ENGINEERS
AUSTRALIA

The impact of AI and generative technologies on the engineering profession

January 2025

The impact of AI and generative technologies on the engineering profession

ISBN 978-1-925627-92-3

Author: Michael Bell AffilIEAust

Acknowledgements: Engineers Australia acknowledges Ergo Strategy and the research team Alicia Mintzes, Laura Coultas and Michael To.

We acknowledge the Information, Telecommunications and Electronics Engineering (ITEE) College for their continued support on our work on AI.

Engineers Australia
11 National Circuit, Barton ACT 2600
61 2 6270 6555
policy@engineersaustralia.org.au

engineersaustralia.org.au

Contents

Foreword

Artificial intelligence (AI) has been developing since the mid-1900s. Advanced algorithms, machine learning, and data analytics have helped engineers solve complex problems faster and more effectively as it has evolved.

In engineering, AI excels in design optimisation. AI-driven tools, such as generative design software, can analyse constraints and objectives to generate optimal designs for structures, components, or systems. These tools not only reduce design cycles but also offer solutions that were previously too onerous for traditional methods to assess and improve. For the traditional engineer who previously found juggling a dozen competing constraints and objectives challenging, AI multiplies the number of constraints and objectives that can be navigated.

Its application within complex types of engineering, such as materials engineering, is breaking new ground routinely. AI is also revolutionising mechanical tasks through its integration with robotics and automation. Autonomous machines, powered by AI, can perform tasks without exposing people to traditional hazards, such as those found in mining, manufacturing and construction. The optimisation abilities of AI increase productivity. Generative AI processes create new ways of approaching problem solving; be it productivity, safety, cost, impact or any other combination of parameters.

As with any new technology that shows promise of transformation for good, AI also comes with risks. Engineering advances are sometimes attached to shadows of unintended consequences; we need look only to the industrial revolution enabled by fossil fuel technology to recognise this.

The growth of AI in engineering allows some of the traditionally labour- and cognition-intensive tasks to be delegated to these new technologies effectively. At the same time, it elevates engineers' responsibility to do so with wisdom, and to apply engineering skills to higher-order tasks.

As the national body for engineers, Engineers Australia is deeply invested in comprehensively understanding the implications of AI for engineering. Our goal is to effectively communicate these insights, contribute to thought leadership on managing associated risks, and create the enablers that will allow AI to benefit engineers and engineering appropriately.

To harness AI effectively, we need the right education settings, ensuring the next generation of engineers are trained in the ethical and responsible use of these systems. We must also encourage company cultures that are open to exploring the technology and sharing benefits and lessons learned, and implementing policies and training that safeguard against risks, while realising the productivity, safety and positive impact benefits.

Engineers Australia is well-positioned to support the profession in navigating the evolving technology, including our ongoing work with the tertiary education sector, sharing case-studies through CPD events and promoting ethical and competent use of AI systems. We encourage all stakeholders to review this report and leverage the insights to contribute to our collective success.

Romilly Madew AO FTSE HonFIEAust EngExec
Chief Executive Officer
Engineers Australia

Dr Raj Aseervatham FIEAust CPEng EngExec
National President

January 2025

Executive summary

Over the past year, AI (and specifically GenAI) capabilities has become a topic which is hard to miss. Many of these discussions revolve around the future and how AI will impact the workforce. This report explores how AI and GenAI technologies have transformed engineering businesses and the workforce, and, importantly, how they will evolve.

Generative artificial intelligence (GenAI) will be an essential driver of change within the profession. The key question is how best to build the necessary confidence and support for GenAI to be used most effectively and safely.

Although traditional AI or older AI tools and methods have been used by engineers for 20 or more years, the recent advent of GenAI is already reshaping the engineering profession. More than 70 per cent of respondents agree GenAI will increase productivity in engineering work. This means the ability to use GenAI will be an essential skill for engineers in the future.

This report highlights that developing an engineer's ability to use and adapt to AI and GenAI technologies is a shared responsibility. Industry, professional and peak bodies, the tertiary sector and an individual engineer's own professional development must all play a part.

An important takeaway is that businesses need to foster a culture of openness to AI and GenAI so that engineers feel safe to collaborate, share and explore how the technology can best be used. In workplaces where engineers don't feel safe talking openly about using GenAI, they feel less confident and are less competent with the technology.

The reports also finds a limited understanding of how AI technologies can be applied – hence the need for openness. For instance, the value that toolboxes of advanced AI technologies, including GenAI and large language models (like Open GenAI, Domain-specific GenAI and Secure/custom GenAI) can deliver to the engineering profession is not widely and consistently understood. However, engineers' fundamental capabilities and skills, and their ability to think critically and solve complex problems, will stand them in good stead to embrace these tools – if they have the right support.

As to be expected, younger engineers do adopt GenAI faster than more experienced engineers, with young engineers finding the capabilities of explaining concepts beneficial as they learn and enter the workforce. Senior engineers tend to leave it to the next generation to see how GenAI could be incorporated into their work.

The findings outline the difference between multinationals and domestic firms, as well as larger and smaller organisations. Larger companies are more likely to have policies, training and support covering AI. Training helps to mitigate the risks associated with poor AI deployment. A key insight is that good AI support fosters a culture of learning and innovation, competitiveness and sustainability. As GenAI becomes more prevalent across all fields, including biomedical, electrical, chemical, industrial and systems engineering, it will create new jobs and opportunities for the growth of the nation.

To harness GenAI's benefits this report identifies four key focus areas for businesses to focus. These include:

1. Focus on deploying AI in areas which can enhance productivity by reducing labour-intensive tasks, such as assisting with initial drafts and developing skills.
2. Establish clear guidelines on data usage, risk management and security to prevent breaches and mitigate against biases, ensuring human oversight.
3. Build knowledge by sharing best practices and use cases, prompting skills and support resources.
4. Foster a culture that encourages experimentation with AI within the frameworks of company policies.

Seizing the benefits and opportunities presented by GenAI must also be balanced by appropriate safeguards, particularly where the technology is deployed in high-risk settings or where it impacts vulnerable members of the community. Engineers Australia therefore also advocates for a comprehensive standards framework for AI in Education and a balance of both regulatory and non-regulatory measures, to safeguard professionals, educators, students, and the community.

To further support the findings of this report, in addition to the funding provided to the adopt centres, Governments across Australia should continue to allocate funding for training and other upskilling programs to support workers developing proficiency in using digital tools and AI technologies across. A good example of this already happening is the *Introduction to AI* course powered by the NSW Government's Institute of Applied Technology and the Australian Government Department of Industry, Science and Resources.

Additionally, investing in public campaigns to increase awareness and understanding of AI technology is crucial. Such campaigns will help build trust and encourage the responsible use of AI systems, fostering a more informed and confident public.

Engineers Australia will continue to provide the engineering voice to government and the community on these issues and provide the resources, connections, and growth our engineers need to do ethical, competent and high-value work in our communities.

Introduction

Engineers play a crucial role in our society and economy and are vital to overcoming many of the challenges we face today and in the future. Engineers around the world are grappling with the rapid advancement of emerging technologies such as generative artificial intelligence (GenAI) (and its subsets) as well as the integration of artificial intelligence (AI) technologies with other technologies such as the Internet of Things and advanced robotics.

Engineers are essential to the development, implementation, integration, utilisation and maintenance of artificial intelligent systems and products. The swift adoption and ever-changing landscape of artificial intelligence have made the advancement and integration of these technologies a major priority across many industries. The focus of this study is the use of AI systems to undertake engineering processes and tasks.

Although AI has been around for decades, the evolution and advancements in GenAI systems have highlighted its powerful capabilities and potential negative impacts. It is critical for the engineering profession to understand these opportunities and impacts to adapt effectively. A clearer understanding will enable engineers to use these technologies to increase productivity and expand their skill sets to meet modern demands. This change also necessitates a corresponding shift in engineering education to meet industry needs while ensuring students retain essential tacit learning.

Background

Engineers Australia, through the Information, Telecommunications and Electronics Engineering (ITEE) College, has been examining AI for some time. This work became more of a focus in 2023 when the Australian Government released the consultation on *Responsible AI in Australia*. While some engineering disciplines, such as software engineering, are well known for their central role in building and deploying AI systems, it is essential to recognise that engineers from all fields of engineering are increasingly using AI tools and models and developing expertise in their use to undertake engineering processes and tasks.

At the outset of this work, it became apparent there was no clear and uniform understanding of the use of AI in engineering. Some considered AI and GenAI systems a gimmick, while others thought of AI only in the traditional sense of how it was already being used, rather than how GenAI might play a role in the future. A common thread that came to light was that the increased use of AI would be like the advent of the calculator, meaning that while it is anticipated AI will be a transformative tool for the profession, the skills of engineers themselves will remain in demand.

This report aims to support the adoption of AI within the profession by outlining the impact AI is having on how engineers work. The findings are drawn from exploratory research commissioned by Engineers Australia aimed at further understanding the current views and uses of AI within the profession.

Objectives

In 2024, Engineers Australia commissioned *Ergo Strategy*, a boutique consumer insights consultancy, to explore the impact of AI and emerging technologies on the engineering profession.

The primary objective was to understand how AI and emerging technologies have transformed engineering businesses and the workforce, and how they will evolve. With AI and other digital innovations reshaping the engineering profession, the task for the profession is to keep pace with the changes. Engineers and engineering businesses must be equipped to effectively leverage these technological advancements, while safeguarding the profession and the community from associated risks.

