

Engineers, Engineering and STEM Education

Abstract

This paper discusses the role of engineers in Australian society and the essential differences in the roles and responsibilities of engineers, technologists, and technicians.

It also defines and discusses engineering literacy, engineering design and the difference between Engineering and Technology in STEM education.

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The Role of Engineers in Australian Society

Engineers play a vital role in Australian society by contributing to the development and advancement of the country's infrastructure, industries, and economy. They are responsible for designing and implementing innovative solutions to complex problems, ensuring the safety and reliability of structures and systems, and driving technological progress.

The role of engineers in Australia is governed by the Engineers Australia Code of Ethics, which outlines the professional and ethical standards that engineers must adhere to in their practice. The code emphasizes the importance of placing public safety and welfare above all other considerations and maintaining the highest standards of professionalism and integrity.

Some key areas where engineers contribute to Australian society include:

- 1. Infrastructure development:** Engineers are responsible for designing and building the country's infrastructure, including roads, bridges, airports, harbours, offshore structures, buildings, and water and energy supply systems. They play a critical role in ensuring that these structures and systems are safe, functional, and sustainable.
- 2. Mining and resources:** Australia is a major producer of minerals and natural resources, and engineers play a crucial role in the exploration, extraction, and processing of these resources. They work to develop new technologies and techniques that improve efficiency and sustainability in these industries.
- 3. Renewable energy:** Engineers are at the forefront of developing new renewable energy technologies, such as solar and wind power, which are crucial for reducing Australia's reliance on fossil fuels and mitigating the effects of climate change.

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4. **Defence:** Engineers are crucial in the design, development, testing, and maintenance of the systems utilised by our armed forces in the defence of our nation.
5. **Healthcare:** Engineers contribute to the development of medical technologies, such as prosthetics and medical imaging systems, that improve the quality of healthcare in Australia.

What is the difference between an engineer, a technologist, and a technician?

Engineers, technologists, and technicians all play important roles in technical fields, but there are some differences between their responsibilities, education, and areas of expertise. Here are some key differences between these roles:

1. **Engineers:** Engineers are typically responsible for designing and creating complex systems, products, or processes. They have a strong foundation in math, science, and engineering principles, and they use this knowledge to solve complex problems and develop new technologies. Engineers often have a four-year degree in engineering, and many have advanced degrees. They are involved in every stage of a project, from design to testing to implementation, and they often oversee teams of technicians and technologists.
2. **Technologists:** Technologists are responsible for applying engineering principles to solve specific problems. They are often involved in the implementation and testing of technology, rather than the design phase. They have a two- or three-year diploma or degree in a technology-related field, such as computer science, electronics, or information technology. They work with engineers to implement designs and make sure that technology is functioning as intended.
3. **Technicians:** Technicians are responsible for the operation and maintenance of technology. They perform tests, diagnose problems, and make repairs to technology systems. They typically have a two-year diploma or degree in a technical field, such as electronics, computer science, or mechanics. Technicians work under the supervision of engineers and technologists and may perform hands-on work to implement and maintain technology.

Overall, engineers, technologists, and technicians all play important roles in technical fields, but their responsibilities and areas of expertise differ. Engineers focus on design and development, technologists focus on implementation, and technicians focus on operation and maintenance.

What is the difference between a software engineer, a software designer, and a software technician?

Software Engineer, Software Designer, and Software Technician are all roles related to software development, but there are some differences in their responsibilities and areas of expertise. Here is an overview of each role:

1. **Software Engineer:** A software engineer is responsible for developing software applications from start to finish. They are involved in every stage of the software development lifecycle, including designing, coding, testing, and maintaining software. They have expertise in programming languages, software development frameworks, and development methodologies. They work on complex software projects, developing algorithms and designing system architecture.
2. **Software Designer:** A software designer is responsible for creating the user interface and overall look and feel of software applications. They work closely with software engineers and customers to understand the user's needs and design software that meets those needs.

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They create the wireframes, layouts, and visual elements that make up the user interface. They also work on the user experience (UX) design, ensuring that the software is easy to use and meets user expectations.

3. **Software Technician:** A software technician is responsible for testing and maintaining software applications. They work closely with software engineers and designers to test software applications and identify bugs or errors. They may also perform maintenance tasks, such as updating software, troubleshooting problems, and providing support to users.

Overall, software engineers, software designers, and software technicians all play important roles in the software development process. Engineers focus on developing software applications, designers focus on creating the user interface, and technicians focus on testing and maintaining software applications.

