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The promotion of future opportunities and possibilities for Engineering graduates

Engineering 2035

April 2020

EXECUTIVE SUMMARY

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The *Australian Council of Engineering Deans* is looking 'to promote to future students the diversity of opportunities and possibilities available to Engineering graduates' as part of *Engineering 2035*.

Focus groups were conducted with Year 11 and 12 students, first and second year university students, VET students and graduates, mature age students, graduates, teachers and industry in Melbourne, Brisbane, Adelaide, Townsville and Bendigo.

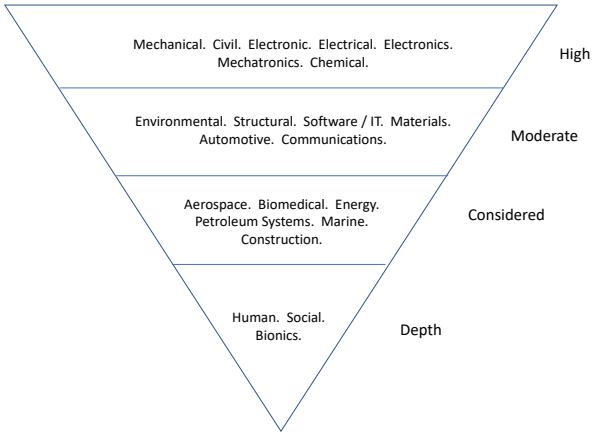
The research identified multiple market segments within each audience category, enabling future messages to be informed by consistent values, selection drivers, aspirations and areas of interest.

The research outcomes and subsequent analysis identified some important outcomes to direct future marketing and communications strategies:

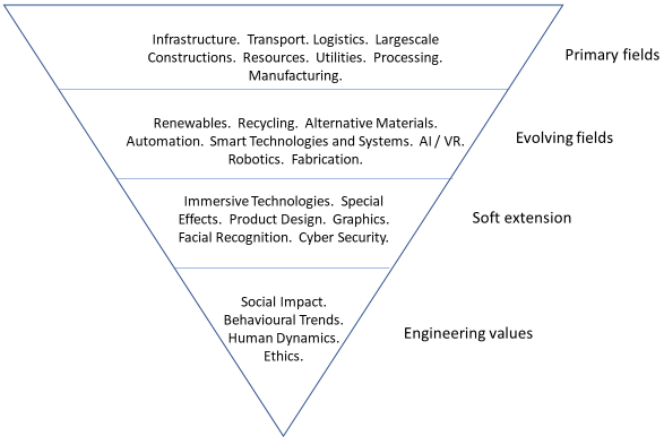
- The various distinctions and interpretations of Engineering across different audience segments impacts how Engineering is both positioned and perceived.
- There are significant gaps in terms of how Engineering itself is viewed such as those who look towards more traditional fields and, those who are attracted by a unique specialisation.
- Many secondary school students associate Engineering with largescale projects such as infrastructure development, construction and production; whereas other segments view Engineering around more niche applications.
- Many students are steered into Engineering by virtue of their ATAR scores and impressions gleaned from events and exposure, such as school visits and Open Days. There are others who choose Engineering based around their performance in particular subjects at school.
- Many of the specialist streams were not automatically associated with Engineering and at times, were confused with the Sciences.
- Many of those who are considering other STEM subjects at university, had been steered into alternative options and appeared to have not given sufficient consideration to the diversity of Engineering options now available.
- Future employment opportunities were often more associated with large Engineering organisations, including multinationals; as opposed to niche organisations, SMEs, start-ups.
- Most university participants only demonstrated awareness of different employment and industry outcomes once they were well-established on their Engineering degree
- There was good overall awareness of the benefits of Double Degrees, although the general pattern was to view Double Degrees as contrasting disciplines rather than a related second degree to augment the Engineering qualification.
- An outcome which resonated throughout all target audiences was the importance of building awareness and perceptions from an early age.
- there was feedback to suggest that students can be influenced by where 'mentor teachers' themselves studied.
- Many industry participants observed that whilst theoretical content is important within the curriculum, future Engineering pedagogy must focus upon replicating the types of environments, projects and settings within which future graduates will work.

The new world order post COVID-19 will also lead to the rapid escalation of new industries and opportunities as organisations across all levels utilise these recent events as a catalyst of change. This may compel many prospective students to refocus their future intentions and utilise the years of repair to reorientate their lives.

The most cited fields of Engineering by Year 11 and 12 students and first year engineering undergraduates



The fields of engineering employment which Year 11 and 12 students and first and second year undergraduates most identified with



The promotion of Engineering needs to extend beyond the articulation of Engineering as a core discipline. Promotion needs to capture the diversity of opportunities, roles and locations which an Engineering qualification can potentially afford. This includes promoting both the core disciplines which have underpinned Engineering per se, and supplanting this with the many fields, technologies and applications which are relevant to a post-COVID-19 world. The current time provides an ideal opportunity to rethink and reset Engineering curriculum.

The focus for Engineering promotion must reflect the diverse values and interests of prospective students. This includes the evolving values such as the human dimensions associated with Engineering (e.g. Social Engineering).

A core Engineering premise is to educate prospective students, whether school leavers or mature age candidates, across the range of applications and opportunities available to students to illustrate potential and create enticement.

Marketing and communications

- This involves the promotion of Engineering through the introduction of those core disciplines which underpin the discipline, including the promotion of Mechanical, Civil, Electronics and Electrical. Aligned to this promotion is the introduction of other specialisations which are generally positioned within the top awareness tier of Engineering qualifications, including Chemical, Environmental, Structural and Mechatronics.

- A clear articulation of the process involved with acquiring an Engineering degree is important, including core subjects and other activities / metrics such as the number of internship days and common First Year subjects.

- Any future promotion needs to include narrative as to the importance of Engineering in terms of economic progress[1] through infrastructure, largescale constructions, transport and responsiveness to next generation industries. This is to facilitate a connection between investments that may not necessarily be associated with Engineering but where Engineering fulfils an integral role.

- There is a strong argument to suggest that engineering should be promoted as a discipline that makes the world a better place. Engineers are equipped with the skills and competencies needed to respond to challenges and alternative environments. This will require a nomenclature that captures the entire engineering ecosystem and then align that nomenclature with outcomes.[2]

- It could be suggested that whilst there are various structural aspects in terms of Engineering curriculum, influenced by *cultural beliefs* that reinforce this behaviour, new curriculum can only emerge from next generation thinking, innovations and ideas. This includes having people who possess extensive industry and applied application experience and, who still possess the ability to research and teach.

- Engineering should be promoted as an innovation qualification, with numerous specialisations and as a global opportunity, meaning that Engineering graduates are well positioned to transition between different locations, industries, workplace environments and roles. Engineering needs to be presented as a highly creative field.

[1] As well as recovery and renewal
[2] *E.g. Invest in Futures*

- In articulating the messages about future Engineering studies, the emphasis must be upon the wealth of new industries that require Engineering capabilities, far beyond the more obvious fields of Civil, Mechanical and Structural.

- Engineering must be promoted as a progressive and dynamic field, which is no longer just associated with traditional disciplines. This can occur through a focus upon both the macro (i.e. infrastructure, largescale projects) and, the micro. The micro includes fields which are more associated with precision applications and those fields where there is a cross-over between both the practical aspects of Engineering and the theoretical and applied concepts behind such disciplines as Health Sciences.

The marketing of Engineering has traditionally been supply-led. The focus in future must be market-led, by associating Engineering with new innovations and next generation thinking; and responding to future target audience values, needs and expectations.

Engineering should be promoted as a highly creative discipline given that creativity is now embedded within the mindsets of prospective students.

It is essential that the curriculum must match the messaging. Engineering needs to widen its remit by both promoting numerous specialisations and streams and, aligning Engineering with the next generation of industries and sectors which are occurring as new fields evolve. This will clearly appeal to secondary students who are invested in new space.

The range of new industries and sectors will soar, given that the world will look towards *skipping a generation* and using events as a *catalyst for change*. The pace of technological change is occurring at such a rate that Engineering should be seen as a 'high impact' and 'frontline' discipline

Important sources of influence, including teachers and career-advisors, must be made aware that Engineering is not a qualification which should automatically be referred to based around the strength of a student's subject performance at school and their ATAR score. Instead, Engineering should be promoted to students who are just as invested in the Sciences and Arts, by demonstrating that Engineering actually embraces a wide range and diversity of fields.

Future messages must reflect diversity. New world frontiers will call for multiple and diverse streams within applications and environments which are only just emerging and evolving. These frontiers will accelerate in response to recent events where one outcome will surely be the rapid escalation of new industries and sectors, in response to the cessation of so many traditional and unviable fields and, a realignment of economic and social boundaries.

The language is changing. The opportunities are diversifying. And the niche specialisations are increasing. All of these need to be captured within a marketing and communications framework that reflects the 'new world order' of Engineering.

Engineering has been a pioneering discipline from the era of the industrial revolution, through to the very latest technologies associated with new constructions and the most recent infrastructure developments. Now the world needs to look at Engineering through a new lens.

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PART ONE: INTRODUCTION

Whilst the platform for Engineering continues to revolve around Civil, Mechanical, Electrical and Electronics, the pace of technological change is constantly creating multiple new fields and specialisations. Some are better known than others, whether in terms of the primary focus (e.g. Mechatronics, Environmental) or in the fields of application (e.g. Renewables, Robotics). And as industry increasingly utilises technology to remain relevant and efficient, demand for professional and vocational graduates who know how to work with advanced and smart technologies, who understand for example automation and sustainability, will continue to grow.

This has all coincided with a new world paradigm based around future employment and workplace environments. Today's generation of Engineering graduates can mostly expect to work in the 'gig' economy which in itself requires diverse skills, particularly around relevance and specialisation. Such graduates will constantly need to build their individually differentiated portfolio. They will need to seek and often create their own opportunities, apply highly flexible and portable workplace behaviours and, know how to utilise complementary skills such as business management, marketing, digital applications and cross-cultural communications.

The nature of Engineering equips Engineers with unique attributes, such as design thinking[3] and risk mitigation, all of which can be applied in a wide variety of settings. This makes Engineers highly sought after given that most organisations are continually updating their business models, whether SME's or multinationals. Such organisations need people who understand systems and processes, who can grasp concepts, pro-actively contribute, remain updated and 'hit the ground running'.

Most Australian universities offer Engineering programmes – although definition is a challenge given the conflict between the broad Engineering genre and specialist domains within the Engineering nomenclature. Most are invested in offering curriculum that will enable graduates to work in future domains – through the delivery of core content and the provision of supplementary knowledge, competencies and experiences. But the question is, just how much do future students know about the opportunities and possibilities that Engineering truly affords?

[3] This refers to the actual mindset, which incorporates such related issues as creativity as distinct from Engineering Design (usually through first year content).

Future students access information about different options through multiple sources. Those who have a deep-seated interest in a particular discipline or field will generally have an easier pathway. But this is the minority, which reinforces the challenges associated with scalability, different interpretations of Engineering practice and academic content and, the influence of both a university's organisational structure and culture.

One of the key reasons behind attrition rates and deferrals is that many students 'fall' into a course or discipline because they may have been steered or advised that way, been attracted by the sound or 'spin' of a programme or, they based their decision around other mitigating factors such as ATAR and location.

An extenuating factor is that there is a finite limit to those learning vehicles which enable discovery, new ideas and innovations. Media has a role and 'significant others' may be able to contribute thoughts and knowledge – but for future students it is their ability to absorb and filter information which still drives so much of their decision-making process.

Schools have an important role to fulfil but most schools are focussed upon results and outcomes. Career-advisors have often been deployed into a role for which they are poorly prepared. They have access to directories, handbooks and Google for a decision today, but what of the world of tomorrow – a world comprised of driverless vehicles, smart spaces, AI, facial recognition, cyber forensics, hyper-sonics, medical devices et al. For most career-advisors and for many teachers, keeping fully informed and up-to-date about new and emerging opportunities is a major challenge – an outcome which could involve more informed introductory processes around the whole field.

Aligned to the above points, whereas the focus is to present Engineering as a new, interesting and challenging field of education, there remains the challenge of balancing technological applications with the human-centred focus and identity. This emerged during the course of the research through the feedback and observations of Engineering students who identify with 'blue sky thinking'.

Against this backdrop, the *Australian Council of Engineering Deans* is looking to identify where the future of Engineering is heading. A key component of this is understanding those drivers which influence future students to consider Engineering and in the process, appreciate the opportunities that Engineering affords. Therefore, to inform the *Engineering 2035* strategy, the Council is looking for relevant and diverse insights to guide future marketing and communications initiatives.

