



State of Engineering

2019

The Secretary
Department of Treasury and Finance
1 Treasury Place
Melbourne, Victoria 3002
Australia

Telephone: +61 3 9651 5111
Website: dtf.vic.gov.au

Authorised by the Victorian Government
1 Treasury Place, Melbourne, 3002

Printed by Doculink, Port Melbourne
Printed on recycled paper

© State of Victoria 2019

Accessibility
This document is available in PDF
and Word format on the internet at
www.opv.vic.gov.au

Email enquiries: enquiries@opv.vic.gov.au
Telephone: 03 9651 1690

Victorian State of Engineering report is licensed under a Creative Commons Attribution 4.0 Australia licence, provided you credit the State of Victoria (Department of Treasury and Finance) as author, indicate if changes were made and comply with the other licence terms. The licence does not apply to any branding, including Government logos.

Copyright queries may be directed to
IPpolicy@dtf.vic.gov.au

Published November 2019

ISBN 978-1-925551-47-1 (Print)
ISBN 978-1-925551-48-8 (pdf/online/MS word)

Treasurer's foreword



The *Victorian State of Engineering* report demonstrates the vital contribution engineers make to our State and our development into the future.

In 2018 the inaugural *Victorian State of Engineering* report was created to better understand the contribution of Victorian engineers to current and future projects and activities in Victoria.

The report highlighted the role the engineering profession plays in delivering environmental, social and economic benefits for Victoria.

In the year since the report was published, many new and exciting projects and initiatives have been announced that will enable our State to continue leading Australia's engineering development.

To reflect these changes and growth, this year's report provides an exploration of the state of engineering in Victoria and the projects that are shaping our State, with a focus on transport infrastructure.

It highlights the achievements of Victoria's engineers, and provides insight into emerging technologies, sustainable practices and resourcing within Victoria.

With the support of the profession, the wider government, and other influential stakeholders, the Office of Projects Victoria through the role of the Victorian Chief Engineer will continue to positively influence the state of engineering in Victoria to maintain our status as the country's leading innovator.

A handwritten signature in blue ink, appearing to read 'T. Pallas'.

Tim Pallas MP
Treasurer of Victoria

Victorian Chief Engineer's foreword



Engineers and the engineering profession are fundamental to the growth of our State.

With high demand for government infrastructure in response to population growth, the importance of Victoria's engineers has never been greater.

Engineers contribute to the delivery of every good and service. Whether you're sending a message on your phone, catching a train to work, or getting water from a tap, your life and the lives of all Victorians have been made easier and more enjoyable thanks to engineers.

Given the importance of engineers to the growth and prosperity of the State, there is a current undersupply of engineers to match existing and future demands within Victoria.

It is important that a greater focus and commitment be placed on the education and support of potential STEM students, increasing the skills pool necessary to accommodate the projected growth of the State.

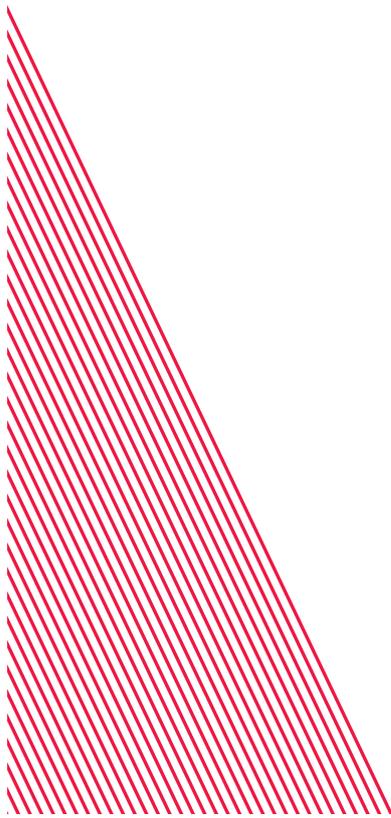
An increase in the pool of engineers within Victoria will not only provide greater capacity to deliver projects but will foster growth and improvement in areas such as technology and sustainability, supporting the move towards Industry 4.0 and enabling a more environmentally conscious approach to Victoria's projects.

In this year's *Victorian State of Engineering* report, we have placed a focus on utilising technology, becoming more sustainable and fostering diverse workplaces.

These are key areas that are shaping the state of the industry and setting a precedent for how engineering will look in the foreseeable future.

A handwritten signature in blue ink, appearing to read 'Collette Burke', written in a cursive style.

Dr Collette Burke
Victorian Chief Engineer



Contents

Treasurer's foreword	1	Biomedical technology	26
Victorian Chief Engineer's foreword	2	Energy	27
Contents	3	Space	29
Victoria into the future	4	Food and fibre	30
World Engineers Convention 2019 – Engineering a Sustainable World: The Next 100 Years	5	Sustainability and waste management	31
Engineers Australia celebrates 100 years	6	Fostering a safe, diverse and inclusive culture	34
Opportunities	7	Women in engineering	34
Population growth	8	Aboriginal and Torres Strait Islander engineers	35
Ageing population	9	International engineers	36
Victoria's economy	10	Interns	37
Skills demand	12	Mental health	39
Growing transport needs	13	Professional Engineers Registration Bill	40
Rapid technological transformation	14	Enablers for prosperity	42
Waste management	15	Victorian Digital Asset Strategy	42
Engineering Victoria's economy	17	Asset management	43
Victoria's infrastructure investment pipeline	17	Cost, time, risk and contingency guidelines	44
Utilising technology	20	Prefabrication and modularisation	46
Digital engineering	20	Capability and capacity	47
Future industries enabled by advanced manufacturing	23	Best practice equity guides	48
Future mobility	24	Engineering Victoria's future	50
Defence	25	Conclusion	52
		Acknowledgments	53

Victoria into the future

Victoria's engineers fuel economic growth and improve the quality of life of all Victorians. As our population grows, so too do the wants and needs of all Victorians, meaning the role of an engineer is becoming more critical.

Engineering encompasses a variety of different and exciting disciplines. Civil engineers help design and build the roads and bridges we drive on, biomedical engineers bridge the gap between clinical medicine and the technology used to help treat the unwell. Electrical, mechanical and aerospace engineers work together to ensure that the next flight or public transport trip arrives safely, and software engineers design the programs that ensure your phone runs smoothly. Without engineers there would be no infrastructure, no clean water and no power.

It is also important to understand that engineers are not confined to traditional roles, such as that of civil, mechanical or chemical engineers. Qualified engineers are sought after in a range of non-engineering jobs from IT, banking, finance and education to consulting and many more. Engineers play a big role in healthcare and food, and in manufacturing and research.

Given the importance of engineering to everyday life, we must work to continue growing our current engineering capability and attract more young people to engineering as a career choice.

This can be achieved by showcasing interesting projects and fostering the development of engineering skills in school to ensure the younger generations understand what a career in engineering entails. We need to continually remind our society that engineers have an enormous role in solving the important issues of our time and have interesting careers.

| Engineering students can apply for programs which support travelling to developing countries and conceiving solutions to local problems. The Engineers Without Borders Humanitarian Design Summit has sent students to Nepal, Cambodia and Borneo, while the New Colombo Plan has sent students to Taiwan and Vietnam.

| Engineering is the knowledge required, and the processes applied, to conceive, design, make, build, operate, sustain, recycle or retire something of significant technical content for a specific purpose – National STEM Strategy 2019-2023, Engineers Australia.

World Engineers Convention 2019

Engineering a Sustainable World: The Next 100 Years

Australian engineering will be on the global stage on 20-22 November 2019, when the World Engineers Convention (WEC) comes to Melbourne, and Australia, for the first time.

Held every four years, the 'Olympics of engineering' is a unique opportunity for engineers to advance their technical knowledge, broaden their network and tackle many of the big questions facing the world.

Engineering's peak body Engineers Australia – which has around 100,000 individual members – is proud to co-host WEC with the World Federation of Engineering Organisations under the theme Engineering a Sustainable World: The Next 100 Years.

Over three days in Melbourne, WEC will enable engineers from approximately 70 countries to learn about cutting-edge technologies and processes across a range of sectors from over 500 speakers, as well as to engage in bigger picture thinking.

WEC will also set the global engineering agenda with engineers to articulate priorities in what will be called the Melbourne Declaration.



| One of the finest examples of ancient aquaculture and hydraulic engineering is right in Australia's backyard. After a decades-long campaign by the Gunditjmara people, the Budj Bim eel traps have become the first Australian UNESCO World Heritage site to be listed exclusively for its Aboriginal cultural values.

The eel traps at Budj Bim comprise a vast network of weirs, dams and stone canals to manipulate water levels in various lake basins. Some of the channels are hundreds of metres long and were dug out of basalt lava flow. Located in southwest Victoria, Budj Bim has been carbon dated to 6600 years old, meaning it predates more internationally well-known examples of ancient engineering like the Egyptian pyramids or Stonehenge.

Engineers Australia celebrates 100 years

Driven by a sense that anything is possible, engineers have shaped our world. This year, Engineers Australia turns 100 and is celebrating across Australia by showcasing the critical role engineering plays in the lives of all Australians.

Brought together by a need to raise the standing of the profession nationally, 12 foundation societies came together in 1919 to form The Institution of Engineers, Australia.

Celebrating the centenary is a significant milestone for the organisation. Today, engineering is an internationally-respected profession, integrally involved in every field of human endeavour.

The centenary is a time to look forward and imagine the future of the organisation and the profession. It's a springboard for the next century, continuing the legacy of supporting human progress and continuing to expand the boundaries of what is possible.

Engineers Australia has encouraged its volunteers, members, engineers in every professional field, educators, students and all Australians to participate in centenary celebrations through events, participating in interactive experiences, sharing engineering stories, engaging through social media and conveying the incredible accomplishments of Australian engineers.

The expression 'anything is possible' captures the spirit of the World Engineers Convention – the world's pinnacle engineering summit – where the international engineering spotlight will this year shine on Australia.

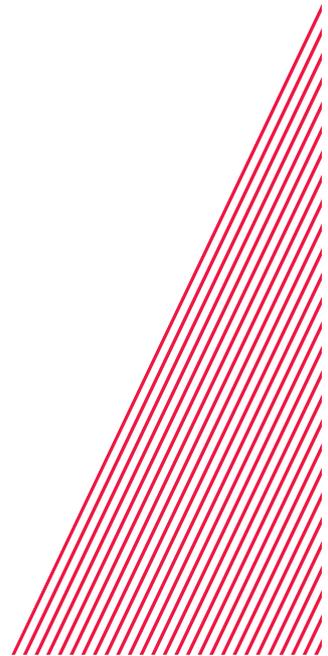
Opportunities

Our State is growing, our technology is advancing, and our economy is shifting. Victoria remains focused on turning cracks into breakthroughs.

The ageing population presents our State with significant opportunities. The skills gap illustrates how the ageing population affects our economy. Magnified through Industry 4.0, Victoria's economy is shifting from one based on low value added manufacturing to a services-oriented economy.

People from all corners of the world will call Victoria home as they migrate to showcase their talent. The significant impact on infrastructure means Victoria must have a plan in order to have a prosperous and sustainable future. People, processes and technology are the tools we must support.

This section will highlight some of the current opportunities engineering is presented with in Victoria, that will allow the profession to showcase talent and demonstrate success on a global level.



Population growth

Victoria has long been highly regarded for its liveability and Melbourne is consistently ranked as one of the world’s most liveable cities. Our success is no accident. It is the product of careful planning and investment over many years. As a result, Victoria has become an increasingly desirable place to live.