The study was designed to provide a common understanding of AI, how it is being used, and what engineers needed to know. This was done through three lenses:

1. Implications for the profession

2. Implications for the workforce and education
3. How Engineers Australia can support our members and the profession

Approach and methodology

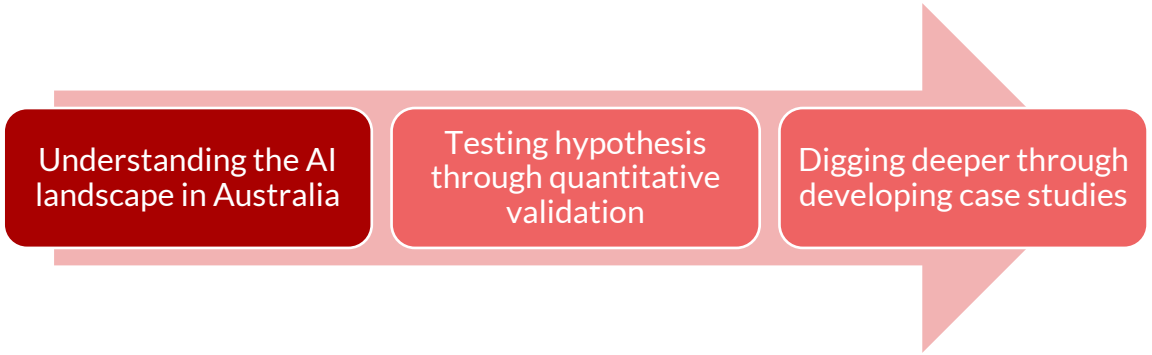
Engineers Australia undertook consultation with members and industry experts to develop the scope. As part of this, Engineers Australia adopted the definition of AI to be:

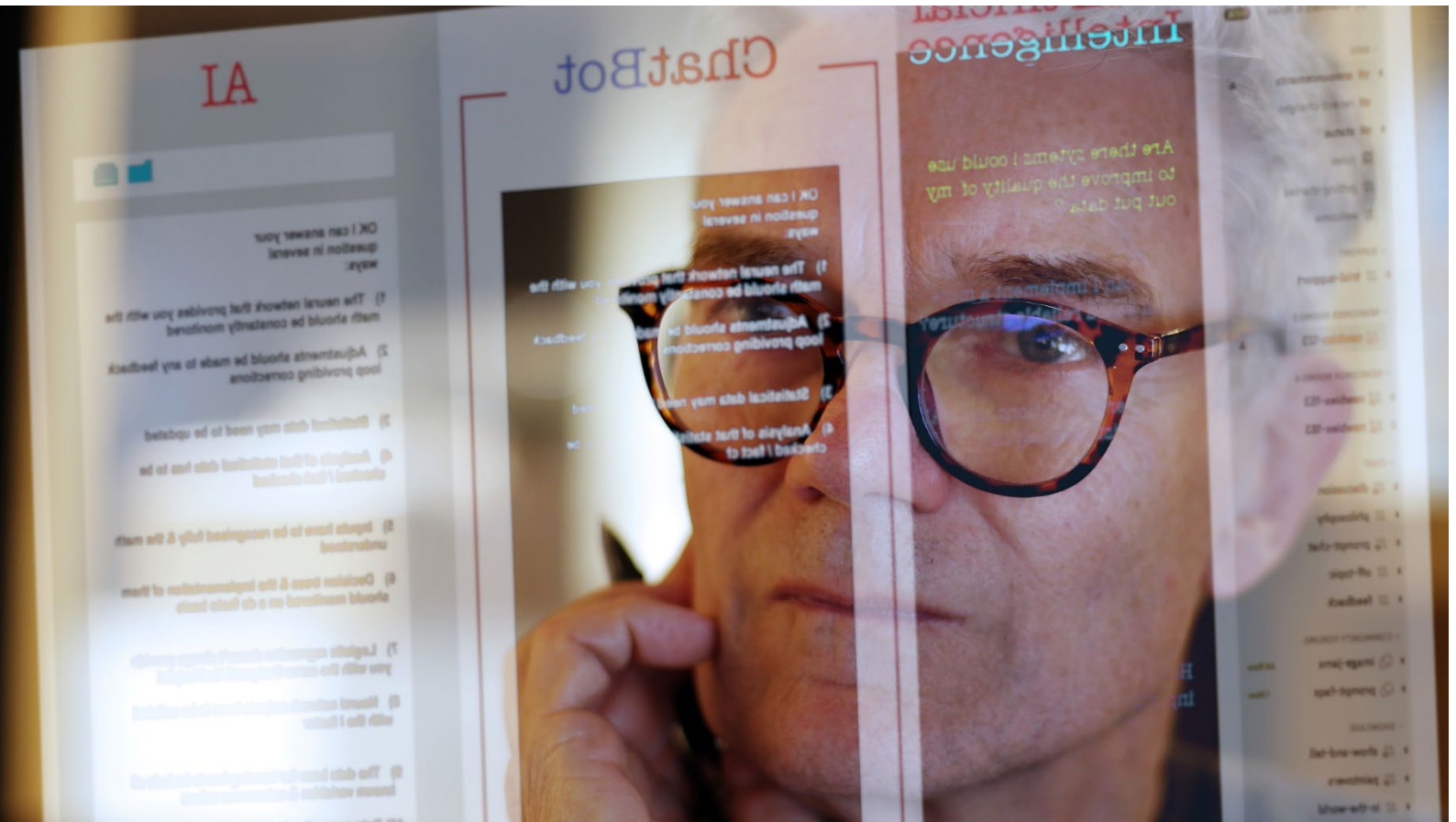
The theory and development of computer systems able to perform tasks normally requiring human intelligence.

Subsets of AI included machine learning, deep learning, expert systems, natural language processing, fuzzy logic, and machine perception. GenAI was defined as:

Generative AI refers to systems that use data models to generate new examples of content such as text, images, audio, code and other data modalities. Generative AI applications are typically trained on large amounts of real-world data and can approximate human generated content from prompts, even prompts that are limited or non-specific.

A three-stage approach was undertaken in gaining insights to achieve the objectives of the study. This included:

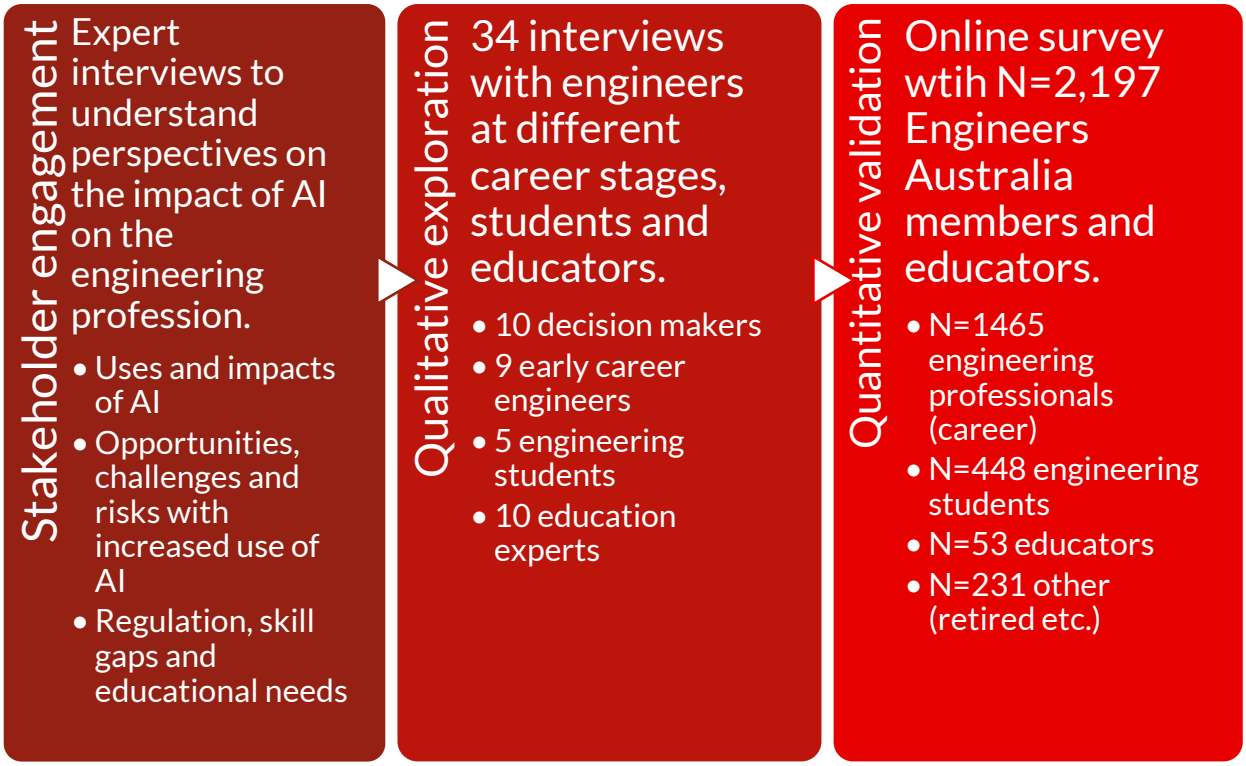




Methodology

To fit with the approach, the methodology consisted of three stages as outlined below.

Note: Weighting applied to career sample on age and size of company to be representative of the Australian engineering workforce and companies



About Engineers Australia

As Australia's national body for engineering, Engineers Australia is the voice and champion of our 130,000-plus members. We provide them with the resources, connections, and growth they need to do ethical, competent and high-value work in our communities. A mission-based, not-for-profit professional association, Engineers Australia is constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community.

Engineers Australia maintains national professional standards, benchmarked against international norms. As Australia's signatory to the International Engineering Alliance (IEA), this includes accreditation of undergraduate university engineering programs.

