year, Solow's Paradox was invoked by Torsten Slok, Chief Economist at US asset management firm Apollo Global Management, who observed that "AI is everywhere except in the incoming macroeconomic data", noting that "[t]oday, you don't see AI in the employment data, productivity data or inflation data. Similarly, for the S&P 493 [the S&P 500 once you exclude the top seven technology firms], there are no signs of AI in profit margins or earnings expectations. Maybe there is a J-curve effect for AI, where it takes time for AI to show up in the macro data. Maybe not."[13]

This view is buffeted by a recent study published by the U.S. National Bureau of Economic Research, arising from survey work conducted with 6,000 senior business executives in U.S., U.K., German, and Australian firms on AI adoption and its effects on jobs, productivity, and output. The study found that, while 69% of firms actively use AI, with more than two-thirds of executives regularly engaging with the technology, average usage rates only sit at around 1.5 hours a week.[14] Additionally, "executives report little own-firm impact of AI over the last three years, with nine-in-ten reporting no impact on employment or productivity."[15]

Furthermore, a recent study by MIT's NANDA Project found that "[d]espite $30-40 billion in enterprise investment into GenAI, ... 95% of organizations are getting zero return" with most AI pilots failing "due to brittle workflows, lack of contextual learning, and misalignment with day-to-day operations."[16]

Despite generally low usage of AI across the economy, and little evidence of its effects on productivity or macroeconomic data, economic modelling suggests a considerable impact by AI on the future jobs market, perhaps more reflecting the technology's potential than its current capabilities.

In Ireland, The Economic and Social Research Institute has predicted that around 7% of current jobs could be displaced in the short to medium term, with those in clerical and ICT roles are

11 Future of Life Institute, Pause Giant AI Experiments: An Open Letter, 22 March 2023, available at: https://futureoflife.org/open-letter/pause-giant-ai-experiments/

12 J. E. Tripplett, 'The Solow Productivity Paradox: What do Computers do to Productivity?' in *The Canadian Journal of Economics*, Vol. 32, No. 2, Special Issue on Service Sector Productivity and the Productivity Paradox (April, 1999), pp. 309-334.

13 T. Slok, 'Waiting for the AI J-Curve', *The Daily Spark*, 14 February 2026, available at: https://www.apolloacademy.com/waiting-for-the-ai-j-curve/

14 I. Yotzov et al., *Firm Data on AI*, National Bureau of Economic Research, Working Paper No. 34836, February 2026, available at: https://www.nber.org/system/files/working_papers/w34836/w34836.pdf

15 Ibid.

16 A. Challapally et al., The GenAI Divide: State of AI in Business 2025, MIT NANDA, July 2025, available at: https://mlq.ai/media/quarterly_decks/v0.1_State_of_AI_in_Business_2025_Report.pdf.

amongst those at most risk of automation by AI.[17] In its report, Artificial Intelligence and Income Inequality in Ireland, the think-tank suggested that "AI-driven employment and wage changes are unlikely to be evenly distributed across occupations or income levels. Unlike previous technological revolutions, such as robotisation, the exposure of occupations to AI is positively correlated with the education level required for the occupation. Unlike previous waves of technological change, AI tends to place higher earning and highly educated workers at greater risk of disruption, because the occupations most exposed to AI are predominantly in these groups." A displacement of 7% of the Irish workforce would be 111,780 people, based on the CSO's Labour Force Survey Quarter 1 2026.[18]

The prediction is roughly aligned to that of a number of advisory and research firms such as Forrester, and Goldman Sachs, which suggest short to medium term replacement figures of 6% to 7% of the workforce.[19]

There exist, however, far more aggressive assessments of how AI could negatively impact employment in the near-term, largely posited by senior executives of AI development firms, that a high percentage of what may be termed "white-collar work", or work performed at a computer, will be fully replaceable by AI within a few years. In mid-February this year, the S&P 500 dropped a percentage point on foot of a scenario posited by a little-known U.S. insights firm Citrini Research, which contended that U.S. unemployment rates could sit north of 10% by mid-2028, a perspective quickly contested by Citadel Securities and others, who argued that such analysis was guilty of misreading macroeconomic fundamentals, pointing to the rapidly rising demand for software engineers currently as evidence that AI may expand, not contract, the job market.[20]

