Humanitarian Engineering in Australia & New Zealand: Past, Present, and a Way Forward

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EXECUTIVE SUMMARY

Humanitarian engineering (HumEng in this report) in Australia and New Zealand has rapidly grown in the last five years, with universities now offering courses specifically in the specialisation. Accompanying these new programs are organisations, such as Engineers Without Borders (EWB) and university HumEng societies, which deliver experiential programs, often in the Asia-Pacific region. Since 2006, EWB Australia has been driving much of this growth, and now universities are delivering many of these programs independently.

This paper examines the state of HumEng in Australia and New Zealand, developed through desktop research and interviews. It catalogues the various educational offerings offered by universities and outlines the current and future challenges to the ecosystem as identified through interviews with key academics.

This research finds one diploma, one major and three minors in HumEng are currently offered by universities in Australia and New Zealand. Additionally, one university offers a social impact undergraduate stream and five others offer bespoke subjects or experiential learning programs. It also catalogues various design and innovation centres, conferences and NGOs actively operating within the ecosystem.

Key findings from the interviews include 1) differing opinions on the term and definition of HumEng, 2) a lack of established pathways available locally for students interested in HumEng careers or further studies, and 3) the increased need for collaboration amongst academic institutions.

Key student and faculty insights include 1) prevalence of EWB Australia as the initial touchpoint for students that pursue further HumEng opportunities and 2) the unanimous reflection of graduates that HumEng exposure was of benefit to their career, despite not pursuing a career in it.

Key opportunities and challenges include 1) the need for alignment on the terminology and definition moving forward, to avoid a splintering of completing groups in the existing ecosystem, 2) clear communication of student competencies and skills acquired through HumEng coursework to industry, such that employers understand the benefits of this growing cohort to their organisations, and thus student employability grows with it, and 3) the development of a framework that guides universities to deliver work adhering to good HumEng principles, such that the harms and risks associated with poor community development are mitigated.

Key pathways forward include 1) the establishment of an Engineers Australia (EA) Humanitarian Engineering Community of Practice (HECoP) that brings professional recognition to the area, 2) the establishment of a broader series of “EWB Challenges” engaging students from first-year to post-graduate level, and 3) the recognition of HumEng field placements as satisfying 12 of the 16 EA Stage 2 Chartered Competencies.

Key recommendations include 1) engaging the large traditional engineering firms to better communicate the value of the skills developed through HumEng pathways, 2) establishing a national work experience or internship platform that aggregates the community of employers and students/graduates in one place, and critically 3) the continued collaboration amongst universities, with the goal of establishing cross-teaching and cross-enrolment capabilities.

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1 Humanitarian Engineering: An Overview

Definition by Colledge (2012):

> **Engineering:**
>
> *"artful drawing on science to direct the resources of nature for the use and the convenience of humans."*
>
> **Humanitarianism:**
>
> *"active compassion directed toward meeting the basic needs of all — especially the powerless, poor, or otherwise marginalized."*
>
> **Humanitarian engineering:**
>
> *"the artful drawing on science to direct the resources of nature with active compassion to meet the basic needs of all—especially the powerless, poor, or otherwise marginalized"*

Humanitarian Engineering is a term used commonly in Australia and New Zealand referring to the application of engineering skills towards the betterment of underserved communities, through development, disaster response and relief, and resilience (Smith, et al., 2017). It was coined locally by Engineers Australia (EA) in 2011 in their 'Year of Humanitarian Engineering' campaign, although some uncertainty on the exact definition remains and is explored extensively in Smith, et al., 2019. Despite this, it has been generally adopted by the academic community since it first appeared at the Australiasian Association for Engineering Education (AAEE) conference in 2013 (Smith, et al., 2017).

In the global setting, humanitarian engineering is used by universities such as Colorado School of Mines (CSM, 2019), where a collaboration between engineering and social science faculties arrived at the working definition for HumEng to be "design under constraints to directly improve the wellbeing of underserved populations" (Munoz & Skokan, 2007). HumEng is also referred to as engineering for community development (CSM, 2019), engineering for global development (EGD) (ASME, 2019), development engineering (Dzombak, 2017), and global engineering (Council, 1999), all common terms used in the United States. Garrett (1999) states there are numerous definitions of HumEng, which can change due to contextual factors, whilst VanderSteen (2008) believes that HumEng should not be viewed as a discipline of its own, but an overall 'meta-discipline' that encompasses all of engineering. Despite a broad understanding of these areas of study, there remains disagreement amongst institutions on the correct terminology, scope and teaching methods.