Contact

Engineers Australia welcomes the opportunity to discuss this report further. Enquiries can be sent to policy@engineersaustralia.org.au

The evolution of AI

Artificial intelligence (AI) is not a new concept and has been used in many industries and by many professions, including engineering, for years. Applications of more 'traditional' AI include smart assistance (devices such as Amazon's Alexa and Apple's Siri use AI to understand and respond to voice commands), chatbots, machine learning applications for predictive maintenance in manufacturing or quality control and control of systems. Retailers have used AI for years to support inventory management and to make online shopping experiences more 'personalised'. Many entertainment streaming services use AI to help suggest content for users based on their preferences as does Meta and TikTok.

Within the engineering profession, AI has been used for decades to optimise designs and analyse vast amounts of data, providing insights that inform decision-making, control systems and lead to more effective engineering solutions.

In 2022, OpenAI released ChatGPT, based on the generative pre-trained transfer (GPT) 3.5 architecture. This changed the way AI was considered by the public and brought it back to the forefront of public discourse. The discussion around AI has become pervasive, with governments around the world grappling with how to regulate the new and developing technologies. This includes Australia, where the safe, responsible and ethical use of AI has become a focus.

Engineers perceive recent advancements in AI and emerging technology as progress in Generative AI and large language models.

Regulating AI and AI policy

Respondents to the survey perceive Australia as lagging other nations in AI policy and investment. This is impacting the engineering profession's ability to implement these technologies and innovate. Australia needs to position itself as a leader at the forefront of AI and emerging technology development to enable the country to be globally competitive and get the most out of the technology. To do this, Australia needs to invest in AI technologies and work to develop the right policy and regulatory settings which safeguard AI usage while promoting greater investment in research and development, leading to innovation and commercialisation.

To support these policy settings, a comprehensive framework around the use of AI is needed to limit inconsistent and potentially unsafe AI applications. Businesses also need to be supported in implementing AI solutions to continue to compete on a global scale. Government initiatives such as the funding of AI Adopt Centres and the collaboration between the NSW Government and the Australian Government Department of Industry for free introduction to artificial intelligence courses will support businesses in this transformation.[1][2]

Australia needs to also ensure there is sufficient funding and support for AI and emerging technology research and development (R&D). Investment in quality research is crucial for the development, implementation, and control of emerging technologies that will enable Australia to stay current and reduce its reliance on other nations. The sentiment of engineers points to Australia lagging the US and China in research and patented technology. Focusing on this will allow for greater Australian innovation and quicker progress in developing AI use in crucial fields.

Addressing these areas is essential for Australia to harness AI's full potential and secure its position as a global leader in technology, spurring on economic growth and technological advancement.

[1] The Australian Government is funding up to five AI Adopt Centres to help small to medium enterprises grow their business through AI - $17 million to boost AI adoption by SMEs | Department of Industry Science and Resources

[2] 'Introduction to Artificial Intelligence' *NSW* Government https://store.training.tafensw.edu.au/product/introduction-to-artificial-intelligence/

Regulatory frameworks

The Australian Government's response to AI has largely been targeted towards the use of AI in high-risk settings, while ensuring the majority of low-risk AI use continues largely unimpeded. In 2023 the Australian Government published an interim response to the Safe and Responsible AI consultation.[3] Part of this work includes considering mandatory guardrails for AI development and deployment in high-risk settings, whether through changes to existing laws or the creation of new AI specific laws. To support this, the Government has set up a temporary AI expert group to provide guidance on implementing testing, transparency, and accountability measures for AI in legitimate, yet high-risk environments to ensure the safety of AI systems. The Australian Government has also released:

- **Voluntary AI Safety Standard** – a standard which provides practical guidance to enable more businesses to develop and deploy AI safely and responsibly.
- **AI Ethics Framework and Principles** – developed in conjunction with existing and emerging initiatives these guide businesses and government aimed at reducing risks and achieving high standards of ethics.
- Standards Australia has adopted the international standard ISO/IEC 42001, Information technology - Artificial Intelligence - Management System.[4]
- Australia has endorsed **OECD AI principles** – the first intergovernmental standard on AI[5]

Engineers Australia's position on AI

Engineers Australia advocates for a balanced approach, implementing both regulatory and non-regulatory measures—to harness AI's benefits while safeguarding professionals, educators, students and the community.

This must prioritise regulation for AI systems with high-risk implications, including a comprehensive standards framework for AI in education, to ensure public protection while maximising AI's benefits.

[3] 'The Australian Government's interim response to safe and responsible AI consultation' *Department of Industry, Science and Resources* (17 January 2024) https://www.industry.gov.au/news/australian-governments-interim-response-safe-and-responsible-ai-consultation

[4] 'Standards Australia adopts the international standard for AI Management System, AS ISO/IEC 42001:2023' *Standards Australia* (16 February 2024) https://www.standards.org.au/news/standards-australia-adopts-the-international-standard-for-ai-management-system-as-iso-iec-42001-2023#:~:text=In%20summary,%20AS%20ISO/IEC%2042001:2023%20provides%20organisations

[5] 'AI Principles' *OECD* (accessed 25 September 2024) https://www.oecd.org/en/topics/sub-issues/ai-principles.html#:~:text=The%20OECD%20AI%20Principles%20are%20the%20first%20intergovernmental

Perceptions of AI and emerging technologies

GenAI

One of the key insights when exploring this topic was the lack of a unified understanding of AI technologies. Broadly, engineers mainly recognise recent advancements in AI as progress in generative AI (GenAI) and large language models. Engineers are increasingly adopting advanced AI technologies, particularly GenAI and large language models, over traditional AI tools. Using these, it is easier for individuals to see the direct benefits to their job. GenAI tools include:

- **Open GenAI** – mainstream large language model AI tools, typified by mainstream models such as ChatGPT and LLaMA (an open-source AI LLM) which can manage tasks like administrative duties, summarising documents, research, etc.
- **Domain-specific GenAI** – GenAI embedded in software programs which can assist with specific tasks such as coding, image generation, rendering, etc. These help to streamline and automate tasks and assist with error detection.
- **Secure/custom GenAI** – systems and tools applied to secured internal data such as the enterprise version of Microsoft Copilot. This offers secure functions like proposal writing, data access and other task automation without businesses being concerned about the data being shared.

Traditional AI

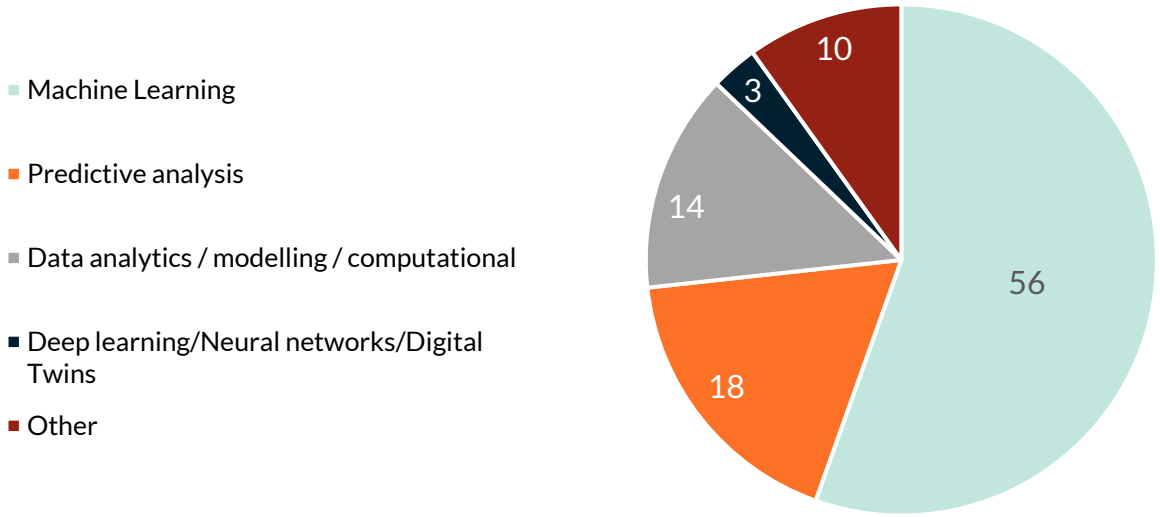
Traditional AI or older AI tools and methods, including fuzzy logic, machine learning, and neural networks, primarily focus on making decisions, predictions, or classifications based on pre-defined rules or learned patterns without generating novel outputs. These AI tools have been around for 20-plus years and are understood as an engineering specialty requiring trained experts. Traditional AI is often used in software or machinery with the user unaware AI is involved. An example of this is fuzzy logic in vehicle automatic transmission systems. Here fuzzy logic helps to determine best gear shift points considering inputs such as engine load, throttle position and speed. Operators of a vehicle are seldom aware this is occurring.

These tools are tailored to specific business needs and the process follows a typical product development and implementation cycle which includes:

- identifying business requirements
- assembling a team – often with external contractor/experts
- product development and testing
- pilot/trialling solutions
- implementation.

The most common of the traditional AI systems being used in workplaces is machine learning, with 56 per cent of engineers reporting machine learning is being used in the workplace.

FIGURE 1: OTHER TYPES OF AI USED (%)



What other artificial intelligence system(s) is your workplace using, besides generative ai? Base: career sample who use other types of AI other than GenAI n=295

Reshaping engineering practice

GenAI is identified as the major change reshaping the engineering profession compared to 'traditional' AI technologies. GenAI is free and accessible to everyone, producing easy to understand outputs and requires no technical expertise to operate, although technical competence is needed to discern whether the answers offered by GenAI are correct and credible. GenAI is rapidly evolving with improvements and advancements happening exponentially. Therefore, it is difficult to predict how GenAI will impact the profession in the future. Policies, frameworks, business case development, and education are all trying to catch up.

