Are you having difficulty finding the room to stand on the morning train, do you even have public transport nearby, is your internet connection fast and reliable, are there sufficient schools and medical facilities near your community, are the water supplies and rivers clean and safe? Infrastructure includes the physical elements of our work, home and communities that support our life, including the transport system of roads, ports, rail and airports, the energy and water supply, the communication systems and the buildings to enable us to learn, recuperate and govern.

# The Insatiable Demand for Infrastructure

**Jeremy Stone**
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The demand for this infrastructure is driven by the requirement to replace existing assets built many years earlier, the relentless need for increased productivity, safety, care for the environment and a rapidly growing population.

Recently there has been much debate in Australia regarding population targets, with projections by the Australian Bureau of Statistics indicating a higher bound population of up to 45 million by 2056, up from the current 22 million. To highlight the effect on infrastructure demand, from a water supply perspective, a recent report by Water Services Association of Australia (WSAA) indicates this populations size will require some 1,600 billion litres of additional water per year (about the volume of 640,000 Olympic size swimming pools).

The financial scale of infrastructure demand is significant. Infrastructure Partnerships Australia (IPA), a forum bringing together public and private sector leaders in Australia's infrastructure industry, values the nation's economic infrastructure investment task in the coming decade at some $800 billion. Some of these projects are already under construction including the $43 billion National Broadband Network, $3.1 billion desalination plant in Victoria and the $1.8 billion Northern Link Road tunnel in Brisbane.

It is clear keeping up with ever increasing needs for infrastructure is not only an Australian challenge. It is estimated between $24 trillion and $30.5 trillion will need to be invested in new plant and equipment worldwide from 2008-2030 as reported by the Washington-based firm CG/LA Infrastructure. In addition, the World Economic Forum Global Competitiveness Index 2009-10, ranked Australia twenty fifth out of 133 countries in infrastructure. Any way you look at it, there is a lot of work to be undertaken.

## The supply of skilled resources to deliver the infrastructure

An on-going threat to Australia's productivity and living standards is the declining numbers of skilled resources available to deliver infrastructure of strategic importance. Innovation is one avenue to enable us do more with less and to inspire additional students to follow technical career paths such as engineering.

Engineers Australia (EA), the peak body for advancement and professional development of engineers in Australia, estimates that over the next 5 years an estimated 75,000 engineers will retire and only about 45,000 will graduate from tertiary institutions, resulting in a net reduction of some 30,000 engineers. Over and above the numbers deficit, retirees also remove from the industry significant years of practical experience, a confronting issue for young graduates when helping to deliver the much needed infrastructure projects.

Much has been written about Australia's skills shortage. In 2009, more than half (53 per cent) of companies surveyed by Engineers Media, a subsidiary of EA, reported a shortage of professional engineers. EA warned that "during the course of 2010 shortages of skilled engineers will re-emerge as a serious constraint to infrastructure development".

This problem has its roots at school level, EA says too few students are choosing advanced maths and science courses. In 2001, 13.9 per cent of year 12 students studied advanced maths but by 2007 the proportion was 11.6 per cent. The number of year 12 students studying chemistry and physics has also fallen significantly. In 1976, 28.6 per cent of year 12 students studied chemistry, but by 2007 the proportion was down to 18.0 per cent. Figures on physics tell a similar story: 27.5 per cent of year 12 students studied physics in 1976 but by 2007 it was 14.6 per cent.

This skills deficit puts Australia at a competitive disadvantage against its global peers and developing economic powerhouses such as China and India. A situation supported by the 2010 World Competitiveness Yearbook where out of 58 countries surveyed, Australia ranks 41 on the availability of skilled labour including engineers.

## How Innovation Can Assist

The current gap between the demand for infrastructure and the supply of skilled resources requires the Government and industry to work in partnership to find new and better ways of supporting and delivering these projects.

Innovation provides one of the keys to unlock this potential.