1.1 Student outcomes and learning opportunities

A survey of engineering recruiters from multinational engineering organisations identified the primary attribute that engineers of the future will need is an "increased sensitivity to societal and cultural issues" (Colledge, 2012). HumEng provides a real and rich context for students to explore deeply to understand ethics, environment, economic and societal impacts of engineering (Campbell & Wilson, 2011). It is considered to be highly multidisciplinary, where the physical sciences such as mathematics, physics and chemistry meet the social sciences, such as psychology, behavioural science and anthropology (Passino, 2015).

One of the core skills that HumEng develops in students is systems thinking, and how changing one element in the system can drastically affect it in unforeseen ways (Campbell & Wilson, 2011). An example is given by Campbell & Wilson (2011), where students from University of Washington EWB Chapter travelled to Bolivia to address the difficulty of transporting crops and products to market in the rainy season. The proposed solution was a road that was not prone to being washed away with each season, which would benefit the local community. But this would also introduce more trash, noise and air pollution as other communities use this more reliable road. The unintended impacts are consequences of working within a system, and a finding from Campbell & Wilson was that these impacts encourage students to consider a greater number of variables in their problem solving process.

Similarly, Colledge (2012) synthesises a set of transferable skills in Figure 1, based on what the US industry's want for engineering graduates were (through studies conducted by the US Department of Labour, The Center for Improved Engineering and Science Education and Boeing Corporation). He identifies them all as learning processes, or as skills that are acquired through practice and application, and argues that humanitarian engineering provides the context within which these skills can be learnt.

Citizenship/Social Responsibility	Problem Solving
Adaptable & Flexible	Creativity
Ethics	Critical
Lifelong Learning	Communication Skills
Application (Context) to the Real World (including business, history, economics, etc.)	Manage Complexity in a Systems Environment
Information and Technology Literacy	Leadership
Teamwork	Self Actualization
Multidisciplinary	Curiosity

Figure 1. Transferable skills as described by Colledge (2012)

ORDERED RESPONSES TO LEARNING GAINS FROM AN INTERNATIONAL HUMENG EXPERIENCE, 1 IS *NONE*, 4 IS *SIGNIFICANT* (N=26).

Learning Gain	4	3	2	1	% 4
Cross-cultural awareness	22	3	0	1	85
Engaging with users or stakeholders	21	4	1	0	81
Ability to work internationally	21	4	1	0	81
Ability to incorporate social factors into engineering	19	4	1	1	76
Communication skills	18	8	0	0	69
Application of engineering to the real-world	17	8	1	0	65
Adaptability	14	6	5	0	56
To the systems engineering core	13	7	5	0	52
Creativity	12	13	1	0	46
Teamwork skills	12	10	4	0	46
Ability to work on complex problems	11	12	3	0	42
Incorporating sustainability into engineering	11	12	3	0	42
Ethical practice	11	12	2	0	44
Engineering design	11	10	4	0	44
To my discipline major	3	1	12	9	12

Figure 2. Student learnings from a 2019 study by ANU (Smith, et al., 2019)

A study conducted at the Australian National University (ANU) in 2019 surveyed students' perceived learning from HumEng opportunities. A summary of responses can be seen in Figure 2, and shows similar skills, such as communication skills, and the application to the real world social responsibility, identified by Colledge (2012) in Figure 1. Importantly, students perceived their HumEng experience enhanced their employability (Smith, et al., 2019).