Advancements in GenAI are seen as helping to improve productivity with 72 per cent of respondents agreeing GenAI will increase productivity in engineering work. AI is automating administrative tasks and assisting with first drafts of documents like proposals, emails and reports. As more companies invest in AI tools, and create and pilot systems, further productivity gains will be realised.

The impacts on the profession will be even deeper as AI and GenAI continue to be integrated with existing technologies and as various types of AI are incorporated into other emerging technologies (such as advanced robotics, computer vision and the potential in quantum computing). An example of this is computer vision and machine learning merging to create powerful diagnostic medical machinery.

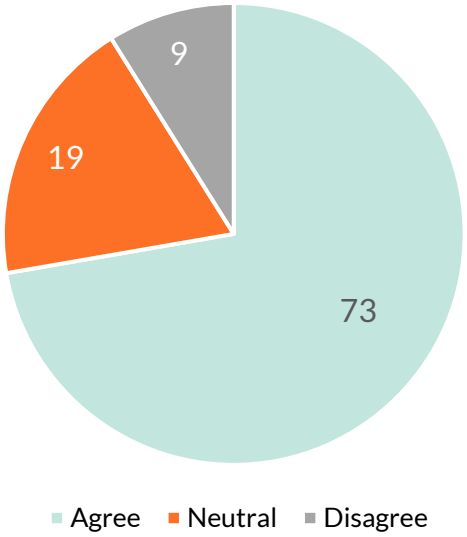
As the use of GenAI grows in the engineering profession, so will the need to have the capability to use it. Figure 2 shows more than 70 per cent of respondents believe the ability to use GenAI will be an essential skill for engineers in the future.

> "What the generative AI wave is doing is changing computing …it's almost democratising knowledge in a way that's never happened before. Allowing us to do things like reason over unstructured information and that is going to change so much in professional services."
>
> - Engineer at large multinational

While GenAI will be an essential driver of change within the profession, frequent analogies were drawn between GenAI and other technologies. Examples such as when the profession moved from slide rulers to calculators to CAD were often shared. While there can be initial resistance to change, due to concerns of engineers losing valuable skills, the methods of achieving results change over time which is a natural part of a profession.

There is significant transformative potential of GenAI in the profession. However, the fundamental capabilities and skills of engineers along with their ability to think critically and solve complex problems will still be needed. Embracing these new technologies and adapting to the changing engineering landscape will be crucial, ensuring the modern engineer is using all the resources available to solve the world's most complex problems.

FIGURE 2: BEING ABLE TO USE GENAI WILL BECOME A CRITICAL SKILL? (%)



How much do you agree or disagree with the following statements? Base: Total sample N=2,197

CASE STUDY: "TRADITIONAL" AI IN ROAD MAINTENANCE

Challenge:
An engineering consultancy specialising in road maintenance faced significant challenges in assessing road conditions and developing renewal models and work programs.

A manual process of reviewing road data and identifying faults required for maintenance was time-consuming and labour-intensive. The primary employee handling this task was overburdened and despite efforts to train additional staff, the team was not large enough to keep up with the workload.

AI solution:
To address this, an AI-based solution involving a predictive analysis tool was developed and implemented. This tool automated the road condition analysis process by using AI to identify defects from images and recommend maintenance schedules.

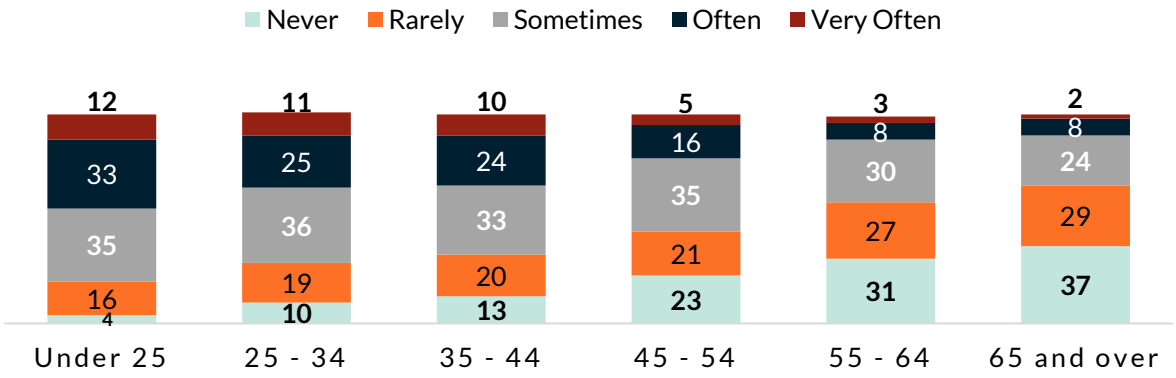
Development:
A dedicated team consisting of contractors, existing staff and a new hire was assembled to develop, train and test the AI model.

Outcome:
Currently, the team is in the trial phase, which is expected to last six months. By leveraging AI, the company was able to save considerable time and resources with the system currently able to do in 30 minutes what used to take a day. **This automation has not only boosted productivity, but also improved employee satisfaction** by reducing the amount of tedious manual work involved.

Engineers using GenAI

In the workforce, 43 per cent of engineers surveyed reported using GenAI, while the figure is much higher among engineering students with 74 per cent using the technology. Younger engineers are using generative AI more than senior or older engineers. Those aged between 18 to 24 years reported the highest use (more typically the age of an engineering student), followed by 25- to 34-year-olds (typically early to mid-career engineers).

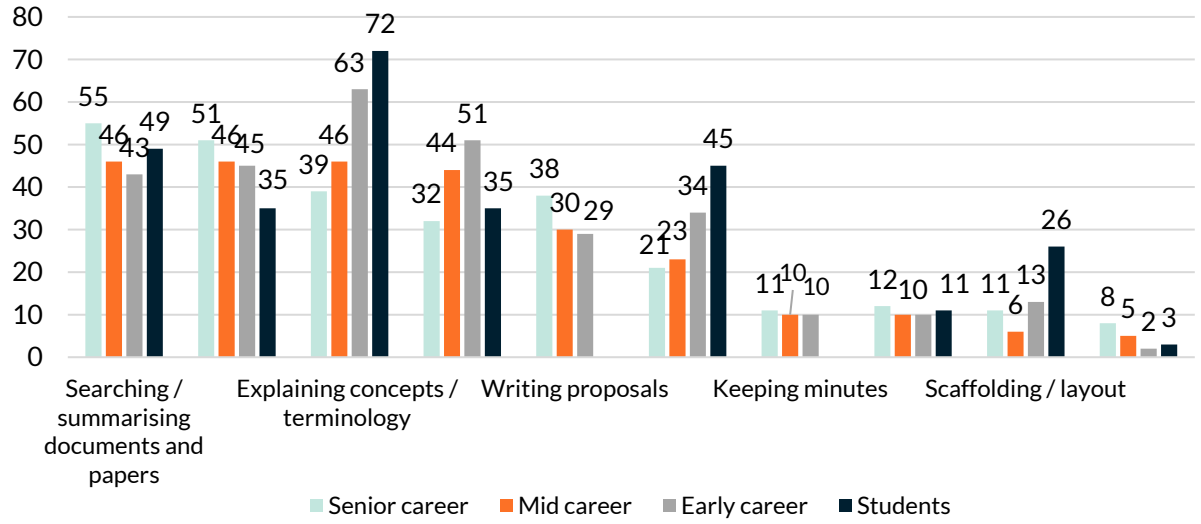
FIGURE 3: USE OF GENAI FOR ANY PURPOSE BY AGE GROUP (%)



How often do you use Generative AI for the following purposes? (Personal, Education, Work). Total sample: N=2,197

Depending on the stage of an engineer's career, their experience and knowledge impacts the use of GenAI. A common reason for the adoption of GenAI among younger engineers is because they have less established ways of working, making them more likely to adopt new technologies. Early career engineers and students are much more likely to use GenAI to explain concepts and terminology. This is due GenAI being good at answering questions on topics emerging engineers have a lower understanding and/or lack of confidence in. In contrast, senior level engineers tend to use it primarily to summarise documents and write proposals. This aligns with the specific tasks an engineer would be engaged on at different stages of career. Over 50 per cent of senior engineers use GenAI to search/summarise documents and papers and draft content, compared to 63 per cent of early career engineers who use it to explain concepts and terminology. No matter how the technology is used, low competence in GenAI decreases the chance GenAI is used effectively, and it also increases the risks to data safety.

FIGURE 4: GENAI USE BY LEVELS OF SENIORITY (%)

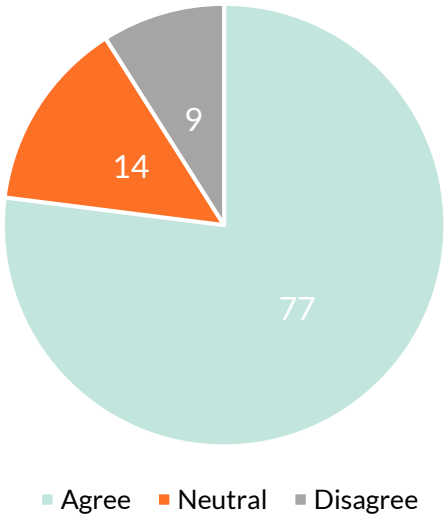


What do you use Generative AI to help you with in your work? by A11: What level are you at in this role?
Base – those who use GenAI: Senior Career N=276, Mid career N=574, Early career N=92, Students N=406, Educators N=47

Individual GenAI adoption is faster among engineers in younger age groups. Speed of adoption decreases with seniority among engineers. Many senior engineers reported leaving it to the next generation of engineers to see how it could be incorporated into the work. However, a universal understanding of how GenAI can be applied in engineering remains limited.

