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Introduction

Engineers harness science and technology in order to explain and enhance everyday life. Almost every aspect of our lives has somehow been influenced by an Engineer – the water we drink, the buildings we live, learn and work in, products created in factories, computers we surf the net on, the appliances and vehicles that make our lives more efficient and comfortable...all owe their existence to Engineers. Engineering courses provide students with a strong foundation in science, and the problem solving skills to design, create and improve systems throughout their careers.

A great deal of engineering work uses computers. This can include software design, testing, the control of systems, direction of equipment and analysis of the properties of materials. To become a professional Engineer, you need to complete a four-year full-time Bachelor of Engineering degree at a university. Many students choose to undertake a combined degree course, combining Engineering with Science, Business/Commerce, Arts or a range of other disciplines. It is also possible to qualify as an Engineering Technician or associate through completing a diploma course at a TAFE. Relevant work experience is usually a key element of any Engineering qualification.

Graduate Employment and Salary Information

At the time of writing, salaries for graduate Engineers are among the highest graduate salaries in the country, particularly for Engineers working in remote regions. Salary rates can change, however, so for current information about the starting salaries and destinations of Engineering graduates visit Graduate Careers Australia's website GradsOnline. GradsOnline provides state-by-state and gender breakdowns of engineering industry activity, five-year trends in graduate salaries and activities and salary comparisons with other fields of education. For salary and labour market information for TAFE graduates, please visit National Centre for Vocational Education Research (NCVER) website. 

Professional Engineering Disciplines

Historically, Engineering has been divided into the four broad disciplines of Chemical, Civil, Electrical and Mechanical Engineering. Within each discipline there are several branches of Engineering covering an enormous range of fields. In recent years, new disciplines of Engineering, such as Computer Systems, Environmental and Biomedical Engineering and Mechatronics Engineering have emerged.

Aerospace Engineering (also known as Aeronautical Engineering)

Aerospace Engineers design, construct and operate aircraft, aerospace vehicles and propulsion systems. This includes planes, jets, helicopters, gliders, missiles and spacecraft. They are involved in researching, developing and testing new materials, engines, body shapes and structures that may increase the speed and strength of aircraft. They are also responsible for planning thorough maintenance programs for aircraft and exercising strict safety and environmental controls. Aerospace Engineers also use their knowledge of electrical, electronic and computer systems for automatic control and communication systems for the operation of aircraft.

Aeronautical Engineering deals specifically with aircraft such as airplanes and helicopters, and is concerned with their design, manufacture, modification and operation.

//In recent years, new disciplines of Engineering, such as Computer Systems, Environmental and Biomedical Engineering and Mechatronics Engineering have emerged//

Aerospace Engineers may be responsible for investigating faulty engines or other components, and for developing repair systems. They may be involved in designing improved air-conditioning or fuel systems for aircraft, or ground-based systems for operations such as flight control. They may prepare technical or commercial information when competing with other companies for the manufacture or supply of equipment.

The aerospace industry in Australia is changing from having an introspective, defence-dependent focus to a more export-oriented outlook. Opportunities now exist for research and development into composite material and manufacturing techniques, exploring how products are made. Many aircraft components are now manufactured from advanced composite materials, such as carbon fibre reinforced plastics.

There are three main areas of work in the aerospace industry: design and manufacture; research and development; and airworthiness operations. A new graduate Engineer may be involved with one aspect of a project such as calculating the type and weight of material to go into a component. Senior Engineers may be in charge of coordinating a whole project, giving other Engineers, Technicians and Draftspersons different tasks to complete, and ensuring that the project meets budget requirements.

The Civil Aviation Safety Authority employs Aeronautical Engineers whose main task is to ensure that Australian aircraft are airworthy. This covers the certification of aircraft and involves the assessment of manufacturers' data from within Australia and overseas. They may have to assess mechanical systems, flight characteristics and aircraft performance. This may be done by test flights, measuring take off distances, rate of climb, stall speeds, manoeuvrability and landing capacities and comparing results with safety standards.

Aerospace Engineers may also work for commercial airline companies, aerospace manufacturers, government defence departments and defence forces, and in government research laboratories. The Australian aerospace industry is very small and many graduates find their advanced technological skills are transferable when working in related fields. One such example is the automotive industry, which occasionally advertises for Aerospace Engineers.

Agricultural Engineering

These Engineers are involved with conserving and developing the world's natural resources such as soil, water, land, rivers and forests, and they research and develop solutions to combat problems such as soil erosion and salinity. They are responsible for designing better methods of farming and forestry, improved farming machinery and buildings, and also in lessening the impact of humans on the environment.

Agricultural Engineers may work towards solutions for problems such as sustainable agricultural production, the environmental impact of intensive agriculture and also look at the ways in which agricultural and primary products are handled.

Many Agricultural Engineers are employed by government departments in areas such as water supply, agriculture, forestry, soil conservation and in environment protection agencies. Private employers may include consulting firms, manufacturers and distributors of agricultural and irrigation equipment, corporate farms, intensive animal industries and food processing plants. Work may also be available on overseas agricultural aid programs.



Biomedical Engineering

Biomedical Engineers work with doctors and medical scientists, researching and designing ways to improve health care and medical services. They may use microcomputers, lasers and other materials to develop and improve medical research equipment that is used to diagnose health problems. They may be involved in the development of medical products and of different types of equipment used to monitor and treat patients, and in designing and improving equipment for disabled people.

Students may specialise in areas such as Bioinformatics (use of IT to deal with the collection, organisation and analysis of large amounts of biological data), Biomechanics (applying mechanical principles to the study of how the human body moves, including to the cell and tissue level), Biocellular (utilising new methods and procedures to develop tissue, eg. for burns) and Biosignals (to enable understanding and treatment of complex signals within the body, eg. for development of the bionic ear).

A Biomedical Engineer working in a hospital, for example, may be responsible for the development and operation of equipment such as monitoring, diagnostic and therapeutic medical equipment, ranging from catheters, CAT scanners, pacemakers and kidney machines. They may be involved in designing artificial joints and limbs and assisting the surgical team in fitting these to the patient. Biomedical Engineers design and deliver technology to improve the quality of life of people with disabilities. For example, they may develop equipment to assist people who have difficulty walking, communicating or carrying out simple daily tasks.

//Civil Engineers are responsible for the planning, design, project management and construction of everything we see around us in the built environment... //

Chemical and Biochemical Engineering

Chemical Engineers help manage resources, protect the environment and control health and safety procedures, while developing the processes that make the products we require or desire. Chemical Engineers are involved in the design, modification and operation of processes to produce desirable products. Chemical Engineering concerns changing raw materials into useful and commercial end products by altering the chemical, biochemical or physical state of a substance. Biochemical Engineering, a more recent development of Chemical Engineering, involves using cutting edge technology to produce pharmaceuticals and foods.