Population growth adds to the diversity of Victoria’s skill set and offers enormous economic opportunities. It also presents a range of complex challenges that must be planned for appropriately.

As our population increases so does the demand on our roads, airports, bridges, water supply and sewer system, public transportation as well as our social infrastructure such as schools, hospitals and parks.

Victorian engineers can meet these anticipated opportunities and challenges with ingenuity and innovation.



| The Just Be Nice Project is improving access to feedback for under-represented aging and growing populations, particularly in the low socio-economic, regional and city fringe regions delivering highest population growth. Ensuring that mobility, service allocation and infrastructure needs for the future are being met in planning and execution.

| La Trobe University engineers are developing new technology to give trams priority at traffic lights. Early switching of traffic lights from red to green will enable late-running trams to catch up to their schedule. This technology is being trialled in collaboration with VicRoads, Australian Road Research Board and Yarra Trams on the Tram Route 75.

Ageing population

Populations across the developed world are getting older, and Victoria is no different. The coming decades will see Victorians living longer, healthier lives as the baby boom generation ages.

Just 30 years ago women in Victoria had a life expectancy of 79 years, and men 73 years. Today, women can expect to live until almost 85 while for men it's 80.

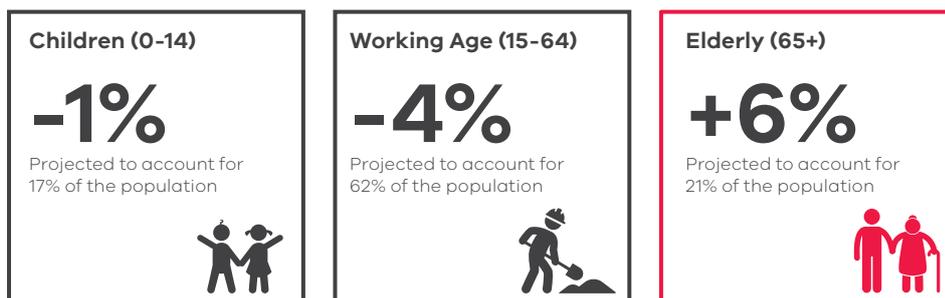
Population ageing will accelerate over the next few decades, with far-reaching effects for the engineering profession.

Designing for social inclusion is important for Australia's ageing population to be able to access goods and services. Engineers will be at the forefront of ensuring we accommodate for the elderly in terms of transport, healthcare and housing.

The ageing workforce creates a gap in skilled workers, which is currently being addressed through skilled migration and training skills through free TAFE and mentoring programs. As the baby boomers retire, they take this knowledge with them and often the technical skills and knowledge they hold can't be matched by education alone.

Younger workers have new multidisciplinary and technical skills, but they lack a comparable amount of industry experience. Despite this growing knowledge gap, there has been an 8 per cent reduction since 2014 in organisations using mentoring programs to facilitate knowledge transfer between older and younger workers.

2017-2066 Projected population age proportions



3 in 5 Victorians are within the working age population



Victoria's economy

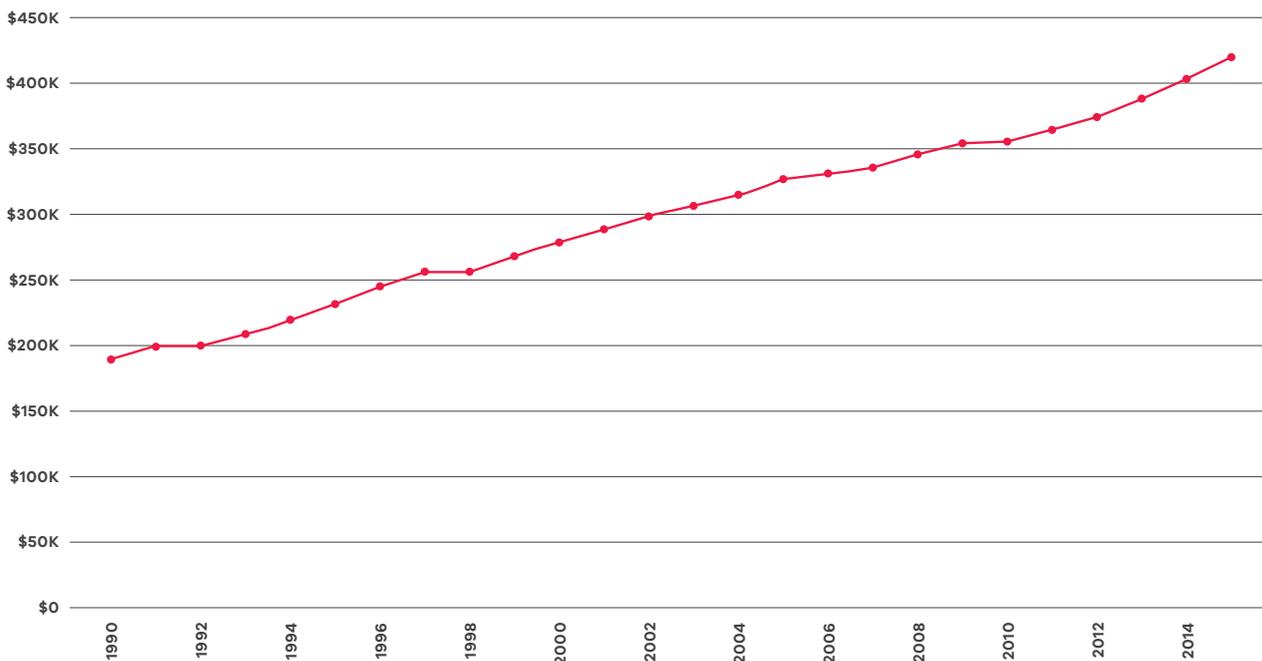
The economy of the State of Victoria has experienced strong growth over the past decade, increasing by an average of 2.6 per cent annually over the 10 years to June 2018. This is above the International Monetary Fund figure of 1.9 per cent for developed countries over the same period.

In total, Victoria's economy generated \$430 billion in gross state product (GSP) in 2017-18.

Similar to many developed countries, over the past 30 years Victoria's economy has shifted from one based on low value added manufacturing to a services-oriented economy. Professional services are the largest segment of the Victorian economy, accounting for \$65 billion of Victoria's total economic output (18 per cent of GSP) and employing over 380,000 people.

Professional services involve a range of activities not directly tied into the manufacture of goods, mining or agriculture. The sector includes occupations such as banking, insurance, transport, communication, engineering, defence, justice, medicine, education, hospitality, entertainment and many more. Services occupations range from relatively low-skilled workers to highly-skilled specialists.

Victoria Gross State Product (millions, AUD)



While predominantly focused on the domestic market, Victoria's services exports are growing rapidly. International education has been Victoria's largest services export industry for more than a decade, generating \$11.8 billion in export revenue in 2018.

Manufacturing remains a critical source of innovation and competitiveness in Victoria. The sector is entering a dynamic new phase dominated by a diverse mix of innovative advanced manufacturing companies that produce higher value goods and services, including those that address the growing opportunities in the biomedical sector. Manufacturing is becoming increasingly complex, relying heavily on interdependencies between services, design and digital technologies.

In recognition of our transition towards a knowledge-intensive economy, a range of sectors will increasingly rely more heavily on engineers' knowledge and skills.

| Monash University and the Indian Institute of Technology Bombay have established a global network of researchers from multiple disciplines, entrepreneurs from international social enterprises, philanthropists, and policymakers to address upcoming challenges and to accelerate the uptake of sustainable energy access through international partnerships.



Skills demand

Industry 4.0 is adding to the computers and automation adopted during the third revolution with new technologies like automation and robotics, artificial intelligence, machine learning, additive manufacturing, engineering simulation, Big Data and technology associated with the 'internet of things'. Behind every one of these innovations, you'll find an engineer.

Industry 4.0 represents one of the most exciting and challenging developments for engineers. Capturing its full potential will require engineers to have the ability to design, build, troubleshoot and maintain Industry 4.0 technologies.

Engineering organisations today are already struggling with recruiting and hiring new talent to fill critical roles.

Nearly two-thirds of firms surveyed by Consult Australia are experiencing a skills shortage. There has also been a significant movement in the percentage of survey respondents who are no longer 'very optimistic' that their firms will find the necessary skills to be competitive over the next three years.

Some fields are especially tight, with engineering managers, civil drafters, civil engineers, and structural engineers most affected by skill shortages.

At the same time, growth of the university engineering population has slowed, and the number of domestic students enrolling in and completing courses is declining.

Universities are relying more heavily on international students to make up the shortfall of domestic students. But many international graduates are not as well prepared for the labour market as domestic students. Employers nominate visa status, poor communication skills, inadequate soft skills, and lack of local work experience as some of the main barriers to employment for international graduates.

Consult Australia reports a decisive shift in the engineering industry's view on the job-readiness of graduates. Only 40 per cent of firms surveyed reported that they have no difficulties recruiting graduates, down almost 40 per cent over the past two years.

The role of the engineer will continue to expand and as Industry 4.0 continues to develop, engineers must adapt or organisations will find it even more difficult to fill the skills gap.



Automation & Robotics



Artificial Intelligence



Machine Learning



Additive Manufacturing



Engineering Simulation



Big Data



Internet of Things

Growing transport needs

By 2050, Melbourne's integrated transport network will have to accommodate 30 million trips per day. This represents an increase of more than 75 per cent on today's trips.

Transport congestion in Melbourne caused almost \$4.6 billion in delay costs per year, and with current population forecasts these costs are projected to increase to \$10 billion by 2030.

On 1 July 2019, VicRoads and Public Transport Victoria came together with the Department of Transport to create an integrated transport department.

This landmark shift aims to ensure the state is better equipped to respond to the changing demands on the transport network. It will lead to more integrated planning that focuses on taking a cohesive approach to planning, quicker responses to innovation and new transport technologies and stronger partnerships, which will address a range of issues, from safety to reducing environmental impacts.

Integrated transport planning is the backbone to Victorian industry. The freight and logistics sector contributes \$21 billion to the State's economy and employs around 260,000 Victorians.

The movement of goods from primary producers, manufacturers, wholesalers and importers enables Victoria to remain competitive and prosperous, while dairy, beef and grain farmers in regional Victoria rely on the export of goods to markets in China, the Middle East and elsewhere.

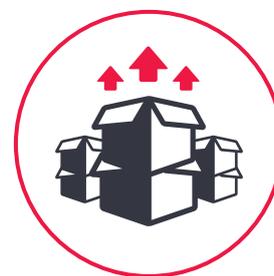
Population growth and globalisation suggest that Victoria's freight task will continue to increase for the foreseeable future. In 2014 freight volumes were recorded at 360 million tonnes a year, and by 2051 this is predicted to increase to nearly 900 million tonnes.

An integrated planning approach will mean Victoria will be well placed to ensure Victoria's continued competitiveness, through careful planning and collaboration.

Freight volume



360M
tonnes in 2014



900M
tonnes in 2051

Rapid technological transformation

New technologies, including artificial intelligence, 3D printing, satellite, renewable energy technologies, robotics, big data and the internet of things are transforming engineering processes.

| Digital technology could contribute between AU \$140 billion and AU \$250 billion to Australia's GDP by 2025, based on currently-available technology alone.

These advancements are timely, since projects are becoming increasingly complex and expensive.

Engineers across Victoria will need to implement strategies like real-world simulation to better improve the way student engineers learn with exposure to the changing technologies.