While there are many anecdotal examples of how AI is being used, understanding of how it works, its limitations and its potential in engineering is not universally known. This continues to impact attitudes and adoption of the technology. The speed at which GenAI is evolving and the hype around it is further affecting attitudes towards it. In many cases, there is confusion and scepticism about the actual capabilities of the technology and the unknown impacts, which is leading to uncertainty around when to invest in its adoption

FIGURE 5: GENAI WILL BCOME JUST ANOTHER TOOL, LIKE GOOGLE OR CALCULATORS? (%)



How much do you agree or disagree with the following statements?
Total sample: N=2,197

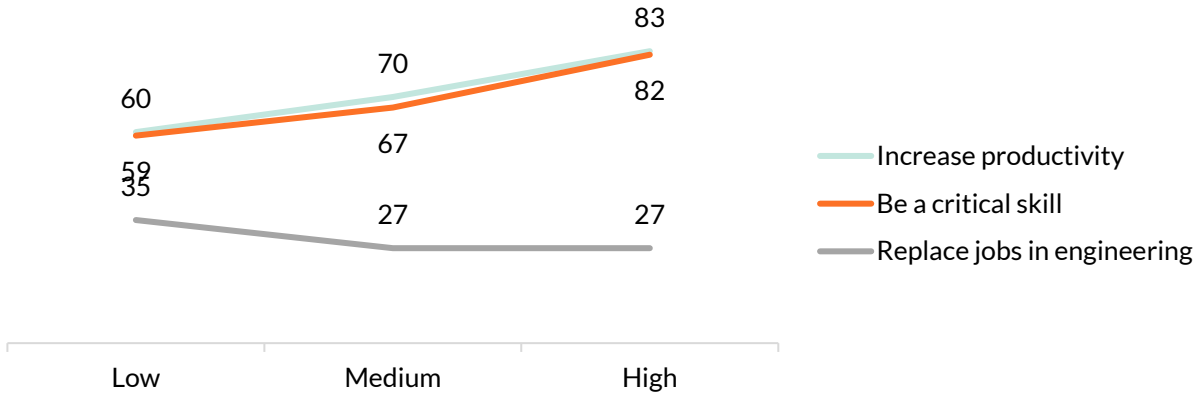
Contributing to this lack of understanding is the perception of 'AI washing', where AI is being marketed everywhere, as being involved in everything. The use of AI has become a buzzword, often applied to technology which may not qualify as AI. The impact of this is an increased desired to apply AI, even if it is costly and will have limited effectiveness. These perceptions are leading to a simplification in how it can be applied and used. Perceptions that AI can and should be used in all areas of engineering is creating high expectations. This leads to an unrealistic view of what it can deliver and the productivity savings it can offer, while underestimating the effort, training and the resources required. The use of certain terminologies further creates confusion. Referring to AI as 'magic' or describing its errors as 'hallucinations' is impacting the perception of GenAI. Developing a clearer understanding of AI can improve engineers' attitudes toward it.

> "It is a great marketing tool to say we are using AI because AI is modern, cool and innovative. But it is a problem with innovation where it is turns into a bit of a buzzword."
>
> 1. Senior Engineer, Decision Maker

Attitudes and perceptions

Attitudes towards AI follow a similar trajectory across industries and engineers, based on their understanding and use of GenAI. As engineers gain a better understanding of AI, their attitudes shift from a position of fear and uncertainty, to viewing it as an augmentation tool. Perceptions of GenAI as a critical skill that supports engineers increases alongside their confidence in using it, while the view GenAI will replace jobs diminishes confidence. The better the understanding, the more that engineers focus on effective use and having the right support mechanisms. While an increased understanding of the use of GenAI leads to more positive views about it, 90 per cent of engineers recognise there will always be risks with using GenAI, regardless of confidence.

FIGURE 6: PERCEPTIONS ABOUT GenAI BY CONFIDENCE TO USE (%)

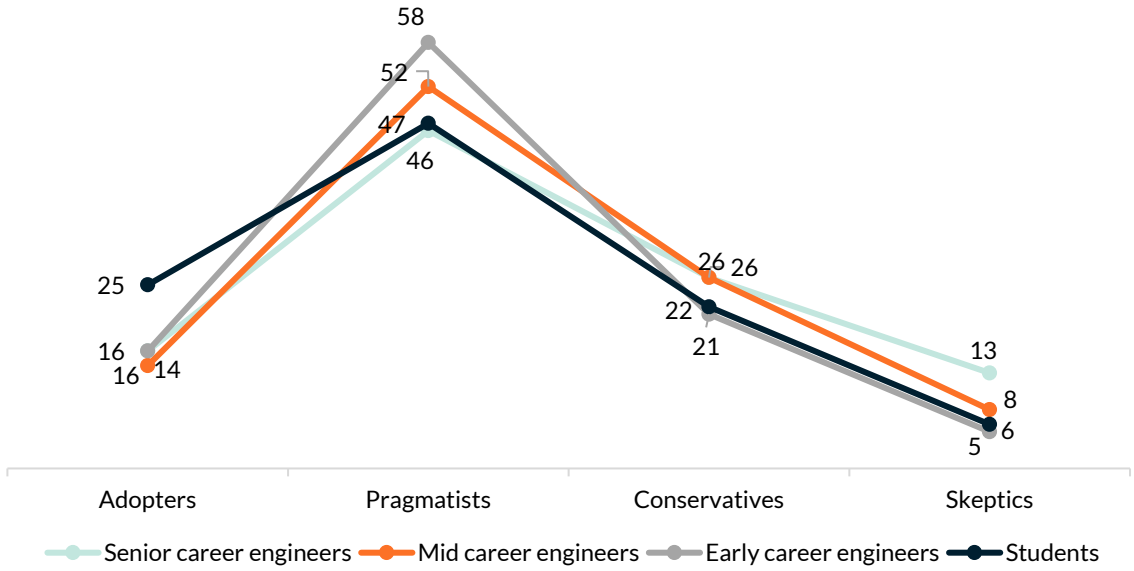


How confident are you in your ability to do the following? How much do you agree or disagree with the following statements? (Top-2-box agreement) Base: Career N=1,465

Confidence and competence in using GenAI

With younger engineers adopting GenAI more quickly, there is a need to ensure there is confidence in the outputs, and competence in safe and responsible use. Competency with GenAI is driven more by a personal desire to learn and upskill rather than formal education. Significantly, 78 per cent of engineers in the workplace and 81 per cent of students agree learning about GenAI is largely self-directed. The ability to effectively harness GenAI is due to self-motivation and personal research, often conducted on platforms like Stack Overflow and Reddit. Learning to use these technologies requires a strong willingness to learn independently, with young engineers more likely to be self-motivated compared to those who have been in the workforce longer. A contributing factor to this is the level of experience and confidence younger engineers possess in undertaking the work assigned to them, and the usefulness of GenAI to assist in understanding concepts and tasks.

FIGURE 7: ADOPTERS OF AI BY CAREER LEVEL (%)



Company Adoption & Individual Adoption (including sole trader). Base: Senior Career N=418, Mid-career N=881, Early career N=127, Students N=448

CASE STUDY: DEVELOPING AND CUSTOMISING CHATGPT
Small consultancy – self-driven problem-solving exercise by an early career engineer

Challenge:
An engineering consultancy providing flood and stormwater modelling for councils and individual clients for subdivisions and building developments needed to sift through many documents to map floods, flood extents, hazard and velocity, including council planning schemes, flood overlays and storm water codes. The process was labour intensive and time consuming.

GenAI solution:
Using a paid ChatGPT solution, the early career engineer trained the system with public data sources on flood overlays, storm water codes, suburb data, planning schemes and flood maps. An automated process was then developed whereby ChatGPT would provide stormwater codes and appropriate documentation based on a postcode search.

Development:
A challenge in the development was training ChatGPT to use the *most relevant* and appropriate data from councils and other government bodies. Development also requires working through errors, piloting results and checking for accuracy.

Outcome:
Development is ongoing.

The above case study demonstrates GenAI can be used by engineers to support their work. The system was trained on publicly available data with the intention of reducing a manual search process and therefore increasing efficiencies. This showcases how GenAI systems such as ChatGPT and Microsoft Copilot can be used with limited investment to produce benefits to businesses. It also shows the importance of validating the data used to train the AI model as well as the need to select the most appropriate AI model. This may require the participation of experienced engineers to validate the results.

Risks of limited competence

Lower competence and understanding by individuals of how GenAI works can lead to an increase in the associated risks. These risks include the likelihood of employees unintentionally leaking sensitive information through providing it to a GenAI platform; and trusting GenAI responses which are wrong or biased. Where businesses were getting the best value out of GenAI, the user knew how to prompt correctly. Those who didn't have knowledge about prompting were more likely to get suboptimal outputs.