The difficulty of forecasting AI's effects on jobs is demonstrated by the World Economic Forum's white paper Four Futures for Jobs in the New Economy: AI and Talent in 2030, where four distinct and largely incompatible scenarios are presented, instead of a single prediction: Supercharged Progress, where economic growth allows for new job creation to replace displaced roles; The Age of Displacement, where automation results in significantly increased unemployment; Co-Pilot Economy, where AI largely augments existing jobs, rather than replacing them; and Stalled Progress, where AI adoption is limited.[21]

Among the risks of widespread AI adoption listed within the report are the "[c]oncentration of power in a handful of technology platforms and governments distorts markets and regulatory frameworks" and the "[b]reakdown of societal and economic foundations following mass unemployment, collapse of social safety nets, growing environmental externalities and AI-driven disinformation."[22]

At this juncture, such a scenario cannot be excluded.

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17 K. Doorley et al., ***Artificial intelligence and income inequality in Ireland***, The Economic and Social Research Institute, Jointly-published Report No. 16, April 2026, pp. 17-18, available at: https://www.esri.ie/system/files/publications/JR16_0.pdf.

18 Central Statistics Office, ***Labour Force Survey Quarter 1 2026***, May 2026, available at: https://www.cso.ie/en/releasesandpublications/ep/p-lfs/labourforcesurveyquarter12026/employment/#:~:text=Numbers%20Employed%20and%20Employment%20Rate&text=The%20employment%20rate%20for%20those,compared%20to%2069.3%25%20for%20females.

19 J. P. Gownder, AI And Automation Will Take 6% Of US Jobs By 2030, Forrester Featured Blogs, 13 January 2026, available at: https://www.forrester.com/blogs/ai-and-automation-will-take-6-of-us-jobs-by-2030/; Goldman Sachs, How Will AI Affect the Global Workforce?, 13 August 2025, available at: https://www.goldmansachs.com/insights/articles/how-will-ai-affect-the-global-workforce.

20 F. Flight, ***The 2026 Global Intelligence Crisis, Global Macro Strategy Series***, Citadel Securities, 24 February 2026, available at: https://www.citadelsecurities.com/news-and-insights/2026-global-intelligence-crisis/; N. Lichtenberg, 'Citadel Securities demolishes viral AI doomsday essay, arguing the real 'Global Intelligence Crisis' is ignorance of macro fundamentals', Fortune, 26 February 2026, available at: https://fortune.com/2026/02/26/citadel-demolishes-viral-doomsday-ai-essay-citrini-macro-fundamentals-engels-pause/.

21 World Economic Forum, ***Four Futures for Jobs in the New Economy: AI and Talent in 2030***, White Paper, Scenarios for the Global Economy Dialogue Series, January 2026, available at: https://reports.weforum.org/docs/WEF_Four_Futures_for_Jobs_in_the_New_Economy_AI_and_Talent_in_2030_2025.pdf.

22 Ibid, p. 15.



AI Safety

Beyond the impact on employment and economies, there are significant fears that AI, if allowed to progress unchecked and unregulated, could pose a far more existential threat to humanity.

Both Geoffrey Hinton and Yoshua Bengio, who shared the 2018 Turing Prize with Yann LeCun for pioneering work on artificial intelligence and who, with LeCun, are collectively dubbed the 'Godfathers of AI', have long warned of the dangers AI may pose. Bengio has warned that "[i]f we build machines that are way smarter than us and have their own preservation goals, that's dangerous. It's like creating a competitor to humanity that is smarter than us", and has called for a moratorium on AI model development to focus on safety standards.[23]

Daniel Kokotajlo, a former OpenAI employee, courted considerable controversy in early 2025 by publishing AI 2027, positioned as a possible future where a superintelligent AI system is created, leading to humanity's destruction. Already Kokotajlo has rowed back on his timelines, stating that he now believes that such a scenario could more likely arise in the early 2030s than by next year, but he is resolute on the dangers AI may pose. The projection has many detractors, including Gary Marcus, Emeritus Professor of Psychology and Neural Science at New York University, and AI expert, who derided it as "pure science fiction mumbo jumbo".[24] Nevertheless, Kokotajlo is one of a growing number of voices seriously questioning the safety of the current trajectory of AI development.