It is vital that the umbrella of professions within the engineering industry are leading the innovations. As the production and distribution of goods and services is transforming, the infrastructure of the city will need to adapt.

The challenge across the industry will be to integrate professions, eliminating any segmentation to continue to create innovative solutions for a world in rapid transformation.

| The impact of this rapid technological transformation on Victorians is substantial, from continuous glucose monitoring for patients with diabetes to facial recognition at international airport smart gates.

Products such as electric vehicles with autonomous driving capabilities will influence the design of not only car parking but the way in which road networks and signs are developed.

| Led by AiGroup, with Swinburne as the education provider and Siemens as the industry partner, the Industry 4.0 Higher Apprentice Program prepares students for jobs that are emerging in the digital economy.

It combines elements of an apprenticeship and a higher education degree. The apprenticeship-style program involves training students in cutting-edge manufacturing technologies including 3D metal printing, automation, machine vision and virtual reality.

Waste management

The production, consumption and disposal of products and infrastructure often have negative environmental and social impacts.

Various types of pollution to soil, water and air (including greenhouse gas emissions), and amenity impacts like litter, noise and odour are examples of some adverse effects of the often unconscious consumption of material. Finding ways to design products differently, use materials more efficiently, reduce waste and recover resources can minimise environmental and social impacts.

Governments around the world are making the shift to a more circular global economy, and many businesses are employing circular economy principles. Responding to this is important for Victoria's international competitiveness.

Global recycling markets have long played a significant role in Australia's waste management. In recent times, disruptions to these markets have negatively impacted Victoria's waste and resource recovery system.

Plummeting commodity prices for plastic and cardboard are putting additional pressure on Victoria's recycling system.

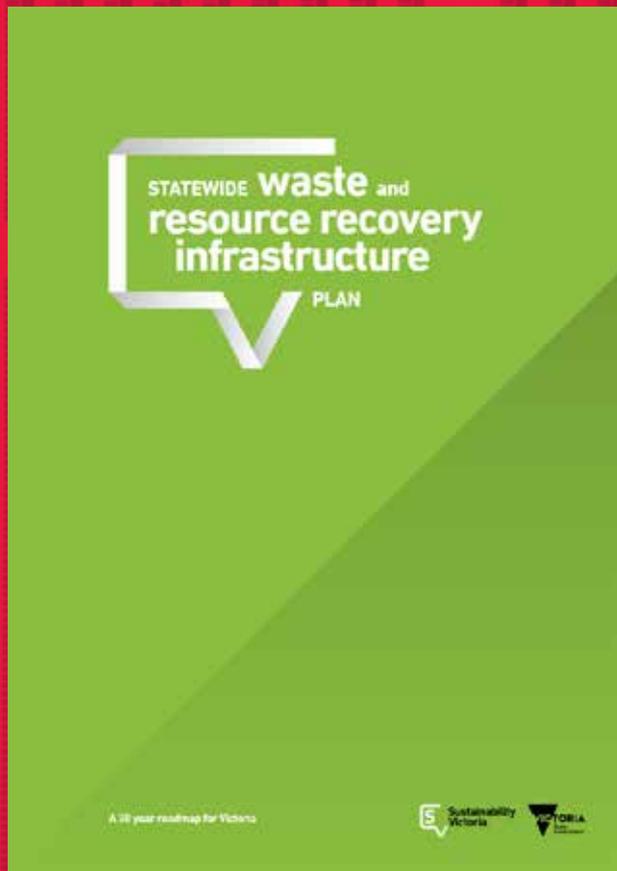
| Victoria's waste and recovery sector manages a variety of waste streams, including construction and demolition, commercial and industrial and household municipal collection. In 2017–18 the data from these collections showed that in Victoria:

- 14.43 million tonnes of waste generated
- 4.44 million tonnes of waste sent to landfill
- 9.99 million tonnes of waste diverted from landfill at a diversion rate of 69 per cent
- 88 per cent of recovered material remained in Victoria for reprocessing
- 12 per cent of recovered material was exported overseas

The heightened concerns for waste management leaves Victoria with a significant opportunity to showcase our engineering talent. The construction and demolition industry has a 33 per cent contribution to landfill, so it is important to tackle waste management as the State's record breaking infrastructure spend is underway.

Our State has begun responding, the resource recovery sector is growing, and greater recovery of valuable resources is increasing. Engineers are finding solutions to manage waste materials, mitigate our impact on the world's natural resources, and support positive action on climate change.

Opportunities



| Prepared by Sustainability Victoria on behalf of the Victorian Government the Statewide Waste and Resource Recovery Infrastructure Plan is an Australian first. The 30-year plan provides Victoria with a sustainable roadmap for waste and resource recovery.

Influencing local government and reprocessors in their infrastructure planning, Sustainability Victoria expects to see a continued positive change in waste management right from the planning, development and management of waste.

Set up with four goals, the plan addresses extraction of materials fit for recovery to reduce the demand imposed on landfill expecting to see up to 72 per cent of materials recovered for recycling or energy in the near future.

Engineering Victoria's economy

Victoria's transport infrastructure pipeline is powering our economy, with almost \$70 billion committed in projects.

Our future infrastructure will embrace technology, utilising digital engineering as a gateway to better infrastructure development, management and sustainable outcomes.

An integral part of its development will be workplaces that implement cultures that facilitate productivity and belonging.

This section outlines transport infrastructure projects, technology utilisation within advanced manufacturing and how to foster diverse cultures.

Victoria's infrastructure investment pipeline

The Victorian Government has significantly increased investment in transport infrastructure assets, supporting continued growth and ensuring benefits are more widely distributed.

Victoria's major project pipeline exceeds \$100 billion with \$70 billion committed to the transport sector, with the construction of 100 major road and rail projects to be delivered and planning underway for several future projects that are set to transform the way Victorians travel.

Metro Tunnel

The \$11 billion Metro Tunnel project will free up space in the City Loop to run more trains, more often right across the city – creating capacity for more than half a million extra passengers a week in the peak periods, post expected completion in 2025.

Four tunnel boring machines will dig the twin 9km tunnels. The first two tunnel boring machines have now started to dig and will run 24 hours a day for around the next three years. Each tunnel boring machine is 7.28 metres wide, 120 metres long and weighs more than 1 100 tonnes. Major works have also commenced at all five station precincts and the two tunnel entrance portals.

Level crossing removals

In the plan to remove some of Victoria's most dangerous and congested level crossings, the Victorian Government has committed to the removal of 75 level crossings by 2025, as well as upgrading or constructing more than 33 train stations. So far 30 level crossings have been removed, 15 train stations rebuilt, and 4 500 jobs created.

The Level Crossing Removal Project has been a leading example of social procurement, value capture and creation, and sustainable practice.

The completion of the Caulfield to Dandenong Level Crossing Removal achieved a 'Leading' Design ISCA sustainability rating and created 11 Melbourne Cricket Grounds' worth of newly converted urban space by removing nine level crossings. The project was also certified four-star in the Green Star rating system by the Green Building Council of Australia.

Regional Rail Revival

The Regional Rail Revival program is a \$1.75 billion joint initiative between the Australian and Victorian governments to upgrade stations, signalling and rail tracks across Victoria. The collection of works will create more than 1 000 jobs and will upgrade every regional passenger line in the State, increasing the reliability of regional rail, improving passenger experience, and supporting local economies.

Suburban Roads Upgrade

To accommodate for the increasing population in Melbourne's outer suburbs, a \$4 billion investment into 22 road upgrades is currently underway. The Suburban Roads Upgrade will widen and improve priority roads across Melbourne's north, west, and south eastern suburbs. Construction is well underway on the Western Roads Upgrade, with the Northern and South Eastern Roads Upgrades subject to Government tender. Following completion of construction, the projects include road rehabilitation and maintenance programs that will continue for 20 years.

West Gate Tunnel Project

The West Gate Tunnel Project is a \$6.7 billion city-changing project that will deliver a vital alternative to the West Gate Bridge, providing a much needed second river crossing, quicker and safer journeys, and remove thousands of trucks from residential streets.

The project involves building four more lanes on the West Gate Freeway, twin tunnels under Yarraville and a new bridge over the Maribyrnong River that links to an elevated road above Footscray Road, taking people where they need to go in the city's north. When the West Gate Tunnel opens there will be 24/7 truck bans on local streets in the inner west, helping to improve road safety, local air quality and noise.

The project also includes 14km of new and upgraded walking and cycling paths for a continuous journey from Werribee to the city. It will cut travel times by up to 20 minutes, make travel more reliable, and create a more efficient route for freight to the Port of Melbourne. Due for completion in 2022 the project will create 6000 new jobs.

Completion of the West Gate Tunnel Project will also deliver more than 14km of new and upgraded walking and cycling paths, including a 2.5km elevated veloway.

Melbourne Airport Rail

Melbourne Airport Rail is targeted to commence construction in 2022. With passenger numbers expected to almost double by 2038 to more than 67 million people, the Victorian and Commonwealth governments have committed up to \$10 billion to this project to ensure Melbourne's public transport infrastructure is ready to connect tourists and business people to where they need to go.

Suburban Rail Loop

The Suburban Rail Loop is the proposed 90-kilometre underground circle line connecting Melbourne's outer suburbs. The Rail Loop will connect into every major passenger railway line in Melbourne and will be completed in multiple stages, representing the biggest public transport transformation in Victoria's history. More than 20 000 jobs will be created as a result of the project during construction.

North East Link

The \$15.8 billion investment in North East Link will finally complete the missing link between the Eastern Freeway and the M80 Ring Road. The project will enable travel time savings of up to 35 minutes between the Eastern Freeway and the M80 Ring Road, increase the capacity of Melbourne's freight network and create more than 10 000 jobs.

North East Link will connect with Melbourne's existing freeways, providing continuous traffic flow conditions for long distance travel across and through Melbourne, with links to key parts of the arterial road network. In addition to providing a safe and efficient freeway connection that removes significant volumes of trucks and other vehicles per day from local and arterial roads, North East Link will:

- » avoid environmentally and culturally sensitive areas by including a 6km twin three-lane tunnel;
- » upgrade the Eastern Freeway with additional lanes and new technology, resulting in considerably faster trips;

- » deliver a new busway with dedicated express bus lanes along the Eastern Freeway, resulting in 30 per cent faster trips from Doncaster towards the city; and
- » deliver around 25km of new and upgraded walking and cycling paths.

| The idea for North East Link was first considered in 1929. It is now identified as Victoria's priority road project by Infrastructure Victoria and will be the single biggest investment in road transport infrastructure in Victorian history.



Utilising technology

Digital technology has become a revolution that has allowed mankind to design and build things that may have been thought impossibly complex only 50 years ago.

The rapid technological transformation experienced all over the world is dominating the state of our present and future industries. Within Industry 4.0, technology has become one of the most valuable assets to enable organisations to remain competitive and sustainable.

Digital technology will be critical to address the opportunities available to our great State and ensure its ongoing prosperity.

Digital engineering

Digital engineering creates and connects emerging technologies with structured data. Without digital engineering, the information processes in the architectural, engineering, construction and operations industry would still be siloed, paper-based, non-repeatable and rarely integrated throughout the asset lifecycle.

Digital engineering delivers an integrated set of data, information and decisions that builds and expands across the physical asset's lifecycle. It builds greater confidence that we can make and manage projects more effectively through enabling project teams to compare different scenarios in a virtual environment and make effective decisions on the preferred design option.