Research of raw materials and their properties, design and development of equipment and the evaluation of operating processes, are all part of Chemical Engineering. These skills are combined to extract raw materials which can then be refined and manufactured to produce such things as food, petrol, plastics, paints, paper, ceramics, minerals and metals. Often these processes are carried out at large scale plants and the safe operation of these plants is also part of Chemical Engineering.

Extracting these raw materials without harming the environment is also a major area of work for Chemical Engineers. For example, new types of fuels which can be used to provide energy without adversely affecting the environment are currently being developed and tested. Chemical Engineers are also involved in the production of pharmaceutical products as diverse as penicillin and shampoo.

Chemical Engineers may work in companies involved in the production of products such as food, plastics, ceramics, pharmaceuticals, metals and glass. Many Chemical Engineers also find employment in environment protection and the reclamation or clean up of contaminated sites, or in research laboratories, chemical plants and petroleum refineries. Other major employers of Chemical Engineers include manufacturers of basic iron and steel products, organic industrial chemicals and the mining industry. Chemical Engineers are in demand all over the world; working on projects as diverse as providing water for third world communities, leading edge tissue engineering research, shaping the hydrogen economy and creating pollution free iron production.

Engineers working in this field may specialise as Combustion Engineers, Petroleum Engineers, Principal Chemical Engineers, Smelting Engineers, Water Treatment Engineers or Environmental

Engineers (see section on Environmental Engineering). There is also scope for Chemical Engineers to move into related areas including Biotechnology, Food Engineering and Mineral Engineering.

- **Biochemical Engineering** deals with the study of chemical reactions and processes that occur naturally in living systems (plants and animals) so that these processes can be copied and used for human benefit. For example, biochemical processes are used in brewing beer, in sewerage and waste water treatment and in many food manufacturing processes.
- **Food Engineering** involves the design of equipment, machinery and production methods that increase the life of food while maintaining its quality and nutritional value. They also ensure that the food produced is free from bacteria and disease and does not lose its original texture and colour.
- **Petroleum and Petrochemical Engineering** finds, produces, uses and improves oil and natural gas based on geological studies. Methods of removing oil and gas from the earth safely and economically are constantly being researched and tested. Raw materials extracted from the earth or oceans are turned into synthetic fibres, dyes, detergents and many forms of plastic materials and products.
- **Pharmaceutical Engineering** – Equipment that produces life-saving drugs and medicine is designed and operated by Engineers in the pharmaceutical field. These drugs need to be made very precisely in both small and large quantities. Engineering teams work closely with medical research teams to achieve the most effective results.
- **Process Control** is concerned with the creation and maintenance of computer software and systems which are designed to control the quantity and quality of a particular product when it is being manufactured. Computers are used in a chemical plant to control such things as pressure, temperature and liquid levels in a tank. It is also important to ensure that the minimum amount of waste material is produced during manufacturing.

- **Production** – Engineers are responsible for the equipment and processes used in various chemical or manufacturing plants. Production Engineers ensure equipment is maintained and operating at the peak level of production, and may also be involved in advising on the layout of the factory floor to maximise production levels, or on the purchase of new equipment.

Civil Engineering

Much of the physical infrastructure of our modern society is provided by Civil Engineers. Civil Engineers are responsible for the planning, design, project management and construction of everything we see around us in the built environment, including dams, bridges, pipelines, roads, towers and buildings of all sorts. They are responsible for the design and construction of all our transport systems, the design and management of our gas and water supply, sewerage systems, harbours, airports and railways. Civil Engineers plan, design and test the structures of private and public buildings and facilities.

They are also involved in many environmental areas such as the assessment of the impact large scale projects have on the environment and the collection and treatment of sewage and industrial wastes, pollution and environmental control and resource protection and management.



A Civil Engineer will consider whether the chosen materials for a particular building will be strong enough to hold a structure of that height or design. At the same time they would also think about how the structure might affect its surroundings. It is the responsibility of the Civil Engineer to produce safe, economical and environmentally sound structures.

Civil Engineers may specialise as Chief Civil Engineers, Construction Engineers, Municipal Engineers, Structural Engineers, Transport Engineers or Water Supply Distribution Engineers. Civil and Public Health Engineers may work in the private sector as Consulting Engineers, Project Managers or Construction Contractors, or in a wide range of government departments.

- **Geotechnical Engineering** provides information on how the soil and rocks beneath a proposed structure will behave under pressure. An understanding of the structures being built is needed in order to assist in the design of their foundations. Geotechnical Engineers spend a lot of time outdoors, collecting samples and testing ground areas, and advising on work in progress.
- **Hydrology** – The science of water. Hydrologists deal with the occurrence, distribution and circulation of water on earth. Engineering Hydrologists may deal with planning, designing and operating water engineering structures (such as dams, water supplies and breakwaters), the prediction of river flows and floods and may create computer models aimed at controlling and protecting both inland and coastal waterways.
- **Structural Engineering** – Natural forces such as wind, waves and earthquakes and their effects all need to be taken into account when a structure is designed and built. Certain stresses caused by the modern environment, such as human and vehicle traffic, also need to be considered. A Structural Engineer ensures that structures are built in such a way that they can withstand these forces. Innovative solutions to these problems are researched, developed and tested by Structural Engineers.

- * Structural Engineers often work with architects, builders and those in Mechanical, Electrical and Chemical Engineering, to organise and supervise the construction of particular structures.
- * The study of Structural Engineering is often combined with Civil Engineering, but certain subjects can be chosen at university in order to specialise in Structural Engineering, or work after graduation may be focused in this particular area.
- **Transport Engineering** is concerned with the means of transport for both people and freight.
 - * Transport Engineers design, test and improve systems and structures which are used to move people, cars, trains, airplanes and ships. For example, it is vital that traffic intersections are designed in such a way that traffic flows freely and does not cause avoidable congestion. The layout of train lines needs to be designed with similar objectives in mind. Transport Engineers also plan future travel needs of city and country areas, as populations increase and their needs change.

Consulting Engineering

Consulting Engineers research, design, create, manage, test, innovate and analyse – by definition, a consultant provides 'expert and professional advice'.

After completing formal study at university, Consulting Engineers draw on technical knowledge and develop their skills from day one on the job. Surrounded by talented and like minded individuals, they work with a diverse range of public and private sector clients, providing quality, innovative solutions for complex problems.

Consulting Engineering provides a broad and varied landscape on which to develop a lifetime career. Disciplines within the engineering industry are vast; civil, environmental, mechanical, geotechnical, electrical, structural, mining, energy, water and chemical, to name just a few. Each has its own layers of further specialisation. Consulting Engineering is not just about designing roads, bridges and tunnels. It's also about hazardous waste management, designing machinery and building telecommunications networks.