But what do we mean by innovation? And how do we differentiate it from value engineering, where these terms are often used interchangeably? "Value engineering" is project based innovation, whereby the idea can successfully be applied for the benefit of that one project. An example might be a reconfiguration of a road alignment to save significant amounts of earthworks allowing cost and time benefits.

"Innovation" is an idea (product, service, process, technology) that can successfully be applied to multiple projects throughout the industry i.e. an industry wide application. The introduction of membrane technology in the desalination process would be defined as an innovation and a more detailed review of this example communicates the benefits of successful innovation in infrastructure.

In the 1850's drinking water was extracted from saltwater by distillation (boiling water and passing it through various chambers using the principles of condensation and evaporation), when the concept was developed by an engineer from the sugar industry. It was a slow, energy intensive and expensive process, however it proved to be useful in the shipping business. In the early 60's, US President John F. Kennedy once commented, "If we could ever competitively—at a cheap rate—get fresh water from salt water, that would be in the long-range interest of humanity, and would really dwarf any other scientific accomplishment". After much research and development, primarily with US Government funding, the first reverse osmosis (RO) membrane process was commercialised in the 1970's. Since 1985, there has been a five fold increase in installed capacity around the world, providing communities and industry with clean water supply.

This case study included two innovations in infrastructure. Firstly the introduction of distillation in the 1850's, followed by the acceptance of membrane technology in the 1970's. It also highlighted the importance of leadership and focus as displayed by the US President.

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**Successful innovation in infrastructure delivers numerous benefits including:**

- The ability to achieve more with less resources (people, financial, energy).
- Developing new approaches to overcome the challenges of climate change and ensure we focus our efforts on the areas of greatest importance and value.
- Delivering infrastructure in a timely, sustainable and safe manner for a growing global population.
- Extracting additional value over an above the delivery of the project, such as commercialisation and positive reputation and legacy;
- Encouraging interaction and collaboration across industries, companies and geographies;
- And inspiring more students to take up maths and science subjects in secondary school, leading to them to professional technical qualifications, such as engineering and architecture.

## Barriers to innovation in infrastructure

When asset owners such as governments or private companies require infrastructure to be delivered, the typical parameters for success include quicker, cheaper, safer and in a more environmentally sensitive fashion. Although this does provide the stimulus and incentives for creativity, if innovation is mentioned, it is usually in the context of the project (value engineering), not industry-wide, multi project innovation as defined previously.

Some of the barriers preventing the effective movement from (project based) value engineering to (multi project) innovation in infrastructure include:

- Intellectual property (IP) – in many contracts IP generated from the delivery of the infrastructure is owned by the asset owner, leaving no real incentive for companies to propose new ways that can be adopted on other projects or throughout the industry. Compounding this issue is that most asset owners do not have the resources, skills or passion to use this IP for value creation which is a waste.
- Time – project delivery periods are getting shorter for a number of reasons, including regulatory, health, political etc. There is also more pressure to start construction work early (fast tracking), often leaving little time for research, investigation, planning and capture of the innovative ideas.
- Resources – the resources are focused on delivering the job at hand, leaving limited or no capacity to further develop the innovation ideas.
- Investment – infrastructure projects involve substantial borrowings and financial arrangements, with nothing available for supporting additional work in further developing these innovations.
- Risk – fear of failure with an emphasis on risk (versus opportunity). New ideas take time and often fail, causing potential negative impacts on reputations and finances.
- Limited skills and processes to successfully deliver on the innovation, including opportunity identification, efficient and effective collaboration across industries, countries and organisations, access into appropriate research, commercial planning and acumen, marketing, communications and financial support.
- Incentives - the procurement focus is on delivering the project and there are no incentives to encourage identifying and developing multi project innovations.