Governments from the United Kingdom, Finland, Norway, Scotland, Singapore, Denmark, New Zealand, United States and the Netherlands have already adopted methods to create and capture value from digital engineering. A multitude of strategies and standards are being created, developed and adopted.

Within Victoria, the Victorian Digital Asset Strategy, a whole of Victorian Government approach to digital engineering and building information modelling, has been developed to ensure cost-effective, innovative, and value added digital assets for all Victorians for decades to come.

A critical benefit of digital engineering is design reuse. It is a design concept that finds an already complete design and reuses it as is or uses it as a starting point for a new asset design. Through utilising previous designs that the market has proven, design reuse makes engineering more productive and guarantees quality.

Digital engineering is rapidly being adopted as business as usual by departments and agencies delivering Victorian projects.

I The Centre for Spatial Data Infrastructures and Land Administration at The University of Melbourne designed and developed a digital twin platform in achieving the virtual Fishermans Bend pilot project. The project addresses a range of unresolved challenges confronting urban renewal, city planning and digital cadastre modernisation. Through strong partnerships, the project testbed for addressing the challenges involved in aggregating, managing and visualising complex and multi faceted (4D) digital information about cities in an interoperable way.

The intended purpose of the testbed is to provide a foundation where various government stakeholders can build intelligent, innovative digital information systems that will satisfy future initiatives for the coordinated management of smart, sustainable and liveable cities, suburbs and regional centres.

Internet of things

Smart phones, smart homes and smart cities – the world is adopting the revolutionary concept that all things should be smart. The internet of things (IoT) is changing the way our State is connected.

Demonstrating how the internet is powering more than just our computer and smart phones, IoT encompasses the collection and distribution of data. It enables us to respond in real time to data, whether by human or machine.

Industries are beginning to utilise real time sensors to collect data from sectors including agriculture, health and infrastructure. Detecting motion, temperature, moisture, air quality and blood sugars are just a few examples of how real time sensors can improve asset management and increase productivity and safety.

- | Through implementing Wyndham City's Council's Smart City strategy, the council is in the planning phase of implementing low-power wide-area antennas on council structures across the city, which will enable them to roll out a range of IoT devices such as air quality sensors, water pressure monitoring, temperature monitoring and asset tracking.
- | The University of Melbourne digital twin project aims to bring multiple datasets from across the university into a uniformed 3D online platform for campus space utilisation monitoring, planning, analysis and visualisation. The data sources include real-time IoT data streams, hierarchical 3D space information, space usage transaction logs and timetables, live energy consumption data (smart meter readings) and historical (computed from Wi-Fi data) as well as live (IoT sensors) occupancy data.



Big data

Victoria is experiencing the effects of big data and machine learning at individual, industry and government levels.

The big data revolution is changing the day-to-day lives of Victorians. As we utilise technology, we are constantly producing data that is stored, monitored and interpreted to improve processes and decision making.

Big data plays an important role in machine learning, where algorithms build analytical models based on data which influence up-and-coming technologies such as autonomous vehicles.

The future prosperity of our State relies on the capabilities of data engineers. Data engineering impacts the future of every industry as it builds the pipeline that transforms data into a format that can be utilised and managed by the end user.

| The Office of Planetary Observations draws on big data to frequently map environmental variables using state-of-the-science satellite observations. They supply satellite time series analysis products of environmental variables to determined boundaries and time periods. That is, every five days at 10m resolution, providing quantitative data sets.

| La Trobe University engineers are developing new technology to gain a nuanced understanding of local weather variations in Bendigo. The Clever Weather Project rolled out 100 3D-printed weather stations onto Bendigo's IoT network to potentially inform Council planning around temperature extremes. This technology is being trialled throughout the CBD, at local landmarks, as well as in the yards of interested residents and business owners within the City of Greater Bendigo.

| Social networking sites, such as Twitter, have become prevalent communication platforms in our daily life, with posts ranging from mainstream topics like TV and music to specialised topics like politics and climate change.

Tracking and understanding these posts provides valuable insights into the general opinions and sentiments towards specific topics and how they change over time. These insights are useful to researchers, companies and government organizations for a variety of purposes, such as advertising, marketing, crisis detection and disaster management.

Despite its usefulness, the large volume and wide variety of tweets makes it challenging to track and understand the numerous discussions. To address these challenges, a collaboration between University of Melbourne and Australia's Defence and Science and Technology Group has developed the Real-time Analytics Platform for Interactive Data mining (RAPID) for topic tracking and analysis on social media.

RAPID is a big data analytics platform that tracks social media data 24/7 and offers a unique topic tracking capability using query keyword and user expansion to track topics and related discussions, as well as various analytics capabilities to visualise the collected tweets, users and topics, and understand tweeting and interaction behaviours.

Future industries enabled by advanced manufacturing

Victoria is the powerhouse of manufacturing in Australia. Manufacturing in Victoria is a \$26 billion industry and leads the nation in research and development.

In a global environment of change, forward-thinking initiatives are a cornerstone for Victoria's continued economic growth.

Advanced manufacturing employs more than 283 000 people, embracing diversity by employing people from a range of backgrounds and industries.

Advanced manufacturing describes businesses and supply chains that have established sustainable global competitiveness through advanced capabilities and characteristics.

Through Industry 4.0, advanced manufacturing is at the forefront of the Victorian economy and spearheading the development of future industries.

| For the transition from automotive manufacturing, the Victorian Government's Future Industries initiative is supporting our economy through expanding the space, defence, food, construction, transport, biotech and energy sectors.

It is imperative Victoria remain internationally competitive to ensure a prosperous future. Through boosting manufacturing leadership, our State will become more internationally competitive by ensuring industry has the strategic planning in place to build our advanced manufacturing capabilities.

| The demand for STEM capabilities to support advanced manufacturing will be critical for a sustainable workforce. Initiatives being implemented to create the foundation for the leaders of the future include the Education State agenda and the Primary Mathematics and Science Specialists initiative.

| With the support of Sustainability Victoria, developed and tested by the Monash Institute of Railway Technology, sleepers made from recycled composite plastic have been installed on Victoria's Metro Trains Melbourne and regional V/Line tracks. They are an alternate for the current timber and low-profile concrete sleepers and are more sustainable and less carbon intensive to make. For every kilometre installed, the sleepers use 64 tonnes of plastic waste that would otherwise have gone to landfill.



\$26B
Industry



283K
people employed

Future mobility

While developing and upgrading the road and rail infrastructure, Victoria is reshaping the future of mobility through utilising evolving technologies.

Victoria is planning for greater frequency and reach of mass transit options and an increase in our freight capacity. With attention to safety and efficiency, transport infrastructure is being prioritised.

Rapid technological transformation is seeing smarter transport solutions being developed and adopted. These technologies include: automated connectivity; autonomous driving; electric and hybrid vehicles; zero emission alternative energies and energy storage (e.g solar or hydrogen fuel cells); functional materials; and advanced light-weight structures.

All these technologies contribute to the realisation of user-centric, safe, sustainable and connected transportation of people and goods. These technologies, which depend on knowhow and expertise across multiple engineering disciplines, are developed and taught in Victoria.

| Autonomous driving technology is becoming more and more mature. Driver assist functions, such as self-parking and advanced cruise control are already being implemented. This technology has the potential to help vehicles achieve full self-driving at any time, in any place and in any weather conditions.

Victoria is already seeing autonomous vehicles hitting its roads. Following the introduction of an Australian-first automated driving system permit scheme, this year Bosch was awarded with a \$2.3 million grant for on-road testing of highly automated driving systems.

| Swinburne's Future Urban Mobility program is guided by an overarching vision for making cities accessible to their populations through connecting the social, physical, economic and information infrastructure. This program finds ways to create safe and resilient urban transport and mobility solutions that enhance access to services, places and economic opportunities, and improve the quality of life for citizens.

Together with industrial partner Tradiebot Industries and supported by the Innovative Manufacturing Cooperative Research Centre, Swinburne is developing a revolutionary solution for the automatic repair of headlight housings. It's an excellent example of an Industry 4.0 solution, integrating 3D scanning, 3D printing and advanced robotics.

Defence

Victoria's defence, aerospace and security sector contributes around \$8 billion to the Victorian economy. With the Commonwealth Government injecting \$200 billion into defence capabilities, this sector is primed for growth.

Victoria can lead the way through diversifying capabilities vertically in global supply chains and growing our defence, aerospace and security research, development and education capabilities.

This can only be achieved by showcasing and utilising our engineering expertise. Growing Victoria's technical capability in this sector will require further development of domestic talent in all areas of engineering.

| Thales' plant in Bendigo manufactured the Bushmaster Protected Mobility Vehicle and will now manufacture the Hawkei vehicles.

Victoria is home to:

- » Australia's largest concentration of military vehicle engineers;
- » significant maritime engineering design and development capabilities;
- » leading aerostructures designers and manufacturers;
- » the Defence Materials Technology Centre; and
- » elements of the Defence Science and Technology Group.

Victoria is also the home of many research and development facilities, advanced manufacturing and education precincts that focus on defence and aerospace, such as those located at Fisherman's Bend. As we continue to grow our skills in all engineering disciplines, Victoria is in a prime position to lead many future defence and aerospace projects that underpin Australia's security.

| Melbourne-based Marand will supply 700 vertical tail fins to the F-35 Joint Strike Fighter project over the next 20 years.

| For the past three years, the US Office of Naval Research has funded research at the University of Melbourne to better understand the way submarine wakes are formed and to improve the ability of a submarine to remain undetected from surveillance systems.



Biomedical technology

Victoria's medical technology and pharmaceutical industry is the largest in the nation and one of the world's largest biotechnology clusters.

Home to two universities in the global top 20 biomedical rankings, the skilled and innovative workforce has around 20 000 researchers working across universities, hospitals and research organisations and 23 000 in the commercial sector.

Engineers are the cornerstone of biotechnology innovation. Their role in taking conceptual ideas and producing cutting edge solutions is key to the design and development of the life-changing technologies rapidly hitting the homes of Victorians.

Victoria's manufacturing sector is the enabler that will link innovative design with manufacturing technologies and techniques. Encompassing leading multinational pharmaceutical manufacturers, MedTech manufacturing capabilities are a Victorian strength and include biomedical engineering, bionics, and advanced and additive manufacturing.

New technologies are successfully manufacturing products locally and selling on the global market. The demand for pharmaceutical products coming from Australia stems from our reputation for providing clean, safe, and high-quality products.

I Additive manufacturing is changing the practice of medicine as global demand for personalised 3D printed medical implants grows. Biomedical engineering, with its emphasis on interdisciplinary approaches, is instrumental in delivering innovative 3D printed medical solutions that improve the health outcomes of patients. A new Australian Research Councils Training Centre for Medical Implant Technologies at The University of Melbourne will equip a new generation of industry-ready interdisciplinary engineers with knowledge and expertise on:

- 3D design and modelling using a patient's computed tomography (CT) imaging data;
- biomechanical functional analysis of implants;
- development of new biocompatible material for next generation implants;
- lean manufacturing process design and production; and
- industry and clinical best practice in personalised implant manufacturing and implantation.

Energy

Victoria has committed to legislating a long-term target of net zero greenhouse gas emissions by 2050.

The challenges associated with transitioning to net zero emissions require coordinated action across the whole Victorian economy, including the energy industry, with engineers integral to the process.

The Victorian Government has committed to generating half of Victoria's energy from renewable sources by 2030. Victoria's electricity supply is currently primarily sourced from lignite (brown) coal. Brown coal's share of electricity generation was 76 per cent in 2018, down from 85 per cent in 2016.