2 A Brief History

Since the 1980s, many engineering organisations from the UK, USA and Canada such as Engineers Without Borders, RedR and Engineers Against Poverty have sought to tackle poverty (Smith, et al., 2017). This consequently led to a growing student interest in these organisations (Amedei, et al., 2009) and to the rise of HumEng education at academic institutions around the world (Smith, et al., 2017). The formation of Engineers Without Borders Australia (EWB) in 2003 would soon lead to the launch of the EWB Challenge, which was crucial in the development of HumEng education locally and embeds human-centred design principles and cross-cultural communication into a real-world project brief. Launching nationally at 21 universities in 2007 (Smith, et al., 2017), it has now grown to 29 universities in Australia, New Zealand and Malaysia (EWB Australia, 2019). In 2011, EWB Australia partnered with EWB UK to launch the Engineers for People Design Challenge, which is now delivered in 30 universities across the UK and Ireland, and expanding to South Africa and the US in 2019-20 (EWB UK, 2020).

Since the growth of the EWB Challenge, EWB Australia has launched several other programs to engage students at stages throughout their degree, including experiential study programs known as Humanitarian Design Summits (EWB Australia, 2019), and final-year student research projects (EWB Australia, 2019). The success of these programs has led universities to launch their own courses, with at least five universities that were offering or planning award programs in 2017 (Smith, et al., 2017), and 6 that now offer award programs.

Figure 3 summarises key events since the formation of EWB Australia, to which the growth of HumEng in the region is largely attributed. A brief summary of key events is discussed below.

Figure 3. Timeline of the development of Humanitarian Engineering in Australia and New Zealand.

The launch of the EWB Challenge in 2007 has become the primary mechanism of early student exposure to HumEng. The program has steadily grown in the number of universities engaged and consequently the number of students reached, as seen in Figure 4. Whilst the EWB Challenge remains a first-year program (2019 saw 12,000 students participate), a recent announcement of a new integrated suite of "Challenges" will engage students from first-year right through until post-graduate studies (EWB 2019).

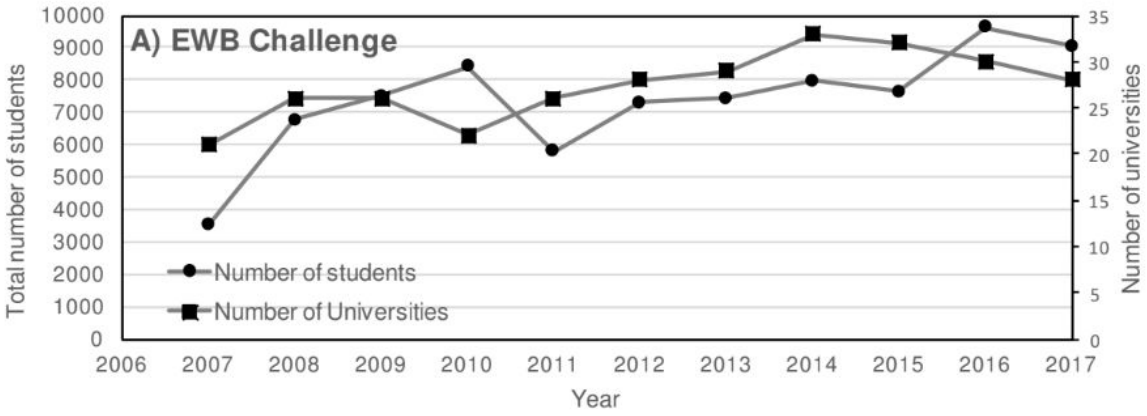

Figure 4. Number of students and universities participating in the EWB Challenge since its conception (Smith, et al., 2017)

The launch of the New Colombo Plan (NCP) Mobility Program by the Australian Government's Department of Foreign Affairs and Trade in 2014 has provided a vehicle for students to attain funding for study and work-experience opportunities in the Indo-Pacific region. It has supported over 40,000 students in 40 host countries since its conception (DFAT, 2020) and remains a key enabler for HumEng-related experiential and immersive programs. In addition to this, internal university mobility offices have supported many students with scholarships, with funding coming from a variety of internal sources.

Other funding opportunities included AsiaBound grants (for UG and PG students) and the Department of Education Endeavour Leadership Program mobility grants (for PG students only), both of which supported overseas experiential learning programs. They have both ceased offering grants in 2015 and 2019 respectively, such that the NCP Mobility Program remains the primary scholarship provider for university students.