The following report was commissioned in early February 2020. It has been produced by Rob Lawrence of Prospect Research and Marketing P/L. Rob possesses extensive experience undertaking market research and building marketing and communications strategies for Higher Education providers around the world.

2
OBJECTIVES

The primary objective is ‘to promote to future students the diversity of opportunities and possibilities open to Engineering graduates.’

In fulfilling this objective there are many secondary considerations which need to be incorporated within the outcomes:

- To position Engineering as a qualification of first choice
- To clearly articulate the Engineering narrative to appeal to future students and their key opinion leaders
- To illustrate the types of skills, competencies and experiences which are unique to Engineers and which can be applied in different industries and locations
- To segment those audiences who want or may be willing / attracted to study Engineering based around their values, circumstances, needs and expectations
- To build strategies which enable effective engagement into schools
- To build strategies which enable effective engagement with other categories including the mature age reskill and upskill market, those seeking to transition into Engineering and those interested in fields which could be aligned with Engineering
- To identify the experiences, competencies and capabilities of recent graduates (defined as those who graduated within the past four years) to determine those attributes which they currently possess and those which they consider necessary in the future
- To identify how graduates will source additional employment and life portfolio assets in the future
- To identify how the experiences of graduates can be used to inform future Engineering programme content and delivery
- To build a communications strategy that allows for the full range of opportunities and possibilities for Engineers to be presented
- To illustrate the applicability and relevance of Engineering to next generation industries, workplaces and specialisations
- To present Engineering as the qualification for the future given the breadth and depth of touch-points which Engineering provides

3

METHODOLOGY

The core methodology was based around focus groups which involved open discussions with between 10 and 12 participants per group. The reason for choosing qualitative focus group research was to examine a wide range of issues pertinent to each target audience and subsequently, explore various hypotheses in response to the core lines of enquiry.

Each focus group lasted approximately 80 minutes and all of these focus groups were moderated by the author of this report. Specifically, the focus groups consisted of the following segments[4]:

- Year 11 and 12 students (10)
- Post Year 12 gap students (2)
- First and second year university students (4)
- VET students and graduates (3)
- Mature age students (3)
- Graduates from within the past four years (5)[5] [6]
- Secondary school career-advisors (2)
- Teachers (2)
- Industry opinion leaders and employers[7] (3)[8]

In addition, information regarding the current and future potential for Engineering graduates was obtained from several sources to provide an oversight as reflected in the following report.

Focus groups were conducted with 332 participants in Melbourne, Brisbane, Adelaide, Townsville and Bendigo. The field research was accelerated and therefore completed within 24 hours of lockdown.

[4] Number of groups per category are in brackets

[5] These graduates were employed across a wide variety of industries including large-scale construction, water and electricity utilities, roads, fabrication, horticulture and agriculture production / processing, emergency services, air conditioning and refrigeration, public transport, composites production and design, facilities (i.e. hospitals, hotels, stadiums), network systems, security systems, VR simulation, digital applications and technologies, consulting, business (e.g. marketing, HR) and finance

[6] The types of organisations within which graduates were employed included multinationals (3), large corporations (6), SME's (10), government (7), health (3), education (1), utilities (2), transport (2), professional services (3) and maritime (1)

[7] This was not included in the original brief but considered essential in light of the feedback from the pre-university and university students

[8] The industry opinion leaders and employers were engaged in many industries including large-scale infrastructure projects, resources, port utilities, architectural practice, intermodal transport systems, water resources, distribution centre logistics, telecommunications, data analysis, carbon fibre production, engineering maintenance, construction, consulting, procurement, health, finance and media. These organisations were a mix of multinational, large-scale industry, medium-sized industry, SME's and government

4

PART TWO: PRIMARY FINDINGS

For ease of interpretation, this section of the report contains the headline observations from each of the target audiences rather than as a merged document. This is because the experiences, needs and expectations of each audience proved to be fundamentally different, yet when all of the results were aggregated[9] there appeared many patterns which can be used to inform the overall outcomes.

Year 11 and 12 students, including GAP students

- Most of the Year 11 and 12 students were considering / had considered either Engineering or Science, or both, often as a Double Degree (of which there was relatively high awareness). The general reason for the choice of these disciplines was that subjects such as Science, Mathematics and Technology were their greatest strengths at school; particularly at those schools with a strong STEM focus. Chapter 3 provides insights of the drivers into other fields and why students have therefore shifted their focus away from Engineering.

- The Year 11 and 12 students did not share the same reasons for undertaking a Double Degree as the Career-advisors. Whereas Career-advisors often referred to determining the best single degree outcome, the Year 11 and 12 students (a view endorsed by the First and Second Year students) had a far more complementary approach.

  Many of the Year 11 and 12 students saw the benefits of having one degree stream as a vehicle to augment the other degree stream. Consequently, this was ultimately seen to improve and enhance future employment opportunities, including those in specific industries and locations[10]; as well as test two options to determine which area they are best suited for. Several students also referred to taking advantage of HECS[11] / FEE-HELP in terms of maximising the benefit of Government supported education.

[9] Refer Chapter 6: Analysis

[10] Additional input from a project stakeholder indicated that there is anecdotal evidence around students with a single Major in Engineering (i.e. less depth in the field) receiving starting graduate salaries that are significantly lower than those with extended Majors (i.e. depth) in Engineering, within the same organisation. Whilst this was not validated during this research project, it was an observation which the author has witnessed empirically.

[11] The term most consistently referred to by all target audiences

- Those students who were most committed to Engineering had often been involved in various projects with an Engineering orientation, ranging from the solar car challenge to an active interest in projects with a strong technical focus.

- Those students most committed to Engineering generally had a family member or close family friend who is either an Engineer or a retired Engineer, mainly around more 'traditional' or 'established' fields such as Civil and Structural Engineering.

- All of the Year 11 and 12 students were aware of the major Engineering disciplines and most had determined a) which course they would study and b) at which university. However, when the major Engineering disciplines were probed, the responses were invariably around Mechanical, Civil, Structural, Electronic, Electrical, Mechatronics, Software and Environmental.

  There were few specific references to Systems, Chemical, Automotive, Aeronautical and Communications – a reflection that prospective students are less inclined to probe into depth options and instead, prefer to reflect upon core disciplines. This could also be indicative of the feedback, or lack thereof, they receive through schools.

- Several students referred to Software Engineering although they tended to associate this with IT / Computer Sciences (and their largely IT orientation). Equally, Biomedical was more strongly aligned with Sciences.

  Significantly, the whole genre of Systems[12] was rarely mentioned and when probed, was often as a reference with another field or application[13]. This observation was equally relevant to students, graduates and influencers.

- Most of the students were oriented towards an Engineering discipline, based around their personal interests. Whilst there was a general pattern of response to indicate that Year 11 and 12 students were aware of Foundation or as some described, a 'grounding' Engineering platform, they tended to view each field separately.

- Despite a clear cohort of Year 11 and 12 students who were seriously interested in Engineering, there were many other students who were equally strong in technical, scientific and mathematical disciplines but who had not given Engineering serious consideration. They were interested however in various applications which could have an Engineering focus but which they did not categorise or label this way.

[12] Often assumed to be part of Software Engineering and IT
[13] E.g. Defence Systems, Robotics

Examples included biotechnologies, driverless vehicles, robotics, renewables and environmental sciences.

- Most of the students who were stronger in the Sciences per se generally had at least one teacher who was acting or had acted as a mentor. However, few students viewed the career-advisors this way and often described career-advisors as information sources more invested in distributing information rather than offering deep counselling support.

- All of the Year 11 and 12 students were aware that there are many employment opportunities for Engineering graduates but as a general observation, were not fully aware of those fields where there are either shortages of graduates or where the greatest career and employment outcomes reside.

- Few of the Year 11 and 12 students were giving serious consideration to a GAP year, although as a general observation, the duration of Engineering and in particular, Engineering as a Double Degree, meant that most students felt compelled to start earlier than their counterparts intending to study such fields as Business and the Arts.

  As an author's observation, students who participate in a GAP year generally experience high levels of retention, secure future employment and generally, 'cope' with all of the challenges associated with tertiary study[14].

- A significant number of students invested in STEM were motivated by the opportunity to participate in some form of mobility programme, although it was noticeable that few of these students had participated in a study tour whilst at school. This was reported as the domain of students more invested in studying Arts, Law, Business, Humanities, International Relations and Languages.

- Almost all of the STEM students had participated in at least one open day and further, most had attended one or two events at universities. This was far higher than students more inclined towards non-STEM subjects. Further, the STEM students appeared to have undertaken deeper investigation of alternative options and other associated benefits including scholarships and other forms of financial bursary.

[14] An additional comment from one of the project stakeholders is that the additional requirements of the Double Degree accentuate the desire to base decision-making around time commitments, which reinforces the more 'hurried' start which was evident amongst these students, compared with empirical studies across many other fields.

- Irrespective of intended field at university or career aspirations, most of Year 11 and 12 students, as well as the gap students want to make some form of contribution. For some this was based around underlying concerns regarding the environment, particularly around climate change, rising sea levels, pollution, renewables, deforestation etc; and other because of some area of personal interest which have impacted attitudes and perceptions. This was especially true for those students engaged in such areas as volunteering, youth groups and community associations. As well as those who had participated in some form of tour at school.

  The sense of contribution was often couched around participation in worthwhile projects that impact societies and communities, locally, nationally and internationally. There was reasonably strong awareness of different campaigns and charities, from Greenpeace and Sea Shepherd through to Homes for Humanity and various conservation groups. Therefore whilst not explicitly stated as 'wanting to change the world' there was certainly an undercurrent of wanting to contribute and, become involved in ethical and worthwhile projects – a formative years essence which will undoubtedly flow into mainstream course, career and employment aspirations.

- An interesting observation was that very few Year 11 and 12 students considered Engineering to be a male domain. This was partly attributed to the encouragement of STEM subjects within schools, including within single sex girls' schools; and strong advocacy about the future career opportunities and potential for female Engineering graduates. However, the same pattern was less evident for scientific fields where there was a leaning towards female Year 11 and 12 students studying Sciences.

First and second year university students

- All of the university students were asked which fields they were mostly aware of whilst at school. Students consistently referred to Civil, Mechanical, Electronics and Electrical Engineering, with most references involving Electronics being referred to as Mechatronics. This was particularly evident among students with a strong technical orientation. Other cited examples include Chemical, Environmental and Materials. The latter was generally reported by students at those universities with a focus upon Materials Engineering.

- All of the Engineering students were asked whether they prioritised choice of course or choice of university. Almost invariably, they said choice of course which was particularly applicable for those studying more niche or specialised fields. The exception were those students who applied high levels of ranking status and / or who wanted to maximise their ATAR score. Many of these students preferred to study at a Group of Eight university. Part of this was also due to family and school pressures.

- A surprising number of the Engineering students had already experienced some form of career which included several students who had moved back to University from the ADF. Some of these students were intending to return to the ADF.

- The general view was that if a school-leaver is science-oriented then they will require a degree given the very hierarchical nature of scientific environments.

- The general view was that Engineering is a precursor to employment within fields which reflect their area(s) of interest. In this regard, many students were focused on specialisations in such areas as Renewable Energies, Environmental Engineering, Chemical Engineering, Smart Cities, Artificial Intelligence, Energy and Power and even, Bionics.

- Several students volunteered that a greater emphasis needs to be placed upon social and humanitarian fields, given the responsibilities of Engineers and Scientists to provide outcomes which benefit people and societies.

- As a general observation, most students did not fully understand the types of specialisations which could be found until after they had commenced their studies and honed their areas of interest. From other empirical studies, this pattern is particularly evident amongst students choosing Business, Commerce and to a lesser extent, Communications.

- Most students who had transitioned directly from school into university asserted that with the benefit of hindsight, most career-advisors and teachers were not particularly well-informed about the types of opportunities and specialisations available through Engineering. Further, for those studying Double Degrees the general consensus during the decision-making process was to align Engineering with broad discipline areas such as Business and Science, with the focus then refined during studies. Consequently, such fields as Marketing and Finance tended to strengthen in terms of student interests subsequent to their enrolment.

- In each of the test markets, there was sufficient feedback to indicate a hierarchical order of universities in terms of overall status[15], but that many of the mid-tier universities offer interesting course options, programme structures and immediate access to specialist facilities[16].

- Despite empirical evidence to suggest that today's generation of domestic Higher Education students now spend less time on campus than their predecessors, there are still aspects of the overall experience which students welcome from a non-campus orientation. These have been facilitated by a gradual shift to such pedagogical platforms as 'flipped' learning, group projects, access to specialised facilities and events.