A career in Consulting Engineering provides opportunities to balance time in the office with time in the field, to work for a small or large organisation, be part of a multidisciplinary team or be self-employed. It provides interstate or overseas travel and interaction with a diverse range of clients; from multinational companies to remote rural villages. Ultimately, a career in Consulting Engineering has the flexibility to enable individuals to contribute to

//The engineering industry has a diverse range of professional associations and a vast array of professional development opportunities.//

a variety of projects, work with a range of teams and it provides constant exposure to new challenges, industry trends and developments.

Graduates need to keep up to date with the latest industry trends and developments. They also need to be focused on and aware of where the future of Engineering is heading. Clients turn to Consulting Engineers for expert technical advice, and successful Consulting Engineers strive for continuous improvement in order to deliver excellence in all they do.

The engineering industry has a diverse range of professional associations and a vast array of professional development opportunities. Graduates employed as Consulting Engineers discover there is a vast body of resources, tools and industry knowledge at their disposal, which are constantly evolving. It's an exciting, rewarding and challenging career choice with unique opportunities for career development.

Electrical Engineering

Electrical Engineering encompasses Electronic, Computer Systems, Telecommunications, Control and Electrical Power Engineering. It is concerned with the way electrical energy is produced and used in homes, the community and industry. Electrical Engineers design and build the systems and machines that generate, transmit, measure, control and use electrical energy essential to modern life.

▪ Electronics and Telecommunications

Engineering deals with devices and systems that use small amounts of electrical energy to analyse, transmit and store information.

- * Transmission of these electronic signals forms the basis of communications and the information technology industry, and includes the field of microelectronics and the use of silicon chip technology. Various systems for communication between people both nearby and on the other side of the world have been developed and are constantly being improved and refined. This communication takes place using satellite, telephone, optical fibres and

computer systems. These systems are of vital importance in everyday communication, defence, transport, civil aviation and medical equipment such as the bionic ear, pacemakers and life support systems.

- * People who specialise as Electronics Engineers may work in such industries as communications, broadcasting, aviation, defence, robotics, computers, medical engineering or meteorology. Many Electronics Engineers are now finding more opportunities in the entertainment, transport and telecommunications industries. Data communications, mobile radio and the broader entertainment industry all require the input of Electronics Engineers. An example of one growth area is the use of satellites and cable systems in pay television. The transport sector is employing more Electronics Engineers as the vehicles and the systems controlling them become further automated.



- * Electronics Engineers in the field of communications may be responsible for the operation of satellite television transmission, or for the smooth running of telephone switching exchanges. Often these systems or operations are monitored using complicated panels of instruments. It is the responsibility of the Electronics Engineer to find and correct faults quickly and to ensure the smooth working of the operation.
- * Electronics Engineering is a very diverse field and it is currently undergoing expansion as new applications are found for electronic equipment. This has led to the development of two relatively new fields of Engineering – Software Engineering and Mechatronics.
 - Software Engineers design and modify complex software systems and computer hardware.
 - Mechatronics combines the disciplines of Mechanical and Electrical Engineering. It is associated with the use of digital computers to control machines and processes. It is also used to create diverse products such as substitutes for human sensors and organs, and computer controlled machine tools.
- **Computer Systems Engineering** is based on Electrical Engineering and Computer Science. These days computers are used to operate many of the things we use in everyday life, eg. our cars, telephone systems, trains, TV and radio stations. Computer Engineers are involved in the analysis, design, development and operation of computer hardware and software. Most electronic design is based on the use of computer aided simulation.
 - * Computer Systems Engineers may work in the private sector with computer manufacturing and service companies, business consulting firms, the information systems divisions of companies and a wide range of government organisations.
- **Control Engineering** involves the use of electrical signals to move and operate equipment and machinery. Control Engineers design, test and improve automatic control

systems for large industries such as oil refineries, mining operations and production plants. The safe flow of road and air traffic is also the responsibility of the Control Engineer.

▪ **Power Generation and Distribution**

Engineering provides electricity to our homes and to industry. It is concerned with planning, developing, testing, installing, use and maintenance of power plants or stations that provide electric power. It also deals with the transmission of that power to where it is needed – cities, towns, railway lines, large businesses and industry. Power Engineers also conduct research on developing alternative power sources such as solar and wind energy. Electrical Power Engineers work for companies and government departments that are involved with providing and using electrical power.

Environmental Engineering

Environmental Engineers are concerned with protecting the environment by assessing the impact a project has on the air, water, soil and noise levels in its vicinity. This is done by studying the project's design, construction and operation, and minimising any adverse effects that it may have on the environment. Environmental Engineers are also involved in removing problems caused by past activity, such as cleaning contaminated industrial land so it can be used for housing. Environmental Engineers predict what problems may be caused by accidents such as oil spills, and assess what may cause problems for the environment in the long term. They also plan and design equipment and processes for the treatment and safe disposal of waste material, and direct the conservation and wise use of natural resources. They are involved in the research and development of alternative energy sources, water reclamation, waste treatment and recycling.

Environmental Engineers may work with local or overseas consulting engineering firms, government departments such as conservation and natural resources, with agencies such as environmental protection agencies or in the private sector with mining companies and industries.

Industrial Computer Systems Engineering

Industrial Computer Systems Engineering is concerned with the computer-based hardware and software systems associated with industrial measurement and control applications. It is an emerging specialisation in its own right, given the growth and increased dependency on computer-based systems in industrial processing

//Mechatronic applications range from...washing machines... and microwave ovens to...mining machinery...and robots.//

and manufacturing. In the past, Engineers from more traditional discipline areas such as Electrical Engineering have moved into this area after graduation.

Industrial Computer Systems Engineering is concerned with the design, specification, implementation, testing and maintenance of industrial computer systems, which are a combination of both computer hardware and software. These systems are created from more fundamental, but 'off the shelf' building blocks. It is the role of the Engineer in this area to create and implement an architecture in which these building blocks will be used to provide a cost effective, robust and safe computer-based system which meets user requirements.

Instrumentation and Control Engineering

Modern industrial and manufacturing processes require the integration of advanced instrumentation and control technologies to achieve effective and efficient production performance. Most existing Engineering courses include some topics in instrumentation and control. Some new courses provide a program specialising in these topics, applied across a wide range of industrial and manufacturing areas, with a strong focus on the process industries, particularly the minerals process industries.

Instrumentation and Control Engineering involves design, construction, testing and management of tools, equipment and management practices. These are used for the control, measurement, monitoring and performance assessment of a wide range of industrial and manufacturing processes. All of these specialist areas are now central to the efficient and effective operation of most industrial operations.