The launch of EWB's Humanitarian Design Summit in 2015 provided to students a deeper exploration into HumEng principles and enabled them to participate in a guided experiential-education program with a community partner. More than 1,200 students from around Australia and New Zealand have visited 6 countries on the two-week design summit, learning about human-centred design and community development. Other organisations delivering HumEng-related short-term immersive education programs include AIMOverseas (founded 2010), Project Everest Ventures (2015), Unbound (2016) and Humanitarian Education Xperience (2018). To complement and strengthen student experiences on these programs, some universities have also developed formal subjects and informal coursework for students to undertake both before and after participating in these mobility programs.

3 Humanitarian Engineering: Where we are now

A review of the university programs and interviews with academics, students and associated NGOs provided many perspectives on the rapidly changing state of HumEng in Australia and New Zealand. The key findings summarised below are elaborated on in an associated report and student capstone, and some next steps for HumEng in Australia and New Zealand forecasted.

3.1 Academic Offerings

As of October 2019, 27 universities out of a total of 51 universities in Australia and New Zealand have embedded the EWB Challenge, and 11 offer dedicated HumEng subjects or facility for students to engage with HumEng experiential programs. Of these 11 universities, 3 offered minors in HumEng, 1 offered a major, 1 offered an undergraduate diploma, and 1 offered a social impact stream. A detailed overview of these programs is presented in the 2019 E4C State of Engineering for Global Development in Australia and New Zealand Report.

3.2 Student and faculty insights

A series of interviews conducted with academics representing 7 faculties from Australia and New Zealand provided revealing insights. One insight found 7 out of 7 academics had direct HumEng NGO and/or field experience as part of their career, and all of which confirmed that a key barrier for students looking to pursue graduate work was the difficulty of finding HumEng-related jobs locally. Of the students interviewed from 4 universities, all were introduced to HumEng directly through an EWB-led program based at their university, and of the graduates interviewed, all believed HumEng exposure had a direct benefit in their careers.

3.3 Opportunities and Challenges

The opportunities and challenges identified during the interview process attest to the rapid development of HumEng in Australia and New Zealand, and highlight the intertwined relationships between universities, EWB and similar NGOs, traditional engineering industry, communities of practice and of course, students. The key opportunities and challenges found were:

1. **Collaboration:** Collaboration is a key ingredient in the growth of HumEng in Australia and New Zealand, with organisations such as EWB developing programs for universities to embed into curriculum. It was these widespread successful partnerships that resulted in the EWB Challenge being embedded in 27 universities in the region. For continued growth, collaboration between institutions is key. Currently, expertise is siloed within universities, where it is not readily accessed by those outside of the institution. A network known as Humanitarian Engineering Education Network of Australasia (HEENA) has been formed with the purpose of sharing material and resources. Recently, the Humanitarian Engineering Community of Practice (HECoP), supported by Engineers Australia, has been founded with it's purpose to capture and update the concepts, skills and practices that are generally accepted in the HumEng community. Networks such as HEENA, HECoP and other collaborations help to break down these silos and create national and international communities of practice.
2. **Terminology:** Whilst the term humanitarian engineering grew with the movement in Australia and New Zealand, some academic institutions and NGOs including EWB Australia, who have widely used the term, are moving away from it. Reasons stated include that the term doesn't accurately represent local communities (such as indigenous communities), nor encompass the activities of social impact groups (such as Disability Services Australia) that don't engage in traditional development or humanitarian assistance. Additionally, it does not align with other international definitions or contexts and can be confused with traditional "humanitarian assistance" rather than the breadth of connotation given to it by the Australian context.

3. **Career pathways:** Currently, it's difficult for students looking to become practitioners in a humanitarian context due to unclear pathways into the sector, particularly so as these pathways don't offer the traditional entry points that other engineering careers do. As such, Humanitarian Engineering graduate roles often involve volunteering with NGOs, as a lack of practical experience is a common barrier for breaking into the private international development consulting firms or field placements like those offered by EWB. A few of the pathways that recently-graduated students have explored include Australian Volunteers International (AVI), pro-bono work with traditional engineering firms and rarely, direct entry into specialised teams. Regardless of the role a graduate pursues, what is clear is that exposure to HumEng at university is considered beneficial for their career, a statement echoed by the literature and every graduate that was interviewed in this research.
4. **A small local market:** Finally, the vast majority of students that have engaged with a HumEng pathway throughout their university degree have gone on to work in traditional engineering roles, although this may shift as students graduate from newer major- and diploma programs. There currently does not appear to be a large enough job market for the number of HumEng graduates that universities will be producing in the coming years, and emphasis on communicating their strengths and experiences to traditional engineering firms will be key.