Victoria currently has 14 large-scale renewable energy projects under construction, with a further 46 large-scale wind and solar projects in the planning stages. The integration of renewables generation resources, like wind and solar, into the traditional power grid, along with the looming exit of brown-coal generators, brings several technical challenges that affect the quality and reliability of our power supply.

Those challenges, along with their solutions, require collaboration between different engineering disciplines – civil, mechanical, industrial, electrical, software and more.

Victorian engineers are working on innovative energy projects, including next-generation battery prototyping, next generation solar-cell fabrication and carbon capture and storage. They are also integrating carbon reduction technology in large-scale infrastructure projects.

Transitioning to a carbon-constrained future also means supporting new ideas such as deep learning, a subfield of machine learning inspired by the structure and function of the human brain.

The recent establishment of mini-grids in small Victorian communities like that of Yackandandah (Victoria) showcase the practicality of aiming for 100% renewable electricity generation, energy sovereignty and retention of main grid connectivity.



| The Hydrogen Energy Supply Chain (HESC) Project is trialling the feasibility of supplying clean hydrogen for export from Victoria's Latrobe Valley's brown coal, while CarbonNet will provide the CCS network and storage solution for CO₂ produced in this hydrogen generation. HESC and CarbonNet may be the starting point to enable commercial-scale production of clean hydrogen and the development of a CO₂ storage industry in Victoria. The magnitude of these two projects position Australia as a global leader in the clean hydrogen energy supply story.

| RMIT are undertaking a linkage project in partnership with CitiPower and Powercor, Victoria's energy distributor. The project aims at developing a deep learning technology for high resolution electricity demand forecasting and residential demand response modelling.

Electricity consumption data is dynamic and highly uncertain. The deep learning technology expects to provide accurate demand forecasting, and thus enabling optimal use of existing grid assets and guiding future investments. The expected outcome can support data-driven decision-making in Australia's electricity distribution network planning and operation by considering future challenges such as integrating battery storage and electric vehicles into the grid, and thus providing reliable energy. The project expects to train the next generation expert workforce for Australia's future power grid.

In 2019, Australia's leading carbon capture and storage (CCS) research organisation, CO₂CRC, announced a \$45m final investment decision for the third phase of a CCS project in south-west Victoria. The \$100 million Otway National Research Facility is Australia's first demonstration of the deep geological storage of CO₂ and the world's largest carbon capture and storage research demonstration project, with more than 80,000 tonnes of CO₂ injected and stored in a variety of geological formations.

The project brings together Australian and international researchers, industry, government and regulators in a unique collaboration. It will provide regulators and communities with confidence that CO₂ injected deep underground is permanently contained within the bounds of the storage reservoir in large-scale carbon capture and storage operations. The project means Australia is well-placed to lead efforts to cut the cost of CCS and accelerate its global deployment. Technical and scientific work programmes are expected to be completed by June 2022.

Space

In July 2018, the Australian Space Agency was established, which brought together different agencies spread out across government departments. Victoria is home to 250 businesses and organisations in the space and space-enabled industry, employing around 2 300 workers and generating around \$400 million a year.

A strong space industry is backed by our expertise in science, engineering, manufacturing, communications and IT. Proudly home to five top 500 globally-ranked universities, including Australia's top engineering and technology universities, our State is at the forefront of addressing the pipeline of talent that is needed to produce the next wave of space engineers.

The global space economy is transforming, allowing companies of all sizes to make a significant contribution. Technological advancements are seeing the circle of innovation shortening and access to space becoming cheaper.

Space data and associated technologies play a significant role in the operation of many industries. Just as the everyday person uses their mobile phone to check the weather or locate a destination, mining and transportation industries also rely heavily on satellite communications to carry out their operations. This is all made possible by the space industry.

- | **RMIT is exploring ground-based Global Navigation Satellite System (GNSS) tropospheric products and their role in forecasting severe weather events and climate monitoring. The project is using three GNSS systems for the first time – the American GPS, Russian GLONASS and European Galileo – to improve capability on a wide range of areas, from real-time monitoring and forecasting of severe weather, to climate research.**
- | **Australia's national science agency, CSIRO, launched the Space Technology Future Science Platform in November 2018 with an initial \$16 million investment to build world-leading capability and drive cutting-edge research in support of growing Australia's space industry.**



Food and fibre

Victoria is Australia's largest supplier of premium food and fibre products, contributing over 27 per cent of Australia's food and fibre exports in 2017-18.

Engineers contribute to the competitiveness of the sector both on a domestic and international stage.

Technological advances are seeing robotics, new packaging materials, digital and wireless technologies, and biotechnology develop along the food and fibre value chain. The manufacture of new bio-products from plant and animal origins continues to progress.

The sector, like many others, is experiencing a shift in the skill demand. Traditional labour-intensive skills are being fanned out and replaced by demand in highly skilled technical capacity, data analysis and managerial capabilities.

As food manufacturing employs 66 000 Victorians, with exports valued at \$14 billion in 2018, it is imperative to realise our strengths for the sector.

Climate change continues to present challenges. Managing the risks associated with significant seasonal, cost and market volatility, natural disasters and the threat of biosecurity incursions is essential to safeguard the sector.

Continuous engineering talent is needed for this sector to remain strong and competitive nationally and globally.



\$14B

in exports



27%

of Australia's
total exports



80%

of Australia's
dairy exports



39%

of Australia's
prepared food
exports



48%

of Australia's
horticultural
exports

Sustainability

In 2015, the United Nations General Assembly set 17 global sustainability goals to be achieved by 2030. These goals provide a shared blueprint to achieving peace and prosperity for people and the planet.

Victoria's State of the Environment report demonstrates how the State is aligning with the Sustainability Development Goals environmental reporting framework to help drive ecologically sustainable development over the next decade.

Government organisations such as Sustainability Victoria and the Environmental Protection Authority are primarily focused with the facilitation and promotion of sustainable use of our resources, as well as keeping Victoria prosperous and liveable by preventing and reducing harm from pollution and waste.

Policies, frameworks and acts such as Victoria's Social Procurement Framework, *Climate Change Act 2017*, and Recycling Industry Strategic Plan lay the foundation for embedding sustainable practice within Victoria.

The Victorian Government is also developing a circular economy policy and action plan for Victoria. The policy will identify fundamental, longer term improvements to how we use resources and manage waste. It will identify new ways for Victorian businesses and communities to use materials more efficiently and avoid waste in all stages of making, using and disposing of the products and infrastructure we rely on every day.

A more circular economy will reduce waste generation and greenhouse gas emissions and ease pressures on the environment. It can also prompt new kinds of economic activity, generate savings for households and create new business opportunities and jobs for Victoria.

Shifting to a more circular economy will also drive improvements in the quality of recyclable material collected, increase demand for recovered materials and ultimately improve the performance and resilience of the recycling system.

- | **Effective from 1 July 2019, the Victorian Government banned all e-waste from going to landfill.**
- | **As part of the commitment to embed sustainable practice in Victoria's major projects, the Office of Projects Victoria (OPV) is currently updating the Sustainability Investment Guidelines. These guidelines have been developed to assist in implementing sustainability into government infrastructure investments throughout the investment lifecycle.**
- | **The Yarra City Council is trialling a new initiative, the *Yarra Waste Revolution*, in Abbotsford. Through collecting specific items valuable to the Australian recycling industry, it will ensure them a new life as a new product, and not end up in landfill or overseas. This is occurring through collecting glass separately, so that it doesn't break and contaminate general recycling, and turning it into new glass products. Any glass which can't be recycled back into bottles will be used in road resurfacing works here in the Yarra Council area. The Council is also collecting food waste, processing it to reduce emissions, and turning it into nutritious compost that will be used on Victorian farms and council gardens. This will facilitate a clearer, greener and more circular economy.**
- | **51 million used tyres are discarded annually in Australia, causing environmental and health problems. Only five per cent of used tyres are recycled locally in Australia, so researchers from the University of Melbourne have teamed up with Tyre Stewardship Australia and Merlin Site Services to come up with an innovative way to reuse the rubber in pavements.**

Extractive resources

Victoria's unprecedented pipeline of infrastructure works is placing a significant strain on the finite supply of natural resources needed to construct projects such as the North East Link Project and West Gate Tunnel Project.

Historically civil construction materials have been sourced from virgin sources, such as quarries, mines, and river beds, however with current demand for quarriable material tracking above previous worst-case forecasts, this reliance on virgin material is not sustainable.

The unsustainable demand for virgin material, particularly in road construction, presents an opportunity to leverage the current oversupply of recyclables to mitigate both problems through increasing the use of recycled alternatives in lieu of virgin material.

The 2018 Australian National Waste Report found:

- » 1.1 Mt (44 kg per capita) was glass waste, with 57 per cent being recycled;
- » 2.5 Mt (103 kg per capita) of the total waste was plastic waste, with 12 per cent recycled, 87 per cent sent to landfill and 1 per cent sent to an energy waste facility

Problem materials such as aggregates, masonry and soils, glass, and rubber can be reused as a replacement for virgin materials in Victoria's roads as wearing course, base and subbase applications, as well as in low-risk applications such as carparks, bike lanes, and footpaths. There is significant work, both in research and through standards reform, being undertaken to utilise a range of waste materials appropriately in new construction materials.

| OPV and Sustainability Victoria have partnered to form the 'Sustainable Asset Futures' Committee. Consisting of both government and industry stakeholders, the committee focuses on reviewing existing standards across state and local government and consider options to increase the amount of recycled content in our roads.



| Deakin University is developing non-corrosive concrete with recycled plastic. The project began when two kidney specialists from Barwon Health and Melbourne Health approached Deakin University to find a practical solution for their waste issue. In 2017 Deakin carried out a primary investigation on both raw and shredded dialysis plastic waste.

The major finding from this project is a 30 per cent reduction in water absorption rate in concrete with plastic waste, a significant change. This means that using the plastic waste could be a very effective way to reduce the penetration of harmful chemicals and chloride from seawater into concrete, avoiding damage to the concrete and subsequent steel rebar corrosion. Normally, concrete elements in coastal areas are exposed to harsh environmental conditions and are at risk of early damage and durability deficiency.

At this stage, research shows that around 20 kg of recycled plastic could be used in one cubic meter of concrete to obtain a new product with improved properties. This is equivalent to 0.5-1.0 per cent by weight of cement in the concrete mix. For example, when using the new product in housing construction, a 1000 kg of plastic waste could be reused in a typical two-storey house, knowing that around 50 cubic meters of concrete will be required for casting the footings and floor slabs in a single house. This is a huge intake, which will improve the recovery rate significantly.



Fostering a safe, diverse and inclusive culture

Diversity is critical for the innovation of ideas, capabilities and cultural intelligence that will enable future cities with technological, social and economic changes. As the demand for engineers across Victoria exceeds supply, industry is under pressure. Focusing on gender, ethnicity and disciplinary diversity will help to solve this talent shortage.

Research has found companies that build gender diverse and culturally diverse teams are 15 per cent and 35 per cent respectively more likely to incur higher financial returns than their national industry medians.

Women in engineering

To ensure engineering is an attractive career path for young women, it is fundamental that women in engineering are visible and accessible.

However, women remain a minority workforce, making up only 12 per cent of the engineering labour force.

If organisations can articulate their approach to gender equality, including a commitment to reducing the gender pay gap, setting targets for female representation and building a pipeline of senior female talent they are more likely to be appealing to female candidates.