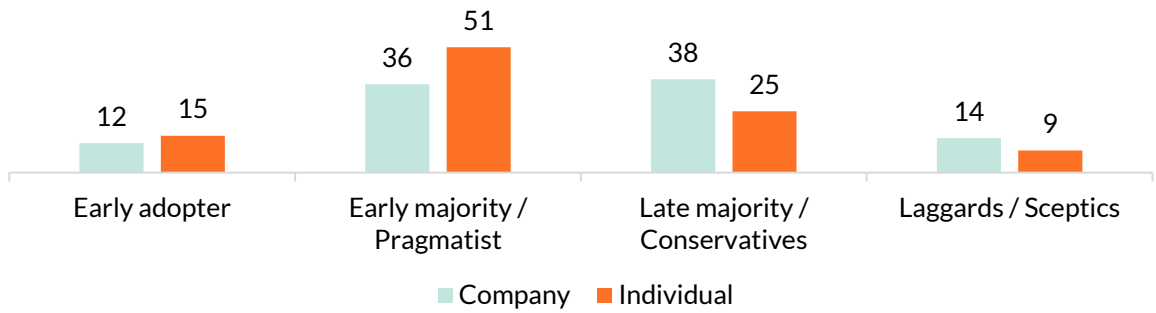
Engineers are more competent in using GenAI when there is more open discussion about the use of the technology and how it is being applied. Therefore, businesses should foster a culture of openness regarding the use of these technologies so that engineers feel comfortable to talk about and explore their use, in a safe way. The findings show the importance of building confidence and providing support for GenAI to be used most effectively including policies and processes for the use of AI.

> "No matter how tight your processes are, no matter how good your technology is, humans are your biggest vulnerability."
>
> - Engineer, Decision maker

GenAI in engineering workplaces

The rate of adoption[6] of GenAI in engineering workplaces is similar to the typical technology adoption lifecycle. Twelve per cent of companies reported being early adopters, investing in adopting GenAI tools early to leverage productivity gains. Those who gradually adopt GenAI tools after seeing proven value make up 36 per cent of companies, while the majority, 38 per cent, report adopting GenAI tools cautiously as they become widely accepted. Only 14 per cent reported not adopting GenAI tools until it's necessary or unavoidable.

FIGURE 8: ADOPTION OF GENAI (%)



Company Adoption & Individual Adoption (including sole trader), Career sample N=1,465

The companies which invested in adopting GenAI tools early, tended to be more multinational organisations or companies which operate internationally. Of the early adopters, 89 per cent use GenAI tools. Their attitudes toward GenAI were more open, with 95 per cent reporting they talk about and use GenAI across all levels of the organisation. There was also strong support (89 per cent) from superiors to use these technologies. These organisations were more likely to offer AI training, with 65 per cent having an expectation GenAI is going to be used at work.

The second cohort, early majority companies, are those which are gradually adopting GenAI tools after seeing proven value. They were more likely to be multinational or international companies as well as large private companies. These companies are open and progressive towards AI; however, they were less likely to provide training. GenAI was more likely used by those mid-low-level employees within the company, with only 66 per cent of respondents reporting support from superiors to use the technology. Within this segment, 82 per cent were using GenAI tools. The use cases leaned towards non-technical tasks for enhanced productivity.

Late majority adaptors, or those adopting GenAI tools cautiously as they become more widely accepted, skewed towards Australian organisations operating only in Australia (50 per cent), and SMEs in the private sector (52 per cent). These companies were less open to talk about using GenAI, with 40 per cent of them low in progressiveness to try new technologies broadly. Companies within this segment had more than 65 per cent of employees paying for their own GenAI licences. Overall, 59 per cent of late majority adopters were using GenAI tools. Similar to the early majority adopters, GenAI was mainly used for simple, non-technical tasks, with usage being less frequent.

[6] Company adoption segments developed based on the following dimensions about the workplace:
- Openness to talk about using GenAI
- Understanding GenAI is an expectation
- Encouragement in use of GenAI for simple, non-technical tasks
- Using GenAI in innovative ways
- Who uses GenAI
    - Everyone / senior
    - Junior / peers / other teams
    - No one / don't know / just me

The companies which are not adopting GenAI tools until it's necessary or unavoidable (those classified as laggards/ sceptics) were more likely to be Australian organisations with 52 per cent of them operating only in Australia. Just under half of them (49 per cent) were SMEs. This segment showed minimal openness to talk about using GenAI and very low appetite in trying new technologies broadly. These companies were more likely to see using GenAI as 'cheating' compared to others. Only 39 per cent of the laggards reported using GenAI tools, with use only being in simple, non-technical tasks. However, 69 per cent of employees reported paying for their own GenAI licences.

Individual adoption of GenAI is occurring faster than workplaces, with more than 50 per cent of engineers in the early majority/pragmatist phase and a further 15 per cent in the early adopter category. Bridging the gap between early adopters and the rest of the workforce requires careful planning and engagement.

Implementing AI in workplaces

Engineering companies are adopting AI technologies at different rates, influenced by their size and resources. The ability to use GenAI effectively in engineering requires appropriate application, clear oversight and data considerations to mitigate risks. For companies, setting parameters around GenAI use increases trust in its ability to provide useful outcomes.

Smaller companies are concerned GenAI will give larger organisations a competitive edge. Smaller companies are more likely to lack the financial means as well as the research and development capabilities needed to implement safe and secure AI systems. This is particularly the case for more advanced AI systems. However, smaller companies have an advantage as they can act more like a startup and implement new tools and systems faster. They are also finding the large language model (LLM) AI beneficial in assisting with basic tasks, as they don't have the level of staffing that larger companies have.

Medium-sized companies can find it harder to implement AI systems as they require more investment yet have less capital to risk. They also face difficulties in justifying investment in the technology, particularly for minor productivity gains. They tend to be more cautious and risk-averse, making it harder for them to embrace advanced AI technologies despite recognising the potential benefits.

For larger companies, the investment in new AI technologies is often higher, however, they are more likely to have the capital to invest in research and development to develop and implement the tools and systems. They are often better positioned to adopt AI technologies due to their superior data quality. They often already have or can invest in the necessary infrastructure and are better equipped to handle the complexities of AI implementation, viewing it as essential for maintaining their competitive edge and driving innovation. Often, larger companies see AI as a strategic advantage and are more likely to integrate the technology into their core operations.

Transitioning to an AI enabled business requires investment and support to drive AI discovery projects and monitor change. Among respondents, 22 per cent are involved in implementing GenAI in the workplace. Of these, 38 per cent hold leadership roles, with 20 per cent serving as lead decision-makers. Additionally, 26 per cent of middle managers were part of the implementation team, while only 13 per cent of engineers in team roles were likely to be involved in implementing GenAI.

> "Just giving someone a calculator does not mean it works, they need to be trained. GenAI and LLMs are the same."
>
> - Stakeholder

CASE STUDY: JOHN HOLLAND EMBRACES GENERATIVE AI

While the construction industry traditionally lags in digital adoption and innovation, John Holland has been bucking the trend over the past six years with its focus on technology and digital transformation.

Challenge:
Seeing the emergence and opportunity of GenAI and LLMs, but with concerns about data security, John Holland set out to develop a system which could realise the potential but limit the risks.

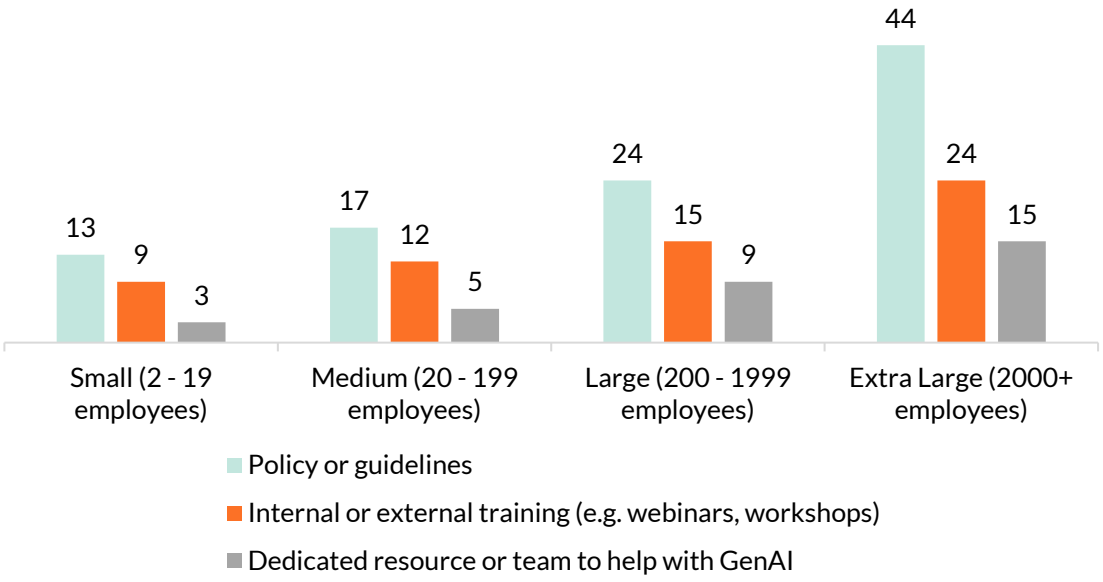
GenAI solution:
Partnering with Microsoft, they developed a secure, private version of OpenAI's ChatGPT. This collaboration allowed employees to utilise the capabilities of generative AI to find relevant information within the company while ensuring the protection of their data. The system can also be used by third parties, reducing risks through collaboration.

Outcome:
While still in pilot phase, the system is helping to increase productivity with developing/writing content and searching information. It is also improving the quality of communication from those with English as a second language.

Policies, training and support

Larger companies are more likely to have policies, training and support covering AI. Having these within the business is crucial to ensure the use of GenAI aligns with ethical standards and regulatory requirements. It also helps prevent misuse and sharing of sensitive data. Broadly speaking, policies, training and support will help organisations to manage the risks associated with AI deployment by enhancing employees' understanding of AI capabilities and limitations. This will enable them to integrate these technologies into their day-to-day work efficiently. Training fosters a culture of lifelong learning and innovation, ensuring a company's workforce stays up to date with the latest processes.

