

How the Surveyors of Australia Have Changed the World

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ABSTRACT

The world as it is today could not have taken shape without the indispensable contributions of its surveyors. The ancient surveyors of Egypt, Greece and Rome feature at the start of our kaleidoscope of survey brilliance, then a parade par excellence of legendary figures of history make their appearances. This paper focuses specifically on those surveyors who came to the southern hemisphere to chart our unknown coastlines as well as some of our own home-grown heroes without whom edifices and structures like the world heritage listed Sydney Opera House and Harbour Bridge could not have been erected to such precision. Even the progression of the continually skywards growing tallest buildings on our planet has been surveyed by Australians. In addition, the only two surveyors of Olympic tracks in the southern hemisphere in the 20th century were Australians for the Melbourne 1956 and Sydney 2000 games (the track was set out and checked by the end of 1999!). With such a proud list of achievements by Australian surveyors, it would be hard not to invoke immense emotions of fulfilment in being included as a member of a profession without which this world could not survive – the surveying profession!

KEYWORDS: *Surveyors of Australia, achievements, world-changing contributions, history.*

1 INTRODUCTION

The world as it is today could not have taken shape without the indispensable contributions of its surveyors. Famous historical figures have already been highlighted in my first two Hall of Surveying Fame spectaculars, together with their notable attributions. The ancient surveyors of Egypt, Greece and Rome feature at the start of our kaleidoscope of survey brilliance, then a parade par excellence of legendary figures of history make their appearances. US presidents George Washington, Thomas Jefferson and Abraham Lincoln comprise a formidable trio of eminent achievers, immortalised in stone atop Mt Rushmore in the US state of South Dakota. Swedish surveyor Anders Celsius gives us an alternative temperature scale, while making geodetic surveys of his landscape. Japan's most famous surveyor Ino Tadataka proves how valuable senior members of the community can make amazing contributions after the age of 55 years in 1800 when he walked the entire landmass of Japan with his teams for 18 years to compile the first accurate map of his nation in 1821 (which was published 3 years after his passing). Then come surveyor/astronomer Nicolas Copernicus, surveyor/artist Leonardo Da Vinci, creator of World Standard Time Sir Sandford Fleming, George Everest, Surveyor-General of India after whom the world's highest mountain is named, Mason and Dixon and their renowned boundary line between US states Pennsylvania and Maryland, intrepid US western explorers Meriwether Lewis and William Clark, Flemish surveyor Gerhard Mercator and his universally adopted map projection, gunslinger Marshall Wyatt Earp and iconic Scottish poet Robbie Burns.

Following two presentations on how surveyors have changed the world, this paper specifically focuses on how our world has been transformed by those surveyors particularly associated with Australia. Of specific interest is the planet's greatest explorer, James Cook, whose charting of the eastern coast of the Great South Land in 1770 directly resulted in the First Settlement at Sydney Cove on 26 January 1788, leading to the great nation that we all enjoy today. From this fateful expedition, the beginnings of an amazing Hall of Fame of later surveyors have carved their names into the fabric of some of the most famous and memorable events and monuments enacted for the posterity of humankind.

2 JAMES COOK, THE WORLD'S GREATEST EXPLORER/SURVEYOR

There is an iconic group of seafarers who have ventured to and from the southern hemisphere with maritime legends emblazoned across journal chronicles with names like Willem Janszoon, Dirk Hartog, Abel Tasman, Willem De Vlamingh, Luis de Torres, William Dampier, Jean-Francois de Galaup comte de Laprouse, Nicolas Baudin and Antoine De Bougainville.

Some may ask: "How do I know that James Cook was a surveyor and not just another sextant-wielding sea captain?" Well, firstly, he was personally trained by the inaugural Surveyor-General of Canada (which he became later!), Samuel Holland, as well as being given his first theodolite by the Governor of Newfoundland, Sir Thomas Graves in 1762. Secondly, on some of his personally drawn plans he declares in copperplate calligraphy that he is a "Surveyor", just to definitely convince you of his qualification and skills. When he placed orders for measuring equipment for his explorations, his request lists always included a "theodolite and Gunter's chain", which are solely applicable to measurement on land, not at sea (Brock, 2004).