Career breaks and part-time work have contributed to negative impacts on the progression of women. Organisations need to do more to disrupt the caring/working divide between female and male employees and they need to support women to bridge the gaps that currently emerge due to caring responsibilities.

If flexible work and parental leave is actively promoted and utilised by people of all genders then engineering as a career will attract more talent overall and reduce stigma and discrimination.

Only 17 per cent of university engineering places are taken by women, a record high in 2017, but the calibre of those female students is significant. Nearly 60 per cent of female engineering students score above 90 in their ATAR compared to just 40 per cent for male students, making them highly capable.

It is imperative employers start with a diverse hiring team and are deliberate in the way they advertise a position to ensure it reaches, and is appealing to, a wide variety of candidates. Suggested approaches include:

- use language and content that appeals to women (appeal to growth mindset, promote flexible working);
- challenge the ideal of the perfect candidate;
- recognise potential as well as past performance;
- place the advertisement where candidates are likely to look for job vacancies; and
- once there is a diverse candidate pool, ensure that the recruitment process is structured to minimise bias.

Aurecon's new Managing Director for Australia and New Zealand, Louise Adams, has appointed a leadership team with equal representation of men and women. This team is driving cultural transformation through its leadership – in words and actions – and policies that disrupt the status quo, including challenging historical definitions of talent. Aurecon's flexible working policy and parental leave policy create a mandate for change. The parental leave policy provides 14 weeks of leave for all parents that can be taken interspersed with days of work, plus the offer to pay an employee 150 per cent of their salary for up to 14 weeks if their non-Aurecon partner takes unpaid leave to care for their child (within the first 12 months).

Aboriginal and Torres Strait Islander engineers

Underrepresented across the engineering sector, Aboriginal people make up 0.28 per cent of all qualified Victorian engineers.

In 2017, only 17 Aboriginal students commenced an engineering program in Victoria compared to 14,984 non-Aboriginal students. In the same year less than five Aboriginal students completed an engineering and related technologies program.

Aboriginal and Torres Strait Islanders provide a unique cultural offering in engineering. Strengthening sustainable engineering, Aboriginal and Torres Strait Islander engineers offer not just a skill set, but a connectedness to country, and this has been observed in dealings with Australia's natural ecosystem.

| The Residential Indigenous Science Experience (RISE) is a week-long camp held at the University of Melbourne each year to engage Year 9 and 10 Indigenous students with science, technology, engineering, and maths (STEM) and inspire them to consider a career in STEM as an option for the future.

| *Before I came to RISE my expectation was that I wasn't very good at science and thought I was not going to have a good time, but now at the end of it I had so much fun and learnt so many new things and realised that there are so many different elements to science than I thought.*
– RISE participant

Victorian Government policies and programs being put in place are working to incorporate Aboriginal employment targets. For example, all Major Transport Infrastructure Program contracts with the construction industry require a 2.5 per cent Aboriginal employment target.

These initiatives are beginning to address the issues that have been neglected for too long. Developing pathways for Aboriginals to pursue a career in the engineering sector requires comprehensive and collaborative work to reflect Australia's Indigenous peoples.

| The Level Crossing Removal Project, which will remove every level crossing between Dandenong and the city, is creating 2 000 jobs and providing skills, qualifications and opportunities for young Aboriginal Victorians.

| In 2017 and 2018, The RMIT School of Engineering held the David Unaipon celebration, where indigenous and non-indigenous staff, students and special guests celebrate the engineering achievements of Aboriginal and Torres Strait Islanders.



International engineers

The Australian Government has implemented migration policies to improve the capacity of the engineering profession. Data from Engineers Australia shows 57 per cent of engineers currently working in Australia were born overseas, compared with 40 per cent in other professions.

More than two thirds of the Migration Program allocated to the skilled stream. Currently there are about 290 listings for medium-long term skill shortages, 35 being within the engineering profession.

Consistency in professionalism

Educational qualifications are fundamental to the engineering industry, and several engineering areas now require registration. As such, Australian visa applications are monitored by the appointed authority, Engineers Australia.

Permanent Skilled Migrants undergo the same accreditation criteria that university engineering courses are assessed on. Recognition will occur when migrating engineers have undertaken accreditation in line with the Washington Accord, Sydney Accord or Dublin Accord.

Retention of international students

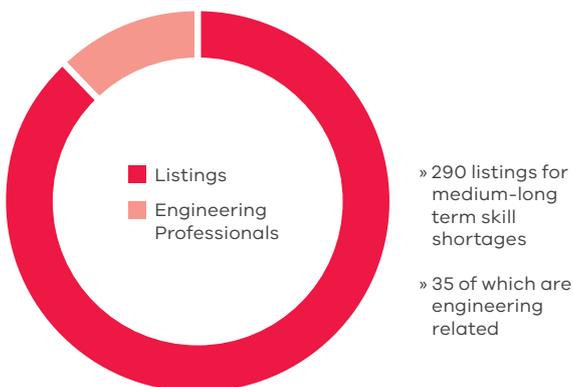
For over 10 years, international education has been Victoria's largest services export industry, generating more than \$70 billion for the economy in that time. In 2018, the sector generated \$11.8 billion in export revenue for the state and supported almost 79 000 Victorian jobs.

As domestic enrolments in engineering courses decline, universities are looking more towards international students. In 2001, 19.5 per cent of engineering students were overseas students – this share grew to 42.3 per cent in 2017.

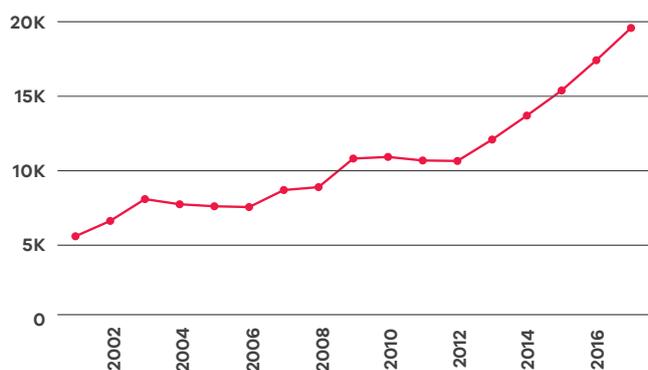
Opportunities to acquire work experience in the host country labour market are now a key driver of student choice. Understanding the issues surrounding international students and employment will be closely linked to Victoria's continued success in the international education sector.

I Australian migration sees approximately 80 per cent of migrants call one of our major cities home. There has been a renewed focus on providing incentives for migrants to live in regional Australia

Medium to long term skill shortages



Overseas students commencing engineering & related technologies courses



Interns

Across all industries, career ready graduates are in demand. Victorian universities offer a range of work integrated learning programs to provide students with opportunities to gain industry experience that will assist to land a graduate position.

As the State undertakes our historic infrastructure build, opportunities for businesses to take on students has never been so apparent.

Internships drive better outcomes for all stakeholders. They give students and recent graduates real-world experience and a chance to develop their skills. Employers find interns bring many significant benefits to their organisation, including new perspectives to the job. They may make new suggestions, drive motivation from other employees and act as the catalyst for enhanced workplace performance.

Good interns can also turn out to be some of the best full-time employees, with over 80 per cent of all hired interns going on to full-time employment.

The intern recruitment process also presents a good opportunity to build an organisation's relationships and brand identity with schools and reduce the cost of recruiting.

All Overseas Commencements

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	237	226	257	264	272	361	431	575	804	798	907	1028	1127	1161	1152	1132	1428
Research masters	121	140	158	203	177	178	198	180	208	218	232	225	199	211	163	161	204
Coursework master	1305	1745	2850	2787	2579	2295	2528	2552	3100	2770	2435	2758	3592	4517	5473	6764	8101
Other postgraduate	221	257	148	162	295	322	301	309	365	318	238	181	249	129	177	153	178
Bachelors	3374	3859	4280	3936	3778	3854	4289	4465	5311	5626	5589	5223	5417	5963	6510	7094	7482
Ass degrees & advanced diplomas	16	30	15	25	41	49	162	133	191	157	273	198	204	192	198	236	244
Diplomas	1	47	12	17	108	115	431	313	475	671	618	658	1005	1235	1401	1517	1594
Other undergraduate	5	10	63	42	51	73	53	63	60	65	92	81	0	0	23	77	79
Total	5280	6314	7783	7436	7301	7247	8393	8590	10514	10623	10384	10352	11793	13408	15097	17134	19310

» Source: Data provided by the DET

» From Engineers Australia - a statistical overview

Intern Programs

Office of Projects Victoria (OPV) is embracing future engineering talent through the Victorian Chief Engineer Intern Program which recruits an average of four interns in a 6-month period. Interning at OPV is a good way to understand the role of engineering within government. Our interns are at the forefront of developing policies and guidelines surrounding the evolving complexities in projects. Sustainability and digital assets are two examples of initiatives that interns are gaining experience in, whilst receiving mentoring from professionals with more than 20 years' industry experience.

Exposure to the industry brings interns at OPV opportunity to liaise with stakeholders, build valuable industry connections and meet with potential employers. Through multiple platforms our interns gain opportunities to take part in site tours and converse with public and private bodies, empowering them with knowledge and skills they can take with them into their future careers.

Lachlan: *As an engineering intern working at OPV, I have had the opportunity to not only take the next step in developing my career, but also to provide new perspectives and insights into the organisation. Being fresh out of uni, I have come into the workplace with the ability to identify gaps that more experienced engineers may overlook, and by supporting senior managers I tackle tasks that may seem tedious yet are new and exciting to an intern like myself.*

Apart from professional placements or internships, Swinburne University of Technology source and manage a wide range of industry-linked projects for undergraduate as well as postgraduate students. The new Master of Professional Engineering provides industry-engaged learning opportunities to local and international students, such as site visits and site-based projects with renowned organisations.



Mental health

Driven by a competitive market for contracts, engineering can be a very high-pressure industry. Projects can be very large, and engineers often work long hours due to pressures imposed by heavy workloads and deadline pressure.

Depending on the organisation and the role, engineers can often find themselves traveling or working fly-in fly-out (FIFO) rosters when working remotely. FIFO hours can be long and tiring.

There is a well-recognised, two-way relationship between fatigue and mental illness. A culture of working long hours is unsafe and damaging to individual engineers, organisations, the engineer's professional standing and the viability of the profession.

Industry-led research, conducted by Swinburne and Roads Australia, into mental health professionals working on Victoria's infrastructure construction industry show the severity of the mental health challenge we face. Average levels of depression, anxiety and stress exceed population norms by 40 per cent for depression, 38 per cent for anxiety, and 37 per cent for stress. The study also found between 29-38 per cent of respondents were suffering from psychological illness; compared with 18 per cent of the Australian population.

The engineering workforce is predominantly male, and despite some changes, the subject of mental health can be hard to bring up in conversation with colleagues and mates on site. Stigmas around mental health mean that many at-risk engineers suffer in silence.