  Further, whilst the trend for domestic students has been to spend less time living and socialising on campus, various empirical studies have shown that some cohorts (e.g. international students) are actually spending more time on campus given that their university is their primary source of reference.

  In addition, there are some domestic segments who require an on-campus experience, given past conditioning. This particularly applies to mature age upskill and reskill students whose preferred mode of learning is around face-to-face teaching and learning interactions.

- Many of the seemingly higher performing students including those who studied at an independent school, stated that their teachers strongly pushed Group of Eight options and did not necessarily appreciate opportunities available at other institutions and cities. Consequently, some students lamented their choices.

- From a contributing values perspective, some of the aspirations of students were in keeping with the Year 11 and 12 students. Many of the students want to make an active contribution in a worthwhile form and this was already evident by approximately half participating in such areas as volunteering, mentoring and acting as student ambassadors. However, their sense of idealism around such areas as climate change was less explicit even though the importance to global societies was just as strong.

[15] Status was associated with various terminologies including rankings, graduate employment outcomes, modern facilities, heritage, aesthetics and community endorsement.
[16] E.g. 3D printers for first year students at Deakin University.

Graduates within the past four years

- Approximately two-thirds of more recent Engineering graduates were working directly within an Engineering-aligned role. However, the remainder were working in roles where they were applying on a daily basis many of the skills and capabilities which they had acquired through Engineering, such as design thinking, creative applications and supply chain management – qualities which graduates have subsequently identified with the necessities of their workplaces. However, their counterparts in other Science-related fields tended to be more involved in scientific roles or areas where new sciences and applications were being developed, including materials, biosciences and more traditional laboratory environments[17].

- Several Engineering graduates reported that they had given serious consideration, after graduating, towards living and working abroad, with several having selected this option. However, the general consensus of these graduates was that based upon their own experiences, they would advise future graduates to build a 'local' workplace knowledge and skills portfolio. At the time of the research, this included accessing international opportunities such as mobility and study tour options whilst at university, given the early exposure to different environments and cultures.

- Most graduates obtained a relatively secure Engineering position within 12 months of graduating, although several lamented not having made a greater effort to access opportunities during their final year at university and thereby, secure employment more quickly. However, only 20% of the graduates had managed to secure a position on a formal and structured graduate entry programme and those who had secured this opportunity, observed that the patterns of interaction with graduate employers has reportedly changed markedly over recent years[18].

- When the above point was probed, the main reasons attributed to the shifting environment and structures associated with graduate entry programmes is that more employers now require graduates who can 'hit the ground running' in a more niche or specialised role. This was generally based around discipline. Therefore, there is far less tendency today for graduates to shift between different layers, levels and locations of an organisation. This infers that they have a less rich and immersive graduate entry programme experience than that which many older graduates reportedly experienced. This observation was upheld by the industry opinion leaders and employers[19] who either worked in or had worked in large organisations.

[17] E.g. pathology labs.
[18] A view endorsed by several employers
[19] An important observation from one stakeholder is that this may also be a reflection of 'quality of life' over 'corporate loyalty'. Whilst this was not apparent, there were clear signals that many students and graduates are driven by their desire for future quality of life, based around a work / life balance.

- There appears to be a notable career progression differential which has occurred over recent years between those graduates who have experienced more established Engineering disciplines such as Mechanical and Civil and those who have experienced more specialised applications. This included Environmental and Sustainability.

  This career progression differential includes those who have been employed in largely tenured positions, largely based around such fields as Civil, Infrastructure and Resources; whereas those employed in more niche categories, tended to experience a more transactional employment history, including opportunities associated with often short-term contracts and projects. In some instances, those in niche categories employed on a contract have earned more than those in tenured positions however several of the graduates in SME's reported that they have generally earned less.

- When the above issue was probed, there appeared to be a long chain of what can best be described as more focussed or specialised[20] Engineering graduates such as those employed in fields associated with, for example, Mechatronics, Chemical, Renewables, Robotics and Medical Devices. This was often attributed to exposure to new and diverse fields at university, rather than the discovery of an area of interest once graduates had completed their studies.

- The choice of preferred type of organisations was often aligned with an individual values fit. Some graduates wanted to work within large multi-dimensional organisations with large networks and future opportunities whereas others preferred to work in smaller and even in one instance, a boutique organisation.

- In addition to key disciplines, there were several areas where graduates reported that their early stage careers would have benefitted from a more advanced understanding of specific applications and fields associated with 'subject matter expertise'. This covered a broad range of genres, including project planning, financial modelling, advanced communications, coding, alternative technologies[21], supply chain management, marketing and business / financial management.

[20] i.e. graduates who are less defined by such fields as Mechanical and Civil and who instead, displayed a greater diversity of interests and the ability to transition between different sectors and industries.
[21] E.g. different CAD systems.

- Compared with students, there were far fewer references to making a worthwhile contribution by the graduates however, most considered that there work had a positive impact upon the wider community. This was reflected in commentary around the economic value of various projects, the importance of fields such as renewables and recyclables, advances in knowledge and, opportunities to generate future employment through new technologies, start-ups, the supply chain etc.

  Several graduates were also making a contributory role through mentoring and volunteering.

- When the above points were probed, several graduates observed that today's Engineering students would benefit significantly from secondary qualifications which equip them with relevant business, finance, HR and communications expertise. Cited disciplines included Finance, Management, Accounting and Commerce.

  Several graduates couched this in terms of a Double Degree whereas others referred to a mix of Diplomas, Professional Development Awards and non-engineering postgraduate qualifications.

- Approximately half of the graduates observed that whilst they were steered into different options whilst at university, they were unaware of the potential afforded by such economic imperatives as infrastructure development (including rail), construction and intermodal transport logistics.

  These were largely viewed as fields which require a broad range of disciplines and specialisations and, fields where graduates would be better equipped in terms of their knowledge and applications capabilities through their university studies. Exacerbating the impact of this point, several participants reported that these were all areas more associated with traditional graduate entry programmes.

- All of the graduates were asked which areas they would have benefitted from in terms of human dimensions, interpretations and applications. Invariably, the major patterns were reported as networking capabilities (which includes self-promotion), interview skills, presentation capabilities, all forms of interpersonal communications[22] and 'human dimensions' attached to Engineering (i.e. impact of concepts and initiatives upon the social and human experience). All of these clearly contribute to employability, given the importance which many graduates attributed to the benefit of acquiring a broad portfolio of skills, competencies and experiences.

[22] Including several references to what the author classified as cross cultural communications

Whilst most graduates were largely focused upon the core skills and knowledge[23] which they apply in a workplace setting, it was apparent that graduates are increasingly aware of those employability attributes which enable differentiation and ultimately career / employment progression. Further, these attributes strongly aligned with the importance of remaining both relevant and updated within an increasingly competitive workplace environment and dynamic.

VET students and graduates

- This market segment illustrated a major differential between those who initially enrolled into a VET programme and those who chose the university pathway – a situation which was almost entirely impacted by market dynamics and individual considerations.

  The students who selected the VET Engineering pathway were generally in receipt of lower entry results (e.g. ATAR) and interestingly, many had other prior commitments before enrolling on their VET pathway. These often included personal and family considerations, workplace commitments, financial pressures and general lack of engagement with future education options, including limited careers counselling, poor school experiences / opportunities and, the influence of significant others[24].

- Most of the VET students and graduates had chosen a pathway directly associated with employment opportunities rather than a pathway aligned with longer term niche roles and specialisations. This included opportunities which were more immediate and localised rather than those which can provide access into, for example, major corporations and multinationals – domestically and internationally. Further, the choice of Engineering VET programmes was often associated with the local economic landscape such as logistics, smart manufacturing, construction etc.

- It became evident that the VET Engineering students required a different type of education experience, including one which was more applied and practical, rather than one which was associated with a greater emphasis upon independent learning, projects and, theoretically based knowledge. In part, this was attributed to English sometimes being a second language for these students and, more limited knowledge about different Australian workplace environments. Therefore, rather than the more obvious progression pathway which was evident amongst the Higher Education students, for VET students this was more of a stage by stage transitionary pathway.

[23] E.g. Communications, reporting, project mapping
[24] E.g. to provide support within the family business

- Aligned to the above, the VET students were not generally seeking an immersive education institution in terms of extra-curricular and co-curricular options. Such factors as on-campus accommodation, recreational facilities, societies, entertainment etc. were not considered important parts of the decision-making process – unlike tertiary Engineering students who were more focused upon on-campus opportunities and experiences, including those associated with direct industry exposure, mobility programmes, placements and access to networks[25].

- The VET students appeared more dependent upon an on-campus, in-situ learning environment. This was partly a product of their school learning experiences and how they best engage with education. They were less invested in brand status but more focussed in terms of location / access. They were also more aware from the outset, of employment-led Engineering pathways, such as Engineering Technologies.

- When the issue of Engineering Technologies was probed, the general consensus was 'front-line' fields where graduates could use such applications as robotics and smart manufacturing systems were considered more attractive and accessible, as opposed to working in a more inventive and systemised role 'behind-the-scenes'.

- For VET Engineering graduates, the opportunity to study for a more formal and specialised Engineering qualification, particularly at postgraduate level, was considered a more distant possibility. That said, this option still applied to approximately one quarter of the VET graduates, notably those who had secured a strong employment position and who felt more comfortable in their ability to pursue the next level of study.

- The journey into VET Engineering was largely based around the types of options available at an accessible VET provider, which included dual sector universities, meaning that they would seek institution first. In determining their choice of institution, such considerations as location, access, entry requirements, parking, fees etc. were all part of the decision-making process. Further, unlike the tertiary Engineering students, the VET Engineering students appeared to balance many more external considerations and influences such as their commitment to family, employment and financial obligations.

[25] i.e. through different events, seminars and connections, often based around external presentations.

Mature age students[26]

- The mature age Science and Engineering students demonstrated different selection criteria than their post-secondary counterparts[27]. There were some evident market segments based around individual values and circumstances which emerged during discussions with the mature age students. These included those seeking to upskill or reskill from a role which was technical by nature but where future career and employment opportunities were more limited.

  In addition, there was a segment where individual circumstances enabled a transitional opportunity to pursue a new career, experience a life change and pursue a personal interest.[28]

- Approximately 40% of the mature age students possessed a core Engineering or Science degree but had embarked upon a career where opportunities for personal development were more limited. Consequently, to maximise their individual potential and enable a catalyst for change, these students were now seeking to obtain a specialist qualification and skills platform which would provide a foundation for a next generation career and employment move.

  One relevant example was a number of students who were reorienting their academic qualifications and knowledge to work on major infrastructure projects, including national investment into submarine manufacturing capability, the various rail projects around the country and other largescale construction investments.

- An underpinning influence for many mature age students was the need to remain relevant in light of what they considered were highly adept and technically inclined younger graduates. In other words, they wanted to remain relevant and based around their core technical knowledge, still believed that they could make a major contribution given informed knowledge, workplace experiences and updated qualifications.

[26] For the purposes of this report, the mature age students are those aged 21 plus at their point of enrolment. This includes those students who could be categorised as those seeking an upskill or reskill opportunity, based around their individual needs for a change of career and / or lifestyle direction. They include both undergraduates and postgraduate coursework students.

[27] Post-secondary defined as those who entered into Higher Education within three years of completing their secondary studies.

[28] This segment may grow significantly in the light of recent events as well as the investment in infrastructure as a vehicle to recreate economic momentum

- Approximately one-third of the mature age students had been forced into an Engineering course because of circumstances outside of their control. These included those students who had been subject to redundancy, the completion of tenure (e.g. ex-ADF), completion of major infrastructure projects[29] and changing personal circumstances[30]. This particularly applied to Masters by Coursework students seeking to specialise and / or acquire additional skills relevant to newly evolving next generation industries.

- The mature age students were predominantly motivated by a) access into a course of interest, b) convenience of location, c) entry criteria / requirements[31] and d) the overall investment required[32]. Point d) particularly applied to those who had significant personal commitments, including employment, finances and family.

  Brand status had less traction with this segment than was evident among post-school leavers. There was also a much greater appreciation about the equivalency of different education providers vis-à-vis the overall quality of education, as opposed to reputation in terms of graduate outcomes.

- A critical consideration for the mature age students was their ability to transition from a workplace environment back into education. This was particularly the case for those mature age students who have not been working in an Engineering-related field (for many years), despite having an Engineering background, given their concerns about their ability to work with some of the new technologies and applications.

- Aligned to the above, several mature age students observed that they possessed extensive work experience and therefore, were slightly concerned that any form of internship or placement programme may not recognise their breadth and depth of experiences and skillsets.

