Submission to Productivity Commission that water infrastructure should be an innovation-ecosystem candidate for an area of focus for concentrated innovation support in New Zealand.

(This refers to draft recommendation 7.4 that the Government should partner with stakeholders to choose such areas of focus.)

Water Infrastructure

This submission takes "water infrastructure" to include urban networks for water supply, sewage disposal, and drainage; flood protection works and bridge waterways in rivers and estuaries; irrigation schemes including storage design; hydropower canals, dams and reservoirs, power stations; harbours; coastal highway embankments and discharge outfalls; and coastal works for protection against tsunami, storm surge and wind waves.

Repeated infrastructure failures must be seen as engineering failures, because only the engineering profession has the resources and training to combine two key aspects of a proper corrective response: forensic investigation of possible contributing causes, and research into improved design and maintenance procedures.

Yet over the last thirty years New Zealand has had to endure (and continues to endure) many major failures of water infrastructure where any corrective engineering response has been left to those few overseeing the original failure. This is because the retention of a permanent specialist team of failure investigators has been beyond the resources of almost all of the relatively small authorities now assigned total responsibility for their water infrastructure.

Examples

Two examples have had a recent high profile:

Capacity Failure of the Ports of Auckland

What engineering opinion contributed to the two contradictory studies by Ernst and Young of future expansion sites? In comparable strategic planning studies recently completed for both Northport and Port of Tauranga, high technology harbour modelling (computational and physical) was a key engineering investigation strategy. Were such techniques offered by Ernst and Young?

It would seem that whoever recommended Ernst and Young to undertake each study had no experience of how these things were done. Clearly the market lacks a reference source for objective specialist advice grounded on peer reviewed engineering research.

Replacement of the Original "National Battery"

Although the terminology was not invented in the 1970s, the vast Tekapo-Pukaki storage enlargement was very much conceived as the first "national battery", supported by extensive computational model analysis. In fact the government of the time spent an unprecedented sum to set up the Vogel Computing Centre, with engineering analysis of the national electricity system one of the priority applications put forward to support the purchase.

The original concept was later seen to be incompatible with the new market model of competing generators, as none of the competitors could be allowed the market dominance associated with controlling the only national battery. This was resolved in 2011 by disconnecting the Tekapo-Pukaki battery into two parts, each controlled by a competing generator. This made the originally planned pumped storage expansion impossible, for administrative rather than engineering reasons.

Now a national battery is again gaining priority, the solution appears to be to begin again on another site, but no computational model network analysis has been published to support this option. If it will be acceptable now to place this new storage under the control of one of the competing generators, surely the alternative of restoring the original national storage concept by reconnecting Tekapo and Pukaki (with pumped storage) should be reconsidered?

Of course, the only way to compare the options is with high technology engineering models, and the market again needs objective specialist advice about which models have the required capability.

Special Challenges in New Zealand Engineering Practice

Our electricity grid must run in total isolation from other countries, and has hydropower as the main renewable storage source. This also applies to our Pacifica neighbours, where we take responsibility for engineering advice, especially in the Realm islands.

Our water infrastructure is exposed to medium levels of seismic and volcanic risk, involving construction across active fault lines, plus tsunami and lahar hazards.

We are subject to some of the most intense rainfall in the world, which can now only be exacerbated by climate change. Our urban design based on separation of sewers and drains.

Yet our "level playing field" technology strategy has resulted in millions of dollars worth of engineering design technology being imported from northern Europe (where none of these factors apply) without any requirement for validation testing to demonstrate compliance with New Zealand design practice. For example, the Lord Mayor of London (a bankruptcy expert with no engineering background) visited in 1997 and simply proclaimed "there is nothing better than British engineering" to a meeting with the (then) Auckland City Council. The next day I was advised that a strategic decision had been taken to drop their existing New Zealand design software in favour of the nearest British equivalent!

The two developed countries most similar to New Zealand in physical challenges are Italy and Japan. Language barriers have inhibited engineering collaboration in the past, but both countries now publish most of their engineering research in good English. We are now building collaboration on standards with both countries, where New Zealand has the significant competitive advantage that we do not have to continually translate our internal research to and from another language for international communication.

Yet when applied to technology exports, what does our "level playing field" strategy mean? In practice, it could be paraphrased as "the New Zealand Government does not undertake technical analysis of imported products. Correspondingly our export products are also not Government tested." This lack of endorsement was particularly baffling to an agency of the government of Japan, for example, when the consulates of other countries were queueing up to demonstrate competing products for which development was directly funded by their governments.

A Solution

Water infrastructure specialists were largely removed from the public service after creation of the Crown Research Institutes in 1992. This has concentrated engineering research into the universities

From my long experience with publicly funded engineering research under various structures in New Zealand (starting from my Post-Doctoral Fellowship awarded in 1970 by the National Research Advisory Council), I believe that the University of Auckland engineering faculty is now our only remaining institution with the critical mass to be the reference source for peer reviewed engineering

research, both for the domestic and international markets. Importantly, such professional experience has also carried an ethical responsibility to maintain networks of awareness when it would be better to seek outside advice, and where (inside or outside New Zealand) such advice might be found.

Examples of Successful Reference Research Projects

The University of Auckland has a strong history of providing reference research to the market. Three examples from my own experience are:

1. Transfund: Following a succession of bridge failures resulting from waterway scour under the road crossing, Transfund (a Crown Entity established under the Transit New Zealand Act, 1989) approached the University of Auckland to review the causes. The results were published in the United States by Professor Bruce Melville and the late Stephen Coleman, becoming a textbook classic. The foreword was written by Professor Robert Ettema, an Auckland graduate who was by that time part of the New Zealand hydraulic engineering diaspora. He is currently Vice President of the IAHR and therefore now one of the most distinguished hydraulic engineers in the world.

2. Team New Zealand (via Tom Schnackenberg) approached me in 1998 to organise a tidal prediction system for the Hauraki Gulf, the venue of the 2000 defence of the America's Cup. Since contributors had to organise their own funding, my business could not undertake the job on the same basis as the multi-year harbour development strategic study then in progress for Northport. However, based on my experience with tidal prediction on that and other projects, I was able to assemble a team with access to enough funding to undertake the various parts of the study. An important component was the numerical modelling, for which Dr Colin Christian of the University of Auckland stepped forward. The resulting paper https://www.researchgate.net/publication/251614539 is still the authoritative source for the latest America's Cup courses, as evidenced by over 300 downloads during 2020.

3. The then Auckland Regional Authority had concerns about a report written by another consultant. They approached the University of Auckland and HYDRA Software Ltd to advise on the results, and we recommended a new expanded study. As a private consultant, it was easy for me to arrange collaboration with Professor Asaad Shamseldin in this study, where his hydrological skills perfectly complemented my expertise in hydraulics. The results of this study of flooding in the Opanuku Stream have now been adopted as a world hydraulic model validation benchmark by the IAHR.

Local Government Endorsement

Watercare have already recognised the need for a reference research source, and have chosen to fund a Watercare Chair in infrastructure in the Department of Civil and Environmental Engineering at the University of Auckland.

I submit our central government should consider expanding on this initiative.

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