Areas of application will cover virtually all processes, which are now largely automated and require specialised control and monitoring systems; all manufacturing and most other industrial activities require knowledge of instrumentation and control.

Some areas with significant needs are: mining and mineral processing; refining and chemical manufacture; energy generation and use; food processing and manufacture.

Marine Engineering

Marine Engineers are involved in designing, testing and improving machinery and equipment used at sea. This machinery may include propulsion machinery, electrical, refrigeration, air-conditioning, cargo handling and domestic services equipment. It is their responsibility to check that it is all functioning effectively and being properly maintained. A Marine Engineer needs to have a good understanding of the way in which all these systems operate.

Marine Engineers must also become familiar with pressure vessel operation, including steam generating equipment and the associated control instrumentation. Automatic control systems are becoming more widely used, so an understanding of computer controlled processes is also important. Computers now mean that Marine Engineers do not have to be on constant watch in the engine room.

Marine Engineers may also work with organic pumping or mooring systems, pipelines, dockyards, port and harbour operations, equipment for offshore oil rigs and platforms. This is a relatively small field of Engineering and there tends to be a low turnover of staff. Demand is determined by activity in the water transport industry.



Materials Engineering

Materials Engineers test the ways certain materials behave when put under pressure, when they are heated or joined with other materials (metals, plastics, rubber, timber, ceramics). Materials Engineers are involved with developing new materials and improving certain qualities of existing materials. They may also be involved with developing new and improved methods of recycling plastics and paper. Materials Engineering deals with the manufacture, structure, properties and use of metals and non-metallic substances, such as polymers, ceramics and composites.

Materials Engineers work in diverse areas, particularly those where Chemical, Electrical, Manufacturing and Mining Engineers find employment. These areas include large foundries, steel works, aluminium plants and companies involved with alloy research.

Mechanical and Manufacturing Engineering

Mechanical and Manufacturing Engineering turns energy into power and motion. Mechanical Engineers design, create and improve systems and machinery that are used for domestic, public and industrial purposes. This area covers the design and manufacture of a great variety of products, such as domestic appliances, industrial machinery, ships, aircraft, engines, pumps, compressors and turbines, or complex systems such as the air-conditioning and ventilation systems of buildings. The mechanical area interlinks closely with other areas of Engineering, and applies knowledge of materials, energy and structures.

Mechanical Engineers often work for industry designing systems and machines that generate power, make products, move things and help in building. They may also work in chemical

//Mining Engineers are responsible for protecting the conditions for people and the environment, in the vicinity of mines.//

processing, power generation, the automotive industry, manufacturing, building services, the aeronautical industry, defence technology, food processing and public utilities.

Demand for Mechanical Engineers depends on activity in the manufacturing and construction industries. Many graduates cross over into the field of Industrial Engineering and building services.

- **Manufacturing Systems Engineering** is concerned with the processes and systems that are used in industry. Systems and equipment that complete tasks accurately, change raw materials into products with the smallest wastage of time, materials and energy are designed and improved by Manufacturing Systems Engineers.
- **Hydraulics** involves the design of new and improved ways of applying fluid control, so that machinery can operate smoothly and effectively with the least amount of pressure. For example, hydraulic oil pressure is used to move large cranes.
- **Pneumatics** refers to the use of air pressure to control machinery. For many industries, air is a much safer material to use because it is clean and can be used safely in flammable areas. It is practical to use pneumatics in food processing as it is much cleaner, and it is also used for safety reasons in machines that process flammable substances such as petrol and paint.
- **Thermodynamics** deals with heat energy transfer and machinery that turns heat energy into mechanical power. Engineers in this field design, manage and improve machinery such as boilers and gas and steam turbine generators, as well as facilities like cooling towers, heating and refrigerant systems.

Mechatronics Engineering

Mechatronic Engineers design, build and operate the intelligent products and systems of today and tomorrow. Mechatronics crosses a range of disciplines, including Mechanical Engineering, Electronics, Information Technology and decision-making theories. Using mechanical and electronic processes in addition to computers, Mechatronics is the science of developing new solutions to industrial problems.

Many technical processes and products in the area of Mechanical and Electrical Engineering are showing an increasing integration of mechanics with electronics and information processing. This integration is between the components (hardware) and the information-driven functions (software), resulting in integrated systems (Mechatronic systems).

Mechatronic applications range from household appliances, such as washing machines (eg. which can sense the amount of dirt and vary water and electricity use accordingly), DVD players/ recorders and microwave ovens to industrial equipment such as mining machinery, automated manufacturing machinery and robots. Cars, aircraft and generators also constitute Mechatronics products. Mechatronics also allows Engineers to create completely new products, not just improve previous designs, and robotic lawn mowers and robot floor cleaners fall into this category.

Mechatronic Engineers may also be employed by product developers and manufacturers, large and small, by the mining or forestry industry, by the aerospace and defence sectors, and by the government and industry research groups. They may also work in electrical plants and companies where automation and process control is required and employment could also extend to areas such as developing new processes in underwater exploration. As an example, a Mechatronics Engineer may be involved in the design, construction and running of factory production lines and processes. In this application their skills with computers, microcontrollers, programmable logic controllers (PLCs), computer programming, industrial sensors, hydraulic, pneumatic and electric drives, design of mechanical structures and mechanisms, together with their knowledge of manufacturing processes are invaluable.

The workplace may be a laboratory, processing plant or engineering office. Many graduates also identify niche opportunities and set up their own companies. As Mechatronics is at the cutting edge in the development of new products, devices and processes, there are research opportunities in nanotechnology, robotics, by-wire technologies for motor vehicles, bioengineering and many other developing fields.

There is a strong demand for Mechatronics Engineers from both large, global enterprises (eg. in the automotive, aerospace and consumer product industries) and the smaller, innovative 'high-tech' companies which supply software, parts and equipment. In the future, Mechatronic Engineers will be in great demand as more industries seek to apply the evolutionary advances in computers, electronics, sensors and actuators to improve their products, processes and services. Career prospects are virtually limitless, as graduates are positioned to take a leading role in the development of intelligent technology that is transforming our world.