- As a general observation, several mature age students observed that academic staff do not always recognise the different types of personal circumstances and workplace / industry experiences which apply to these students and instead, tend to adopt a more holistic approach including a focus upon younger students. Whilst acknowledging that they could adapt their thinking and approach given their maturity, there was still some frustration that the sense of inequality was somewhat lacking at times.

[29] E.g. Natural Gas and similar resource investments.
[30] This included several students who had returned to Australia following an extended period abroad.
[31] This included several references towards recognition for prior employment experiences.
[32] This included the ability to offset costs.

School teachers and career-advisors

- As a general observation, the school teachers were more aware of different career and study options around the Sciences and to a lesser extent, technology-related disciplines. Whilst acknowledging that Engineering represents a strong career pathway and, in realising that there are many fields within the broad Engineering genre, their knowledge of different fields was limited. Their knowledge mostly revolved around Mechatronics[33], Civil, Chemical, Software / IT, Automotive and Mechanical. Few references were volunteered around Systems, Electrical and Electronics per se.

- Most teachers reported that the students most suited to Engineering were those who were strong in Physics, Mathematics and Technology-related disciplines. Several teachers taught Engineering programmes, although the focus was generally around an Engineering project, involving such fields as Robotics, Devices, Models, Recycling etc.

- Upon secondary probing, teachers tended to refer to fields of Engineering application rather than a discipline per se. These fields of application were also viewed as areas where future career opportunities would be greatest, given such influential factors as climate change, pollution and renewables. Consequently, the focus tended to be around such fields as Environmental, Robotics, Renewables, Driverless Vehicles, Photonics, Medical Equipment and Advanced Manufacturing.

- Few of the teachers referred to the opportunities presented by major infrastructure projects. Whilst fully aware of what types of projects were in train, where they were located and that infrastructure investment is a global phenomenon, their perspectives tended to be more localised, including those industries relevant to the area where the school is located.

  Further, when the scale and scope of these major infrastructure projects was presented in terms of the types of opportunities and skillsets required, there was strong agreement that these need to be better communicated to schools through opportunities for students to gain first-hand exposure.

- The career-advisors had a generally strong understanding of the broad Engineering disciplines, although their focus was more around the disciplines offered by universities, rather than the specialisations which could be undertaken later in the course of a student's studies.

[33] This was often based around the different types of school-based competitions

All of the career-advisors were aware of Mechanical, Civil, Chemical, Software, Environmental, Mechatronics, Electrical and Electronics. Some were also aware of more niche streams, such as Mining and Resources, Structural, Materials, Automotive, Communications / Telecommunications and Aeronautics / Aviation. Some references were made to Robotics and Artificial Intelligence, with these references not necessarily aligned with more overt fields such as Mechatronics.

- The career-advisors were asked how they would prioritise where they would recommend a Year 12 student chooses to study. Invariably, feedback suggested that career-advisors lean towards those universities which have a strong reputation in a particular field and, those universities which allow a student to maximise their ATAR, based around the fact that some universities have higher ATAR requirements than others. These higher ATAR requirements were often associated with greater brand status and reputation, as well as better facilities, industry connections and graduate outcomes.

- Most of the career-advisors were aware of the different streams offered by universities and a general understanding of how an Engineering qualification is structured in terms of the pedagogical model. They were also aware of the types of subjects which would best enable access into Engineering, although there was some confusion about whether some subjects were needed to pursue a particular field[34].

- The evident gaps in the career-advisors' knowledge were two-fold: a) the diversity of careers within which engineers can now work and b) the types of specialisations and therefore opportunities which Engineering graduates can pursue. Whilst the career-advisors were more aware of broader applications such as Robotics, AI and Renewables, a more in-depth awareness and therefore understanding was generally lacking. This included no references being made to rail infrastructure, LPG gas pipelines, intermodal transport systems and other such niche specialisations. Instead, the focus was more around production, AI, VR and construction.

- The career-advisors tended to streamline Year 11 and 12 students according to whether they were more suited for the Sciences or more suited to the types of disciplines associated with 'Physics' (i.e. Engineering). This was a notable skew and highlighted a high level of compartmentalisation and direction, based around an individual student's strengths and interests and therefore, not a platform for recommending alternative fields.

[34] E.g. Chemistry in order to study Chemical Engineering.

Further, in the author's opinion, this highlighted the extent to which career-advisors are focussed upon broader subject choices and academic performance, as opposed to participation in broader activities at school such as performing arts, creativity, debating, literature, leadership, volunteering and community projects.

- The career-advisors were aware of the different types of degree options available to students, including Double Degrees. That said, awareness of these options was often based around how they perceived different universities[35].

  It was further apparent that most career-advisors and to a slightly lesser extent, teachers, recommended Double Degrees as a means of choosing a particular option in the event that one degree stream proved more difficult and / or less enjoyable than the other.

  Few references were made to the benefit of one degree such as Business, complementing and enhancing the future career opportunities then available to Engineering graduates.

- Although the teachers and career-advisors were aware of future international career opportunities, this did not feature strongly in terms of how they would advocate students choose a particular field.

  When asked about what types of international employment would be more likely to attract Australian graduate engineers, responses tended to reference more 'local' industries such as aviation, production, utilities and telecommunications.

- Both the teachers and career-advisors were strong advocates of any opportunity for STEM students to a) engage in projects which have a strong technical / scientific orientation and b) attend on-campus events, including open days, careers seminars, competitions etc. Further, most participants referred to the importance of seeing 'first hand' the types of facilities and resources which are available to students and in the process, meet with university students, academics and researchers.

Employers and industry opinion leaders

The author acknowledges that employers and industry opinion leaders were not part of the brief. However, as the project evolved, it became increasingly apparent that this segment can have a direct influence on future Engineering pedagogy, based around the types of specific skills employers require and the attributes which they both need and expect from prospective graduates.

[35] E.g. many references were made to both Monash University and UQ within the Double Degree space. Equally, Deakin University was strongly associated with trimesters as a point of difference.

Most employers lamented the demise of traditional graduate entry programmes since these were viewed as an ideal vehicle for equipping graduates with a broad range of skillsets. Instead, most participants observed that industry is now seeking graduates with the competencies to 'hit the ground running' in terms of directly applying specific capabilities within a role which is often associated with a specialisation. Therefore, there was a high expectation amongst employers and industry opinion leaders, that graduates must possess both workplace experiences and, the ability to fit immediately into an environment or field which could be regarded as specialised[36] (as distinct from generalised[37]).

This led to the types of employability attributes which enable industry immersion, with the following reported as high-level responses:

- Appreciation of all risk principles
- Business management skills
- Continual desire to acquire new knowledge and understandings
- Enterprise aptitude
- Global / external perspectives
- High levels of creativity
- Problem-solving capabilities
- Strategic thinking
- Strong communication skills
- The ability to identify new ideas, applications and opportunities
- The ability to multitask – qualities associated with workplace agility and flexibility
- The ability to rapidly grasp concepts[38]
- The ability to see the whole picture
- The desire to problem-solve and apply lateral thinking in terms of solutions
- The ability to plan strategically

The industry participants were asked to identify those attributes which should feature in any future Engineering programme. This resulted in various patterns of response, some of which appear unrelated to core Engineering qualifications but still deemed relevant. These included the following observations:

- Broad technology capabilities
- Business and people management skills
- Business communications
- Comprehensive understanding of digital media
- Core financial capabilities
- Leadership
- Market and data analytics

[36] E.g. smart manufacturing, automation.
[37] i.e. broader infrastructure development, consulting.
[38] This was considered particularly important for SME and larger organisations engaged in major projects

- Problem-solving within complex project settings
- Project planning and mapping – the whole picture
- Teamwork and team building capabilities

Many industry participants observed that whilst theoretical content is important within the curriculum, future Engineering pedagogy must focus upon replicating the types of environments, projects and settings within which future graduates will work. Hence the importance of access to incubators and hackathons.

This will have a direct impact upon how industry endorses future qualifications. There was also an underlying concern that not all Engineering programmes offer a comprehensive understanding of entire Engineering systems, reflected by the types of projects and challenges which Engineering students will eventually face on a scale far larger than that which can be produced within a university context.

There were many individual attributes which the industry participants referred to that mirrored some of the commentary from the students themselves. This included references to qualities associated with situational awareness, cognitive wisdom, emotional intelligence, resourcefulness, curiosity and empathy – factors which are captured in some of the student commentary around Social and Human Engineering. This is clearly a factor which will gain resonance over the next few years, particularly in response to recent COVID-19 events[39].

The employers and industry participants were asked for their opinions regarding future workplace dynamics as they impact the next generation of Engineering graduates. These are captured in the following points:

- A substantial proportion of graduates will be employed on specific projects, often on a short-term basis. Consequently, they will need to demonstrate a wide range of personal skillsets to succeed within the *gig* economy, which includes the ability to source new opportunities, build new networks, apply enterprise and business management capabilities and, rapidly move between different environments[40].

- The ability to switch between different ecosystems, appreciate cross-collaboration and know how best to apply creative attributes through problem-solving and lateral thinking.

- Graduates will need to constantly acquire subject matter expertise to remain both relevant and up-to-date in the workplace. Such subject matter expertise extends to both technology capabilities and qualities associated with both business processes and human interactions[41].

[39] The author acknowledges that the diversity of the aforementioned fields will take time to develop and consequently, will require staged introduction and development across different Engineering programmes.
[40] i.e. transition between different industries, locations, workplace settings and roles.
[41] E.g. cross-cultural communications.

- Graduates will need to be both locally engaged and globally aware. By local, graduates will need to relate to immediate market conditions whether around industry, vocation and dynamics; whereas global requires an understanding of different cultures, economies, environments and workplace settings.

- Graduates will increasingly need to work within environments that require the ability to multitask, particularly given that the majority of roles will be within SMEs – even if these SMEs are engaged in largescale enterprises and projects. This extends to graduates who may elect to enter the start-up space.

- There are two ways of interpreting multitasking. The first is through a wide combination of applied technical skills and capabilities and the second, is to provide the types of support associated with areas as diverse as customer services, finance, marketing and promotion.

- Graduates will constantly need to build a portfolio of experiences, skills and competencies in order to remain differentiated. Whilst some participants observed that there remains a shortage of Engineering graduates per se, employers still cannot afford to compromise upon the types of skills and competencies which are needed to progress with the shift towards next generation industries and specialisations.

- Graduates will need to possess several core attributes as 'given'. When this issue was probed, examples included *design thinking* qualities, the ability to comprehend *data analytics*, the ability to apply all forms of *digital engagement*[42] and, the latest *technology applications*.

All of the employers and industry participants referred to the importance of ensuring that graduates possess the ability to work within next generation industries and applications. Numerous examples were cited which for illustrative purposes included the following:

- Advanced manufacturing systems
- Defence systems
- Driverless vehicles
- Fabrication systems[43]
- Immersive technologies[44]
- Marine systems and technologies[45]
- Materials[46]

[42] This includes communications, marketing, networking, business interactions etc.
[43] Stated in reference to construction
[44] E.g. 3D applications, special effects
[45] Several references were made to the submarine project.
[46] E.g. carbon fibre, composites

- Medical devices
- Rapid intermodal transport systems
- Recycling
- Renewables[47]
- Robotics
- Smart cities
- The automation and AI landscape[48]

To enable a more comprehensive understanding of different industry settings and specialisations, several industry participants referred to the importance of having partnerships with organisations that are engaged in next generation space. This included the provision of on-campus incubators and 'hackathons', as well as the importance of university / industry partnerships through technology parks – thereby providing direct access to diverse applications[49] and internship opportunities.

As a closing point, most of the employers and industry participants observed that whilst an Engineering qualification provides a solid platform for entry into multiple industries and occupations, the next generation of programmes need to cater for a world which will demand specialisation, based around the diverse range of applications where Engineering qualifications are applied. This not only includes Engineering per se but fields where core Engineering attributes can play a pivotal role in the development of such applications as smart-cities, automation, logistics and processing.

Consequently, most participants suggested that Engineering is best suited as a Double or Dual Degree option, not necessarily in conjunction with such broader domains as Business but rather, complementary technology fields such as design, construction, urban planning and computer sciences[50].

[47] The ABS reports that the full-time equivalent number of jobs between 2018 and 2019 increased by 5,700 positions to reach an overall figure of 26,850. This included 72% growth in Victoria and 41% in South Australia. The CEO of the Clean Energy Council, Cane Thornton, stated that 'the ABS data is an excellent illustration of the tip of the iceberg of what is possible in the renewable energy sector in terms of employment'.
[48] E.g. including VR and AR
[49] Examples included Curtin University, Deakin at Waurn Ponds.
[50] One of the project stakeholders observed that Double Degrees may benefit from a linking course in which elements from both degrees have to be combined to provide additional context for the purposes of complementarity. Based upon the general sentiments provided by the industry opinion leaders, together with other empirical studies, the author would endorse this observation.

