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

Understanding Employability in the Context of Engineering Practice

Dennis Friedrichsen[a], Roger Hadgraft[b], Anette Kolmos[a], Jette Egelund Holgaard[a], Henrik Worm Routhe[a]
Aalborg University, Denmark[a], University of Technology Sydney, Australia[b]
Corresponding author email: jeh@plan.aau.dk

ABSTRACT

CONTEXT

Many factors influence employability for engineers. The topic remains of concern because employability is central for both early-career engineers and experienced engineers. Inspired by this, the guiding research question for this article is: which factors influence engineers' employability in engineering practice?

PURPOSE OR GOAL

The goal of this research is to further understand relevant factors in the context of employability in engineering by analysing data gathered from employed engineers.

APPROACHES OR METHODOLOGIES/METHODS

We analyse qualitative data collected from 9 interviews and identify areas that influence and impact employability. The interviews were collected in February 2024. The data was transcribed using the Whisper software and double-checked by the authors, followed by coding in NVivo.

ACTUAL OR ANTICIPATED OUTCOMES

Our findings indicate that factors beyond technical skills and a diploma are important, but these can be hard to articulate and are often context dependent. This makes the situation particularly precarious for early-career engineers, but also means that employability is positively affected by areas including personal experiences, attitudes, proclivities, attributes, and generic competencies, which apply across jobs and human activities, often referred to as transferable skills. Furthermore, engineering practice is not a uniform and homogenous entity. The importance of an awareness of both technical competencies and generic competencies remains foundational.

CONCLUSION/RECOMMENDATION/SUMMARY

As this article will show, the issue of employability is multifaceted and diverse. Our research may shape how engineering practice is taught and discussed in university settings to better prepare students for life after graduation.

KEYWORDS

Employability, engineering practice, competencies

Introduction

The concept of employability transcends simple employment; it is a dynamic entity rather than a fixed outcome, and an individual may influence their employability in productive ways. This principle should underpin all discussions on employability, given its multifaceted nature and varied interpretations depending on the context. For instance, employability holds significance not only for individuals pursuing their specific educational and career goals, but also for society, where the role of higher education increasingly implies employability, assuming a general relationship between higher education and success in the job market.

In 2006, Yorke proposed a definition of employability in three parts: professional capabilities, disciplinary knowledge, and personal attributes:

> *Employability can be described as the combination of a set of professionally oriented capabilities, disciplinary knowledge and personal attributes that allow an individual to make a positive contribution to society and the economy (Yorke, 2006)*

The complexity inherent in employability is captured well in this definition. Although personal development is absent (despite its role in an individual's employability), it is nevertheless apparent that both professional skills are desired.

In the context of personality and employability, some scholars argue that students themselves must take and strive to develop desired personality traits (Villar & Albertin, 2010). The role of higher education institutions, then, would be to assist this development in addition to providing necessary professional competencies. To some, this begs the question: is the role of higher education to actively support employability? While some say yes (Andres & Higson, 2008; Ng & Feldman, 2009; Rae, 2007; Yorke, 2004), others argue that organizations themselves must take (some) responsibility in forming graduates into employees because work-based experience is attained at work.

Furthermore, while universities can provide a range of professional skills and competencies, the diverse and complex range of jobs and responsibilities that exist in the job market requires that employers offer training and professional development for employees. In *Education for Employability*, Higgs raises the question of the role of university education if it is to educate for status quo or for the future (Higgs, 2019).

One study (Cranmer, 2006) concluded that employment-based training and work experience were much more effective. While all stakeholders (graduates, employers, and universities) are interested in university graduates obtaining jobs and putting their skills and knowledge to use, the issue of *employability* is complex and for many years universities have tried to adapt to an increasing expectation of 'work ready' graduates, from both students and employers.

A review study found that both engineering knowledge and professional skills are important for employability. Engineering knowledge makes it possible to solve problems and professional skills enable collaboration with others (Winberg et al., 2020). Communication is one of the core professional skills that is very often regarded as a low value skill in education (Idkan et al., 2021).

Based on practitioners' perspectives, an Australian study identified six variables for engineering practice: self-management and personal awareness, engineering responsibility, human collaboration, engineering processes, engineering knowledge and career thinking (McHenry and Krishnan, 2022). This emphasizes that employability is a broad with many facets.