Some of the dangers AI possesses, however, are less existential but more immediate. From late December 2025 through to January 2026, X's Grok AI became embroiled in a scandal, whereby users were able to prompt Grok to produce sexualised images of identifiable persons including, in some instances, children. In Ireland, media regulator Coimisiún na Meán announced that it was liaising with the European Commission on the issue and the Data Protection Commission has opened an investigation to determine whether the matter contravened the GDPR. Similar investigations are open in other jurisdictions globally.

The creation of convincing impersonations of individuals online through the use of generative AI, also known as 'deepfakes', is a growing phenomenon, with cybersecurity firm DeepStrike estimating that that, while roughly 500,000 online deepfakes were published in 2023, this had risen to about 8 million in 2025, with annual growth nearing 900%.[25] This creates unprecedented potential for fraudsters and cyber criminals to steal identities and perpetrate scams digitally, and render fact far more difficult to discern from fiction than ever before.

It is also becoming increasingly evident that LLMs possess strong capacities to discover and exploit cybersecurity vulnerabilities. In April, Anthropic announced that it was delaying the public launch of its latest LLM, Mythos, because the model was "strikingly capable at computer security tasks" and could be used by bad actors to expose flaws in existing systems. It was, Anthropic said, instead going to be first released to a select range of technology firms to allow them to correct bugs and security gaps before wider release. It may well be that Anthropic's move possessed a marketing dimension (OpenAI temporarily withheld its GPT-2 model from the public in 2019, citing similar concerns), but an assessment by the U.K.'s AI Security Institute, which was granted early access to the model by Anthropic, found that Mythos succeeded in expert-level hacking tasks 73% of the time.[26] Prior to April 2025, no AI model could complete those tasks at all.[27] In the wrong hands, LLMs are increasingly capable of posing enormous threats to data privacy.

Preparing for a Brave New World

The Bletchley Declaration, agreed at the AI Safety Summit at Bletchley Park in November 2023, and signed by 28 countries, affirmed that "for the good of all, AI should be designed, developed, deployed, and used, in a manner that is safe, in such a way as to be human-centric, trustworthy and responsible" and that, concerning the impact of AI systems, "the protection of human rights, transparency and explainability, fairness, accountability, regulation, safety, appropriate human oversight, ethics, bias mitigation, privacy and data protection needs to be addressed."[28]

The summit was organised by the UK Government to agree safety measures to evaluate and monitor the most significant risks from AI but, three years on, the extent to which effective ex-ante regulation is guiding the development of AI is questionable.

As is noted in by the recent National Economic and Social Council's report "the EU AI Act represents the most comprehensive binding regulatory framework currently governing artificial intelligence. It adopts a risk-based model, categorising AI systems according to the level of risk they pose."

Despite the fact that the EU's AI Act was, and remains, world leading in terms of AI regulation, it nevertheless is not without its shortfalls, and has been criticised for allowing industry self-assessment and limited oversight.[29] Whatever criticisms may be made against the AI Act, however, its prohibition of certain AI systems, such as those designed to compile facial recognition databases or those deploying subliminal, manipulative, or deceptive techniques, should be welcomed.

To be truly effective, global regulation of AI against its most pestiferous effects would be required, something that may prove

23 I. Bousquette, 'A 'Godfather of AI' Remains Concerned as Ever About Human Extinction', ***The Wall Street Journal***, 1 October 2025, available at: https://www.wsj.com/articles/a-godfather-of-ai-remains-concerned-as-ever-about-human-extinction-ec0fe932?mod=tech_lead_story.

24 A. Down, 'Leading AI expert delays timeline for its possible destruction of humanity', ***The Guardian***, 6 January 2026, available at: https://www.theguardian.com/technology/2026/jan/06/leading-ai-expert-delays-timeline-possible-destruction-humanity.

25 DeepStrike, ***Deepfake Statistics 2025: AI Fraud & Data Trends***, 8 September 2025, available at: https://deepstrike.io/blog/deepfake-statistics-2025.

26 C. Stokel-Walker, 'What is Mythos, Anthropic's unreleased AI model, and how worried should we be?', ***Scientific American***, 17 April 2026, available at: https://www.scientificamerican.com/article/what-is-mythos-and-why-are-experts-worried-about-anthropics-ai-model/.

27 Ibid.

28 The AI Safety Summit, ***The Bletchley Declaration by Countries Attending the AI Safety Summit, 1-2 November 2023***, available at: https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-declaration-by-countries-attending-the-ai-safety-summit-1-2-november-2023.