As Mechatronics is still an emerging field, and is in so many ways 'multidisciplinary', not all employment vacancies will be labelled 'Mechatronics Engineer'. Mechatronics Engineering positions may also often be advertised as the following:

- Asset Management Engineer
- Automation Engineer
- Control System Engineer
- Data Logging Engineer
- Electrical/Electronics Engineer
- Instrumentation Engineer
- Maintenance Engineer
- Manufacturing Engineer
- Mechanical Engineer
- Plant Engineer
- Process Engineer
- Project Engineer
- Software Engineer
- Systems Engineer



Minerals and Metallurgical Engineering

This form of Engineering is concerned with turning raw material of low value into valuable products, eg. changing bauxite into aluminium. Minerals Engineers use a wide range of treatments to process materials in the most efficient way. This might involve physical or chemical separations, and hydro- or pyro-metallurgical processes. Metallurgical Engineering takes this one step further by combining metals and non-metals to make new composite materials. These new composites are designed to be light, strong, durable and heat resistant, for use in the design and enhanced performance of cars, boats, jets, spacecraft and other vehicles.

Mining Engineering

Mining Engineers work together with geologists to investigate and carry out the extraction of ore bodies and mineral deposits, as well as the extraction of non-metallic ores and fuels such as coal and uranium. They are responsible for planning the safest and most cost effective method of removing minerals from the ground, rivers or the sea bed. They may be involved with designing, installing and supervising the use of mining machinery and equipment, and for inspecting the progress of mining operations.

Computerised techniques are often used in the development and operation of mines. Mining Engineers are responsible for protecting the conditions for people and the environment, in the vicinity of mines. Mining Engineers work on mining sites and in the head offices of mining companies. Many mines are located in remote areas and young graduates should be prepared to travel and live in non-urban areas. Salaries for those working in the mining area are usually well above that for most other professionals and the opportunities for travel are excellent.

//There is a growing awareness in the general public of the need for risk assessments to be carried out before a project begins.//

Experienced Mining Engineers have a wide range of career options including:

- consulting
- contracting
- general management
- investment analysts and advisers
- mine planning and design
- operations management
- research
- technical specialists
- tertiary education
- the mines inspectorate.

Renewable Energy Engineering

It is readily apparent from many social and environmental concerns that the effective use of renewable sources of energy represents a desirable (if not the only) way of sustaining the long-term survival of the planet. Renewable Energy Engineering is concerned with solving the technical problems associated with making this future a reality.

Renewable Energy Engineers must have a thorough grounding in a wide range of basic and applied sciences, so that they can understand how to effectively utilise the diverse range of renewable energy sources (eg. wind, solar, tidal, biomass). This requires studies to be undertaken in mathematics, physics, chemistry and computing. Specialised knowledge must also be gained in the various energy sources; how to harness these and convert them into forms that can be readily used. Applications for renewable energy technologies occur at all scales, from the domestic level, to large industrial/commercial applications and region-wide/urban systems.

A graduate in Renewable Energy Engineering would expect to find excellent career opportunities working in both small and large scale power generation and distribution organisations; as well as in large manufacturing and processing plants where there are opportunities to efficiently use renewable energy resources. There will also be opportunities to work in areas such as energy policy and resource planning where the long-term sustainability of the environment is of paramount concern.

Resource Engineering

Resource Engineering is concerned with the development and efficient use of natural resources and the management of the environment in rural areas. This includes the development, conservation and control of water resources, soil conservation

and the recovery of degraded land, catchment and land management and the assessment and control of water pollution from agricultural and mining industries.

Particular roles in Resource Engineering may include estimation of water yields from catchments, flood analysis or the design and construction of drainage and irrigation systems sympathetic to the environment.

Resource Engineers are employed by government management agencies and local government bodies, Consulting Engineers, the mining and forest industries and civil engineering and construction companies.

Risk Engineering

There is a growing awareness in the general public of the need for risk assessments to be carried out before a project begins. This involves analysis based on knowledge of chemistry, physics and the operational aspects of any given project. It is important to identify any potential hazards, the consequences of these hazards and the frequency and magnitude with which they are likely to occur. These hazards need to be managed and emergency response procedures identified.

Risk Consultants often carry out detailed risk assessment studies for private companies, or review studies done by other parties.

Software Engineering

Software Engineering is an emerging specialisation concerned with the construction of complex software systems using the principles of Engineering Design. Given the many major failures observed in software systems, it is now recognised that a much greater investment is required in the design and implementation processes, to ensure that software systems meet their specifications and can be implemented within budget.

Software Engineering is thus concerned with the theory, design, implementation, validation, maintenance and life cycle management of software systems. There is a strong emphasis on design, the design process, the management of design and the use of well-defined theories, as well as good practice, regulations, quality assurance and performance metrics.



GRADUATE PROFILES

Robert Sinclair

– Bachelor of Engineering (Mechanical)/Bachelor of Technology (Aerospace)



I gained a better understanding of the type of projects I could be working on both in Australia and overseas

I have always wanted to be a pilot but, due to eyesight complications, could not follow this career path. I knew I wanted to do something related, so I decided on Engineering at Monash University "because of the general first year and extracurricular opportunities available".

As part of the double degree program, I was required to undertake three months vacation work experience and was really keen to work with a company involved in aerospace. I completed my experience with Australian Aerospace in Sydney which is part of Eurocopter and affiliated with the European Aeronautic Defence and Space (EADS)

//...It [engineering] is a profession which hones and develops one's capacity to think and problem solve innovatively.//

Lucy Broughton – Bachelor of Engineering (Chemical) and Bachelor of Science (Pharmacology, Biochemistry)

organisation. I was offered a place working on the newly acquired army reconnaissance helicopter which mainly involved the development of the simulators for crew training. I worked with many European, as well as Australian co-workers. As a result of this experience, I gained a better understanding of the type of projects I could be working on both in Australia and overseas and I am now pursuing overseas employment opportunities, probably in the US or Europe.

I suggest students not to limit their jobsearch to local employers and also consider tapping into organisations such as IAESTE (International Association for the Exchange of Students for Technical Experience) which will assist students find temporary work in many engineering industries throughout Europe and the US.

David Hobbs

– Bachelor of Science (Physics and Maths) and Bachelor of Science/Bachelor of Engineering (Biomedical Engineering) Honours



I wanted to contribute in a tangible fashion and saw Engineering as providing me with the ability to do this.

I am employed as a Rehabilitation Engineer – combining Engineering and technology to benefit people with a disability. I chose to study this area of Engineering as I wanted to use my skills to make a positive difference in the world. Biomedical Engineering allows me to combine my enthusiasm and interest in technology and Engineering with my passion for helping others. It's a very 'people-oriented' degree and this aspect appealed to me.

I wanted to contribute in a tangible fashion and saw Engineering as providing me with the ability to do this. I also admit to having a very enquiring mind, especially about how things work and why something is designed the way it is. I also like gadgets, particularly electronic ones, like most Engineers!

I have been involved in a lot of testing of Rehabilitation Engineering products, mainly wheelchairs, to conform to International and Australian Standards. The tests are mainly mechanical and cover areas such as strength, durability and static and dynamic stability. I have also been involved in the area of researching how someone with a disability can access a home phone, and recently travelled around Australia promoting the field of accessible telecommunications, through the running of educational workshops.