The significant impact of work experience is colloquially well-known, and both graduates and employers value work experience highly. Universities focus on theoretical and disciplinary

knowledge, while hands-on work experience often requires collaboration between organizations and higher education institutions. Graduates benefit from a combination of theoretical foundation (from universities) and practical skills gained through specialized tasks (from employers) to enhance their employability. These issues have inspired this research in which the guiding research question is: which factors influence engineers' employability in engineering practice?

Methodology

This study is based on nine interviews with experienced engineers (more than 10 years of work since graduation). The study is part of a larger investigation of engineering practice at Aalborg University, Denmark, where interviews have been conducted across several organisations.

The present study design includes an interview guide and is inductive in its approach; this is to ensure that the interviewer can follow conversational paths and let interviewees contribute with their viewpoints and experiences even if these are unexpected in the context of the interview guide. The interviews are based on probing questions and spontaneous, emerging questions (Kvale & Brinkmann, 2009), and were semi-structured (Creswell, 2016).

The qualitative interviews were conducted in February 2024, subsequently transcribed in the software program Whisper, and finally re-checked by the authors before coding in NVivo began. Each interview was done individually and lasted approximately one hour. Given that this research project is interested in perspectives that may illuminate aspects relevant to employability in an engineering practice, the qualitative approach as defined by Patton (2015) is helpful as it proves an approach that makes use of experiences. The following table shows basic information about each participant.

Table 1. Participant information overview

Participant ID	Educational background	Location	Years of work experience	Gender
P1	PhD, Electrical engineering	Australia	24	Male
P2	BA, Chemical engineering	Australia	10	Male
P3	BA, Civil engineering	Australia	29	Male
P4	PhD-student, Systems engineering	Australia	40	Male
P5	PhD, Electrical engineering	Australia	19	Male
P6	MA, Engineering practice, Public Works, and Infrastructure	Australia	14	Male
P7	PhD, Electrical engineering	Australia	43	Male
P8	MA, Applied geology	Australia	41	Male
P9	BA, Electrical engineering	Australia	20	Male

Findings

Technical baseline

The relationship between technical abilities, instrumental approaches, and technical writing all influence engineering practice and, therefore, employability. In the following findings, we present our analysis of the data which will highlight some of the aspects described by participants. As literature on the topic of engineering practice and generic competencies show (Higgs, et al,

2019; Cranmer, S, 2006; Stagnitti, et al 2010; Walker, et al, 2013), the relationship between technical competencies and generic competencies is complicated.

Generic competencies apply across jobs and human activities and are often referred to as transferable skills. Technical competencies are the foundation of engineering practice, but they rely on generic competencies to be effectively utilised. Thus, engineers need a strong base of technical knowledge, which becomes valuable when applied in combination with generic competencies.

As we will see in the following, the technical baseline is central, and P1 stresses how effort put into their technical baseline paid off by opening new opportunities. The two quotes, which are from two different points in the interview, underscore how the technical baseline is intertwined with generic competencies such as speaking, and other competencies like writing.

> *Well, I think one of the things that was really important was I put a lot of effort into developing very good instrumentation skills, so the ability to do measurements which are not straightforward at high frequencies. So I got a lot of opportunities. (P1)*

> *Writing and technical writing and also to a lesser extent speaking. (P1)*

P1 highlights a difficult aspect of employability, namely the unpredictability of opportunities. While mastering the technical competencies is central, it is noteworthy how P1 was proactive in their acquisition of new competencies – in this case in the context of high-frequency measurements. In this way, their employability was directly impacted by their proactive approach to learning. In the same vein, the following two quotes by P2 adds nuance by illustrating that employability and engineering practice exists on a spectrum.

> *If you are the world's best grid connection engineer, then you probably can get away with sitting away in the back of the office churning through grid connection models for wind farms and not talking to people; you can probably do quite well. There's a spectrum and almost everyone lives somewhere in the middle of that spectrum. (P2)*

Consequently, to influence employability, an engineer must be cognizant of both their technical competencies and their generic competencies.

Collaborative approach

One of the most central aspects for employability in the context of engineering practice concerns the collaborative approach. The ability to collaborate, also across disciplines, departments, cultures, nationalities, and so on, is crucial. In the following two quotes by P3 and P4, they stress how the ability to collaborate and to have the right mindset is meaningful.