5

PART THREE: TARGET AUDIENCE SEGMENTS

There were several key outcomes informed by the research which help to clearly segment the future market for Engineering qualifications and, shape the messages which need to be incorporated - messages that successfully match the values, needs and expectations of prospective students. These target audiences segments allow the core Engineering proposition to be supplemented by separate messages that appeal to different cohorts based around their individual drivers to choice.

Based around the field research results, the broad genres need can be segmented as follows:

- Year 11 and 12 students and first and second year university students

  The reason for combining these two audience categories is that the first and second year university students displayed similar drivers to choice as the Year 11 and 12 students. Therefore, their insights (whilst acknowledging that they are no longer prospective students) contribute to how Engineering providers need to engage with the promotion of future skills and competencies.

- Next generation audiences, including mature age students and students transitioning from VET

  This will constitute a significant market, particularly based around the economic, workplace and social impact of COVID-19. A large proportion of 'workers' will need to reskill and upskill, even those who already possess a Higher Education Engineering qualification or have the technical ability to transfer from past studies and employment into an Engineering discipline.

- Key opinion leaders[51]

  From the perspective of this brief, these opinion leaders include key influencers within schools and 'significant others' located as other sources of advocacy. These opinion leaders help to formulate the attitudes and perceptions of prospective students.

[51] i.e. teachers, career-advisors, advocates, parents

Year 11 and 12 students

Segment	Selection drivers	Core values	Needs and expectations	Areas of interest
Those strongly committed to studying Engineering	Reputation of the university in the core field Course structure, particularly in the first two years Industry profile and exposure to industry Quality of / access to facilities ATAR score / rankings	Many have family / friends who are Engineers Inherent interest in STEM subjects Practical applications To be engaged / immersed in projects[52] To be a proactive and worthwhile contributor to society To become actively engaged within a team environment To be challenged in both thinking and application Understanding the complete process	Highly focused academic structure around Engineering stream Opportunities to pursue a career within the specialist and preferential area A course structure which has a strong practical focus as well as theoretical content Opportunities to experience industry engagement and exposure Support with securing internships and placements	Generally more traditional fields Largescale environments such as infrastructure development Making an active contribution within a challenging setting – including activities that make a positive impact upon society Particular technology applications[53] Next generation concepts and developments, including alternative materials, designs and applications

[52] Often reflected by involvement in projects and competitions at school
[53] Driverless vehicles

Those who are strong in STEM but are only considering Engineering	To identify a course which will attract their interest and enable long-term motivation An opportunity to participate in a field which enables some form of differentiation via contribution Quality of / access to facilities A greater diversity of interests beyond Engineering (making more suited for Double Degrees) The actual university environment – sense of community, opportunities Extra and co-curricular opportunities	To feel part of a community, including university immersion / engagement Diversity of interests meaning that whilst Engineering is of interest, there are other options to pursue To build a portfolio of knowledge and experiences[54] To experiment, work on projects and new ideas To make an active contribution through volunteering, cause connections, networks and events	To maximise possible career directions and not necessarily be streamlined into a particular path Future opportunities to combine areas of interest To be flexible in terms of workplace settings and experiences, including travel	With regard to Engineering, greater inclination towards more specialist streams such as Environmental, Aerospace, Biomedical, Energy and Construction Secondary interests particularly based around other technical aptitudes such as Architecture as well as more specialised Business and Mathematics streams (e.g. Economics) Making an active contribution within a challenging setting – including activities that make a positive impact upon society

[54] This segment were particularly interested in mobility options

Those who are strong in STEM but are inclined towards the Sciences	Reputation of the university in the Sciences, including Medicine and Health Opportunities to undertake deep investigation Quality of / access to facilities including laboratories Opportunities to participate in research projects Research reputation, including rankings	Many have family / friends who are engaged in health, teaching and research Deep interest in certain Science streams, including Biology, Human Development, Health Team players To become an active participant and contributor inside and outside the classroom (i.e. research, volunteering) To make an active contribution through volunteering, cause connections, networks and events	Strong focus upon specialist Science streams Ability to access equipment, materials, facilities, projects Diverse university experience, including extra and co-curricular options, including mobility	All matters relating to health, including such specialist streams as Pathology, Immunology, Veterinary Sciences Scientific projects, although some evidence to show that this can extend into niche Engineering specialisations (highlighting Double Degree potential) Team-based projects, including those involving travel

Those who are good at STEM but are attracted into other fields	Reputation of the institution in general and across different fields Diverse course options, including those which cater for niche areas A broad mix of course options which can be combined through Double Degrees and / or as a broad course mix within a particular field Range of extra and co-curricular options, including mobility, volunteering, mentoring etc.	Highly diverse range of interests Attracted by new ideas Inherent interest in creating own opportunities, including building networks Deep interest in media – both content and applications To participate in team-based activities and events, including those which provide community benefit Attracted by new ideas and innovations	To be constantly challenged by pursuing areas of interest To acquire wide knowledge not only through learning but through experiences To have an opportunity to build and apply creativity whilst also establishing answers An interesting and diverse course structure with opportunities to participate in projects and research	Diverse fields covering a myriad of different topics Creative applications, including visual arts, performance etc. Strong predisposition towards travel experiences and other interactive / participative community events Worthwhile projects including those which contribute to community

Those who are good at STEM but do not view Engineering as a viable option	Reputation of the institution in general and across different fields Diverse course options including those which cater for niche areas Greater inclination to balance other activities (e.g. employment) and convenience of location with choice of institution A broad mix of course options, although more inclined to single stream Range of extra and co-curricular options, including mobility, volunteering, mentoring etc. Opportunities to experiment with different fields and ideas	Embrace diversity but generally more inclined towards a particular area of interest (e.g. graphic design, performing arts) Some evidence to indicate an interest in self-generated enterprises Attracted by new ideas and innovations Deep interest in media, both content and applications Independent learners High level of attraction towards those fields where family / friends are employed	Ideas to be presented to enable interests to be honed Exposure to a wide genre of fields, although inclined to ultimately specialise Different learning experiences Evidence of an interest in conducting research Opportunities to pursue individual interests and spark new ideas Whilst independent by nature, generally keen to build networks	Diverse fields but skewed towards creative ideas and opportunities To acquire knowledge which is not necessarily based around experiences and performance to date Greater willingness to undertake a gap year and potentially pursue VET The opportunity to become immersed into a future project or opportunity whilst unsure for now where that exists

Mature age and technical prospects

Segment	Selection drivers	Core values	Needs and expectations	Areas of interest
Those who possess a technical qualification and are looking to work in Engineering	Individual commitments, particularly around employment, finances and other personal circumstances Ability to study at a time and place of one's choosing – online potential Course structure and content which is attainable and appealing in general Confidence that the institution will match individual circumstances and needs (e.g. small class sizes, location) Clear guidelines as to potential outcomes – employment, income, industry etc. Understanding of mature age student dynamics	Established areas of interest To achieve greater employment and income security To reskill / upskill into a field of interest To maximise individual capabilities – build self-worth To escalate career path and therefore future opportunities To contribute to the greater social good	Career change Greater employment security To maximise opportunities around new investments (e.g. infrastructure) A formal qualification from a reputable institution To utilise education as a catalyst for change To pursue an inherent area of interest To work as part of a team on a worthwhile project	More focussed around the larger discipline areas (e.g. Mechanical) but less in deeper technical areas (e.g. Mechatronics) The size and scale of major infrastructure developments and opportunities Generally, one or two industry sectors and / or types of applications (e.g. aviation) Industries that support major Engineering projects (e.g. transport infrastructure)

			To be comfortable with the education environment, particularly as a mature age student To have a qualification that incorporates longevity and security	
Those who have an inherent interest in Engineering and whose circumstances have now changed[55]	Individual commitments, particularly around employment, finances and other personal circumstances Ability to study at a time and place of one's choosing – online potential Course structure and content which is attainable and appealing in general Confidence that the institution will match individual circumstances and needs (e.g. small class sizes)	To achieve greater employment and income security To reskill / upskill into a field of interest To maximise individual capabilities – build self-worth To escalate career path and therefore future opportunities To create alternative pathways	Career and lifestyle change Greater employment security, including employment within a more specialised field To maximise opportunities around new investments (e.g. infrastructure) A formal qualification in a field of interest To utilise education as a catalyst for change	More specialised fields of Engineering, including Environmental, Aeronautical and Marine The environment / appeal of major infrastructure projects Engineering fields which make a valuable community contribution

[55] This segment could prove significant in light of COVID-19 and the transformation which will impact both the economy and future workplaces

	Clear guidelines as to potential outcomes – employment, income, industry etc. Understanding of mature age student dynamics	To reconfigure life direction To be a valued part of the community	To pursue an inherent area of interest To work as part of a team on a worthwhile project To be comfortable with the education environment, particularly as a mature age student To have a qualification that incorporates known specialisations To reconnect and rebuild To study at one's own pace	
Those who have been employed within a technical capacity / industry but who do not possess an Engineering qualification	Individual commitments, particularly around employment, finances and other personal circumstances Ability to study at a time and place of one's choosing – online potential	Desire to remain in a technical role but with a greater professional / vocational focus To progress individual directions and opportunities	Career change / movement Greater employment security, together with future employment options	Engineering in general Generally, one or more technical aspects, often utilising specific equipment (e.g. CAD) Next generation industries and the associated opportunities

	Course structure and content which is attainable and appealing in general Confidence that the institution will match individual circumstances and needs (e.g. small class sizes) Clear guidelines as to potential outcomes – employment, income, industry etc. Understanding of mature age student dynamics	To reskill / upskill as a career reconfiguration To challenge oneself and embrace change To prove individual worth to oneself and significant others To become more deeply involved in experiences that matter To feel wanted and worthwhile (emphasis upon recognition)	To work within a team environment but not necessarily around scale (e.g. SMEs) A qualification which carries appropriate recognition To utilise education as a catalyst for change To be comfortable with the education environment, particularly as a mature age student To study at one's own pace	Often interested in a particular domain, including such fields as motor sports
Those who possess a VET Engineering / technical qualification but are not qualified engineers	Ability to study at a time and place of one's choosing – online potential Course structure and content which is attainable and appealing in general	To challenge oneself within an environment that is not necessarily conducive To create a greater sense of future security for oneself and significant others	Career establishment Greater employment security To be recognised as qualified engineer across all layers of employment	A broad genre of interests not just around Engineering applications but also different fields, sports, etc.

	Confidence that the institution will match individual circumstances and needs (e.g. small class sizes) Clear guidelines as to potential outcomes – employment, income, industry etc. Strong desire to maximise capabilities and therefore opportunities Recognition by the industry	To maximise one's own capabilities – personal, career, security etc. To feel wanted and worthwhile (emphasis upon recognition)	A formal qualification from a reputable institution To utilise qualification as a catalyst for change To be comfortable with the delivery platform, particularly as a mature age student To have a qualification that incorporates longevity and security To be a viable contender for future employment	General predisposition towards the established Engineering disciplines, particularly Civil, Mechanical and Structural Limited interest in more specialised domains such as Chemical

Teachers and career-advisors

Teachers and career-advisors play an important and influential role in the decision to study Engineering. Some of these can be classified as 'inspirational mentors' during the formative years of students, typically around Years 9 to 11. However, their role is not necessarily based around advocacy of Engineering per se but rather, through the articulation and promotion of STEM subjects at school and, helping to determine the broad fields of post-secondary study.

As a general observation, career-advisors are more associated with distributing information, from knowledge around open days, seminars and school visits; whereas teachers play a more instrumental role in helping students to hone their areas of interest and in the process, consider broader parameters and fields of study. Further, there was sufficient feedback to suggest that students can be influenced by where 'mentor teachers' themselves studied.

These points aside, it was apparent that most students still determine whether to study Engineering through their own volition. They receive information from multiple sources and many are guided into Engineering and Sciences in particular, based around the experiences of immediate family, close connections and friends. There is also the issue of natural aptitude based around exposure to different activities, industries and developments – exposure which occurs through school trips, visits to points of reference[56], school projects, competitions[57] and even visible trigger points[58].

An observation that was particularly apparent with both teachers and career-advisors was that whilst they are aware of Engineering qualifications in general and, such factors as reputable courses, programme structures, required industry hours etc., their knowledge of specialisations in terms of Engineering disciplines and potential fields of employment is quite limited.

The above pattern of response was particularly evident among the career-advisors and those teachers with more of a scientific leaning. Consequently, whilst important sources of information dissemination, their knowledge of scope and potential, particularly around new and emerging fields, proved far less overt.