Cook's amazing influence on worldwide navigation is unmatched in maritime legend. He himself said that he had gone further than any man had ever been, but it was not just his extensive expeditions which opened up previously unknown territory, his techniques of marine mapping which included land surveying, along with his revolutionary sea diet to avoid scurvy (which became compulsory in ship cuisines).

Cook did not just grab the attention of royals and VIPs during his lifetime. Long after his passing, his exploits so impressed the sci-fi writer/producer Gene Roddenberry that he took James Cook as his model for James Kirk as commander of his Starship fleet in the Star Trek sci-fi cult phenomenon, with the similarity of the names of their vessels not unnoticed: *The Endeavour* and *The Enterprise* (Figure 1). Keeping Cook's achievements in the forefront, it is not surprising when Roddenberry pronounced the mission of the Starship Enterprise: "To boldly go where no man has gone before!" Sound familiar?



Figure 1: Captain James Kirk (left) and Captain James Cook (right).

3 THREE MARINERS FORM THE COOK DYNASTY AND AUSTRALIA IS NAMED

When it comes to the other mariners whose charting techniques employed land surveying to lock their networks together, there is a clear exception between all of those individuals trained or influenced by James Cook and the rest. William Bligh, who is most remembered for his infamous shipboard “Mutiny on The Bounty” and his disposition as NSW Governor in the Rum Rebellion (Figure 2), was personally tutored by Cook while sailing on *The Resolution* with him during Cook’s third world voyage between 1776-79. The next recipient of Cook’s expertise was when Bligh transferred his skills to Matthew Flinders, who sailed with him on *The Providence* during 1790-93. Some 10 years later, Flinders drew his first map of “Australia” in 1804 while under house arrest on an alleged charge of espionage on the *Ille de France* (now Mauritius) by the authority of Governor Charles De Caen (Figure 3).



Figure 2: Captain William Bligh (left) and The Mutiny on the Bounty (right).



Figure 3: Ile de France Governor Charles De Caen (left) and Matthew Flinders (right).

This first map of “Australia” had a subtitle of “or Terra Australis” (Figure 4), but when the bureaucracy at the British Admiralty saw this, they rejected his proposed naming of the South Land, making him reverse the wording on his title as is shown on the 1814 published version of the map (Figure 5). The NSW Governor from 1810-22, Lachlan Macquarie, supported Flinders in his usage of the word “Australia” to describe the southern British colony, and it was shortly after 1821 that the Admiralty ended its rejection of this name on official charts prepared for its records.



Figure 4: Flinders 1804 Map of Australia.



Figure 5: Flinders 1814 published Map of Terra Australis.

To complete the brilliant quartet of master seamen, Phillip Parker King (PPK) was aided in his mapping prowess through his observation and adoption of the skills demonstrated by the three previous geni of map making. When Flinders was finally released from house detention on Mauritius in 1810, he returned to England, being instrumental in arranging a get-together of prominent gentleman connected with the NSW settlement as well as the early charting and naming of Australia at Sir Joseph Bank's Soho residence on Sunday, 24 November 1811. A surprise guest at this encounter was William Bligh himself.

With further engagement by the British authorities to extend the mapping of north-western Australia, PPK's charts, made on his vessel *The Mermaid* between 1819-22 and using the description "Australia" were formally adopted (Figure 6) and thus the name we all know became the accepted name of our nation for the whole world.