> *And so if you're going to a technical job, then that's probably, you know, it's OK if you're better technically than in some of the other areas. But there are very few jobs where you just work by yourself in a little black room. It's working with other people, so you're gonna have an ability to work with others. (P3)*

> *So when I look for others, I want them to be able to understand that, umm, that kind of systems approach that they look for that that I'm looking for. I will even employ someone who has a better mindset around how to employ these positions, who may not be as academically qualified as another individual because they understand and have the mindset, and they had a grasp. They paradigm and translate it into something that people can relate to. (P4)*

Communication is a unifying component here, highlighted by P4 when the need to translate something is described, and by P3 who stresses that a person must be able to work with others. Relating this to employability, it seems a ubiquitous truism to mention the value of networking

for one's employability; it is also reflected in the following where P3 describes how they were often hired because of who they knew (rather, perhaps, than *what* they knew).

> *I'm not saying I got all my jobs because of who I knew, but that is certainly part of it and reinforces the value of networking. (P3)*
>
> *You have to build that network, you know, through your industry and then that definitely helps with employability. (P2)*

In a similar vein, P5 deliberately looked for signs of teamwork competencies when hiring new team members. This is interesting because it counters the misguided narrative that technical competencies by themselves are enough.

> *So, you know, those are, those are employable skills. Obviously having, I think it's less important now, but people do want to know that you have a basic competency and that you're going to do technical studies. But I think most people are now looking past that to say, well, what else have you done? And, you know, have you been working, like for instance, I employed people for a while and I was looking for signs of being able to work in a team, whether it was sports or community or, you know, some evidence that they could interact successfully with people. (P5)*

P5 touches on the link between extracurricular activities (for lack of a better term) and employability. For people with hiring experience, employability transcends the strictly academic; evidence of efforts in other contexts may positively influence a person's employability to highlighting desirable personal characteristics, such as the ability to work in a team.

Design thinking

In design thinking, we highlight (among others) the importance of interdisciplinarity and generic competencies. In the following it is described, with candour, how generic competencies may be a challenge to teach.

> *So I've heard from a few hiring managers, actually, that they're not worried about the technical stuff because they can teach that to people. But they're worried about what we sometimes call generic competencies. We started with that too. We used to call them, what were they called? Generic skills or generic attributes. (P5)*

With increased awareness of the importance of generic competencies, engineering education may reflect on practices and approaches that help students develop these generic competencies alongside their technical skills

The following section bundles together three quotes that all describe the value of understanding context, understanding disciplines, and possessing interdisciplinary collaboration skills, generic competencies which can be related to a design thinking approach.

> *So it's called good practice and that good practice requires the only way you can do that is to have understood the context and understood stable legal framework. (P6)*
>
> *As a systems engineer I have seen very much the opportunity to be bringing a number of interrelated technical and non technical disciplines together to deliver outcomes and produce effects. (P5)*
>
> *You need people that are cross disciplinary, so I think people that do have some of that are actually quite valuable. (P7)*

These all describe various competencies; some of them can be honed and developed during a degree, while others rely on personal attributes that might be slow to change. It is noteworthy that experienced engineers describe interdisciplinary collaboration skills as 'valuable', and that technical and non-technical disciplines may together produce something. This underscores that

employability is a multifaceted entity where several factors may influence an individual's employability.

Attitude match

Building on the previous section, attitude match was mentioned as an aspect of employability. While attitude match may seem vague, it houses aspects of employability that are relevant to explore as part of the non-technical skillset. For example, in the first quote there is an overlap between generic competencies and an attitude match. The second quote is particularly interesting because a person who was formally less qualified ended up being chosen for a job because of their attitude.

> *Employability is, I think a lot to do with presence, build, engage with somebody, communicate effectively. (P5)*

> *She was probably the lowest, technically speaking; the other two guys had already got undergraduate degrees and were doing their masters. And she's still she's in final year now, but she's still doing her undergrad, but personally, she was miles ahead of them. She was really proactive, really happy. She had done research on the organization, had worked out where she wanted to work, you know, and there's the other guys were a bit uncertain about themselves and. And so now I'm not having a go at them. (P3)*

In this way, participants describe how employability includes considerations about personal attitudes and that one may compensate for certain lack of experience or other professional deficiencies by showcasing strengths of personality in other contexts.

