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Transport Engineering Education

A Transport Australia Society Discussion Paper

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Engineers Australia
11 National Circuit, Barton ACT 2600
Tel: 02 6270 6555
Email: publicaffairs@engineersaustralia.org.au

www.engineersaustralia.org.au

Table of Contents

Purpose

This document has been produced by the Transport Australia Society of Engineers Australia as a discussion paper on the topic of engineering education in Transport Engineering. It does not represent a formal position of Engineers Australia, but is intended to guide the benchmarking of Transport Engineering streams in Civil Engineering Bachelor degree programs in Australia.

Definitions and Scope

The development of transport infrastructure such as roads, harbours and ports was included as one of the primary tasks of Civil Engineers from the first definition of the profession by Thomas Telford for the Institution of Civil Engineers in 1828.

For purposes of this paper Transport Engineering is defined as engineering practices used in the planning, design, construction and operational management of physical infrastructure used for the movement of persons and goods, that is roads, railroads, ports and airports.

As engineering technology and practice have become more specialised over time, the planning, design and construction aspects of transport physical infrastructure has remained within the field of civil engineering. Provision of other elements of transport systems have become the field of disciplines such as mechanical engineering (vehicles and rolling stock), electrical engineering (power and communication systems) and computer engineering (control systems including autonomous vehicles).

Engineers Australia accredits Bachelor and Master Degree programs in Civil Engineering in Australia as being of a suitable standard to train Professional Engineers. Accreditation of degree programs in Civil Engineering is based on an assessment of their ability to achieve learning outcomes for students as defined by the universities.

This paper is confined to consideration of transport engineering streams within Civil engineering courses. There is no mandated content for this at present, but this paper is intended to serve as a benchmark when assessing the ability of a course to prepare students for practice in transport engineering.

Context

Together with geotechnical, structural and water resource engineering, transport engineering forms one of the four primary elements of civil engineering work practice.

Employment in transport engineering, whether in government or private industry, is one of the most numerous work fields for graduate engineers. The construction of transport infrastructure is presently worth 1.2% of GDP and represents approximately 18% of all construction activity in Australia. In the view of TAS, a basic knowledge of transport engineering practice would be an expectation for Civil Engineering degree program graduates.

At present Engineering degree programs are assessed for their technical standard and ability to impart knowledge in mathematics, physical science and engineering practice, problem

solving and design skills to graduates under a range of elements. The assessment includes learning objectives, course content, and their ability to achieve student outcomes. There is not a specific requirement for a minimum amount of content in transport engineering in civil engineering courses.

This has resulted in a varied degree of transport engineering content in tertiary civil engineering programs in Australian Universities. At present there are 19 engineering schools in Australian universities.

All civil engineering degree programs include at least one transport engineering subject. Degree contents in transport range from 1 optional subject to three compulsory subjects with additional electives available. The majority of Bachelor Degree programs include two or three transport subjects. Four university programs currently include only one transport subject, and have only one lecturing position in transport on staff. All engineering degrees include elements of road design and construction, but only three include formal content in rail, port or airport analysis and design.

In TAS' view, this variation is not justifiable in terms of educational outcomes. There is a risk that some civil engineering graduates are not adequately skilled to practice in transport engineering without further training.

Whilst we appreciate that different Universities will choose to specialise in different fields of practice, the current variation is too great to produce graduates of consistent quality. Either some universities are teaching too many transport engineering subjects or some too few. In TAS' view, the latter is the case.

In an industry undergoing significant technical change, this may have negative consequences for the civil engineering profession in terms of its ability to be seen as the specialists best equipped to make technical judgements about transport engineering matters. In this regard we note the growing number of graduates from other disciplines, including planning, mathematics, and economics, in roles traditionally filled by civil engineering graduates. The increase in the diversity of skills is welcome, but civil engineering program must reflect developments in the field and adapt accordingly.

TAS proposes the following framework to benchmark Transport Engineering contents against for Civil degrees.

Tertiary objectives

Provide a range of compulsory and elective subjects to ensure:

- All graduate civil engineers have a basic understanding of transport system elements and their construction.
- All graduate civil engineers have a basic introduction to road and/or rail geometric design and safety engineering.
- Options exist for graduate civil engineers to develop skills in capacity analysis and computational techniques for determining the extent of infrastructure works required.

- Options exist for graduate civil engineers to develop skills in transport planning recognising engineers must be able to evaluate the need and justification for infrastructure as well as its design.

Bachelor degrees

In practice, the bulk of transport infrastructure work is in road and rail engineering, noting that road engineering is taken to include urban street design as well as highways. These topics should form the focus of a transport engineering syllabus. Port and airport engineering can be addressed peripherally. Recent trends towards improved active and sustainable transport, intelligent transport systems, and the implications of autonomous vehicles should be covered. The following subject structure and broad contents is suggested, with a minimum of two subjects forming a transport stream:

1. Road and Rail Engineering - Elements of transport systems, physical components, passenger and freight transport & loads, introduction to road and rail geometry, road pavements and rail 3 track structures, culverts and drainage, urban streets versus rural highways; safe design for pedestrians and cyclists, safe systems approach to design
2. Transport Analysis – basic analytic tools to understand transport operations, capacity and safety, including traffic engineering and PT operations. Queuing theory, gap acceptance, scheduling and networking. Intro to micro and macro modelling of capacity, intelligent transport systems and safety audits. Data collection, data types and big data.
3. Transport Planning – understanding interaction of transport systems & networks, supply and demand for capacity. Introduction to strategic network models and transport demand modelling. Discussion of concepts of demand management, induced demand, active modes and non-infrastructure alternatives to manage congestion, autonomous vehicles and ride sharing. Transport impact on the natural and urban environments and sustainability practices.

Transport planning practitioners are drawn from multiple fields including engineering, land use planning, behavioural science and economics. The planning subject may be taught by or in conjunction with planning degrees.

Staff, resources and facilities

Whilst Engineers Australia does not mandate levels of teaching resources, we note that at present rapid change is occurring in transport technology and transport planning and design practice. The need to review and update the contents of transport engineering subjects to ensure their currency is therefore greater than in previous decades. This highlights the need for a lecturer knowledgeable in contemporary practice to be responsible for transport subject contents.

The lecturer should be a qualified engineer, desirably have post graduate qualifications and be currently active in transport engineering practice or research. Research active lecturers will ensure that course content remains relevant to current industry trends.

Teaching of design and planning subjects will require student access to relevant computer software packages such as road and rail geometric design packages, traffic micro-simulation software and transport demand modelling software. There is a wide and growing range of software used for such tasks. The primary focus should be on giving students a conceptual understanding of the tasks performed by software, rather than mastery of any one platform.

The teaching of transport engineering bachelor degrees will require some laboratory facilities to teach students the physical nature of concrete, granular pavement, asphalt and bitumen surfacing.

Teaching of design and planning subjects will require student access to relevant computer software packages such as road and rail geometric design packages, traffic micro-simulation software and transport demand modelling software. There is a wide and growing range of software used for such tasks. The primary focus should be on giving students a conceptual understanding of the tasks performed by software, rather than mastery of any one platform.