ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

Insights into Industry-university Collaboration on Socio-technical Student Projects

Justine Lawson[a], Osman Mah[a], Chris Wilson[a], Tom Goldfinch[b]
Engineering Futures Initiative, The University of Sydney[b]
Corresponding Author Email: tom.goldfinch@sydney.edu.au

ABSTRACT

CONTEXT

There is a longstanding call for engineering curriculum to reflect practice in industry. Building on the earlier findings of Male and King (2014), a significant part of the ACED Engineering 2035 report (Burnett, et al., 2021) urges universities to meet industry needs and expectations. ACED calls on universities to understand industry's desire for more student exposure to practice and rebalance the theory-practice components of curriculum. Universities are also called to implement industry engagement in engineering programs and provide industry-based personnel to participate in engineering education. The report notes the value of industry-based projects in engineering curriculum as one means of achieving these responsibilities. Responding to this call, the Engineering Futures Initiative (EFI) established National Student Projects (NSP), a program of work designed to facilitate partnerships between academics and industry, and provide authentic project experiences for students with a socio-technical focus.

PURPOSE OR GOAL

The NSP pilot commenced in March 2024, with a remit of sourcing 3-5 projects from 3-5 industry partners for 3-5 universities to trial. The work has resulted in some surprising outcomes, and reflective insights and challenges encountered during the pilot are reported in this practice paper.

APPROACH OR METHODOLOGY/METHODS

EFI appointed two leads for the national student projects work who adopted an approach to connect industry with academics to implement projects. The wider EFI team met weekly to exchange reflective insights. These insights were documented throughout the pilot phase.

ACTUAL OR ANTICIPATED OUTCOMES

The insights are clustered into three areas: insights from industry, insights from universities and insights common to both. Unsurprising insights included confirmation of longstanding identified barriers to industry and university collaboration such as mismatched expectations and time commitments. More surprising was the challenge of developing shared project briefs and the breadth of motivations for industry to work with academia.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The pilot NSP initiative confirmed some of the challenges identified by Male and King (2014) and ACED Engineering 2035 (Burnett et. al., 2021) and identified more. There is a particular challenge in ensuring visibility and maintaining engagement with socio-technical dimensions of industry partnered projects.

KEYWORDS

Industry, socio-technical, project-based learning

Introduction

There is a longstanding call for an engineering curriculum to reflect practice in industry. Building on the earlier findings of Male and King (2014), a significant part of the Australian Council of Engineering Deans (ACED) Engineering 2035 report (Burnett, et al., 2021) urges universities to meet industry needs and expectations. ACED calls on universities to understand industry's desire for more student exposure to practice and to rebalance the theory-practice components of curriculum. Universities are also called to implement further industry engagement in engineering programs and source industry-based personnel to participate in engineering education. The report notes the value of industry-based projects in engineering curriculum as one means of achieving these responsibilities.

Responding to this call and the report's recommendations, the Engineering Futures Initiative (EFI) established National Student Projects (NSP), a program of work designed to simultaneously facilitate partnerships between academics and industry, and provide authentic project experiences for students, ideally with a socio-technical focus. National Student Projects is one part of a broader suite of activity associated with implementing ACED 2035 curriculum recommendations.

This paper outlines the process of the work as it was undertaken, and the emerging insights and challenges.

Purpose

The National Student Projects (NSP) initiative was piloted from March 2024, with a remit of sourcing 3-5 projects from 3-5 industry partners for 3-5 universities to trial. This tranche of work sits alongside others with the Engineering Futures Initiative (EFI) (professional development and benchmarking) and is guided by a governance structure that includes an EFI Steering Committee and Consultative Group. The National Student Projects initiative was conceived to alleviate some of the known barriers that industry experience when approaching universities to collaborate on educational initiatives and to create a platform for engineering academics across Australia to source authentic student projects with particular focus on human/social dimensions of engineering. The purpose was to create a scalable and sustainable means for connecting academics with industry projects with the ultimate goal of enhancing practice-based curriculum for engineering students. The emphasis on human/social dimensions was also informed by the need identified in the ACED Engineer 2035 report.

Approach

In 2024, the Engineering Futures Initiative appointed two leads for the national student projects work. During the pilot phase of the work program they adopted an approach to connect industry with academics to implement projects. The wider team (the authors) met weekly to exchange reflective insights. These insights were documented throughout the pilot phase.