In terms of further studies, I have an Executive Diploma in Business Planning, so either an MBA or PhD within the field of Rehabilitation Engineering is a distinct possibility. I would like to travel and work overseas at some point.

In 2004 David was awarded the National Young Professional Engineer of the Year Award.

My advice for aspiring young Engineers?

"Make the most of any opportunities that come your way and never underestimate the power of networking."

Lucy Broughton

– Bachelor of Engineering (Chemical) and
Bachelor of Science (Pharmacology, Biochemistry)

...my choice of career path evolved during university with further exposure to the industrial processing and design...

Throughout school I was drawn to maths and science subjects. My rationale for undertaking a combined degree in Chemical Engineering and Science at the University of Adelaide was to integrate the highly practical problem solving/ design aspects of Engineering with the theoretical/ research-oriented features of Science.

My original intent was to work in the field of biochemical processing. However, my choice of career path evolved during university with further exposure to the industrial processing and design modules of the Chemical Engineering course, together with experience during summer vacation work. Engineering electives in the final two years of the degree broadened my appreciation for the wide array of employment opportunities for graduate Chemical Engineers in a diverse set of industries.



Over the university summer vacations I took up three Engineering/Science placements: a role in a researched-based project in the University of Adelaide's Biochemistry Department; a consulting engineering support role in URS Australia Pty Ltd (a diversified environmental science and engineering organisation); and, finally, in an operations-based process engineering role in Woodside Energy's onshore gas plant in Karratha, Western Australia.

Through my technical development at university, in conjunction with vacation work, I decided that I wanted to work as an Engineer in a role that offered capacity in planning and project management, teamed with operational experience. As a consequence, I successfully attained a placement as a Drilling Engineer on the graduate program at Woodside Energy Ltd.

My last three years at Woodside have provided me with myriad experiences which have greatly facilitated my growth as an Engineer.

"My first year provided a combination of planning experience teamed with a set of rotations offshore, working on drill rigs in the Timor Sea and Great Australia Bight. In my second year I was transferred into an international division and became part of the Mauritania Drilling team. I completed a six-month assignment on a Norwegian drill ship, northwest Africa. I have since returned to the office, planning exploration and development wells for both Mauritanian and Australian operations. My transition, from a Biochemical Engineering framework to one within the oil and gas industry as a Drilling Engineer, is testimony to the central values of Engineering. It is a profession which hones and develops one's capacity to think and problem solve innovatively. Further, it is a profession that has helped me to realise my technical abilities within the larger framework of a commercial setting and, in the process, see some amazing parts of this world."

//The beauty of a Graduate Development Program with a large company is that you get to try your hand at a number of different jobs//

Adam Davidson

– Bachelor of Engineering (Electrical)

Kym Wilkinson

– Bachelor of Engineering (Civil) Honours

My school Careers Advisor sent me along to Engineering Week and I've got to say it was the best thing that could have happened.

I was inspired to become an Engineer after seeing what the work of an Engineer actually involved.

"In Grade 11, I was invited on a bus tour of engineering sites around Brisbane during Engineering Week. At the time I was contemplating studying Medicine or Veterinary Science at home in Queensland so I had the necessary prerequisite subjects for Engineering. My school Careers Advisor sent me along to Engineering Week and I've got to say it was the best thing that could have happened. The tour included the BP oil refinery, the QANTAS maintenance hanger, Luggage Point Sewerage Plant (Possibly a little too confronting!) and a walk inside the Gateway Bridge."

I am currently working in a small consultancy run by myself and my husband. I am involved in the design of numerous residential and commercial real estate subdivisions, as well as completing environmental reports (such as stormwater management) and structural design and drafting (on small projects).

Prior to working in my own business I was employed as a graduate Engineer for Main Roads and Queensland Transport. During the later part of my employment I was stationed in Bridge Asset Management (BAM). During this time I was responsible for undertaking heavy load assessments, field and desktop bridge assessments and accreditation of Bridge Inspectors. Prior to working in BAM I undertook rotations in Bridge Design, and also worked on the South East Transit Project.

"The fact that my job entails work both in and outside the office. The most enjoyable aspect, however, has to be seeing something that you have designed being used everyday by people"

I am currently undertaking research for my PhD (part-time) on the load capacity of timber bridge girders. In five years I would like to have completed my PhD and be applying my findings in the 'real' world. I believe that I'll still be doing the same type of work but with the possibility of employing and training a graduate.

My advice for aspiring young Engineers?
"Aim high, the sky is no longer the limit!"

Capt. Michelle Wynn

– Bachelor of Engineering (Civil) Honours

Highlights of my career include: ...deployments to an aboriginal community in Queensland, where I was responsible for providing support for a medical centre...

After joining the army I began and studying at the Australian Defence Force Academy. I was then commissioned into the Royal Australian Corps of Engineers upon graduation from the Royal Military College Duntroon. Five years later I completed my Masters of Engineering Science at the University of NSW.

Highlights of my career include: being posted to the 17th Construction Squadron at Holsworthy, with my Troop supporting the SAS during the Sydney Olympics; deployments to an aboriginal community in Queensland, where I was responsible for providing support for a medical centre, and East Timor, where I commanded 40 personnel in the construction of facilities and provision of services for the Australian army contingent; and working in the headquarters of the army's Chief Engineer, where I was responsible to provide support for a variety of domestic and overseas operations, exercises and projects.

I have been awarded the Australian Active Service Medal and INTERFET Campaign Medal. I was also presented with the Young Professional Engineer of the Year award by the Sydney division of Engineers Australia.

I am currently posted to the 19th Chief Engineer Works and currently fulfilling the role of Senior Project Engineer.

Dena Elsewaisy

– Bachelor of Engineering (Civil) Honours



URS gave me the opportunity to be involved in a wide range of work across disciplines.

During my final year of university I was unsure as to which field of Civil Engineering I wanted to pursue. What attracted me personally to Consulting Engineering and to URS was the variety the role provided. URS gave me the opportunity to be involved in a wide range of work across disciplines. This was of crucial significance to me, as I did not want to be 'pigeonholed' into a certain field that may have limited my future development as an Engineer.

The majority of my day-to-day work is technical; whether it is checking the strength and stability of retaining walls or analysing the flows through a catchment. Other activities include consulting with project managers, liaising with clients and report writing. Occasionally I will go out on site to supervise or gather information. More recently, my interest in water saw my involvement in drainage redevelopment schemes stemming from the Victorian Government's Melbourne 2030 policy.