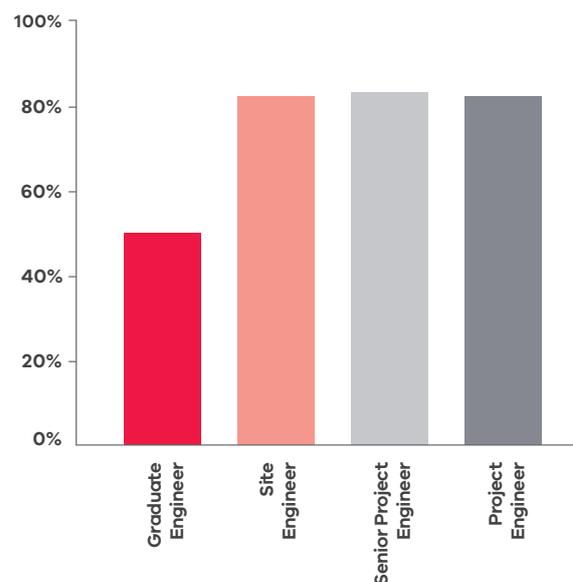
Engineering industries and organisations are stepping up to recognise and approach mental health risks in the same manner as physical risks. From programs that educate workers on mental health to sleep coaching, resilience training and subsidised fitness services, the industry has made progress towards promoting and protecting the mental health of its workers.

Over the years Jacobs has brought the discussion of mental health into new staff inductions so that on day one, new staff know that this is a key issue and that leadership is committed to helping staff. Training has matured to be more focused on effective management of mental health through a series of sessions including:

- building resilience for all employees;
- building resilience for managers; and
- critical mental incident for managers.

The focus is to create an environment where people can bring their whole self to work. In having mental health as an important component of one of their diversity and inclusion portfolios, the focus changes to developing mechanisms and initiatives that include people with mental illnesses in the process.

Percentage of engineers working over 50 hours a week



Professional Engineers Registration Bill

The Victorian Parliament passed the Professional Engineers Registration Bill in 2019. This legislation provides the necessary framework to regulate the profession in Victoria. It establishes a registration system that mandates the qualifications, competency and currency of practising engineers in Victoria.

Despite the fundamental role in the economy that engineers have, the complex and important work they perform and their pivotal role in ensuring public safety, most engineers are not required to hold any kind of formal registration or licence.

The Victorian Government therefore made a commitment to work with relevant stakeholders on the introduction of a mandatory, statutory registration scheme, and work with other jurisdictions to develop a nationally consistent registration scheme for engineers.

Engineers will now be alongside professions like teachers, doctors, lawyers and architects that require registration in Victoria to practice. The scheme reflects that the engineering profession is increasingly globalised and progressive. Some of Australia's trading partners such as Japan, all provinces in Canada, all states in the United States, Korea, Singapore, New Zealand and Malaysia have registration schemes for engineers.



A registration scheme will help Victorian engineers compete in this global marketplace by giving consumers of engineering services the assurance that the engineers they engage:

- » are suitably qualified and experienced; and
- » will comply with well-recognised and internationally understood professional benchmarks such as Washington Accord-level degrees.

There will be consultation on a number of important elements of the scheme, which will be subject to a regulatory impact statement. The Government will continue to engage with key stakeholders during the development of the regulations to support the legislation.

| Currently, consumers have no real way of knowing whether they are dealing with an engineer who is currently qualified and competent, or if they maintain standards through ongoing professional development and are bound by a code of conduct. The introduction of these new laws will allow faux engineers to be weeded out and prevented from calling themselves an engineer, and those who do not uphold the highest standards will be subject to greater accountability – Alesha Printz, Victoria Division, General Manager, Engineers Australia.



Enablers for prosperity

The Victorian Government is squarely focussed on successfully delivering the historic infrastructure pipeline safely.

From providing an integrated approach to digital engineering and building information modelling, better utilising and maintaining assets, how to best adopt modularisation and ensuring the front end engineering design is embedded in projects from day one, this section will explore some of the initiatives OPV is leading that will be important enablers for a prosperous future.

Victorian Digital Asset Strategy

OPV and the Victorian Chief Engineer are developing the Victorian Digital Asset Strategy (VDAS) – a holistic and integrated approach to digital engineering and building information modelling to Victorian Government physical assets.

The vision of the VDAS is to create, deliver and enhance digital assets that inform the delivery and whole-life management of world-class, effective and efficient physical assets across Victoria to the benefit of current and future Victorians.

The VDAS is being developed in collaboration with leading industry bodies, government entities, major designers and educators with expertise in digital engineering, major projects, Victorian Government policy, and best practice across the asset life cycle.

The VDAS includes a staged release of technical and non-technical guidance, procedures and templates for government and industry to apply digital engineering principles within a consistent VDAS approach.

To date, OPV has published the VDAS strategic framework for departments and agencies to apply on major infrastructure projects and both new and existing physical assets. The Strategic Framework is aligned with international approaches and is intended as a high-level framework for digital engineering when used on Victorian Government assets across their life cycle.

Based on the Strategic Framework, OPV is currently developing the VDAS Guidance – which will provide detailed information on effective digital engineering management, information exchange, documentation, integration, roles and responsibilities, collaboration, common data environments and data classification.

Following the Guidance, technical guides, a competency framework and an education map will be developed.

- | The technical guides will provide stakeholders with recommended templates as well as direction and assistance on creating, delivering and operating assets with digital engineering processes.**
- | The competency framework will outline the skill, qualities, experience and roles required to deliver the VDAS across the State.**
- | The education map will provide specific details on the courses, syllabus and contact details of digital engineering educators and providers across the state.**

Asset management

Engineering is a critical profession in asset delivery and maintenance, with engineers a key enabler of effective asset management.

Asset management is the coordinated activity of an organisation to realise value from their assets. Engineers are increasingly in demand in this area as they bring asset reliability, utilisation, knowledge of critical failure points, alongside a holistic knowledge of safety and performance to asset management. This knowledge and skillset underpins financial and managerial decision-making.

The four key stages of the asset lifecycle are:

- » **Planning:** determination of asset requirements, based on an assessment of both service delivery needs and the capability of the existing asset base to meet these needs.
- » **Acquisition:** procurement of assets to meet an identified service need, including the assessment of procurement options.
- » **Operation and maintenance:** management and use of an asset to deliver services, including maintenance.
- » **Disposal:** treatment of an asset that has either reached the end of its useful life, is considered surplus, or is underperforming.

To ensure our future cities are environmentally sustainable, we are addressing the opportunities the existing assets present through improving the quality of Victoria's transport infrastructure assets. The Victorian Government is currently investigating how to leverage existing assets in full life cycle decisions and for development of new assets. This will help boost prosperity, support development and resilience, connect communities' general wellbeing and make Victoria more liveable.

I A new technology to rapidly detect corrosion in concrete sewer access points is being developed by La Trobe University engineers, and will eliminate the need for manual confined-space entry, for improving maintenance planning for our aging wastewater infrastructure. This technology is being trialled with the Intelligent Water Network, a partnership between VicWater, Department of Environment, Land, Water and Planning and Victorian water authorities including Western Water, Goulburn Valley Water and Central Highlands Water.

I Intelligent Transport Systems has enhanced asset utilisation in the United Kingdom. It has achieved reductions of 25 per cent in journey times, 50 per cent in accidents, 10 per cent pollution and four per cent on fuel consumption on the M42 with an expected BCR of 5.0.

Cost, time, risk and contingency guidelines

With the current infrastructure pipeline in Victoria, the Government's exposure to project schedule and cost overruns has increased.

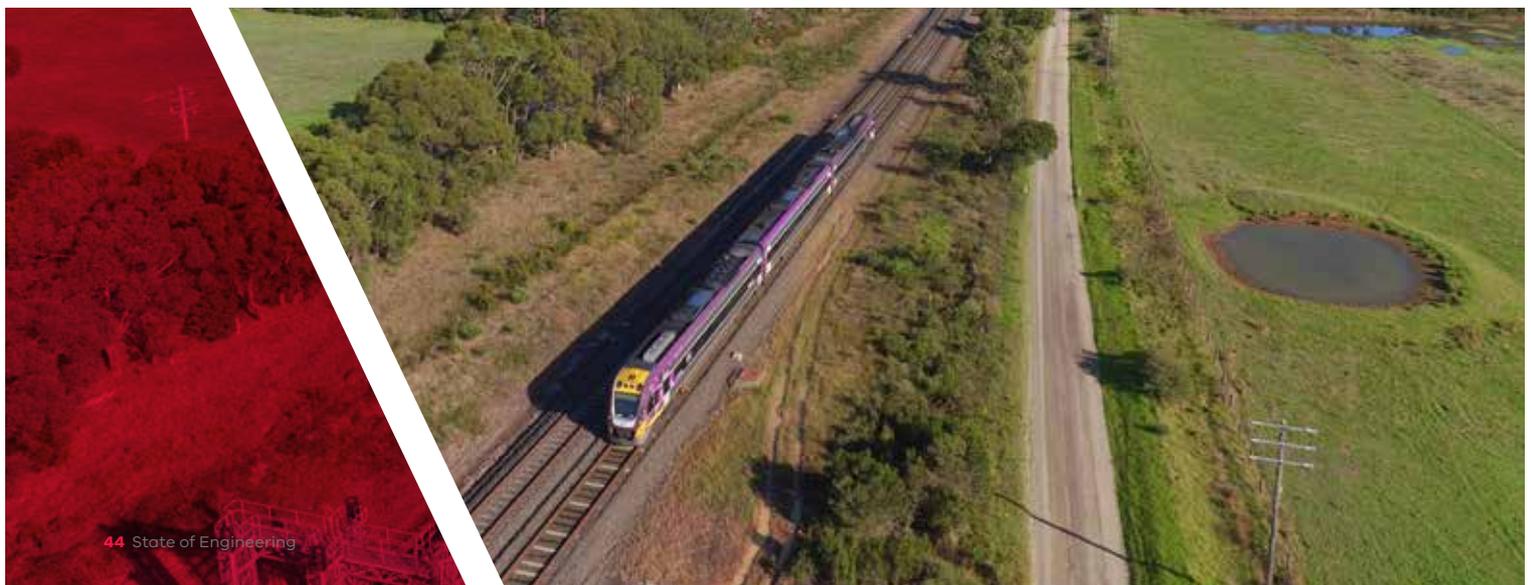
OPV is developing consistent guidance for the identification, quantification and management of cost, time, risk and contingency within the Government's portfolio.

Through considering cost, time, risk and contingencies during business case development and project management, it is anticipated that project outcomes will be improved.

The guidelines are intended to serve as best practice guidance for practitioners, reviewers and decision makers.

Once published, they will provide a framework for all Government delivery agencies to ensure consistent, effective and efficient approaches are used to quantify and evaluate cost, time, risk and contingency in business case development and project delivery.

A consistent and transparent approach will allow more effective project review and facilitate benchmarking for future projects.



Project development due diligence

The effective, timely and cost-efficient delivery of Victoria's infrastructure program is critical. Its unprecedented magnitude requires a strong focus on ensuring that all major projects are planned, designed and executed carefully and appropriately.

The successful execution and performance of a project depends heavily on the quality of its ongoing project development and due diligence activities, which include front-end engineering and design and project development and due diligence.

Project development and due diligence is the basic, initial engineering and design undertaken for a project, usually following a conceptual exploration or a feasibility study. It defines the specific technical requirements for a project, identifies key issues including technical, contextual and environmental matters and resolves them where possible and enables the cost of the investment to be estimated.

These processes will ensure that more emphasis is placed on technical requirements earlier in the project development lifecycle, enabling risks to be identified, quantified, managed and properly allocated at each stage. It will allow initial uncertainties in relation to project planning estimates to be adequately costed and later mitigated through subsequent investigation and design. Potential delays and associated costs can be avoided, whilst construction efficiencies are optimised.

The effective implementation of these policies will result in more transparency that allows for extensive discussion and collaboration between contractors and government during the decision making and approval process.