Development mindset

A recurring theme is centred around self-awareness and self-reflection. While universities teach and enhance these in certain ways, the process continues post-graduation. Being employed presents new challenges and new opportunities for personal and professional development, and as the follow quotes show, reflection and planning are skills that individuals must develop.

> *But, you know, also the reflection stuff. I mean, you know, that constant stopping to think about where you've just, you know, been. And what you need to do next. So, you know, that reflection and planning skill is something that they should be developing. (P5)*

> *And the reason for working with other people is to get to know yourself better. And if you know yourself better, then that will help you. You know yourself what motivates you and makes you feel satisfied in your job. (P7)*

P5 and P7 together emphasize the importance of working with other people, thinking critically about interpersonal relationships, and learning more about yourself and others. This, ultimately, influences collaboration skills and employability. The ability to work with others remains a core component of professional development and being able to showcase reflective competencies will positively affect employability, not least since it also shows a deeper understanding of work. This goes together with the following two quotes by P5 who, at two different points and in two different ways, points out how ignorance can be changed into knowledge, and a learner's mind is a powerful characteristic because it shows curiosity and a willingness to learn new material.

> *The saving face, you know, not wanting to be seen to be ignorant or a fool as they would amplify that ignorance. Nothing wrong with ignorance as long as you do something about it. But the label, a fool, means that you've now constrained yourself from learning. (P5)*

> *So the learner's mind, I think, is a really valuable characteristic or skill that students can bring to a business. (P5)*

In this way, being *teachable* becomes a kind of competence; being, as P5 puts it, “restrained from learning” is a difficult mindset to change. If a person is self-aware, reflects on their experiences and behaviour, and is teachable in a professional context, then these things can impact employability by highlighting personal competencies that in a collaborative context are important.

Conclusion

We may illustrate the previous five sections in the following model that condenses the information to show the interplay between design thinking, attitude match, development mindset, collaborative approach, and technical baseline.

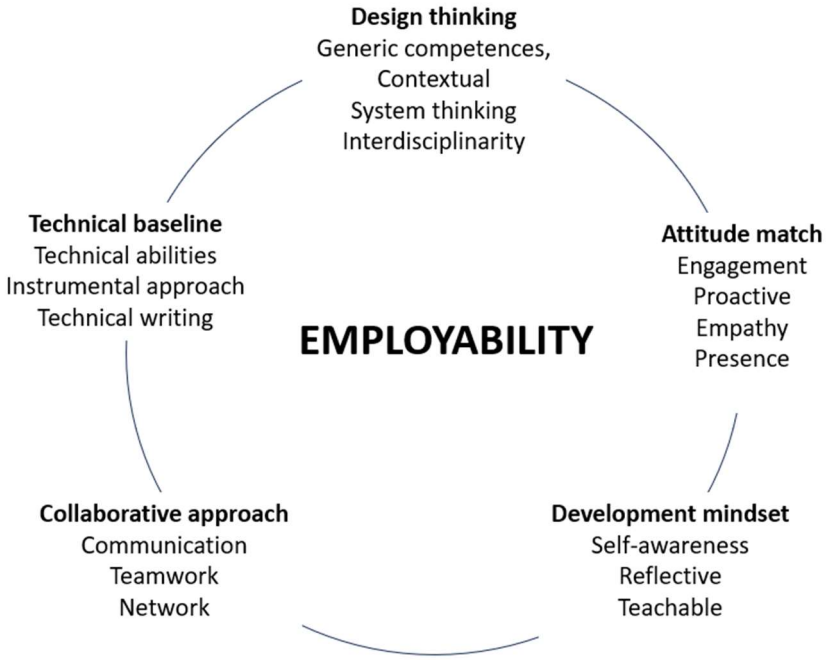

Figure 1. Employability factors

The workplace is a multifaceted and dynamic entity and some of these aspects may be very relevant in one context and less relevant in others; nevertheless, the issue of employability includes considerations of these five aspects.

This study, based on perspectives shared by nine experienced engineers, identified five categories (Figure 1) that are relevant to employability. While it is clear that employability as a topic houses many more potential areas of research, our findings show the importance of generic competences. In the context of engineering practice, a strong technical baseline remains essential, but our findings also point to cross-cutting, attitudes, mindsets, and collaboration approaches as areas that influence employability. Both individuals and professionals in engineering contexts might enhance their ways of thinking by considering employability in light of these topics.

The study has limitations, partly connected to the number of participants. With more data it would be possible to solidify the results and add more nuance and further perspective.