Since joining URS I can say that my technical, report writing, networking and client liaison skills have all developed significantly. URS promotes the personal and professional development of graduates through the GYP – a program created for graduates by graduates. It is a comprehensive program of events to help ease young professionals into the work force.

Past experience has taught me the importance of work environment. My current employer provides a relatively young office with a healthy gender balance, and a friendly, enthusiastic, social atmosphere which I really enjoy.

Adam Davidson

– Bachelor of Engineering (Electrical)



I consider that, regardless of the discipline, Engineering is a career that keeps you at the forefront of technological advancement

I chose to study Engineering as I had always had a keen interest in advanced technologies especially in the field of electronics. With a natural ability in mathematics and physics, Electrical Engineering was the obvious choice for me and I undertook my study at James Cook University, Queensland.

I am currently employed by Ergon Energy in their graduate program. This is a three-year structured professional development program designed to provide a diverse experience base with placements in different business workgroups in major regional centres throughout Queensland.

I spent my first year with Ergon in the Network Forecasting and Development workgroup in Rockhampton. This role involved modelling and

analysis of the electrical network and forecasting of electrical load growth trends to produce long-term strategic plans for network upgrades.

The second placement was in the Transmission Services workgroup in Townsville. In this I was involved in workgroup management and supervision as well as high voltage network construction, testing, commissioning and maintenance.

My current role in the Substation Procurement workgroup involves technical specification production, tender analysis and contract administration.

“The beauty of a Graduate Development Program with a large company is that you get to try your hand at a number of different jobs and then get to choose a more permanent role.”

I consider that, regardless of the discipline, Engineering is a career that keeps you at the forefront of technological advancement and allows you to apply that technology to everyday problems, ensuring maximum benefit to the society in which we live.

Gamada Agung

– Bachelor of Engineering (Mechanical and Manufacturing) Honours



I was responsible for the schedule and plan of maintenance works to enable smooth operation and 98 per cent equipment availability at all times.

I am an Indonesian national. I was initially interested in studying Economics and Business; however, I really enjoyed maths, physics and logical thinking at school. I wanted to continue to study those subjects

//Making contacts through alumni or friends is one of the most important things about getting into the job market.//

Gamada Agung – Bachelor of Engineering (Mechanical and Manufacturing) Honours

in a practical and applied way at university so I enrolled at The University of Melbourne. I liked the idea of Engineering as I knew that I could specialise technically but also that it gave me a very strong analytical background which I could then transfer to any field. This is essentially what I have done.

My current role is as a Commercial Analyst with ExxonMobil in the Gas & Power Marketing unit, Jakarta. Before supplying gas to a client, a commercial agreement needs to be developed between the two companies – I am involved in both the initial development of the agreements and in client management during the contract. I enjoy working in the commercial side of a large multinational company and the fact that I need a broad knowledge of the company and its goals in order to make effective commercial decisions. I also have the opportunity to travel; recently I went to Korea to negotiate LNG (Liquefied Natural Gas) agreements and Hong Kong for training with the ExxonMobil Asia Pacific Division.

After graduating I was originally employed with Freeport McMoran Indonesia as a Planning and Maintenance Engineer – a gold and copper mining company in Papua. I was responsible for the schedule and plan of maintenance works to enable smooth operation and 98 per cent equipment availability at all times.

I completed a Master of Industrial Management at the Catholic University of Leuven, Belgium followed by an MBA at Vlerick Leuven Ghent Management School. I returned to Indonesia and found work with ExxonMobil.

My advice to students?

“I think it is really important for students to focus on what they want to do as early as possible – start thinking about the direction you want to take and what it takes to achieve it. You can of course have lots of fun in the mean time but it is really important to stay focused on long-term goals.”

And advice for students entering the job market?

“Make contacts! Making contacts through alumni or friends is one of the most important things about getting into the job market.”

Rachelle Benbow

– Bachelor of Engineering (Mechanical) Honours

I thoroughly enjoy the diversity and flexibility that my Engineering career offers... the opportunities it has given me to work in...different environments....

I currently work as Project Coordinator for a small engineering consultancy in Parramatta, NSW. After completing my degree at The University of Sydney, I spent five years working for Honeywell Ltd as a Graduate Engineer, Project Engineer and Senior Project Engineer, in Sydney and Hobart. My work with Honeywell involved providing building systems, such as air-conditioning, building management systems and security, to both new and refurbished buildings, and managing a wide range of projects.

I joined my current employer to gain more diverse experience and ‘wear more hats’. In this role, I have been involved in identifying and implementing new ways to run the business, as well as developing its environmental consultancy division. I am interested in practice areas where mechanical and environmental issues meet, such as acoustics, air pollution, noise control and the production of environmental impact statements.



What drew me to study Engineering? I'd always been good at science and mathematics, but wanted to pursue applied rather than pure science, and Mechanical Engineering fitted in with what I wanted to do. The degree gave me very good technical and problem solving skills. I thoroughly enjoy the diversity and flexibility that my Engineering career offers, and the opportunities it has given me to work in a range of different environments and cities, a chance to get out of my comfort zone. Dislikes? I am concerned that Engineers are often not as esteemed in society as other professions, despite their instrumental roles in so many aspects of our day-to-day lives.

Sue Ribbons

– Bachelor of Engineering (Civil) Honours

One of my favourite parts of the job is communicating – talking to people...writing many different documents, including technical reports, questionnaires...

I had excelled at maths and science at school, and was attracted to advertisements for Engineering cadetships with various government departments, which promised to combine an Engineering degree with practical experience. After talking to various people about what Civil Engineering involved, I applied for the jobs...and was offered four! I accepted a Civil Engineering cadetship with the (then) Water Resources Commission, and enrolled in a 'sandwich' course at the University of Technology, Sydney.

The course involved a pattern of six months at work, followed by six months at uni, and so, after six years, I would emerge with a degree, plus three years' work experience. I would say that the sandwich

...the sandwich course is the best thing that can have happened to Engineering... [as] I gained a wide variety of experience...

– Bachelor of Engineering (Civil) Honours

course is the best thing that can have happened to Engineering, and I found the UTS course excellent. I did very well academically, topping my year and graduating with First Class Honours and the University Medal. During the industrial (workplace) semesters of my sandwich course, I gained a wide variety of experience, working on a dam construction site, in a design office, soils and hydraulics labs and learning about irrigation on farms.

Since completing my degree, I have worked in two different consulting engineering firms, again gaining widely varied experience, in tasks such as floodplain management, drainage design, writing environmental impact statements and risk assessments. As a Consulting Engineer, you develop expertise in numerous areas: civil design, economics, biology, ecology, landscaping, psychology, computing, social planning, writing.

"Engineering is about thinking."

One of my favourite parts of the job is communicating – talking to people, and writing many different documents, including technical reports, questionnaires, brochures and proposals.