## The Future

Unfortunately there is not just one, nor any easy solution to satisfy the challenges of delivering the on-going infrastructure needs of Australia. Access to sufficient funding, adjusting legal and regulatory frameworks where needed, accepting and being more responsible for the environment, and ensuring there are sufficient skilled people to plan, design and build the roads, ports, water supply and other required assets of our nation are all key enablers.

Government must take the lead by offering clear direction in setting strategic priorities and support a procurement approach that enables the opportunity for creativity and innovation to flourish when industry delivers infrastructure projects. Clearly the corporate sector also has a significant role to play in nation building, by inspiring, supporting and challenging their people and their future workforce.

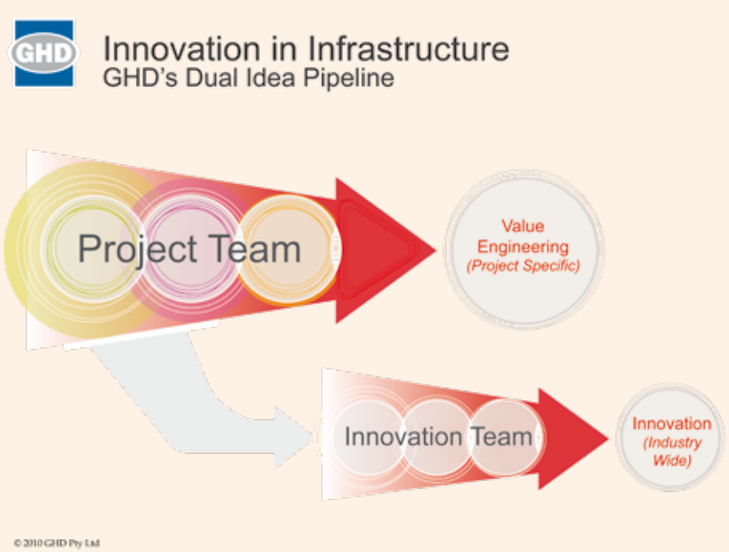
Adopting a dual pipeline approach will not always achieve industry benefiting innovations, but by aiming high and implementing a formal framework for innovation in infrastructure, the industry will learn, interact and inspire and as a minimum, deliver even more project based value engineering ideas.

## GHD's Dual Pipeline Framework: Enabling innovation in infrastructure

Recognising the need, value and barriers to successfully adopt a focus on multi project innovation in infrastructure, GHD, one of the world's leading engineering, architecture and environmental consulting firms, has developed the dual pipeline framework which facilitates this approach.

A structured innovation framework is established by the project team with a leader, or innovation champion, assigned to encourage ideas to be submitted, considered and collaborated on by the wider team. The ideas are taken through a formal evaluation process using GHD's "Value/ Chance of Success" criteria and are either progressed to the next stage or closed out. Ideas taken further are provided with more resources for investigation. If they are deemed project specific and of sufficient value, they are implemented as value engineering opportunities by the project team. However, the ideas that are deemed valuable, but not ready to be implemented on the specific project (for reasons including insufficient research and development, client and regulatory support, market validation etc.), are directed off to a separate innovation team with appropriate skills and focus to further refine and develop. In this manner, the project team are not distracted from delivering the infrastructure project. The scope and governance of the innovation team, including funding, resourcing, reporting and IP ownership, is established at the commencement of the project.

The dual pipeline approach was recently adopted by GHD on a major water treatment project in Victoria. It identified a number of value engineering ideas that were implemented for the benefit of the project. It also supported the identification and further development of a very promising innovation that can be applied across the industry and which may have been lost or overlooked without the framework. A young engineer identified technology used in an allied industry throughout Australia, Europe and the US and developed an application that could significantly reduce the energy used in the water treatment process. A provisional patent has been filed and proof of concept testing is scheduled for the 2010.




***About GHD:*** GHD, established in 1928, is one of the world's leading engineering, architecture and environmental consulting firms employing more than 6,000 people across five continents.
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**Dr Alan Finkel**
**Chancellor of Monash University and Chief Technology Officer Better Place.**