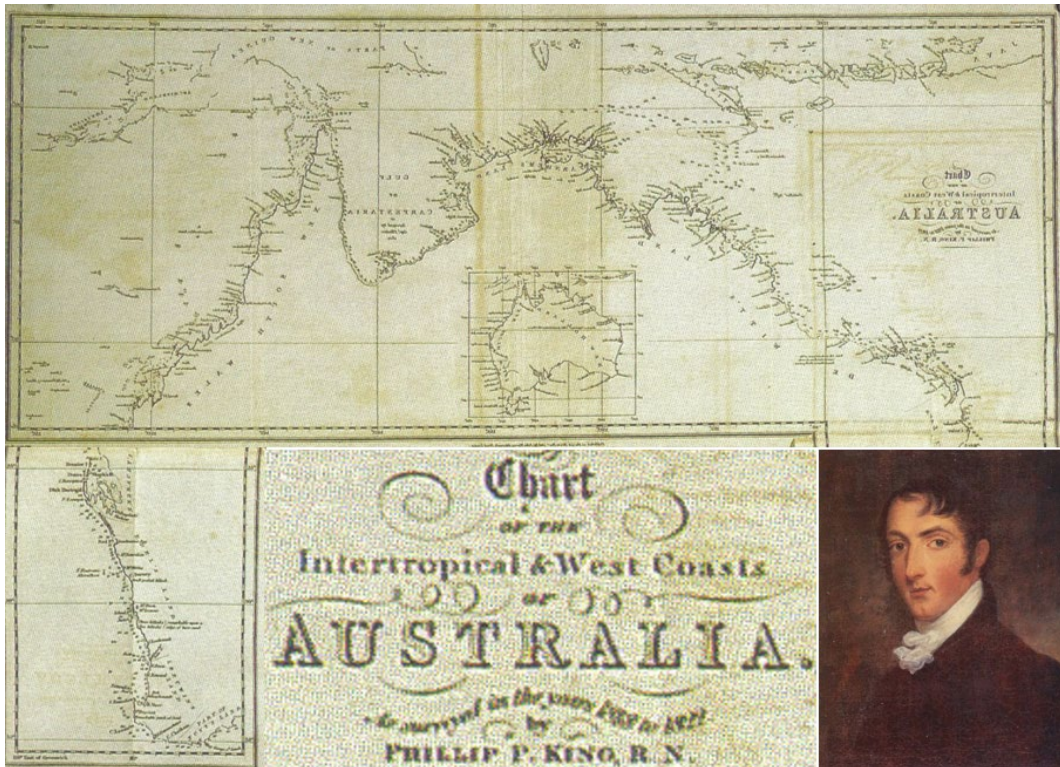


Figure 6: PPK chart of the “Intertropical & West Coasts of Australia” (1822) and P.P. King (bottom right).

4 THE NSW SURVEYOR WHO MADE WHEAT DROUGHT & RUST RESISTANT

William Farrer can be seen on Australia’s original currency, gracing the \$2 note in tribute to his ground-breaking development of drought and rust resistant wheat (Figure 7). However, before becoming world famous for this discovery, he was a surveyor for the NSW Department of Lands from July 1875 until his resignation in July 1886, where he had worked in the Dubbo, Nyngan, Cobar and Cooma districts (Wrigley, 1981). There is a memorial statue erected to him in the main street of Queanbeyan in honour to this phase of his life (Figure 7). Named to commemorate him are Farrer Memorial High School (in Tamworth, NSW), the NSW State Electorate of Farrer (in the southern part of the state extending from the Murray River), an Australian Capital Territory (ACT) suburb (near Lambrigg, where he conducted most of his experiments in the south), a primary school in the ACT and Farrer Street in Braddon, ACT.



Figure 7: Monument to NSW Lands Surveyor William Farrer in Queanbeyan (left) and original Australian \$2 banknote depicting Farrer with a scene of wheat (right).

5 THE FIRST ANZAC WAS A SURVEYOR

Few surveyors, let alone everyday Australians, will know that the man who led the 1st AIF (Australian Imperial Forces) onto the beach at Gallipoli on 25 April 1915 was a surveyor! Major General William Throsby Bridges (Figure 8) was the commander of these forces, and he was one of the two men who founded the Australian Military Mapping Program in 1912, along with Sir John Monash, who graces our new Australian \$100 banknote standing behind his theodolite. There are only three banknotes from any country which depict a surveyor at their surveying instrument, the other two originating from the Miners and Planters Bank of the USA in 1860 and the Antarctic Exchange from the 1970s.