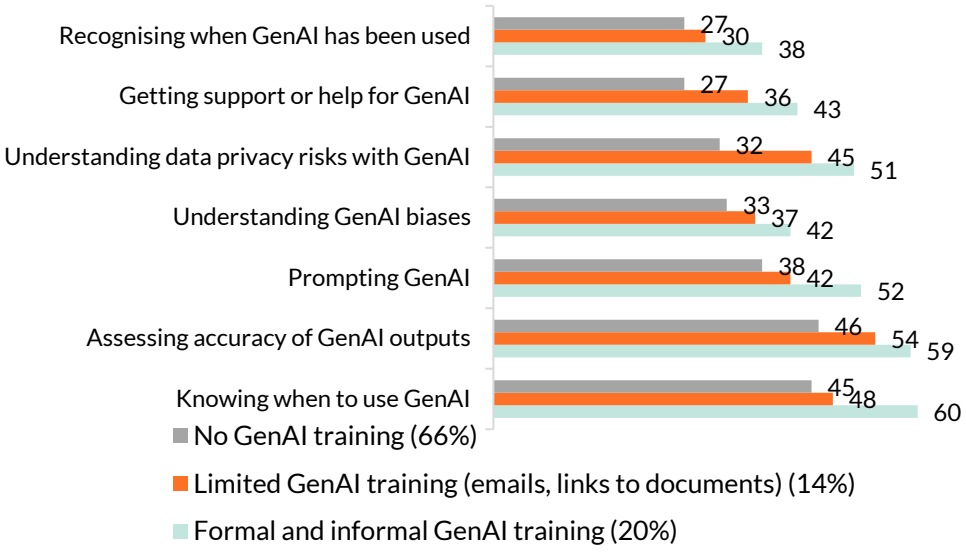
FIGURE 9: COMPANY SIZE BY AI POLICY, TRAINING AND SUPPORT (%)



What training or information about Generative AI have you received from your work? Does your workplace have a policy or guidelines about using Generative AI for work activities? Do you have a dedicated resource or team to help with Generative AI at your workplace? Approximately how many employees does your workplace currently have? Base: Small N=240, Medium N=346, Large N=375, Extra Large N=413

Clarity around data security and ways to use GenAI further increases confidence and abilities. There is a clear opportunity for engineering companies to educate their employees, with 66 per cent of engineers receiving no training at work, thus reducing their confidence in using GenAI and increasing risks.

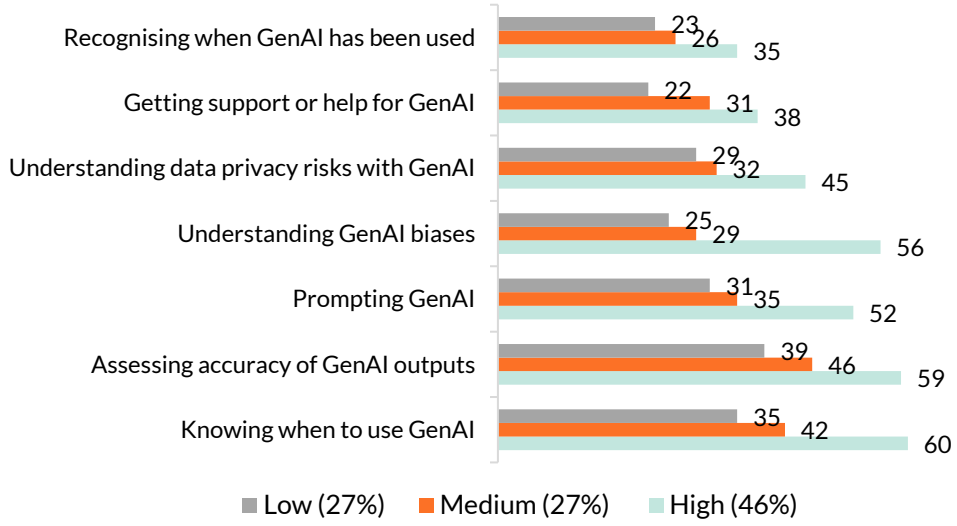
FIGURE 10: ENGINEERS' CONFIDENCE TO USE GENAI BY WORKPLACE TRAINING (%)



How confident are you in your ability to do the following? D4. What training or information about Generative AI have you received from your [pipe: Wording]? Base: Career formal & informal training N=293, Career limited training N=197, Career no training N=884

Just as important as having formal policies and training is building and maintaining a workplace culture that is open to discussion of AI and GenAI technologies. In workplaces where open discourse is encouraged, engineers are more confident in their abilities. Among the metrics used to measure workplace progressiveness on GenAI, openness has the highest correlation with individual confidence to use it.

FIGURE 11: ENGINEERS' CONFIDENCE TO USE GENAI BY WORKPLACE OPENESS (%)



How confident are you in your ability to do the following? How much do you agree or disagree with the following statements? - At work, we talk openly about using Generative AI Base: Career high workplace openness N=596, Career medium workplace openness N=381, Career low workplace openness N=397

Opportunities for businesses to limit risks and build employee confidence

While the use of this technology is increasing, embracing generative AI in engineering does not mean indiscriminate use and blind faith. Engineers are cautious and realistic about using GenAI in engineering with 82 per cent of engineers believing GenAI will always require oversight. There is an opportunity to better harness GenAI potential by addressing existing challenges and barriers.

Implementing AI technologies requires investment from businesses. To get the most out of GenAI and LLMs, Engineers Australia has identified four focus areas for business as follows:

1) Focus on implementing AI and GenAI technologies where they will have a positive benefit such as:
    a) Tasks which can increase productivity
    b) Labour intensive tasks which decrease job satisfaction
    c) Use for first drafts / initials inputs (like an "intern")
    d) Enhancing and developing skills and abilities
2) Develop and establish guidelines, procedures and internal policies on data usage, risk management and security to ensure use of GenAI does not create data breaches and limit negative impacts such as biased information:
    a) Clear guidelines around use and confidential data
    b) Ensure GenAI outcomes have human oversight and are reviewed for accuracy
    c) Knowledge of information sources
    d) Check outcomes for bias
3) Building knowledge around how GenAI works:
    a) Sharing effective use cases and platforms which can be used, and which adhere to company policies
    b) Teaching effective prompting and querying skills
    c) Guidance on where employees can go for assistance and support
4) Maintain a culture of openness to talk about and let employees try these technologies (within the bounds of company policies).

The future of AI and opportunities

It is predicted the use of AI and GenAI will continue to increase, particularly as later stage adopters start to understand the benefits this technology can provide. However, the "how" AI will increase is not yet known. As AI capabilities develop, it is expected the tools will evolve significantly, with enhanced capabilities in solving complex problems, especially in areas like mathematics, data analysis and coding. As GenAI becomes more embedded in the tools we already use, such as the Microsoft 365 suite and Apple Intelligence, it will become a ubiquitous presence in everyday life.

With AI advancing rapidly, governments need to ensure the right regulatory and legislative settings. Policies are needed to create the right paradigm ensuring responsible and ethical use of the technology, while enabling its benefits to support Australian industry and society.

Engineers Australia continues to provide the engineering voice to government on this issue as an essential component to the AI discussion. Certain engineering disciplines, such as software engineers, are well known as playing a central role in building, deploying and utilising AI systems. However, all fields, including biomedical engineering, electrical engineering, chemical engineering, industrial engineering, systems engineering, and sustainability engineering are increasingly using AI systems. As AI becomes more prevalent, the topic demands subject matter expertise to enable these systems to reach their potential while safeguarding against negative impacts. Engineering insights in how these systems are being used is therefore indispensable.

Positively, for the workforce, AI is expected to create new roles within the profession, focusing on the development and management of AI tools. These positions include areas such as prompt engineering[7] and software engineers and developers. It is further expected AI skills will become increasingly essential to an engineer, making it important to have a more structured understanding of the topic. While minimal jobs losses are expected, these are for more lower-level roles.

Opportunities to support the profession

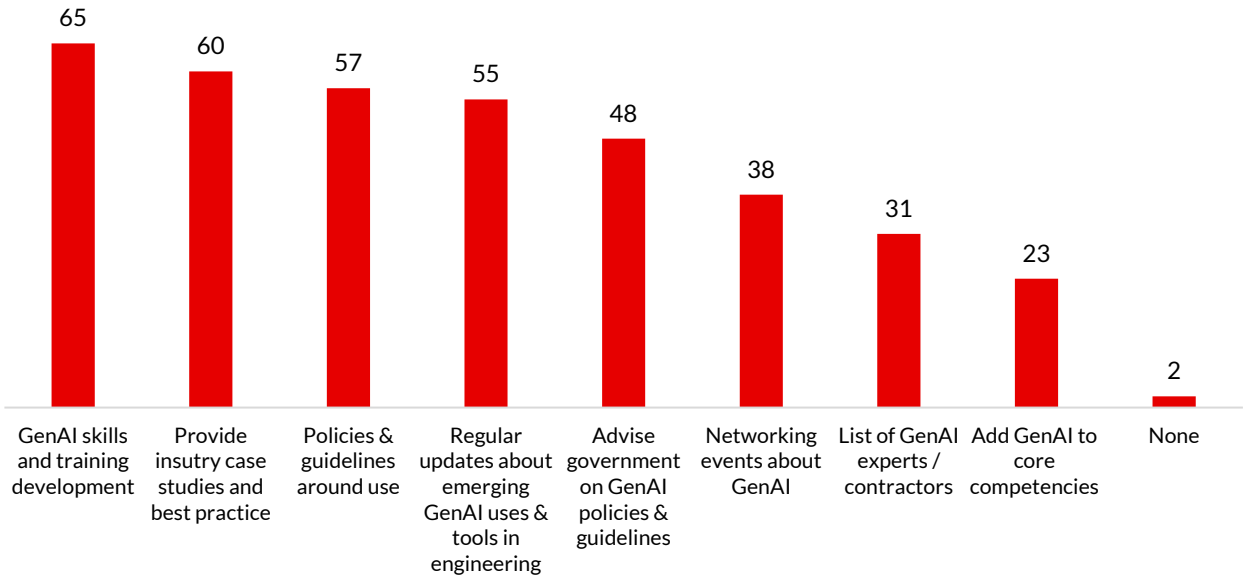
As the profession embarks on this journey, there is a need for greater support to be provided to help increase the understanding of AI and GenAI. Professional and industry bodies, such as Engineers Australia, are well positioned to support engineers. Almost all (98 per cent) of the respondents surveyed see Engineers Australia playing a role in the use of GenAI in engineering. Key areas of interest included GenAI training and skills, industry case studies and best practice, and policies and guidelines around use.