Initially, the two project leads asked for commitment and contacts from universities willing to participate in the pilot. This was facilitated through ACED and gave the leads approximately 10 names and engineering degree programs to work with. Next, the leads approached existing industry contacts and cold-called others to gauge interest. They indicated that socio-technical perspectives were required as a counterbalance to engineers' propensity to gravitate towards the purely technical elements of a project. Once interest was established online introductory meetings were set up.

Initially it was assumed that the best industry partners for universities would be ones local to the university because proximity would facilitate relationship building. However, the common use of online meetings by both parties rendered proximity largely irrelevant. For example, while the first two industry partners in the pilot were both Sydney-based, the partnering universities were in Victoria and Canberra. This suited the intention of having projects available nationally.

The project leads played an instrumental role as the middle player in connecting people from industry with academics. While this “matchmaking” process was very effective in developing mutually beneficial relationships between university programs and relevant industry partners, it was time-consuming and inefficient - posing challenges for scalability and sustainability. The leads began to look for alternatives to this “one-to-one” partnering process. It was decided to continue to promote the one-to-one approach but also compare it to a “one-to-many” arrangement originally envisioned for the NSP initiative. Here, one project could be used in classes across a range of universities.

The leads engaged a number of industry partners ranging from local councils to large companies to startups and received tentative interest from 16 partners.

Insights

The project leads met weekly with the co-chairs of the EFI steering committee and the EFI lead coordinator. Meetings were focused on progress and challenges and were characterised by reflective conversation. Recurring themes included the difficulty in sourcing or shaping projects that included human/social dimensions, ensuring these dimensions are retained in implementation; producing suitable briefs; and shifting from labour-intensive negotiations to scalable processes.

Conversations revealed that the challenges faced were linked to assumptions held by the team. Making these assumptions explicit revealed insights and possible ways forward. Broadly, the insights that emerged clustered into three areas: insights from industry, insights from universities and insights common to both. The insights are summarised in the tables below along with the assumptions challenged and initial ideas for how this might be addressed by each party. The authors have also developed recommendations, building on the existing Male and King (2014) report.

Table 1: Insights from industry partners

Assumption	Insight	Recommendation
Industry has real world projects that they want students to work on and explore solutions/options for.	Industry partners did not expect solutions to their engineering problems. They were more interested in brand exposure and recruiting.	Promote brand exposure and talent opportunities when engaging with industry partners (as well as possible solutions).
Industry will be able to complete a project brief template with some guidance.	Industry partners had little time or interest in developing project briefs, even when offered help.	Prepare briefs for industry partners based on conversation as a way of achieving common understanding.
Industry trusts universities to respect its IP.	Industry partners tended to avoid IP issues by scoping larger projects into smaller components. This impacts authenticity somewhat, but avoids lengthy contract processes.	Be prepared to withhold some details of the overarching project or context and limit scope.
Industry is mostly motivated by marketing imperatives and less by engaging directly with students.	Industry is keen to reward top students with a chance to present their ideas to the company.	Consider competition or reward process as part of assessment. Seek industry partner sponsorship or involvement in selection
New projects will usually require new contacts.	Sourcing projects from consultancies offered opportunities for new projects with the same contact relationships.	Discuss long-term collaboration opportunities with industry partners.
Industry contacts have some awareness of the time required.	Industry contacts are highly conscious of time commitments and may assume a project will require substantial time input.	Keep demands of an industry partner to a minimum and make explicit the hours required.

Table 2: Insights from engineering academics

Assumption	Insight	Recommendation
Unit/course coordinators will view the EFI/NSP as a source of support in sourcing projects.	Academics see the value in the program but were wary of the EFI/NSP as another stakeholder to work through that may add to workload	Clarify the upfront engagement needed for project-based preparation. Focus on early establishment of connection between industry and academic partners.
Unit/course coordinators expect NSP have curated the project to work within their curriculum.	To make a project work within a specific course/unit, the details need to be negotiated by the two parties and this dialogue might be extensive.	Encourage dialogue in scoping the project. Be prepared to adapt course/unit requirements to maintain project authenticity.

Table 3: Common insights from both industry and universities

Insight	Assumption	Recommendation
Both parties will be enthusiastic about the collaboration.	The facilitation phase of the partnerships took longer than anticipated with apprehension on both sides	Invest in business relationship management. Over time the process will become more efficient with established protocols.
Sourcing socio-technical projects will be a challenge. Most engineering projects are purely technical.	Finding socio-technical projects is not a problem. However, finding unambiguously and or fundamentally socio-technical projects is much more difficult. Industry and academic partners readily focus on technical aspects of a project and may sideline the socio-technical.	Provide a clear definition of socio-technical project along with examples. Seek projects with highly prominent socio-technical challenges.