Engineering literacy

A report from the Academies of Sciences, Engineering, and Medicine (2020) in the USA defined an engineering literate person as one who **“has a basic understanding of the people and processes involved in creating the human-built world”**.

The Academies highlighted a number of core features of engineering literacy. These include

- Developmentally appropriate mathematics, science, and technology skills, and
- the promotion of “engineering habits of mind”—ways of thinking and acting that are important for both early engineering learning and overall school readiness (Lippard et al., 2019).

Additional features can be added to engineering literacy for children, namely,

- an appreciation of the work of engineers and engineering in the immediate and wider world, a curiosity for learning “how things work”,
- an awareness of how engineering draws on the other STEM disciplines, and
- a keenness to solve hands-on, real-world problems for which multiple solutions are possible (English & Moore, 2018).

Implicit in these components is an appreciation of aesthetics in engineering.

Engineering Design

Engineering design provides foundational, interdisciplinary links that are invaluable in developing modelling and problem-solving capabilities across the STEM fields (English, 2018a, b).

Engineering design is often referred to as the “interdisciplinary glue” that facilitates learning in the other STEM disciplines, as well as in other domains such as literature and engineering (Tank et al., 2018, p. 175)

However, the multiple applications of engineering design in the curriculum are not being acknowledged adequately, let alone utilised.

Difference between Engineering and Technology in STEM Education

Engineering and Technology are both important components of STEM (Science, Technology, Engineering, and Mathematics) education, but they have distinct differences in terms of their focus

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and application. Here are some of the differences between engineering and technology in STEM education:

1. **Focus:** Engineering is focused on the design, development, and application of systems and structures, while technology is focused on the use of tools, techniques, and equipment to solve problems and improve processes (Streveler et al., 2014).
2. **Process:** Engineering is a process of designing and creating solutions to problems, while technology is a process of applying tools and techniques to implement those solutions (Felder & Brent, 2003).
3. **Education:** Engineering education emphasizes the development of critical thinking, problem-solving, and design skills, while technology education emphasizes the application of those skills to practical problems (Streveler et al., 2014).
4. **Career opportunities:** Engineering careers include roles such as mechanical engineer, civil engineer, software engineer, and electrical engineer, while technology careers include roles such as computer programmer, software developer, and IT specialist
5. **Hands-on experience:** Engineering education provides hands-on experience through design projects, laboratory experiments, and fieldwork, while technology education provides hands-on experience through programming projects, simulations, and prototyping (Felder & Brent, 2003).

Overall, while engineering and technology are both important components of STEM education, they have distinct differences in terms of their focus, process, education, career opportunities, and hands-on experience.

A useful example is the use of computer aided design (CAD). It is a complex tool requiring a high level of skill to use all of its many attributes. When it is used to design and render a 3D artefact or picture it is Technology. When it is used to design and draw up a prototype and then simulate the forces or environmental factors acting upon it - that is Engineering.

STEM vs STEAM

Adding another discipline to the STEM acronym may promote further compartmentalisation of its disciplines, rather than more cohesiveness in their integration. At the same time, integrating five disciplines presents the danger of watering down each of them.

The Engineering Design Process in the Classroom

In a school education context, a standard design process typically involves following a step-by-step approach to developing a solution to a problem or creating a product. This process typically includes defining the problem or need, researching and gathering information, brainstorming potential solutions, evaluating and selecting the best solution, prototyping and testing, and refining the design based on feedback. This process is often used in subjects like art, graphic design, web user interface design, and even some science classes.

On the other hand, the engineering design process is a more structured and systematic approach to problem-solving, specifically tailored to engineering challenges. Whilst standard design processes typically allow more opportunity to consider alternative solutions to the original problem (eg. Is there an alternative to building that bridge?); whilst the engineering design process focuses on delivering an optimal solution to the problem at hand (eg., How high, how long, how strong, how much, how safe, how soon?).

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It involves defining the problem; conducting background research; specifying requirements and constraints; developing and testing potential solutions; optimising cost, safety and aesthetics; determining risk; and finally, iterating and refining the design until it is optimal. This process emphasises a focus on iterative testing and refinement of designs.

The primary difference between the two approaches is that the engineering design process emphasizes a more structured, iterative approach to problem-solving, whereas the standard design process is typically more flexible and creative. The engineering design process is also typically more data-driven and analytical, while the standard design process can be more intuitive and subjective.