Prefabrication and modularisation

OPV is developing the Victorian Government Offsite and Modular Construction Guide to provide common and practical support for the effective use of offsite construction methods for Victorian major projects.

This guidance is used to communicate the key tenets of lean, innovation and offsite construction methods – such as prefabrication and modularisation – to a range of stakeholders: government as a client; engineers; project managers; architects and constructors.

It incorporates the offsite aspects and requirements into the overall process on asset delivery and management and can be used by the Victorian Government asset stakeholders involved in creation and whole of life management of Victorian infrastructure assets.

The guidance is designed to cover concepts and solutions that are applicable to any major project.

The concept of policy is designed to be accessible across the entire life cycle of any given asset – from inception to operation. It can be consumed on an individual 'phase', or it can be read as a whole, or as an integrated philosophy.

| The Victorian Government is delivering 100 modular school buildings across Victoria over a four-year period. When classrooms are constructed on school grounds, the excess noise and dust can disrupt students' learning experience. On-site construction also introduces safety concerns around the delivery and storage of building materials and site construction activities. Modular construction virtually eliminates these risks. This is where modular construction is a natural fit for school projects, with up to 95 per cent of construction occurring offsite, reducing on-site activities to weeks rather than months.



Capability and capacity

Delivery of world class infrastructure requires highly developed skills and capability. The Office of Projects Victoria (OPV) is building project management and leadership expertise across Government to deliver Victoria's infrastructure program.

A number of initiatives are underway to build capability and capacity, which include:

- » building the pool needed to deliver complex infrastructure projects through the Victorian Major Projects Leadership Academy (VMPLA);
- » building the skills and capability of government project delivery staff through specialist training courses in areas such as commercial capability and complex negotiations; and
- » workforce modelling to help ensure that the supply of project delivery professionals keeps pace with Victoria's project delivery pipeline.

OPV is working with the University of Oxford's Saïd Business School and Ernst & Young to design and deliver the new VMPLA.

Oxford Saïd is a world leader in research on complex mega projects, having developed and led the UK Major Projects Leadership Academy for many years.

The VMPLA was established in 2019, with more than 50 Victorian project leaders currently taking part in the program and additional cohorts of 25-30 participants entering in subsequent intakes.

The 12-month program provides high-quality training to ensure that the leaders of complex major projects are at the forefront of current project delivery thinking.

The course is designed to boost infrastructure leadership and capability across the entire Victorian public sector. In addition to delivering structured theoretical content, the VMPLA provides experiential learning with opportunities to apply learning in day-to-day work and solve the issues of greatest impact for major projects.

Best practice equity guides

Office of Projects Victoria in partnership with Parlour Architecture have developed a set of best practice guides to help support and improve diversity and wellbeing within the engineering industry.

These guides cover key areas relevant to employees, employers and the wider profession to ensure every work place is inclusive and equal opportunities are provided to all. They offer useful practices to achieve equity and develop resilience in workforces. There are nine guides in total, they include:

1. Pay equity

Pay equity is about ensuring that employees are paid fairly for the work they perform. This guide offers suggestions to assist engineering organisations in evaluating, establishing and maintaining pay equity, and to help employees seeking to achieve gender pay equity. It also makes suggestions as to how the profession can assist in addressing the issue.

2. Long hours culture

A career in engineering can be high stress and long working hours are a huge issue. This guide challenges the long hours culture in the engineering industry. It examines the complex factors behind it and offers suggestions about how to manage workload and workplace culture for the benefit of all.

3. Part time and flexible work

Meaningful part-time and flexible work is essential to workplace equity. If the industry is to achieve a more equitable environment, serious part-time and flexible work needs to be a more available and acceptable career option for everyone. This guide outlines the benefits to organisations and employees and offers strategies for creating and promoting meaningful part-time and flexible work conditions.

4. Recruitment and new start

Equitable recruitment and properly supporting new hires are an important place to start building an equitable organisation and profession. This guide provides advice on fair and equitable recruitment strategies, processes along with new start support for both employers and employees.

5. Career progression

Every engineering career is different. There is more than one career model and different models suit different people and life stages. This guide looks at how engineering careers might be considered and navigated and offers suggestions for supporting engineers in their professional development.

6. Negotiation

Good negotiation skills play a big role in the development of individual careers, the strength of successful organisations and the continuing viability of the engineering profession. This guide outlines the importance of negotiation skills in engineering. It offers advice to employers and employees about negotiating in ways that provide a fairer playing field for women and men that are beneficial to all parties.

7. Career break

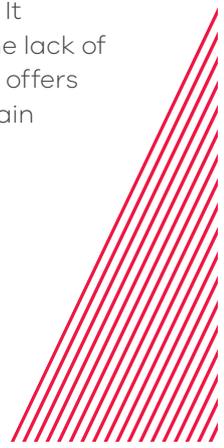
Many engineers take one or more breaks over the course of their career. Whatever the reason for the break, it needs to be carefully managed. This guide assists employees and organisations to collaboratively plan for and manage career breaks, particularly parental leave, and to support a successful return to work life.

8. Leadership and mentoring

Substantial research shows that companies and organisations with diverse leadership groups consistently outperform those without. At the same time, mentoring is a critical tool for developing and retaining engineers. This guide addresses the obstacles women may face in attaining seniority, offers women tips on positioning themselves for leadership roles, provides guidance on promoting and supporting women, and outlines the role leaders in the profession can play in facilitating change.

9. Women on-site and in-trade

This guide challenges the construction and engineering industries to reimagine what it looks like and encourages it to begin redefining itself as an industry more inclusive to women. It examines the complex factors behind the lack of female participation in the industry and offers suggestion about how to recruit and retain female workers for the benefit of all.



Engineering Victoria's future

I *'Building prosperity for Victoria through leveraging engineering ingenuity and action.'*
– Dr Collette Burke, Victorian Chief Engineer

To build prosperity for Victoria's future, engineers must leverage areas where they can positively contribute, advance and develop the profession and maximise benefits to Victorians.

This future requires actions and initiatives across:

People: initiatives to enhance the Victorian engineering workforce and encourage Victoria's best and brightest into engineering;

Projects: initiatives to prepare Victoria for the future; and

Profession: initiatives to increase the engineering community's influence and capacity to solve issues that society will face in the future.

In addition to initiatives currently underway, the Victorian Chief Engineer's workplan also includes:

- » building government's engineering capability by enhancing engagement with industry;
- » developing a strategic long-term framework for STEM education;
- » investigating mechanisms that attract individuals to engineering;
- » enhancing support for engineering and skilled workers;
- » enhancing engineering equality;
- » increasing the number and visibility of senior and leading women engineers;
- » supporting Victorian Government departments, agencies, and wider industry on innovative and best practice approaches to deliver and maintain assets;
- » investigating and applying best practice approaches to cost, time, risk and contingency on state government infrastructure investment;

- » investigating and supporting sustainability-focused engineering reform;

- » building a future cities decision-making roadmap; and

- » increasing research and industry collaboration in innovation by connecting industry with universities.

The Victorian Chief Engineer and OPV will work with the government sector, industry, professional associations and educational institutions to deliver these actions and initiatives. Key stakeholders include:

- » Victorian Government departments and agencies, including the Commissioner for Environmental Sustainability;
- » the Victorian Skills Commissioner;
- » the Office of the Victorian Government Architect;
- » the Office of the Victorian Chief Scientist;
- » Infrastructure Victoria;
- » Victorian engineering academia and technology and the wider tertiary sector;
- » Engineering industry peak bodies, such as Engineers Australia and Professionals Australia;
- » Industry employers and associations;
- » National Association of Women in Construction; and
- » Victorian engineers and Victorian engineering professionals.

Implementations of the initiatives have been divided into three horizons:

- » Short term: Already commenced or in planning prior to the end of 2019
- » Medium term: Planned implementation in 2020
- » Long term: Planned implementation late 2021

	Initiative	Implementation	Timeline
People	Build government engineering capability	Work to increase the engineering capability and technical and engineering intake within Victorian public service graduate programs	Short
	Increase engineering work experience opportunities	Encourage government and industry to provide work experience placements engineering degrees	Medium
	Support of senior women in government	Continuing to support senior women in government to ensure we retain and increase diversity	Medium
	Define the engineering and technical skills of the future	Continuing to support building a bigger pool of resources by attraction, mapping to apprenticeships, cadetships or engineering degrees, support of students and placement in jobs.	Long
Projects	Revised sustainability investment of guidelines	Review construction standards in relation to sustainability, standardisation and rationalisation and update the sustainability investment guidelines.	Short
	Promote recycled and alternative construction materials	Develop a platform to showcase new and proven recycled medium and alternative construction additives or materials, to reduce the drain on our natural resources.	Short
	Implement Victorian Digital Asset Strategy Guide and release VDAS technical guides	Support Victorian Government departments and agencies with best practice advice on implementing DE and BIM on major infrastructure projects.	Short to Medium
	Technical and project advice	Provide technical and project advice on major construction projects as required	Ongoing
	Victorian Offsite and Modular Construction Guide	Development of guidance aimed at Victorian Government project practitioners to drive improvements, productivity, and cost-saving approaches to construction	Short
	Cost, time, risk and contingency	Develop guides with consistent government application on cost, time, risk and contingency management	Medium
Profession	Engineer's registration legislation and regulations	Assist in developing effective implementation of the <i>Professional Engineers Registration Bill 2019</i> with support from industry and Victorian engineers.	Short to Medium
	Continuing to support established communities of practice	Support of developed forums and communities of practice for engineers in the public sector, academia and industry in the areas of: <ul style="list-style-type: none"> » sustainability; » standards change; » digital engineering; » future cities; » and Engineering leading the State 	Long

Conclusion

At the forefront of Victoria's prosperous future are ordinary people who do extraordinary things. Victoria's engineers remain focused on turning cracks into breakthroughs.

The State is faced with growing opportunities to showcase and develop our engineering talent. As the population is expected to considerably increase over the next 30 years to more than 11 million people by 2056, it is critical Government and industry continue to collaborate and plan for our future growth.

Record breaking infrastructure budgets are enabling our future cities to develop and grow innovatively.

Striving towards a more liveable, cleaner, advanced and efficient state, engineers are integral as we move toward a more sustainable future.

We are building the Victoria of tomorrow and we need to seize the opportunity to set up a state that can be passed on to future generations that embeds efficient utilisation and management of our resources.

Engineers must articulate the role they play in the development of our future cities. Technology, projects and processes will not progress without them.

The economy is shifting, and as it does, we need to become more multidisciplinary and keep up with the changing demand of skills.

This report highlights both the success we have had in rising to a host of challenges and also the many opportunities that exist for us to shape the future of the profession and the State.

Acknowledgements

Universities, industry groups, agencies and professional associations involved in the development of this report include:

- » Consult Australia
- » CSIRO
- » Deakin University
- » Engineers Australia
- » Monash University
- » Professionals Australia
- » Roads Australia
- » RMIT University
- » Swinburne University
- » The University of Melbourne
- » La Trobe University
- » Just Be Nice
- » Aurecon
- » Jacobs
- » Innovative Manufacturing CRC
- » Wyndham City Council
- » Yarra City Council
- » Office of Planetary Observations
- » Sustainability Victoria
- » Department of Jobs, Precincts and Regions
- » Department of Transport
- » Major Transport Infrastructure Authority



If you would like to receive this publication in an accessible format please telephone 03 9651 5111 or email information@dtf.vic.gov.au

This document is also available in Word and pdf format at opv.vic.gov.au