Additionally, the study is at this point not diverse in terms of gender, and it seems likely that perspectives from female engineers would add new and important material. It is our hope and intention that this can be a stepping-stone to further research into employability in an engineering practice context so that this knowledge can be used to improve engineering education and ultimately be helpful to both educators and professionals – whether they are employed or not.

References

Andrews, J., & Higson, H. (2008). Graduate employability, 'soft skills' versus 'hard' business knowledge: A European study. *Higher Education in Europe*, 33(4), 413–422. https://doi.org/10.1080/03797720802522627

Clarke, M. (2018). Rethinking graduate employability: The role of capital, individual attributes and context. *Studies in Higher Education*, 43(11), 1923-1937. https://doi.org/10.1080/03075079.2011.604408

Cornford, I. R. (2005). Challenging current policies and policy makers' thinking on generic skills. *Journal of Vocational Education and Training*, 57(1), 25–45.

Cranmer, S. (2006). Enhancing graduate employability: Best intentions and mixed outcomes. Studies in Higher Education, 31(2), 169-184. https://doi.org/10.1080/03075070600572132

Creswell, J. W. and C. N. Poth (2016). *Qualitative inquiry and research design: Choosing among five approaches*, Sage publications.

Davies, A., Fidler, D., & Gorbis, M. (2011). Future work skills 2020. Palo Alto, CA. Retrieved from https://uqpn.uq.edu.au/files/203/LIBBY%20MARSHALL%20future_work_skills_2020_full_research_report_final_1.pdf

Education for Employability (Volume 2): Learning for Future Possibilities, edited by Joy Higgs et al. (2019). BRILL.

Goodyear, P., & Ellis, R. (2007). The development of epistemic fluency: Learning to think for a living. Sydney, Australia: Sydney University Press.

Idkhan, A. M., et al. (2021). The Employability Skills of Engineering Students: Assessment at the University, *International Journal of Instruction* 14(4): 119-134.

Kreber, C. (2006). Setting the context: The climate of university teaching and learning. New Directions for Higher Education, 133, 5–11.

Little, B. (2006). Employability and work-based learning. York, England: The Higher Education Academy. Retrieved from https://www.heacademy.ac.uk/knowledge-hub/employability-and-workbased-learning

McHenry, R. and S. Krishnan (2022). A conceptual professional practice framework for embedding employability skills development in engineering education programmes. *European Journal of Engineering Education*, 47(6): 1296-1314.

Ng, T. W. H., & Feldman, D. (2009). How broadly does education contribute to job performance? Personnel Psychology, 62, 89–134. https://doi.org/10.1111/j.1744-6570.2008.01130.x

Patton, M. Q. (2015). Qualitative research and evaluation methods (4th ed.). Thousand Oaks, CA: Sage Publications.

Rae, D. (2007). Connecting enterprise and graduate employability: Challenges to the higher education culture and curriculum?, *Education+Training*, 49(8/9), 605–619.

Stagnitti, K., Shoo, D., & Welch, D. (2010). Clinical and fieldwork placements in the health professions. Melbourne, Australia: Oxford University Press.

Tymon, A. (2013). The student perspective on employability. *Studies in Higher Education*, 38(6), 841-856. https://doi.org/10.1080/03075079.2011.604408

Walker, A., Yong, M., Pang, L., Fullarton, C., Costa, B., & Dunning, A. M. T. (2013). Work readiness of graduate health professionals. *Nurse Education Today*, 33(2), 116-122. https://doi.org/10.1016/j.nedt.2012.02.017

Winberg, C., Bramhall, M., Greenfield, D., Johnson, P., Lewis, O., Rowlett, P., Waldock, J., Wolff, K. E. (2020). Developing employability in engineering education: a systematic review of the literature, *European Journal of Engineering Education*, 45(2), 165-180.

Yorke, M. (2004). Employability in the undergraduate curriculum: Some student perspectives, *European Journal of Education*, 39(4), 409–427. https://doi.org/10.1111/j.1465-3435.2004.00194.x

Yorke, M. (2006). Employability in higher education: What it is, what it is not (Learning and Employability Series 1). York, England: The Higher Education Academy.

Acknowledgements

This research project was made possible by the Poul Due Jensen Foundation and the Obel Family Foundation. The authors are grateful for these contributions.

Copyright statement