In 1912, with rank of Brigadier General, Bridges became the founder and first commandant of the Royal Military College at Duntroon in the ACT, on the express recommendation of another military surveyor, Lord Horatio Kitchener. Bridges was the first AIF officer killed (by a sniper) in Gallipoli, and, from the over 60,000 Australian soldiers killed in World War I (WWI), his was the only body of a known soldier brought back for burial in Australia. In addition, of the 136,000 Australian horses sent overseas for WWI (Australian War Memorial, 2025), his horse Sandy (Figure 8) was the only animal to return alive to his homeland to the Army Remount Depot at Maribyrnong in Victoria in 1918, after being in quarantine overseas. Most of Sandy's remains were buried at this location, but his head was sent to the Australian War Memorial, where it was mounted to be put on display until it became too shabby, after which time it was placed in storage. Bridges' remains had been re-buried at his beloved Royal Military College, being the only burial on Australian Defence Force territory.



Figure 8: Painting of troops on the beach at Gallipoli in 1915 (left) and William Bridges with his horse Sandy (right).

6 SURVEYING THE SYDNEY HARBOUR BRIDGE

A crossing from north to south across Sydney Harbour had been put forward almost since the First Settlement in 1788, but it was not until 1932 that the Sydney Harbour Bridge came to fruition. The major survey for this project was commenced in 1924 under the control of Surveyor Edward Albin Amphlett (EAA) (Figure 9). In more recent times, followers of Aussie music would recognise EAA's relatives "Little" Patty Amphlett and Chrissy Amphlett of The Divinyls.