Several assumptions were challenged in this work. Most notably from those described above was a general assumption of an eagerness for industry to engage with academia through education. Consistent with Male and King's findings (2014), there was evidence that industry were motivated to be involved to elevate their brand and for recruitment opportunities, yet there was still a substantial wariness about time commitments. Projects and willingness to engage were less forthcoming than anticipated, given the emphasis on this feedback from industry in the Engineer 2035 report.

Related to this was a further assumption that prompting industry to provide projects for engineering students would be relatively straightforward. This was based on the idea that there is an established ecosystem of university and industry engagement for research, internships and some project-based subjects such as capstone, and the NSP would provide a means for removing barriers to extend reach further into educational programs. The barriers to this are

multifaceted and stem from an observation that industry does not actively need/want students to work on their projects and engaging in educational endeavours is time-consuming.

As a result, there were lead times of up to three months to establish and maintain new connections. This involved phone calls, follow-up emails, scheduling meetings, rescheduling cancelled meetings. This speaks to the value of people and relationships. The project does not happen in isolation to people, indeed, how the project is developed is contingent on the people involved. Concomitantly, the success of the implementation of the student project hinged directly on positive relationships between academics and the industry partner. As all partnerships established by NSP were new, there was an acute awareness of the competing demands of a company and the local university needs.

Informed dialogue between parties is the key to making the arrangement work. The main challenges with establishing fruitful dialogue are the different motivations for participation (as described above) and the different communication modes expected on each side. From the NSP experience, university staff prefer discussion of projects to be clearly laid out textually in the form of a detailed project brief or at least a lengthy email explaining project goals and needs. The industry partners tended to resist textual explanation until the project and the relationship had been established through a meeting (either on the phone or through an online meeting). After discussion had taken place, industry partners were happy to provide project details. For academics the negotiation takes place through text; for industry, the text is subsequent to the negotiation.

The final, and overarching challenge for the NSP was that the projects ultimately secured thus far were not sufficiently emphasising the social and human dimensions of engineering, and these dimensions were thus easily sidelined.

Discussion

The NSP pilot addressed the ACED direction to implement national projects to provide students with authentic engineering experience. It experimented with a platform – a basic website – and a template for project briefs. The pilot built on what had been established before it – a commitment to projects and a commitment to enhancing socio-technical understanding through project-based learning. The challenges outlined here reinforce long held barriers to university and industry engagement as well as highlight newer ones centred on the persistence of a paradigm that privileges technical over social dimensions of engineering projects.

This challenge of obtaining socio-technical projects was twofold. First, the industry partners with whom the NSP engaged struggled to see projects as socio-technical and were firmly attached to projects that were largely technical. It should be acknowledged that whilst Crosthwaite (2021) identified the need for curriculum to include greater attention to the socio-technical contexts of engineering, Burnett et al (2021) argue for increased exposure to practice, which, arguably, technical projects such as these enable. Second, the EFI has grappled with clearly defining what is meant by a socio-technical project, with the literature ranging from a position where all engineering is socio-technical (Leydens, 2018) to one where it is distinct from other aspects of engineering such as the technical (Niles, et.al., 2018; Reddy & Mancus, 2021). Other researchers in this space see socio-technical projects as those addressing specific outcomes such as sustainability (Fitzpatrick, 2017; Valdes- Vasquez & Klotz, 2011; Wang, Guthrie, South & Farnsworth, 2022) and social justice (Rulifson, McClellend & Battalora, 2018; Shannon & Mina, 2021; Monteiro, Leite & Rocher, 2018). Mazzurco and Daniel (2019) present socio-technical learning as an expertise embodying three domains: technology, people and the broader context. The EFI is currently working to refine a definition that will integrate these definitions and assist project selection.

In identifying assumptions, the team was also prompted to question wider assumptions both about the role of industry generally and the perception that engineering schools are failing to address fundamental aspects of engineering practice, or not already doing those things proposed in the ACED Engineering 2035 work. The purpose of the EFI was to increase socio-technical

projects in engineering classrooms and make it easier for universities to access projects of this nature. In other work separate to the National Student Projects, EFI has undertaken benchmarking of engineering programs nationally to establish data on the current socio-technical focus of engineering education. This work has identified variability between disciplines and programs in terms of socio-technical emphasis, but not absence. In some cases, up to 40% of units of study within a core program have some element of socio-technical focus within stated learning outcomes (publications pending).

