SOUTH PACIFIC
ENGINEERS ASSOCIATION

Policy

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The Needs for Engineering Education in The South Pacific

1. Engineers are critical for sustainable economic development

Lifting the standard of living in any nation relies on engineers providing many key infrastructural services in a cost-effective manner.

- Water supply – the primary means to ensure good public health.
- Wastewater and solid waste treatment – also critical for public health and the environment.
- Transportation infrastructure – particularly roads, ports and airports.
- Safe and resilient buildings (commercial and residential).
- Energy supply – particularly electricity.
- Telecommunications – including line-based, cellular, satellite and broadcast modes.

As well as these services, engineering can contribute significantly to the earning capability of a nation in the Pacific if there are natural resources to utilise, or the potential to develop niche manufacturing. The role of engineering in making nations attractive to tourists (through safe, affordable, reliable services and protecting the environment) cannot be under-estimated. In all these roles, as well as ensuring that technically sound decisions are made, engineers also have the skills to ensure financial capital is well spent.

Good-quality engineering also acts to mitigate the costs of damage through geohazard (e.g. earthquakes, tsunami) or climate (e.g. cyclones). If sea level rises in future decades, engineers will provide the response in many nations. In a well-engineered country, damage should be far more restricted than it has been in events during the last 20 years.

The engineers of a country are the primary resource in ensuring the economic resilience of the nation and that the environment is protected.

2. Outsourcing engineering is not an option

As a rough guide, many countries have about one engineer per 250 people. In highly developed countries there are more engineers, and in less-developed countries the ratio can be less than one per 1,000 people. These engineers are required for a number of roles, including:

- strategic advice to government on how to best use the resources of the nation, and public sector capital
- carrying out feasibility studies, procurement, detailed design and supervising construction of new infrastructure projects
- operation of infrastructure systems
- maintenance and upgrading of infrastructure systems
- ensuring that private capital expenditure (e.g. housing, commercial buildings, hotels etc.) is to good technical standards.

Historically, many new infrastructural projects were constructed by outsourcing to overseas engineers. However, the ability to operate the infrastructural systems successfully is compromised if there is insufficient talent on the ground. Denying local engineers the chance to participate in capital works projects downsizes the local engineering community, lowers its status and standing, and leads to a situation in which the nation does not have sufficient critical mass to maintain good technical measurement laboratories, and cannot ensure that tradespeople work to good standards.

This is not to say that nations can be self-sufficient for engineers – what is needed is an approach in which those specialist skills that are only occasionally needed are outsourced but core skills are maintained in the local engineering community.

3. Educate one's own or purchase internationally?

To be successful, engineers need to fit socially into the community, be prepared to stay, but to be educated to good standards. It is acknowledged that compared to international engineering possibilities, the opportunities for engineers in a small nation are limited – the engineering work is often more general purpose than specialised, and the salary may be below what is available elsewhere. The problem of retention is probably worsened if the best and brightest students are sent to Australia, New Zealand or elsewhere to study engineering – those students are less likely to return and stay. However, sending students overseas might have a place in a plan, particularly for those small countries that will be unable to provide engineering education locally.

Whilst there will always be some inwards migration of overseas engineers who stay for lifestyle reasons, it would be unwise for the region to depend on that source.

As it will heavily depend on locally educated engineers, the region needs an engineering education plan and a retention strategy.

4. The nature of a regional education plan

An engineering education plan needs to consider four levels of engineering.

- Professional engineers (typically holding a four-year Bachelor of Engineering (BE) or higher degree) who will undertake the most complex work.
- Engineering technologists (typically holding a three-year Bachelor of Engineering Technology degree) who will undertake less complex work, and who are often well skilled to be system operators.
- Engineering technicians (typically holding a two-year Diploma of Engineering) who provide many of the specialist services, e.g. measurement of material properties, in support of engineering projects.
- Engineering tradespeople (electricians, plumbers, gas fitters, construction workers etc.) who need to be skilled to successfully implement an engineering design.

In the very small nations it is not possible to contemplate education at any of these levels. Few nations can contemplate offering degrees. A regional plan, based on engineering degrees in only the two largest nations, Papua New Guinea and Fiji, seems appropriate. In other nations (e.g. Samoa) the national universities and/or technical colleges have particularly significant roles in educating tradespeople, and might have a role in educating engineering technicians.

