

# Chapter 3

## Generic Engineering Competencies Required by Engineers Graduating in Australia: The Competencies of Engineering Graduates (CEG) Project

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### ABSTRACT

*Continuous improvement of engineering education is achieved through curriculum development, program evaluation, and program accreditation processes. This chapter is based on the view that one of the criteria for design of these should be alignment with the competencies required by engineers in the workplace. The chapter provides an 11-factor competency model developed in Australia to help achieve this alignment. The model describes the generic engineering competencies required by engineers graduating in Australia. The competencies embed inter-related technical and non-technical components. An advantage of this model over others is the concise and relatively distinct nature of the 11 factors due to the statistical rather than conceptual method of grouping the competencies. The chapter outlines the theoretical framework, the model, and its development. The research methods employed to develop the model include a literature review, a panel session, two large-scale surveys of engineers, and a focus group. Implications for curriculum design, accreditation, and program evaluation are discussed.*

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## **INTRODUCTION**

Engineering education must be continuously improved and updated. This chapter is based on the view that engineering educators have a responsibility to society and to their students to give their students the best possible opportunity to develop the competencies they will require to become successful engineers. For engineering educators to achieve this they need an understanding of the competencies required by engineers. Large-scale quantitative studies have identified the competencies required by engineers in Europe and the USA, as identified later in this chapter. However, until now, no large-scale quantitative Australian study for this purpose had been undertaken. This chapter addresses this gap. The results can be used to help improve engineering education.

The objective of this chapter is to introduce the 11 generic engineering competency factors required by engineers graduating in Australia, identified in a large, mainly quantitative Australian study, known as the Competencies of Engineering Graduates (CEG) Project. The term “generic engineering competencies” is used here to refer to competencies that engineers across all disciplines require for their work, embedding technical and/or non-technical components. The 11 generic engineering competency factors provide a clear and concise list of competencies that engineers graduating in Australia, across all disciplines of engineering, require for their work. As described below, the study complements large-scale international studies, small-scale Australian studies, and studies using conceptual rather than statistical approaches to group competencies. The results are consistent with results of these studies, yet the competencies are grouped into more distinct clusters. The chapter outlines the study in which the generic engineering competency factors were identified. The study answered the research question,

What are the generic engineering competencies that engineers graduating in Australia require for their work as engineers?

The list of 11 generic engineering competency factors will help the development of program accreditation criteria, engineering curricula, and program evaluation methods.

## **BACKGROUND**

### **Change Processes in Engineering Education**

Continuous improvement of engineering education is necessary for multiple reasons. First, developments in educational theory and learning technology provide opportunities to improve engineering education. An increasing emphasis on engaging students in active learning has seen a move from traditional lectures, tutorials, and laboratories to increasingly more problem-based learning in engineering. Second, engineering science and technology progress rapidly. Third, the nature of engineering practice continues to change. Fourth, universities, their political, national, and resourcing contexts, and students change. The third and fourth of these drivers for change to engineering education are multidimensional as outlined below.

Engineering work which was undertaken by employees in large utilities is now more likely to be outsourced (Ferguson, 2006b). Similarly, society’s demands of engineers change. Engineers must now justify their decisions, consult with community members, and satisfy stringent environmental considerations (Beder, 1998; Florman, 1997; Ravesteijn, Graaff, & Kroesen, 2006). It is now recognised that engineers must lead sustainable development to avoid compromising future generations (Bonnet, Quist, Hoogwater, Spaans, & Wehrmann, 2006; Penlington & Steiner, 2010). Furthermore, globalisation has expanded the international competence demanded of engineers (Becker, 2006; Downey, et al., 2006).

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