4 A Way Forward

Whilst there may be some immediate challenges to overcome, there are exciting prospects on the horizon, even since the release of The Stage of EDG in Australia and New Zealand Report in November 2019. The following list of next steps has been compiled from the academics driving much of the change in this area:

1. **Structured professional program for senior students:** EWB Australia are now offering a series of "Challenges" in 2020, the most senior of which is the EWB Influencer Fellowship. This is an individual and bespoke program aimed at final year undergraduate and post-graduate students that aspire to a career in HumEng and sustainable development.
2. **Legitimise the professional community:** The recent establishment of the Humanitarian Engineering Community of Practice (HECoP), run by the College of Leadership and Management (CLM) and supported by Engineers Australia is an example of a direct engagement with a professional association, and further evidence of the recognition of HumEng as a specialisation. The HECoP is a platform to establish a common understanding and agreed set of competencies for this area of focus, as well as to support and foster collaborations with academics and industry alike.
3. **Professional recognition for HumEng practice:** Engineers Australia (EA) as the peak professional engineering organisation in Australia is responsible for assessing and accrediting university courses and practitioners. At the end of 2019, an agreement was reached between EA and EWB Australia to automatically grant EWB field professionals (that typically undertake a 12-month placement) 12 out of the 16 Stage 2 Chartered Competencies upon completion of the placement. This is further evidence of professional recognition for undertaking HumEng work.

5 Recommendations

The following recommendations and suggestions are compiled from the HumEng academic community and highlight some changes that would further benefit the field:

1. **Adapting university frameworks:** Despite the imminent increase in the number of graduates with HumEng qualification but not the foreseeable job growth in this area, the skills students develop while undertaking HumEng educational opportunities are very transferable to traditional engineering roles. A number of academics have suggested there be a focus on how these skills might be used in other contexts, and for this to be included in university programs to prepare students to create positive social impact wherever they work. Additionally, improving the visibility over these transferable skills would benefit professionals moving between distinctly HumEng spaces and other areas of engineering practice.
2. **Engaging industry in the conversation:** To further support students graduating from HumEng programs, more engagement between universities and industry (particularly large traditional engineering firms) such that the value of skills, knowledge and capabilities developed through HumEng can be communicated and demonstrated. This in turn would encourage graduates working with these firms to continue to stay involved with HumEng activities, as increased support (such as allowing time for engagement) would be offered by employers.
3. **Identification of career pathways and roles for engineers in development:** Currently universities and students arrange work experience and internships opportunities in isolation, despite them engaging many of the same organisations. Suggestions have been made for developing a national work experience or internship program in HumEng, such that an integrated platform is developed and accessed by all universities and students alike. This could be linked to professional roles and opportunities, to create a more visible pathway for students and graduates.
4. **Continued and lasting collaborations:** Perhaps the most important of the list of recommendations is the continued collaboration between academics and institutions. Many academics are suggesting shared courses and curriculum across institutions and universities, with the prospect of cross-teaching and cross-enrolment a possibility. The benefits of this as opposed to programs developed in isolation include easier establishment and operation, reduced risks and costs, shared knowledge and expertise amongst the universities, and the ability to deliver consistently high quality learning outcomes. Suggestions for such programs include domestic immersive programs to local communities, and topics such as disaster response.

Ultimately, the continued growth of humanitarian engineering in Australia and New Zealand can only be attributed to the ongoing strength and support of its community, and further collaboration with the broader engineering profession and academia will only increase the opportunities for all involved. If we would like to see a world where sustainable development, social impact and humanitarian practice converge with industries like energy, technology and manufacturing, then equipping students with such mindsets today will influence the decisions for decades to come. To quote EWB Australia CEO, Eleanor Loudon from the 2019 Impact.Engineered conference, "I hope one day we will stop referring to all this as humanitarian engineering, and it will just be, 'engineering'. "

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