As well as considering the levels of engineering, the plan must also consider any difference in needs between the main discipline areas – civil, mechanical, electrical and chemical.

5. Needs analysis by engineering discipline

In small nations, engineering is very often generalist. Engineers will work in a multi-disciplinary manner, but also will tackle work of widely varying degrees of complexity. In such circumstances, in contrast to large countries, it makes sense to educate relatively more professional engineers and less engineering technologists. Taking this into account, **Table 1** sets out a summary of the needs. In the following sections the level of demand is further discussed.

Table 1: Demand for qualified engineers in the Pacific Island Forum region. Note that individual nations may have needs that differ from the overall regional profile. (1–5 * scale)

	Professional engineer	Engineering technologist	Engineering technician	Engineering trades
Civil	*****	***	*****	*****
Mechanical	***	****	*****	*****
Electrical	****	****	*****	*****
Chemical	***	***	****	***

5.1 Civil fields

Due to the need to withstand earthquakes, high rainfall and high winds, there is a strong demand for professional engineers to design structures and undertake geotechnical work. Roads must also withstand a hostile climate and flood protection works also require professional engineers. Design of water, wastewater and solid waste facilities also requires professional engineers.

Operation and maintenance of civil engineering infrastructure does not need the same skill level – the demand for engineering technologists may be better met by allowing some professional engineers to under-utilise their education rather than have a separate qualification for a small demand.

The demand for engineering technicians and tradespeople is high – they will be used for construction, maintenance, and in the case of technicians, in operations.

5.2 Mechanical fields

Many heavy mechanical engineering devices will be designed overseas and imported. Hence the demand for professional engineering capability is likely to be less in most nations than for civil professionals. The need for local design in building services will be significant, but some of that work can be carried out by engineering technologists. There is a strong demand for operations and maintenance which requires all levels other than professional engineers. Mechanical engineering is also critical in utilities, especially in the power generation area where there are hydro- and diesel-powered generators involved.

5.3 Electrical fields

Electricity supply systems need to be able to run reliably using only local expertise. For this reason there is a need to have a local resource of professional engineers. Strong trades and technicians are very important. The engineering technologist will have a strong role in operations.

In regard to telecommunications the situation is similar. Much equipment will be sourced externally, but there needs to be strong on-the-ground operational and maintenance capability.

5.4 Chemical fields

The demands are low unless a nation has a strong chemical or petrochemical industry. The latter industry works to international standards, and the large companies involved are likely to move the necessary workforce into the region. However, there might be a local need for testing, e.g. for discharges into the environment on behalf of the government.

5.5 More specialised fields

Specific countries might have more specialised demands associated with particular industries, e.g. mining. These are expected to be managed via migration or a local variant on a more general qualification.

5.6 Numbers of graduates

Estimating the numbers of graduates required per year is difficult. The regional population is of the order of seven to eight million. Even producing engineering graduates at one quarter the rate per head of population as New Zealand would require about 500 professional engineers, 200 engineering technologists and 300 engineering technicians per year. There should also be thousands of tradespeople.

6. A network of provision

If a regional approach is taken, it would seem realistic to only produce professional engineers and engineering technologists in the three most important disciplines (civil, mechanical and electrical engineering) in Suva and Lae. In Lae there is a single provider, but in Suva both the University of the South Pacific and Fiji National University could contribute. By having all disciplines at one site in each location there can be useful economies of scale. As well as being produced at these two locations, engineering technicians might be produced more widely in Papua New Guinea, and potentially could be produced in Apia as well as Suva in the longer term.

Taking into account the expertise levels that exist, and considering the three main producers and their demonstrated capability, a possible strategy would be as set out in **Table 2**.

In Papua New Guinea (PNG) there would be an expected demand for BE graduates of 200–300 per year, and a similar combined output from the University of the South Pacific/Fiji National University campuses in Suva. The experience of the Institution of Professional Engineers New Zealand is that it is difficult to create a viable "engineering school" with a student cohort of less than 100–150/year. It is therefore recommended that in Suva there be a single collaborative offering between the Fiji National University and University of the South Pacific (USP), because there would be a risk that two separate offerings would each be too small.