Tim Heron

– Bachelor of Engineering (Mechanical)

This project required time to be spent in Peabody Energy's head office in St. Louis, Missouri and further exposed me as a graduate within the organisation.

Working with Peabody Energy has allowed me to have broad exposure to the coal mining industry. As a Graduate Mechanical Engineer with Peabody Energy, I commenced work at an underground coal mine as a part of a maintenance crew. Once a sound understanding of the underground mining process was established, I was then progressed into the Coal Handling and Preparation Plant facility to complete the cycle of the entire underground coal mining process. This allowed me as a graduate to witness the entirety of mining coal from the coal seam to seeing the finished product departing the mine on a coal train once it has been processed through the Coal Handling and Preparation Plant.

The next phase in the graduate program lead me to a surface coal mine as a part of the maintenance team to gain knowledge of the

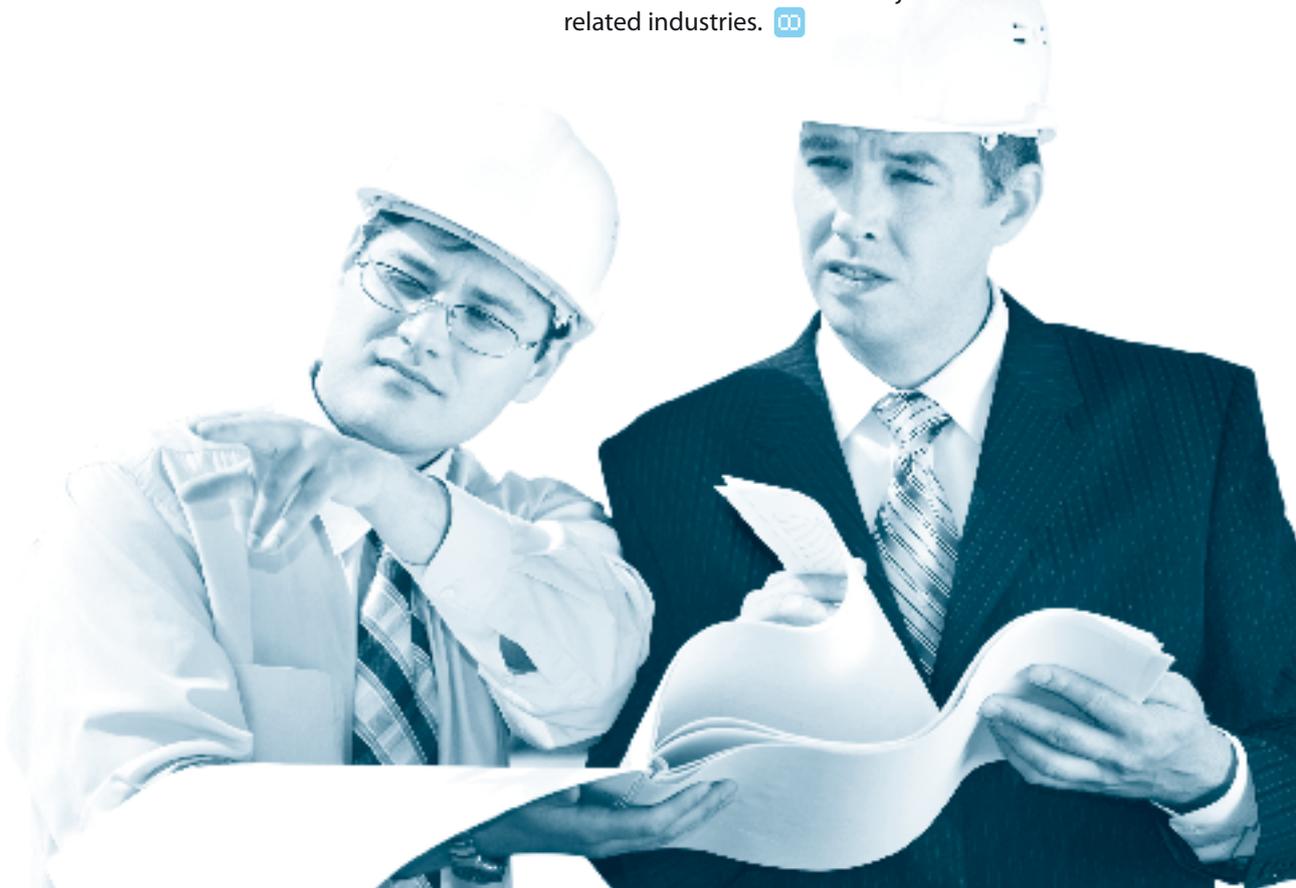
surface mining process, as well as to participate in maintenance planning, maintenance practice/process implementation and to assist in the start/completion of small projects.

At the end of my graduate program I was approached to help implement maintenance processes (use of computerised maintenance management systems) to facilitate world class maintenance practices within Peabody Energy, which included an international team of employees from the USA and Australia. This project required time to be spent in Peabody Energy's head office in St. Louis, Missouri and further exposed me as a graduate within the organisation.

Through out the two-year graduate program Peabody Energy has helped me to develop a sound understanding of underground and surface coal mine processes, as well as how a Coal Handling and Preparation Plant facility operates. The Graduate Program has introduced the development of skills required to deal with people of all backgrounds and has provided the backdrop for a fulfilling career within Peabody Energy.

Further Information

- Consult with the careers adviser and career information service at your university, college or school.
- **Engineers Australia** aims to be an international leader in facilitating and promoting engineering excellence. Its website is a source of engineering information and a gateway to the profession.
- **GradsOnline** – Current information regarding graduate employment trends and graduate starting salaries in various fields including Psychology.
- **Graduate Careers Australia** – GCA hosts Australia's official Higher Education graduate employment website. The site contains information of relevance to both student job-seekers, and those wanting information on career options and guidance. GCA's website includes information on the supply and demand of new graduates and interactive job search for graduates. Contact details for Careers libraries in universities are also available under Campus Contacts on the GCA site.
- **Graduate Opportunities** – Australia's premier graduate employer directory available online and in hard copy from GCA or university Careers Services.
- **The Association of Professional Engineers, Scientists and Managers, Australia (APESMA)** is the largest national non-profit organisation representing professional employees in fields including Engineering, Science, Surveying, Architecture, Information Technology and Pharmacy. The website features a searchable job database for related industries. 



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This booklet is one of a series produced by GCA and intended for use by Careers Advisory Services in Higher Education in Australia. The booklets will also be of interest to secondary students and others considering further study.

A full list of titles available in this series can be found on the GCA website – **www.graduatecareers.com.au** – click on the ‘What Job for You’ button then consult the ‘Career Profiles’ section.

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