Conclusion and ways forward

Despite long standing calls for industry visibility and participation in engineering education and student experience, there remain persistent challenges. Much of the industry sentiment documented in Male and Kings (2014) report is echoed in the ACED calls to action. Their recommendations are grouped into the same categories and there is emphasis on students developing engineering practice skills within socio-technical contexts. The pilot NSP initiative confirmed some of the challenges identified by Male and King (2014) and ACED Engineering 2035 (Burnett et. al., 2021) and identified more. There is a particular challenge around ensuring visibility and engagement with socio-technical dimensions of projects, and vulnerability of these dimensions to being minimised in the actual student learning experience.

There is scope for academics and industry partners to embrace the recommendations documented in the tables above. Concurrently, the implementation of the NSP pilot is addressing expectations around scalability and sustainability, and the necessary emphasis on socio-technical contexts. As the EFI continues working on a clearer definition to help resolve part of this challenge, it is also producing guidelines to make explicit ways that other challenges might be overcome. The EFI and NSP also note and acknowledge that there is continued good work in this space domestically and internationally and is continuing to expand engagement and participation from colleagues in this endeavour to (hopefully) reach a tipping point in the focus of engineering programs called for by the ACED Engineering 2035 reports.

References

Burnett, I., Cameron, I., Crosthwaite, C., Foley, B., Goldfinch, T., Hadgraft, R., Hargreaves, D., King, R., Lamborn, J., Lawrence, R., Wilson, J., Symes, M., & Reidsema, C. (2021). *Engineering change The future of engineering education in Australia*. Australian Council of Engineering Deans.

Crosthwaite, C. (2021). *Engineering Futures 2035: Engineering Education Programs, Priorities & Pedagogies*. Australian Council of Engineering Deans.

Fitzpatrick, J. J. (2017). Does engineering education need to engage more with the economic and social aspects of sustainability? *European Journal of Engineering Education*, *42*(6), 916–926. https://doi.org/10.1080/03043797.2016.1233167

Niles, S., Contreras, S., Roudbari, S., Kaminsky, J., & Harrison, J. (2018). *Bringing in "The Social" Resisting and Assisting Social Engagement in Engineering Education*. Institute of Electrical and Electronic Engineering.

Leydens, J. A. (2013). Integrating Social Justice into Engineering Education from the Margins: Guidelines for Addressing Sources of Faculty Resistance to Social Justice Education. In J. Lucena (Ed.), *Engineering for Social Justice. Philosophy of Engineering and Technology*. Springer.

Male, S., & King, R. (2014). *Best Practice Guidelines for Effective Industry Engagement in Australian Engineering Degrees*. Australian Council of Engineering Deans.

Mazzurco, A., & Daniel, S. (2020). socio-technical thinking of students and practitioners in the context of humanitarian engineering. *Journal of Engineering Education*, *109*(2), 243–261. https://doi.org/10.1002/jee.20307

Monteiro, F., Leite, C., & Rocha, C. (2019). From the dominant engineering education perspective to the aim of promoting service to humanity and the common good: the importance of rethinking engineering education. *European Journal of Engineering Education*, *44*(4), 504–518. https://doi.org/10.1080/03043797.2018.1435630

Reddy, E., & Davies Mancus, S. (2021). Work in Progress Social, Technical… and Environmental?: Addressing Environmental Entanglements as Part of Engineering Education. *2021 ASEE Annual Conference*. Virtual meeting, July 26-29, 2021.

Rulifson, G., McClelland, C. J., & Battalora, L. A. (2018). Project-based Learning as a Vehicle for Social Responsibility and Social Justice in Engineering Education. *2018 ASEE Annual Conference & Exposition*. June 24-27, 2018. Salt Lake City, UT.

Shannon, R., & Mina, M. (2021). The Challenges of Engineering Education, Engineering Practice, Code of Ethics, and Social Justice. *2021 ASEE Annual Conference*. Virtual meeting, July 26-29, 2021.

Valdes-Vasquez, R., & Klotz, L. (2011). Incorporating the social dimension of sustainability into civil engineering education. Journal of Professional Issues in Engineering Education and Practice, 137(4), 189–197. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000066

Wang, X., South, A. J., Guthrie, W. S., & Farnsworth, C. (2022). Rebalancing Civil Engineering Education to Address Social Aspects of Sustainability. 2022 Intermountain Engineering, Technology and Computing, IETC 2022. https://doi.org/10.1109/IETC54973.2022.9796742

Acknowledgements

The Authors acknowledge the financial support provided for this work by the Australian Council of Engineering Deans.

Copyright statement