Further complicating this situation is that many participants demonstrated 'established patterns of behaviour' meaning that they were less proactive in sourcing new information and ideas around next generation opportunities. Instead, their priority is more based around helping students to successfully transition between school and post-secondary education.

[56] E.g. Scienceworks, Questacon
[57] E.g. The Solar Challenge
[58] E.g. The Metro Rail construction

It was also evident that many career-advisors tend to be more 'prescriptive' in the way they engage with students by detailing options without necessarily understanding the values that determine the future drivers and motives of students. This is significant since the greater the impact of advocacy by career-advisors, the higher the risk that students may be steered in the wrong direction – particularly if combined with limited subject knowledge among career-advisors[59]

Another factor impacting the levels of awareness and perceptions amongst teachers and career-advisors is that many appeared 'time poor' in terms of conducting their own independent investigation into alternative careers and study options. In this regard, the best available option for reaching this audience is to provide avenues for exposure through such vehicles as professional development days and study tours, rather than the distribution of marketing and communications collateral ad nauseum[60] .

One final and particularly important observation is that whilst teachers and career-advisors are important sources of awareness, information and perceptions, they also act as a potential barrier to progress. There were many suggestions to indicate that teachers and career-advisors stream students into what can be described as 'hard' disciplines (i.e. Engineering, Construction) and 'soft' disciplines (i.e. Sciences, Mathematics). Whilst not expressed in such terms, in the author's opinion, there may be some gender orientation in terms of where male and female students are steered by some school advocates.

Given all these considerations, it is clearly imperative that STEM teachers and career-advisors need to be equipped with a much greater grounding and information basis for steering prospective students into both current and future Engineering disciplines. This information needs to be supported by knowledge of both the types of Engineering specialisations which today's generation of students can access, how these specialisations can be leveraged following a broad Engineering foundation and, the types of industries and opportunities which Engineering graduates can access. With regard to future opportunities, the emphasis must include a focus upon next generation industries and roles.

There are several core activities which could be immediately implemented to augment the understanding of teachers and career-advisors about the opportunities presented through Engineering, all of which need to be endorsed by primary messages that articulate future potential. Based upon the observations of teachers and career-advisors, those information resources which would prove particularly useful, from a broad Engineering platform as opposed to specific institutional campaigns, are as follows:

[59] This is not just restricted to Engineering but also many other disciplines which have experienced significant change over recent years – the levels of which make it near impossible for career-advisors to remain fully updated and informed.

[60] During the course of the research, the author attended several careers seminars and it became evident that the career-advisors were mostly intent upon the overall class dynamics, rather than the content of what was being distributed.

- A dedicated portal which highlights both diversity and the weight of future opportunities available to future Engineering graduates.
- Information days which include presentations and workshops with industry.
- Enquiry management systems which enable schools to strengthen their knowledge base around such considerations as entry criteria, alternative entry and access mechanisms[61], competitions and events.
- A national Engineering graduate mentor scheme which aligns graduates with schools nationwide.

In articulating the messages about future Engineering studies, the emphasis must be upon the wealth of new industries that require Engineering capabilities, far beyond the more obvious fields of Civil, Mechanical and Structural. Further, the messaging must not only focus upon largescale applications, such as infrastructure projects but, what could be interpreted as more intricate applications such as robotics and medical devices. For this reason, any activity targeted at schools and which involves industry exposure, should also extend to different ends of the Engineering scale.

Aligned with the aforementioned point is that Engineering should be positioned not only as a stand-alone discipline but as a joint discipline. Many students reported that they had been steered into Engineering Double Degrees with such disciplines as Economics, IT, and even International Relations by their school; whereas many of the industry participants reported that whilst some of the business-type knowledge can be acquired through day-to-day applications, Engineering graduates would benefit much more from complementary areas of expertise. Examples included graphic design, creative industries, data analytics and industrial design.

[61] E.g. portfolio entry.

6

ANALYSIS AND REVIEW

The core objective of this project is 'to promote to future students the diversity of opportunities and possibilities available to Engineering graduates'.

In undertaking the field research, the core challenge appears to be around the various distinctions and interpretations of Engineering across different audience segments. This impacts how Engineering is both positioned and perceived. For example, many students decide between pursuing STEM disciplines which may provide access to external environments and large-scale settings[62] and those STEM and STEAM disciplines more associated with predominantly internal and more specialised environments[63].

Equally, there are significant gaps in terms of how Engineering itself is viewed by various cohorts, such as those who look towards more traditional fields and, those who are attracted by a unique specialisation. There is even a newly emerging cohort who view Engineering through a different lens given their bias towards such applications as Social and Humanitarian Engineering.

Another differential is scale. Many of the secondary school students associated Engineering with largescale projects such as infrastructure development, construction and production; whereas other segments viewed Engineering from more niche applications around such disciplines as Mechatronics[64] and Software.

Engineering is considered both a profession and vocation. There is a definite cohort who choose Engineering because of self-interest, individual strengths and the advocacy and experiences of significant others. There are many students who are steered into Engineering by virtue of their ATAR scores and impressions gleaned from events and exposure, such as school visits and Open Days. And there are others who choose Engineering based around their performance in particular subjects at school.

Despite these points, there were several significant top-line outcomes which need to inform the future promotion of Engineering.

- Most of the student participants had narrowed their fields of interest and had rarely considered the raft of alternative streams and specialisations which could be pursued as a focus for their Engineering qualification[65].

[62] E,g. construction sites, production plants, transport hubs
[63] E.g. laboratories
[64] This included such areas as miniature robotics and human implants
[65] Various empirical studies have shown that a large proportion of students either choose to redirect their focus or select alternative subjects, based around their experiences once at university – a situation which is

- Many of the specialist streams were not automatically associated with Engineering and at times, were confused with the Sciences[66].
- Many of those who are considering other STEM subjects at university, had been steered into alternative options and appeared to have not given sufficient consideration to the diversity of Engineering options now available.
- There was a general lack of awareness about how many non-seemingly Engineering professions can actually be characterised as both Engineering-led and as requiring Engineers[67].
- Invariably, future employment opportunities among students were more associated with large Engineering organisations, including multinationals; as opposed to niche organisations, SMEs and start-ups.
- Direct exposure proved to have a significant influence upon the decision to give Engineering serious consideration. Such exposure includes the experiences of significant others[68], high impact events[69] and participation in projects and competitions.

A notable consideration is that most university participants only demonstrated awareness of different employment and industry outcomes once they were well-established on their Engineering degree – their initial priority being to navigate the various challenges associated with first year university studies, such as different pedagogical requirements and expectations[70].

Few of the Year 11 and 12 students, as well as first year undergraduates, made unprompted mention of careers in such fields as renewables, recycled materials, smart manufacturing, bionics, immersive technologies and medical devices. Instead, any references to these fields was prompted and when discussed, was often attributed to IT, design, creative industries and health sciences.

There continued to be some alignment between school subject strengths and the choice of education discipline. This follows empirical patterns. For example, Physics was often associated with Mechanical Engineering, Technology with Electronics and Mechatronics and, Chemistry with Chemical Engineering. Those Year 11 and 12 students who were reportedly strongest in these fields, appeared more determined about their preferred Engineering stream.

especially evident amongst international students, given the poor advice which most international students receive within their home market.

[66] E.g. Environmental, Bio-mechanical, Bionics

[67] E.g. intermodal transport systems, supply chain logistics

[68] Notably parents

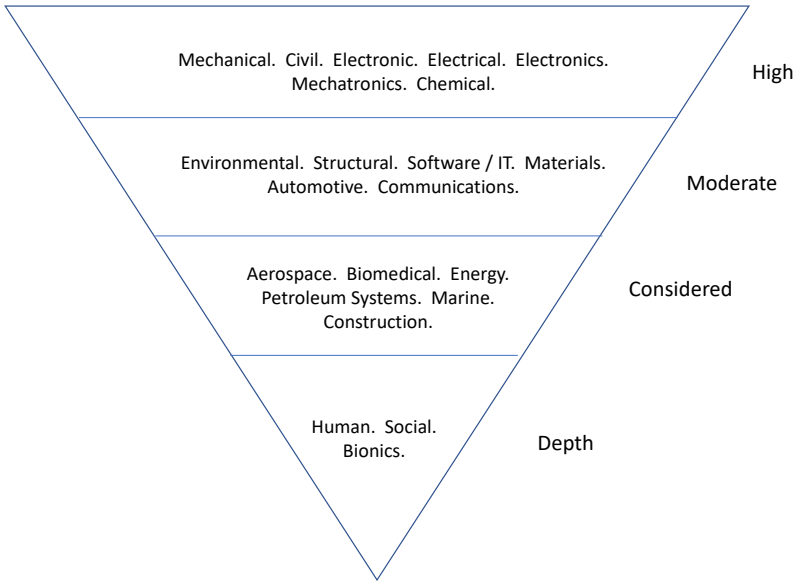
[69] E.g. industry tours

[70] E.g. referencing.

There was good overall awareness of the benefits of Double Degrees, although the general pattern was to view Double Degrees as contrasting disciplines, meaning disciplines that complement one another, rather than expansive combinations, meaning that the second degree can be used to augment the Engineering qualification. This was often based around the recommendation of career-advisors, peers and significant others.

The different Engineering layers illustrate how Engineering streams have evolved over recent years. Figure 6.1 shows how different Engineering tiers have evolved and interestingly, there were some gender skews against each of these four categories. For example, the 'high' and 'considered' Engineering fields were considered more the realm of male Engineers[71], whereas the 'moderate' and 'depth' fields were more equally balanced between both male and female students. Whilst this may appear politically unpalatable, it signals an opportunity to undertake schools-based campaigns to address any perceived imbalance.

Figure 6.1: the most cited fields of Engineering by Year 11 and 12 students and first year engineering undergraduates

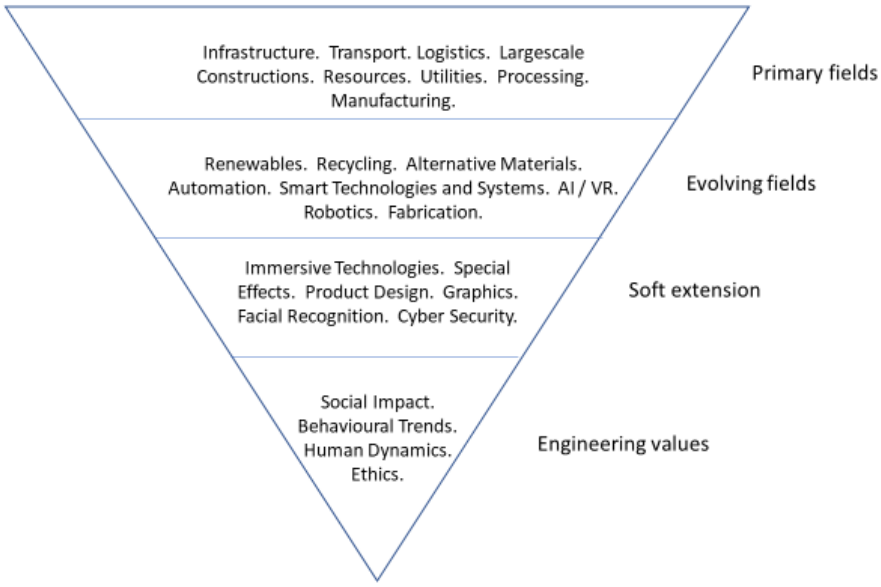


Whilst Figure 6.1 was built upon observations from the research participants, most participants were only able to cite up to half of the number of specialist streams. This signals the significant potential for a communications strategy that demonstrates both opportunity and diversity.

[71] This may be a reflection of the proportion of academic staff in various disciplines who may sit within the one gender category.

In Figure 6.2 a similar pattern emerged in terms of the different applications and environments vis-a-vis future career and employment opportunities. In many instances, there is a direct correlation between the four categories of application (Figure 6.2) and the four levels of Engineering disciplines (Figure 6.1).

Figure 6.2: The fields of engineering employment which Year 11 and 12 students and first and second year undergraduates most identified with



Many of the newer fields of both study and employment are associated with school-led experiences. For example, various Robotics challenges and events have escalated awareness around Mechatronics. Similarly, high awareness of environmental issues has impacted how the environment is perceived from a scientific, technological and engineering[72] perspective.

In addition, advances in technology have enabled prospective students to consider an even greater focus towards alternative applications and this was reflected by some of the insights from the research. One such example was that in addition to Automotive Engineering[73], several of the university students suggested a branch of Engineering specifically dedicated to driverless and hybrid vehicles.