29 A. Minotakis, 'Regulating AI in the workplace: A critique of the EU AI act and the platform work directive through a worker-centred lens' in ***Platforms & Society***, Vol. 2, November 2025, available at: https://journals.sagepub.com/doi/10.1177/29768624251396248#tab-contributors.

unlikely in an environment where national competitive advantage is seen as intrinsically linked to geopolitical and economic success, disincentivising perceived regulatory speed bumps to development.

It is improbable, then, that Ireland will be able shape the global regulation and safety of AI, except perhaps though this human-centric approach. Indeed, as a small but influential open economy, with a strong technology sector, Ireland is well placed to occupy an outsized role, in this regard.

Contained within the Department of An Taoiseach's National Digital and AI Strategy 2030, Digital Ireland: Connecting our People, Securing our Future, are numerous welcome objectives, including the establishment of an AI Advisory Unit, to provide advice and expertise for public service bodies, and the creation of an Artificial Intelligence Office of Ireland as the focal point for AI regulation and innovation in Ireland.[30]

Such developments will only add to Ireland's regulatory expertise in this area and strengthen the role this country may take on as a leader in AI governance and regulation.

Whatever role regulation comes to play in the future it is, nevertheless, the case, that Ireland's economy and society will likely be markedly impacted by AI. As the State's AI Advisory Council noted:

> *"The Fourth Industrial Revolution, powered by AI, is advancing at a pace that surpasses previous technological shifts. Many prevailing forecasts and economic models are rooted in historical data and incremental projections of technology adoption, potentially underestimating the exponential trajectory of AI and the magnitude of its impact. It is essential to plan not only for anticipated growth, but also for scenarios that may exceed our current expectations, ensuring Ireland remains competitive and safeguards our economy, workforce, and citizens."*[31]

Elements of the National Digital and AI Strategy 2030 aim to accelerate the use of AI in Ireland, such as through the development of "a targeted strategy in 2026 to drive AI adoption across key sectors of the enterprise base".[32] As a globalised and service-based economy, highly reliant on overseas investment, particularly in the technology sector, such measures are necessary to ensure Ireland retains a competitive edge. Each major technological development has brought with it immense upheaval in the labour force, and it will be incumbent on the Government to plan for a variety of scenarios, supporting upskilling and transition of workers into new areas of demand, where they arise, at pace, which will likely be essential to mitigating the risks of worker displacement.

It is in this context that the effect of AI in education must be considered. In particular education, at all levels, will need to rapidly adapt to, not only preparing students to use AI tools effectively, in a way that enhances learning opportunities, in a way that places emphasis on ethical conduct and the risks of reliance on AI systems, while simultaneously ensuring students continue to develop fundamental competencies and skills, independent of reliance on AI. This represents a challenging balancing act for educational policy, but one that will be necessary to urgently meet.

Engineering skills, in particular, have a central role to play in leveraging AI for competitive advantage, and broadening Ireland's base of engineering skills should intensify as a policy goal.

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30 Department of An Taoiseach, ***Digital Ireland: Connecting our People, Securing our Future***, 2026, p. 19, available at: https://assets.gov.ie/static/documents/5e511b3a/National_Digital_and_AI_Strategy_2030.pdf.

31 Artificial Intelligence Advisory Council, ***Ireland's AI Advisory Council Recommendations - Helping to Shape Ireland's AI Future***, p. 1, available at: https://assets.gov.ie/static/documents/Irelands_AI_Advisory_Council_Recommendations_-_Helping_to_Shape_Irelands_AI_Future.pdf.

32 Department of An Taoiseach, ***Digital Ireland: Connecting our People, Securing our Future***, 2026, p. 28, available at: https://assets.gov.ie/static/documents/5e511b3a/National_Digital_and_AI_Strategy_2030.pdf.



Conclusions and Recommendations

AI offers many opportunities for the engineering sector, however, the use of AI must be considered a tool for engineers like any other. The output of the AI must be reviewed and signed off by engineers with clear transparency of how decisions are made. It is the responsibility of the engineer to approach the use of AI in an ethical manner in the same way any other tool or supporting role is utilised. Additionally, the progress of AI poses numerous economic, regulatory, and safety challenges, which Government must adequately prepare for, mitigating risks while readying Ireland's labour force for transitions brought about by AI.