Table 2: Possible network of provision for engineer education in Pacific Island nations (note USP offerings classified as Fiji)

	Professional engineer	Engineering technologist	Engineering technician
Civil	PNG, Fiji	No provision	PNG, Fiji
Mechanical	PNG	Fiji	PNG, Fiji
Electrical	PNG, Fiji	Fiji	PNG, Fiji
Chemical	No provision	No provision	PNG

A critical decision is the extent of engineering technologist education, given that the overall regional demand is likely to be of the order of 200/year over the region. One viable approach would be to not teach at this level and produce more professional engineering graduates, knowing that the less capable of these will drop down to technologist work. The cost of over-educating those graduates would be offset to some extent by the greater economy of scale. The other alternative is to maintain very focused technologist education, in a co-ordinated manner linked to the combined BE offerings in Suva.

Strong technician education is required across three disciplines in Papua New Guinea and Fiji. It may be sensible to co-locate this education at the same campuses offering degree-level programmes because of economies of scale and the ability to use similar equipment in laboratories.

Some technician education may also become viable in Apia (e.g. through the National University of Samoa), provided a co-operative approach working with other regional providers is taken.

Trades education/training needs to be strong in each of Samoa, Fiji and Papua New Guinea. It may be viable to educate those trades regarded as critical for resilience of engineering systems in a more limited fashion in other countries.

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7. International benchmarking

It is recommended that a strategy be put in place in both Papua New Guinea and Fiji initially, and then in other nations, to ensure that in the long term the offerings are benchmarked to the Washington Accord, Sydney Accord or Dublin Accord (respectively for professional engineer, engineering technologist or technician education). This strategy will require evaluation of the present offerings, development of a business plan for investment to address issues, mentoring, and then ultimately an accreditation process.

In order to progress the strategy, it is recommended that the Institution of Professional Engineers Papua New Guinea work with Engineers Australia, and the Fiji Institution of Engineers work with the Institution of Professional Engineers New Zealand. The mentoring country will assist with evaluation, preparing the business plan for investment, and then ultimately might be appointed the accrediting agent. The local engineering institution would provide industry representatives to participate in the process.

The total development process may take a number of years.

8. School preparation for engineering study

A critical factor is the preparedness of school children for engineering study. In order to complete internationally benchmarked engineering qualifications successfully, students entering those qualifications must be similarly skilled to school leavers in Australia or New Zealand, particularly in physics and mathematics. If this is not the case it is recommended that nations might establish a "super class" in one or more selected high school in which students pre-selected for engineering study spend extra time to ensure they meet the necessary entry standard. This may be accomplished as a two- to three-month block course after leaving school and prior to entering tertiary study, but it might need to be as long as a full year depending on the national education system.

9. Retaining engineers

Retention of engineers in a Pacific Islands' nation requires:

- pay at a rate seen as sufficiently in line with international pay rates
- status and standing in the local community and recognition by government of the importance of the profession
- access to registration systems comparable to those in Australia or New Zealand
- opportunity to access work (both locally and externally funded) at the right level
- access to ongoing professional development opportunities
- enabling engineers to be connected to other engineers.

Commitment to establishment of good-quality engineering education programmes must be matched by actions in respect of these items if the benefit of the graduates is not to be lost.

10. Role of the South Pacific Engineers Association

As well as preparing this overall policy guidance note for the benefit of governments in the region, the Association and its national chapters intend to have an active role in working with government and tertiary education providers. This includes through working with the Australia and New Zealand engineering professional bodies which will assist in creating tertiary education in engineering of good quality. The Association and its chapters will actively work with governments on the retention mechanisms as well.

11. Disclaimer

The South Pacific Engineers Association (SPEA) is the non-aligned association of national professional engineering bodies in the South Pacific. It seeks to contribute on matters of national and regional importance. One part of its contribution is to issue position papers, which give a learned view on important issues, independent of any commercial interest. Such notes are not consensus papers of the Association membership, although they have been widely peer reviewed amongst the membership. Others are free to quote or use materials from this note.