Throughout the research, participants used the term 'smart' from multiple perspectives – systems, technologies, software, cities, transport, homes etc.

[72] This was reflected by insights regarding renewable energies, the construction of largescale water and renewable infrastructure and the move towards hybrid vehicles.
[73] This was more commonly associated with developing nations.

Several Engineering specialisations lacked overall awareness. This particularly applied to Energy[74], Systems[75], Communications and Marine. In addition, there were several disciplines where there was some confusion about whether specific disciplines constituted Engineering fields, such as Biomedical, Software and to a lesser extent, Construction.

The one Engineering field which students had difficulty identifying as an Engineering discipline was Biomedical. Once the Biomedical field was explained, participants were far more comfortable associating it with an Engineering discipline. This illustrates the importance of promotion and articulation around different streams to both prospective students and their opinion leaders.

Although references were made to Communications, hardly any participants used the term 'Telecommunications'. This is indicative of generational attitude / terminology change and not the demise of the field.

Few references were made by participants to such fields as Food, Nuclear, Biological and Control Engineering – despite when probed, these were all fields considered relevant.[76]

The VET students and graduates warrant consideration. In terms of originally choosing their course, this audience was less invested in the status of Engineering. For most participants, their initial intention was to access a course which would then lead to employment outcomes, given their individual circumstances.

Few VET category participants had given Engineering serious consideration as a Higher Education option, VET was generally their preferred destination for such reasons as location, recommendation, smaller and structured learning and, a less academically intense environment.

Consequently, this segment could potentially represent a difficult group to reach at secondary school level. However, they still represent Higher Education potential. The fact that they have completed a qualification, whether a Diploma, Associate Degree or Higher Education award through a VET provider, is sufficient to indicate that their levels of self-belief and therefore, confidence in undertaking a university degree would now be more enhanced. This is an important segment for future marketing and engagement, particularly around the upskill and reskill space.

One outcome which resonated throughout all target audiences was the importance of building awareness and perceptions from an early age. This would provide early and formative insights regarding the wide range of fields, specialisations and opportunities available to Engineering graduates, including those which reside within the next generation industries, environments and roles.

[74] Including petroleum.
[75] As opposed to Control which was never mentioned
[76] The exception was Control which by definition participants did not understand

Even though the quality of materials has improved significantly over the past decade, the promotion of Engineering has not necessarily conveyed the full scale of opportunities available to graduates.

A priority has also been the conversion of secondary school students into Engineering, whereas there are many other segments which represent potential for the discipline. These include those students who fall within the upskill and reskill segments and who possess good technical and employment experience and, those who are now seeking a change in terms of their career and life development.

The new world order post COVID-19 will also lead to the rapid escalation of new industries and opportunities as organisations across all levels utilise these recent events as a catalyst of change. This may compel many prospective students to refocus their future intentions and utilise the years of repair to reorientate their lives.

To conclude, the promotion of Engineering needs to extend beyond the articulation of Engineering as a core discipline. Promotion needs to capture the diversity of opportunities, roles and locations which an Engineering qualification can potentially afford. This includes promoting both the core disciplines which have underpinned Engineering per se, and supplanting this with the many fields, technologies and applications which are relevant to a post-COVID-19 world. The current time provides an ideal opportunity to rethink and reset Engineering curriculum.

7

MARKETING AND COMMUNICATIONS

The core objective of this project is 'to promote to future students the diversity of opportunities and possibilities available to Engineering graduates'.

Therefore, unlocking the key to future marketing and communications is not necessarily to promote Engineering per se but rather, to find a values-fit between the many options available and the different target audiences. The segmentation of these audiences needs to be based around their circumstances, knowledge, perceptions, needs and expectations.

This will require, in future, an even more diversified approach to the promotion of Engineering utilising such assets as social media, partnerships, professional development for teachers, competitions, events, career seminars and exhibitions.

The focus for Engineering promotion must reflect the diverse values and interests of prospective students. These may cover anything from a fascination for large-scale infrastructure developments to an inherent interest in environmental factors (e.g. Renewables, Recycling). Future promotion will even need to reflect evolving values such as the human dimensions associated with Engineering (e.g. Social Engineering).

There needs to be core marketing communications which attract the majority of students around the broad nomenclature of Engineering. However, it became apparent that part of the core premise is to educate prospective students, whether school leavers or mature age candidates, across the range of applications and opportunities available to students to both illustrate potential and create enticement. Therefore, future marketing and communications needs to be aligned with target audience categorisation and sentiment, as reflected in the following audiences:

- Committed
- Considering
- Capable
- Wavering
- New direction
- Influencers

There are various aspects to each of these audiences which the research identified:

Committed

These are prospective students who are committed to the field of Engineering based around a combination of factors, including aptitude[77], external influence[78], personal interests and an inherent alignment with one or more fields within the Engineering nomenclature. This audience needs to be presented with the diversity of options and specialisations from an early stage.

Considering

These are prospective students who consider Engineering a viable option but who may either be attracted to different fields of study, such as the Sciences and / or who may be resistant to Engineering, based around the length of time it takes for an Engineering graduate to fully qualify[79]. Some of the requisite subjects involved in Engineering may also be a detractor. The focus for this audience is conversion.

Capable

These are prospective students who possess the core qualities and attributes to study Engineering but who are leaning towards alternative fields of study whether through personal motive and course attraction. They are also highly impacted by the influence of significant others. This is a high priority audience.

Wavering

These are prospective students who may have once considered Engineering but who have since been persuaded to pursue an alternative path due to the influence of peers, social media and significant others. The alternative path is in part a reflection of the challenges and limitations associated with Engineering; and, the opportunities which may be available in other domains. This is an audience which requires personalised interaction and engagement through events, exposure and mentors.

New direction

This is a largely untapped market, one which has been traditionally associated with VET qualifications. These are prospective students who possess the skills and capabilities to study Engineering but who are restricted by external circumstances which influence their decision-making. Consequently, these prospective students may look to Engineering as a catalyst for change and therefore, the Engineering option may need to be available 24/7 via blended and online delivery. This audience will need reassurance that the pedagogical model can be adapted according to their needs.

[77] i.e. favoured subjects whilst at school
[78] i.e. the input of family and friends
[79] This includes the subject commitments such as compulsory elements and the number of internship days.

Influencers

Influence has played a significant role in forging the attitudes and perceptions of most prospective Engineering students. To a large extent, this is based around qualities and performance of students at secondary school level. However, it became evident that influencers, particularly at school level, lack depth knowledge to adequately inform and direct students around the next generation opportunities and fields associated with Engineering, including the diversity of careers and industries within which Engineering graduates can work.

•

Most marketing and communications strategies are based around the core elements of promotion, given the needs and expectations of different target audiences. This has been reflected by empirical evidence which shows that Engineering has predominantly been built around the potential afforded from a Higher Education Engineering qualification. These strategies have traditionally included promotion of core disciplines, the alignment of quality with ATAR scores, facilities and resources, unique specialisations, work integrated learning opportunities, attractive First Year structures and, the reputation of individual institutions within Engineering, and specialisations therein.

Most prospective Year 11 and 12 Engineering students and those who could study Engineering but are considering alternative options, know that Engineering as an option exists. They also demonstrated a clear understanding of which universities offer Engineering and had forged perceptions regarding the strengths and weaknesses of these institutions.

Therefore, the future promotion of Engineering should also be built around the articulation of how many avenues and opportunities are available to Engineering graduates, including the size and composition of prospective employers (including SME's and start-ups) and, those outcomes which are not immediately associated with Engineering. This includes fields as diverse as Bionics, Communications, Human Impact, Environmental, Medical and Renewables.

The potentially wider introduction of niche fields such as Social and Humanitarian Engineering also introduces an aspect of Engineering to a market segment which may be well qualified in STEM but which has a predisposition to studying such disciplines as Arts and Humanities.

Given these considerations, the articulation of Engineering, particularly within schools but also across other segments, needs to incorporate the following, all of which need to stimulate both *opportunity* and *imagination*:

Core marketing activities

- This involves the promotion of Engineering through the introduction of those core disciplines which underpin the discipline, including the promotion of Mechanical, Civil, Electronics and Electrical.

  Aligned to this promotion is the introduction of other specialisations which are generally positioned within the top awareness tier of Engineering qualifications, including Chemical, Environmental, Structural and Mechatronics.

- A clear articulation of the process involved with acquiring an Engineering degree is important, including core subjects and other activities / metrics such as the number of internship days and common First Year subjects.

- Any future promotion needs to include narrative as to the importance of Engineering in terms of economic progress[80] through infrastructure, largescale constructions, transport and responsiveness to next generation industries. This is to facilitate a connection between investments that may not necessarily be associated with Engineering but where Engineering fulfils an integral role.

- There is a strong argument to suggest that engineering should be promoted as a discipline that makes the world a better place. Engineers are equipped with the skills and competencies needed to respond to challenges and alternative environments. This will require a nomenclature that captures the entire engineering ecosystem and then align that nomenclature with outcomes.[81]

- It could be suggested that whilst there are various structural aspects in terms of Engineering curriculum, influenced by *cultural beliefs* that reinforce this behaviour, new curriculum can only emerge from next generation thinking, innovations and ideas. This includes having people who possess extensive industry and applied application experience and, who still possess the ability to research and teach.

Specialisation

- The research identified that whilst the interests of prospective Engineering students are many and varied, including among those candidates considering other disciplines (e.g. Sciences), the overall knowledge about specialisations and the association of these specialisations with particular industries, appeared quite limited.

[80] As well as recovery and renewal
[81] *E.g. Invest in Futures*

Therefore, Engineering must be positioned as front and central for fields which include the 'hot' topics, such as Renewables, Environment, Medical Devices, Smart Technologies, Communications, Robotics, AI and Computer Sciences. New fields of Engineering should also be incorporated into the dialogue such as Social Engineering.

- Engineering should be promoted as an innovation qualification, specifically, a qualification which positions Engineering as pivotal in the development of new technologies, industries and careers.

- Engineering should be positioned as a global opportunity, meaning that Engineering graduates are well positioned to transition between different locations, industries, workplace environments and roles.

- Engineering has traditionally been associated with students and graduates who have pursued what some participants described as a *linear* approach to learning, meaning that a focus for learning has been the acquisition of theoretical knowledge.

  Engineering needs to be promoted as a highly creative field. The promotion of creativity and ingenuity as integral features of Engineering will contribute towards growing market share. These qualities will help diversify and expand the potential prospect pool.

<u>Positioning</u>

- Engineering must be promoted as a progressive and dynamic field, which is no longer just associated with traditional disciplines. Whilst there will always be a cohort who are attracted by such areas as Mechanical, given their strengths and interests in Physics, Mathematics etc., Engineering must be promoted as equally attractive for those who are orientated towards scientific and creative fields.

  This can occur through a focus upon both the macro (i.e. infrastructure, largescale projects) and, the micro. The micro includes fields which are more associated with precision applications and those fields where there is a cross-over between both the practical aspects of Engineering and the theoretical and applied concepts behind such disciplines as Health Sciences.

- Engineering is ideally suited for Double Degrees, although these Double Degrees have often revolved around automatically aligned fields and those which can be viewed as complementing Engineering (e.g. Business). However, there are many aspects of Engineering which can be augmented by more technically oriented streams such as immersive technologies, special effects, automation, CAD systems and design; as well as those fields which provide a human dimension such as communications, HR and the arts.

- Engineering has generally been viewed as an applications-led discipline, meaning 'meccano-type concepts'[82]. Whilst there are core elements which contribute towards the DNA of an engineer, such as design thinking and project planning, Engineering must be promoted as both a solutions and creative field – with creativity not only based around such qualities as inventiveness and design but also, the skills associated with enterprise, creativity and innovation.

- The core channels to promote Engineering as a Higher Education qualification are already established through websites, social media, Open Days, school visits, competitions and events. However, whilst these channels are effectively managed, the real issue is messaging because today's promotion is based around *access* rather than *outcomes;* whereas outcomes can be used to instil the inspirational notion of *new horizons and opportunities.*

Articulation

The marketing of Engineering has traditionally been supply-led, namely the presentation of the range of options available, ATAR requirements, facilities etc. Promotion has also encompassed specific disciplines and fields, whereby prospective students have been steered towards aligning their skills and capabilities with a particular field or specialisation (e.g. Mechanical, Civil).

The focus in future must be market-led, by associating Engineering with new innovations and next generation thinking; and responding to future target audience values, needs and expectations. This means aligning Engineering with new technologies, developments and industries - from driverless vehicles and advanced maritime systems, through to smart cities, technologies and homes.