Engineers Ireland AI checklist

- ☐ Engineers consider the guidance mentioned in this report to ensure ethical and risk appropriate approach to the use of AI;
- ☐ Experienced engineers consider opportunities for developing junior engineers, where a greater proportion of entry-level work may be performed by AI;
- ☐ Government provide legal clarification as to whether section 21(f) of the Copyright and Related Rights Act, 2000, governs copyright for AI-generated work;
- ☐ Government supports the increased use of AI, where appropriate, both within the engineering sector and across the economy, to ensure Ireland remains competitive in a global market, having particular regard to the engineering sector as a driver of growth;
- ☐ Government models the potential impacts of AI adoption throughout the economy, across various scenarios, including mitigation planning for negative outcomes for jobs and specific sectors;
- ☐ Government develops bespoke up-skilling and re-skilling programmes, to ensure workforce skills can take advantage of opportunities presented by AI adoption, while supporting workers who may be displaced by this emerging technology; and
- ☐ Government prioritises the delivery of an AI Advisory Unit and an Artificial Intelligence Office of Ireland, to enhance policy-making and regulation in this area.



Appendix

A number of case studies from academia and industry identify how AI is being used currently. These case studies illustrate some of the challenges and opportunities faced by engineering professionals.

Dublin City University (Academia)

Title: Teaching nuanced usage of gen AI

Background: Aiming to empower students to experiment with new technologies and tools. We wanted students to see the advantages and the limitations of gen AI, but also understand the prompt design process, reviewing and refining responses within an engineering design cycle. Society adapted to the introduction of calculators, so how do we learn to work with this newer tool?

Implementation: Key for students was to develop their awareness of usage cases for gen AI. 'Good' and 'bad' examples were presented for class discussion on the merits and limitations of AI. The students involved were not engineers, but a mixed undergraduate class at Dublin City University. Sessions took place during 2024 using ChatGPT-4.

Results: Students found it easier to give honest feedback and discuss the strengths and weaknesses because it was created using gen AI rather than using anonymised student work.

Non-experts can initially find it hard to discern the quality of AI produced text. More sophisticated analysis skills can be developed by reading in detail and discussing; then the limitations of gen AI become more apparent.

Challenges & Lessons Learned: Students more easily engaged with the "bad" example where gen AI was used to outsource all work rather than engage higher level editing and curation skills. The natural language interface resulted in students struggling to identify initial question framing as important, preferring to refine queries after an initial run instead.

Conclusion: Clearer guidance on the benefits and limitations of gen AI is needed to support student understanding as information students receive on AI comes from sources who are either very positive or very negative and lacking nuance. As with any new technology, education is vital to students making best use of it.

Ardmac (Industry)

Title: Walk, Crawl, Run, Fly – AI Transformation at Ardmac

Background: Ardmac launched its AI Pathfinder under the RD&I programme to explore how AI could amplify team performance, streamline workflows, and reduce friction. The goal was to prepare teams for change, identify AI-ready roles, and build a roadmap for scalable AI adoption beginning with pre-contract functions such as estimation and engineering design.

Implementation: Over six weeks, 28 employees participated in interviews and workshops. Using proprietary tools, 52 AI opportunities were identified and assessed for feasibility, risk, and impact. Eighteen were prioritised for next-phase development, with a phased roadmap focusing on high-impact functions like engineering design, estimation workflows, and health and safety documentation.

Results: The Pathfinder exposed manual inefficiencies and clear automation potential. Prioritised use cases could save ~700 hours per month and deliver €275K annual savings via a single AI agent. Sentiment among technical staff was positive, with strong interest from estimators and engineers in tools that improve accuracy, planning, and team development.

Challenges and Lessons Learned: Trust, role relevance, and data integrity surfaced as key concerns. Work is underway to standardise data and classification systems. Departmental engagement varied, underlining the need for tailored change management. Champion users will be critical. Securing early, low-risk wins is essential to build confidence before scaling into more transformative AI applications.

Conclusion: Ardmac now advances to Phase 2: AI Deep Dive. With proven potential to unlock productivity and transparency, a people-focused, phased rollout continues. The next steps include finalising heritage data structures, deploying AI agents in engineering and estimation, supporting adoption, and continuously refining implementation to deliver measurable business and technical outcomes.

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