There was stronger interest among entry-level and more junior engineers for training and skills development, whereas more experienced engineers favoured the need for case studies and best-practice examples. Engineers in middle to senior management were more interested in policies and guidelines around use. Whereas educators placed high emphasis on training and skills development, industry case studies and networking events about GenAI.

> "Becoming over reliant on [GenAI] tools might lead to a knowledge gap. It is important to be able to use the tools, but it is also important to be able to do it yourself."
>
> - Engineer, Decision Maker

[7] '*Prompt engineering is the practice of designing inputs for AI tools that will produce optimal outputs.*' McKinsey (22 May 2024) What is prompt engineering? | McKinsey

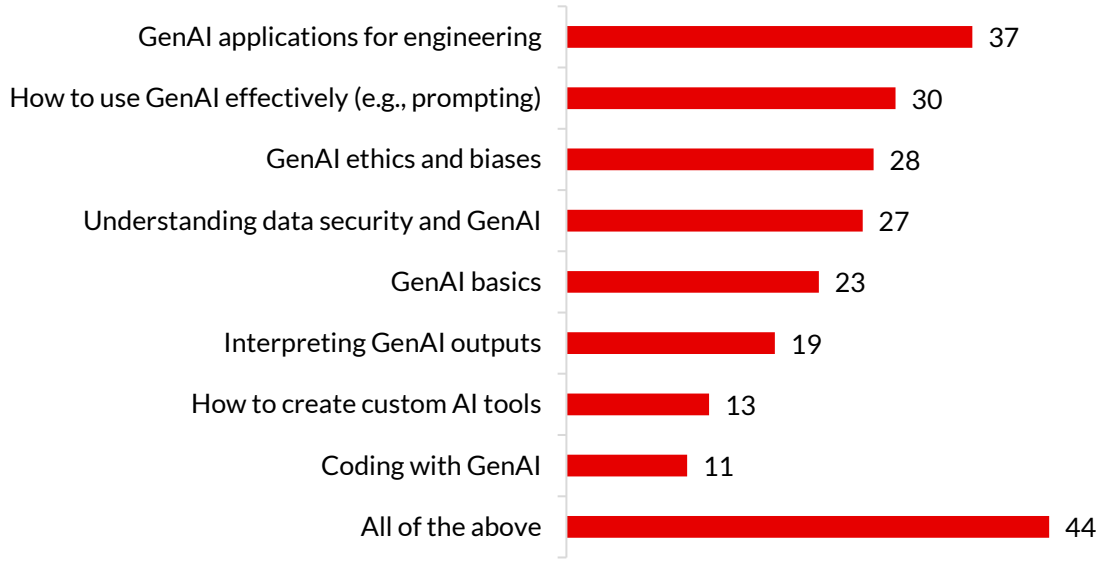
FIGURE 12: HOW ENGINEERS AUSTRALIA COULD BEST SUPPORT THE USE OF GENERATIVE AI IN ENGINEERING (%)



How could Engineers Australia best support the use of Generative AI in engineering? What is the most important thing Engineers Australia should do to support the use of Generative AI in engineering? Base: Career N=1,465, Student N=448, Educator N=53

For those wanting more skills development, having a range of training opportunities was key. This includes webinars, seminars and CPD events, conferences or symposiums, workshops, lunch-and-learns and having AI experts to consult with. The most sought-after training topic for engineers was the application of GenAI for engineering tasks, followed by how to use it most effectively.

FIGURE 13: GENAI TRAINING TOPICS OF INTEREST (%)



What Generative AI training should Engineers Australia provide?Base – those who are interested in training and skills development Career N=948, Student N=292, Educator N=42

Developing an engineer's ability to use and adapt to AI and GenAI technologies is a shared responsibility, with industry, professional and peak bodies, the tertiary sector and an individual engineer's own professional development journey all playing a part.

Impacts of GenAI in education

AI and GenAI in engineering education is still under development. The tertiary sector and program policies are still catching up with the evolution of AI, particularly GenAI. Engineers Australia has been engaging with government and the tertiary sector on these issues.[8] When GenAI first took off, the sector was mainly concerned with the use for cheating and plagiarism. Many institutions initially banned the use of the technology. As such, institutional policies on embracing GenAI to enhance learning have lagged.

The fast-paced change of this technology presents opportunities and challenges. The negative perceptions of GenAI, such as concerns around data privacy, accuracy of responses and the need for human oversight can hinder the willingness of some to embrace the tools in an educational setting.

To adopt GenAI effectively in the tertiary sector some critical issues need to be overcome. These include:

- The competency gap in engineering students on when and how to use GenAI effectively which can lead to misuse and exacerbate risks such as data breaches.
- An over-reliance on GenAI can impact the development of tacit knowledge needed to critically analyse the outputs of GenAI. This has raised concerns in industry as to whether future engineers will possess the necessary skills and competencies required.

There is a need for engineering education to manage and teach GenAI use to mitigate this risk and to help change attitudes. This involves:

- **Education and training:** Provide training to help students understand the potential and limitations of GenAI. This can be incorporated into the current curriculum.
- **Promote the opportunities of the technology:** Showcase the benefits and opportunities of GenAI when used responsibly, ethically and competently.
- **Ensure effective use:** By developing guidelines and best practices to ensure the technology is used in an appropriate manner.

The Tertiary Education Quality and Standards Agency provides guides and resources through the higher education good practice hub which aim to assist providers to meet the challenges and opportunities afforded by GenAI.[9] This includes resources on incorporating AI in classes and engaging students on the topic.

Educators

Educators in the tertiary sector are using AI similarly to both engineers and students, as shown in Figure 4. Like engineers, educators use it for writing emails and drafting content; they are also using it for coding and scaffolding activities. In addition, educators emphasised using GenAI for image generation. However, integrating it into day-to-day administrative tasks is simpler than integrating it into engineering education.

[8] 'Inquiry into the use of generative artificial intelligence in the Australian education system' *Engineers Australia* Submission to the inquiry into the use of generative artificial intelligence in the Australian education system (engineersaustralia.org.au)
[9] 'Artificial Intelligence' *Australian Government Tertiary Education Quality and Standards Agency* (accessed 7 October 2024 https://www.teqsa.gov.au/guides-resources/higher-education-good-practice-hub/artificial-intelligence#:~:text=TEQSA%20is%20closely%20monitoring%20the%20rapid%20enhancement%20of

Making changes to courses and assessments requires investment and training from already time-poor academics and educators. Challenges for educators include:

- Time needed to invest into learning and understanding GenAI for themselves
- Rapid evolution of GenAI makes it difficult to stay on top of the advancements
- Changing assignments and courses is time consuming and adds extra workload to staff
- In some cases, a reduction in support staff means there is an increased burden already on academics to change courses and grading systems.

Positively, the tertiary sector is seeing innovations to support the integration of these technologies into engineering education. Much like the other sectors, there is a need to demystify GenAI, both in industry and within academia to support how the technology can be taught to the next generation.

CASE STUDY: ASSESSMENTS USING ChatGPT

Challenge:
With the introduction of ChatGPT and seeing the use of it take off in student's work (sometimes very lazily), a university lecturer looked at how they could integrate ChatGPT into teaching first year engineers programming.

GenAI solution:
Incorporated the use of ChatGPT into an assignment and asked the students to provide a critical analysis of how ChatGPT performed. The purpose was to help educate students on use, quality of outcomes and how to critically assess outputs.

Outcome:
The activity partly took the fun and ease out of using ChatGPT as it was no longer an easy solution but required careful consideration and analysis of the outputs. The activity helped to teach the limitations of ChatGPT for solving more complex problems. Through this, it encourages sensible use of large language models and ensures fundamental skills are learnt and can be applied. It also reduces the trust on GenAI as it shows the outputs are not necessarily correct.

After the assignment, students reported ChatGPT was good for the basics, but when asked to do the implementation of a physics algorithm, it couldn't get it right.

"AI is a massive productivity booster...It turns a job that would be one day into a job that's one or two hours."

- Educator

Conclusion

The use of AI and particularly GenAI technologies in Australia continues to increase. While the advancements in these systems have powerful capabilities, there is the potential for negative impacts. To navigate this, it is necessary for the engineering profession to have a broader understanding of the technology, the use cases and its limitations. This understanding will enable engineers to adapt effectively, using AI to enhance productivity and expand their skills and capabilities. Engineering companies, industry and the tertiary sector all have a part to play, from creating a culture of openness around the use of these technologies, to more formative learning around correct prompting to get the best and most accurate responses.

Engineers Australia will continue to provide the engineering voice to the broader discourse on this topic, including on how to promote safe and responsible use while having the right mechanisms to safeguard against harm. As the peak body for the profession, Engineers Australia will also continue to support our members with demystifying GenAI and learning how most effectively to use it through continuous professional development and networking opportunities. To further support this work, Engineers Australia will continue to engage our members to explore other ways on how we can strengthen the engineering workforce by adopting and adapting to AI.