Further, Engineering should be promoted as a highly creative discipline given that creativity is now embedded within the mindsets of prospective students. According to many participants, creativity is not an attribute which has been linked with Engineering per se, even though Engineering is strongly aligned with innovation.

[82] As described by two research participants independently

Given the aforementioned point, it is essential that the curriculum must match the messaging. The promotion of Engineering needs to be less aligned with complexity around the *whole picture* but rather, as a discipline associated with *ingenuity*. Whilst Engineering will always have hard applications at its core, there needs to be a differential between *hard* Engineering practices and *soft* Engineering practices.

As evident from the field research, Engineering is strongly associated with Physics, Mathematics, Chemistry, Technology etc. This has steered many people to view Engineering as a male-oriented profession whereas many of the qualities and attributes associated with Engineering apply across all demographic segments.

A key outcome from this research project is that Engineering needs to widen its remit by both promoting numerous specialisations and streams and, aligning Engineering with the next generation of industries and sectors which are occurring as new fields evolve. This will clearly appeal to secondary students who are invested in new space. Further, one inevitable outcome following current events is that the range of new industries and sectors will soar, given that the world may look towards *skipping a generation* and using events as a *catalyst for change*.

Further, the pace of technological change is occurring at such a rate that Engineering should be promoted as a 'high impact' and 'frontline' discipline, one that is positioned at the forefront of innovation. This message needs to be more visible in both the curriculum and the promotion of Engineering.

Many of the Year 11 and 12 participants, together with the first year university students and teachers, were largely unaware of the diversity of fields which have an Engineering orientation. This messaging needs to be an integral component of future marketing communications. This is to ensure that Engineering disciplines are not just limited to more traditional fields and applications but in fact, provide a framework for access into countless other streams and specialisations.

Finally, the question arises as to whether the definition of Engineering has become *typecast*. Engineering is a field which hails back to the world of Brunel and is often associated with *solid constructs* – bridges, roads, manufacturing, transport, towers etc. However, Engineering in the 21st century should also be viewed as a highly creative, innovative and inspirational discipline that not only leverages STEM but which also has a place for those invested in such fields as the Arts and Humanities. This is where new Engineering nomenclatures could be introduced around different societies, cultures and communities.

Messages

Young adults especially are attuned to progress. They access information and knowledge from multiple sources and build networks which are both *actual* and *virtual*. Increasingly, they also seek outcomes which will positively contribute to a new world order, particularly in light of the impact and trauma of COVID-19.

During the latter stages of this project, it became apparent that current events have created an element of fear and uncertainty regarding future careers and opportunities. Further, many students feel confined within a *local* world whereas their thinking and aspirations have been increasingly conditioned to be *global*. Once the restrictions are lifted and the period of renewal is underway, Engineering should be associated with a new wave of opportunities based around internships, mobility, industry exposure, networks and other forms of interaction designed to reinforce that Engineering is integral to the future of global economies and societies.

Future students are already well accustomed to the social impact of climate change, as well as the ideals around recycling, renewables, the environment and sustainability. However, whilst Engineering has a pivotal role to play in all of these fields, it was apparent that the solutions were not necessarily aligned with Engineering. Instead, the environment was often associated with Environmental Sciences, renewables with Energy Systems and even, medical devices was associated with Health Sciences.

Herein lies the core to the future marketing and promotion of Engineering. The future articulation and promotion of Engineering must be associated the development and evolution of every other discipline and not just those fields which represent physical outcomes.

In building the core messages associated with Engineering, there are other features which should ideally be incorporated within the future promotion of Engineering. This is needed to create a far greater breadth of applications and which both dilute Engineering as traditional nomenclature and which instead, elevates Engineering as a vehicle for new ways of thinking, ideas and applications. These include the following:

- Position Engineering as a highly creative discipline where solutions, designs, social needs and constructs are all embedded attributes of Engineering graduates.

- Promote Engineering as a highly innovative discipline which is at the forefront of all new technologies, inventions and developments.

- Promote the diversity of employment outcomes, beyond those which are more generally attributed to largescale corporations and infrastructure developments. This includes promoting the relevance of Engineering to the mass employment markets, including SMEs and start-ups, locally and internationally.

- Shift the momentum away from the core Engineering disciplines whilst still acknowledging that these provide the foundation for the discipline in general. Instead, utilise this core foundation as a basis for *leapfrogging* into other more specialist and narrow streams that cater for individual interests and passions.

- Shift the focus away from school subjects being aligned with Engineering specialisations. For example, Chemistry should not be attached as a condition into Chemical Engineering, just as Physics should not be seen as integral to Civil and Mechanical Engineering. Whilst they may be relevant and bridging courses may be required, it is important to not label specific Engineering disciplines with subjects at school. There are ways to address this perceptual barrier.

- Whilst as a single discipline particularly with specialisation, Engineering is a solid, relevant and future-focussed qualification. Engineering is also well suited to being delivered as a Double Degree, even though there are time and cost impacts.

- It appears that when advocating course options, many significant others suggest the second subject of a Double Degree as an adjunct to Engineering rather than as a complementary qualification which can be utilised for augmenting an Engineering degree in its own right.

- Important sources of influence, including teachers and career-advisors, must be made aware that Engineering is not a qualification which should automatically be referred to based around the strength of a student's subject performance at school and their ATAR score. Instead, Engineering should be equally promoted to students who are just as invested in the Sciences and Arts, by demonstrating that Engineering actually embraces a wide range and diversity of fields.

- Promote Engineering as wide ranging discipline. This will not only contribute towards a greater balance and diversity of Engineering students but will also, appeal to those who may be oriented towards the Sciences because they are unaware of the raft of specialisations that fall within the Engineering nomenclature.

- There is significant potential to grow the upskill and reskill markets. Many potential Engineering students will already possess a technical qualification, including IT and scientific specialisations, people who now realise that Engineering is a resource that can be utilised to change career direction and outcomes - not least because Engineering can lead to longer term career and employment outcomes, with greater security and tenure.

In addition to the core content which needs to underpin the messages, Engineering is a highly visual discipline, a point which was constantly reinforced by the First and Second Year university students.

Most of the research participants observed that Engineering *images* generally show interactions between students and equipment and not necessarily, students and society. This was particularly relevant for those students who are considering the Sciences and for whom community, society, volunteering etc. are all important considerations in their course and institutional decision-making cycle.

To conclude, future messages must reflect diversity. There remains a role for the core disciplines but just as importantly, new world frontiers will call for multiple and diverse streams within applications and environments which are only just emerging and evolving. These frontiers will accelerate in response to recent events where one outcome will surely be the rapid escalation of new industries and sectors, in response to the cessation of so many traditional and unviable fields and, a realignment of economic and social boundaries.

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CONCLUSIONS

Whilst many prospective Engineering students are aware of various features of Engineering, their areas of interest are not necessarily associated with Engineering as a discipline. Instead, their interests may be more aligned with other disciplines such as the Sciences.

In part, this is a reflection of the influence and impact of significant others, including direct connections, many of whom acquired their Engineering qualifications within a more traditional and less diversified environment.

Other significant others, including teachers and career-advisors do not possess the requisite knowledge about how many industries identify with Engineering, from Renewables and Recycling, through to the Environment and Medical Devices.

The mindsets of key opinion leaders have been largely forged by traditional impressions of Engineering, namely that of a hard discipline and one which is associated with visual outcomes.

Engineering needs to be promoted as both a largescale application in terms of infrastructure, construction, manufacturing etc., together with its relevance to less visible and smaller-scale industries. This would help to expand the range and diversity of prospects who are attracted into Engineering.

The challenge is how best to promote Engineering because just as the breadth of applications becomes increasingly wider so too, the depth of different specialisations become that much deeper.

To attract a future generation of students into Engineering means diversifying the proposition, not just around the promotion of Double and Dual Degrees for example, but also through the presentation of Engineering as impacting multiple ecosystems. To this end, whilst Engineering is a collaborative discipline, this sense of collaboration needs to be more effectively promoted and as importantly, needs to impact future curriculum.

Today represents the ideal opportunity for Engineering as a discipline to *skip a generation*. This will represent a major challenge for those whose opinions have been influenced around a more traditional Engineering framework, as determined by the major Engineering authorities, industry leaders and regulatory groups.

Engineering is at the forefront of innovation and creativity. Yet as a discipline, Engineering is a product of history. Consequently, whilst there remain integral pillars which support Engineering pedagogy and which are deemed essential for shaping future specialisations, insufficient attention appears to have been paid towards promoting Engineering within schools especially, as a highly diverse discipline leading to diverse outcomes.

Engineering is at the core of every industry and sector, whether through largescale investments or micro initiatives. Further, Engineering is an evolving discipline which needs to keep pace with technology and the associated advancement of next generation industries. Engineering should be positioned as a dynamic and enterprising discipline, with a far-reaching scope around where future opportunities reside.

There are many aspects of Engineering which students now embrace. In particular, students welcome the concept of projects and the opportunity to explore different places, facilities and resources.

Today's generation of Engineering students have been conditioned to apply their skills, meaning that they want diversity from the very first year, even though it was widely reported that a grounding in the core Engineering streams is essential for future progression.

To attract Engineering students, universities have tended to focus upon academic performance in such subjects as Physics and Mathematics. Consequently, those attracted into Engineering have come from a relatively narrow prospect pool.

However, there are many equally qualified and suitably adept students who could embark upon Engineering but have instead been steered into the Sciences, Technologies and even, such fields as the creative industries.

Any 'new world order' will look towards all disciplines through a different lens. There will be an underlying requirement to reskill, upskill and acquire subject matter expertise. The needs and expectations of future students have changed and, in all likelihood, more people will embark upon more careers in more fields than ever before. This means that Engineering could be viewed as a viable option for those who once never considered Engineering as an option but who meet the criteria to become valuable engineers in their own right. Equally, the question has to be raised as to whether being described as an 'engineer' will still be relevant in a world which will rapidly embrace new technologies and applications.

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Many of the new fields of Engineering were deemed attractive to many students, including those specialisations which deal with human interactions and interventions[83] as well as many specialisations within the broad Engineering nomenclature.

The brief for this project identified Engineering as relevant to Mechanical, Civil, Electronics and Electrical – as the four core Engineering disciplines. However, students clearly define the core elements of Engineering across a much wider remit and as reflected by their feedback, this includes Chemical, Software, Structural and Environmental.

[83] E.g. Bionics

Nomenclatures are also evolving which may eventually eradicate some of the traditional disciplines. For example, whilst few participants referred to Electronics, most drew attention to Mechatronics.

The language is changing. The opportunities are diversifying. And the niche specialisations are increasing. All of these need to be captured within a marketing and communications framework that reflects the 'new world order' of Engineering and which, whilst articulating future largescale opportunities, also instil the enormous breadth of opportunities around next generation industries, SMEs and start-ups.

Engineering has been a pioneering discipline from the era of the industrial revolution, through to the very latest technologies associated with new constructions and the most recent infrastructure developments. Now the world needs to look at Engineering through a new lens. The core elements must remain, but the outcomes and possibilities need creative expansion and articulation. Engineering must be come positioned as a much broader and diverse discipline. And whilst built around the core premise of Engineering, as a discipline Engineering now represents the potential to embrace many other fields and specialisations including those that could have potentially fallen between the gaps.

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At the 2014 AIEC Conference in Brisbane, Rob was presented with the highly prestigious Award for *Distinguished Contribution to the field of International Education*. This award was in recognition of 25 years at the forefront of the industry, undertaking research and developing strategies which have helped to shape the face of Australia's education industry worldwide.

Rob's understanding of education market dynamics, demand and drivers is without equal. Each year, he interviews many thousands of students, academics, employers and opinion leaders, on behalf of universities, government agencies, institutions and cooperative organisations around the world.

Rob is a strategist who describes his role as projecting future market demand, testing market potential and assessing market performance. Much of the work which Rob undertakes is in entirely new space. This calls for thorough project mapping and planning, applied creativity, extensive stakeholder consultation, outstanding communication and interpersonal skills and, the very highest standards of quality control.

Rob has worked in 38 countries on projects for the Australian Federal Government and all State Governments, International agencies (e.g. Education New Zealand, British Council), 14 peak bodies, over 120 universities and countless colleges, schools and institutions.

Rob has constantly stated that no project has ever been the same. And, that every project needs an entirely new methodology and approach.

Rob was a co-author of the Australia Federal Government funded book, *Making a Difference: Celebrating 25 years of Australia's international education industry*. Rob makes on average ten keynote address at conferences and events around the world each year.

Rob is internationally recognised as a world class facilitator of education leadership events, from strategies and workshops to retreats and mediation. Rob brings a charismatic air of creativity, energy, knowledge and insights which always lead to informed and effective results.

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