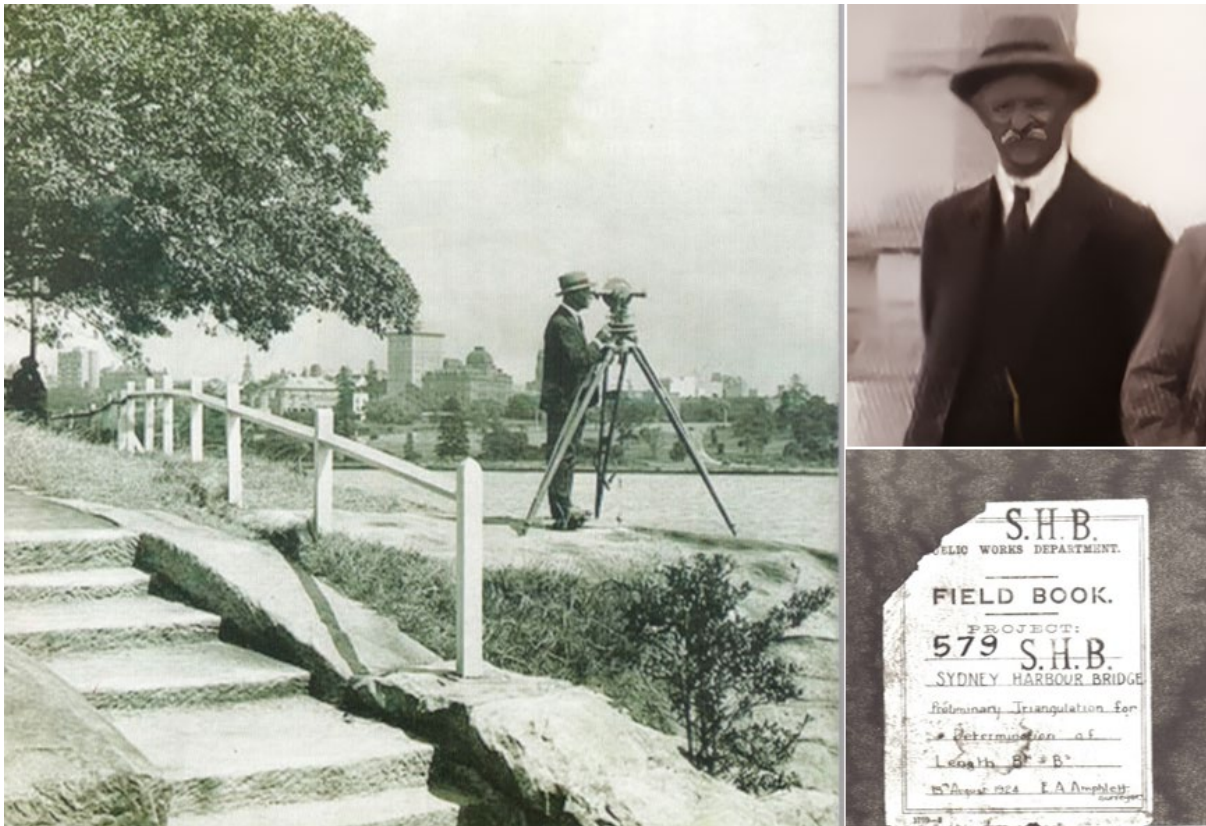


Figure 9: Surveyor E.A. Amphlett on Control point “G” at Lady Macquarie’s Chair (left), EAA (above right) and cover of EAA’s field book with date of 24 August 1924 (below right).

Using the uniquely manufactured large theodolite by E.A. Watts & Sons from England, the surveyor was able to make very accurate observations so that a precise length could be calculated for the bridge placement. Construction began from both sides of the harbour simultaneously, the two halves finally meeting in 1932 with an inch to spare (Brock, 2022). One of Australia’s and the world’s most famous landmarks was opened for traffic in 1932, and another milestone triumph in our surveying history was functioning at last. This harbour crossing remained the only direct link for traffic between the city and North Sydney until another great surveying feat saw the opening of the Sydney Harbour Tunnel in 1992.

7 POWERING NSW WITH TUNNEL-DRIVEN HYDRO-ELECTRICITY

The mercurial concept of harnessing the melting snow from the alpine regions of southern Australia to generate electricity plus supply fresh water, which began materialisation during the late 1940s and through the 1950s, had been espoused by Sir William Hudson many years before the Snowy Mountains Scheme became a reality. The Snowy Mountains Authority Chief Surveyor was Bert Eggeling who had been in the Australian Survey Corps with Major Hugh Powell Clews (Figure 10) during WWI. The Major first visited the site in early 1948 for the Technical Investigation Committee (Ringer, 2012, p. 36). He was the ideal choice for Eggeling to place a control network atop the area of this audacious enterprise.

The responsibility of ensuring that the tunnels remained on course lay with five German surveyors: Wally Wassermann, Henry Kirsch, Fred Georg, Henry Werner (Figure 10 – see also Thomas, 2024) and Bill Mueller, with back-up from two Australians (George Bennett and Frank Johnston) and a Dutchman (Peter Ricardus). Four of these individuals (George Bennett, Fred

Georg, Henry Kirsch and Wally Wassermann) joined with an Englishman (Peter Williams) and an Australian (Ian Foxall) to devise a simple, failsafe procedure for keeping the tunnels on line (Collis, 1990, p. 177). Hundreds of miles (Australia was not metricated until 1966) of subterranean aqueducts and tunnels had to be linked together to collect and drive the waters along hydraulic pathways to rotate the giant turbines which supplied much needed power without the traditionally coal-fired transmission lines (Figure 11).

On a personal level, George Bennett and Henry Werner were both professors who were lecturing at the University of New South Wales (UNSW) during my Bachelor of Surveying degree between 1974-77, while Bert Eggeling partnered NSW Surveyor-General Jack Darby to pass my rural project in the Board of Surveyors examination in 1981 at my first presentation of this work, which had been completed under the master tutelage of Ian Reginald Moreton “Bill” Clark during my country time deployment in Queanbeyan in 1978.

Since its completion in 1974, the Snowy Mountains Scheme has been described as “an engineering wonder of the world”, comprising 80 km of aqueduct tunnels, 13 major interconnecting tunnels measuring over 145 km, 7 power stations (two deep underground), 8 switching stations and control centres, and 16 large dams (DCCEEW, 2025). Tunnel surveying is an exact science with little room for discrepancies when excavation begins from each end at the same time, with the calculated intention of joining smoothly in the middle. George and Henry with their other colleagues must have performed first-class surveying due to the operational fluidity of the scheme with George giving a paper on his participation in the project in 2008 at the UNSW Surveys of the Century seminar run by me.



Figure 10: Henry Werner working on the Snowy Mountains Scheme survey (left) and Major Clews at Scammell’s Lookout (right).

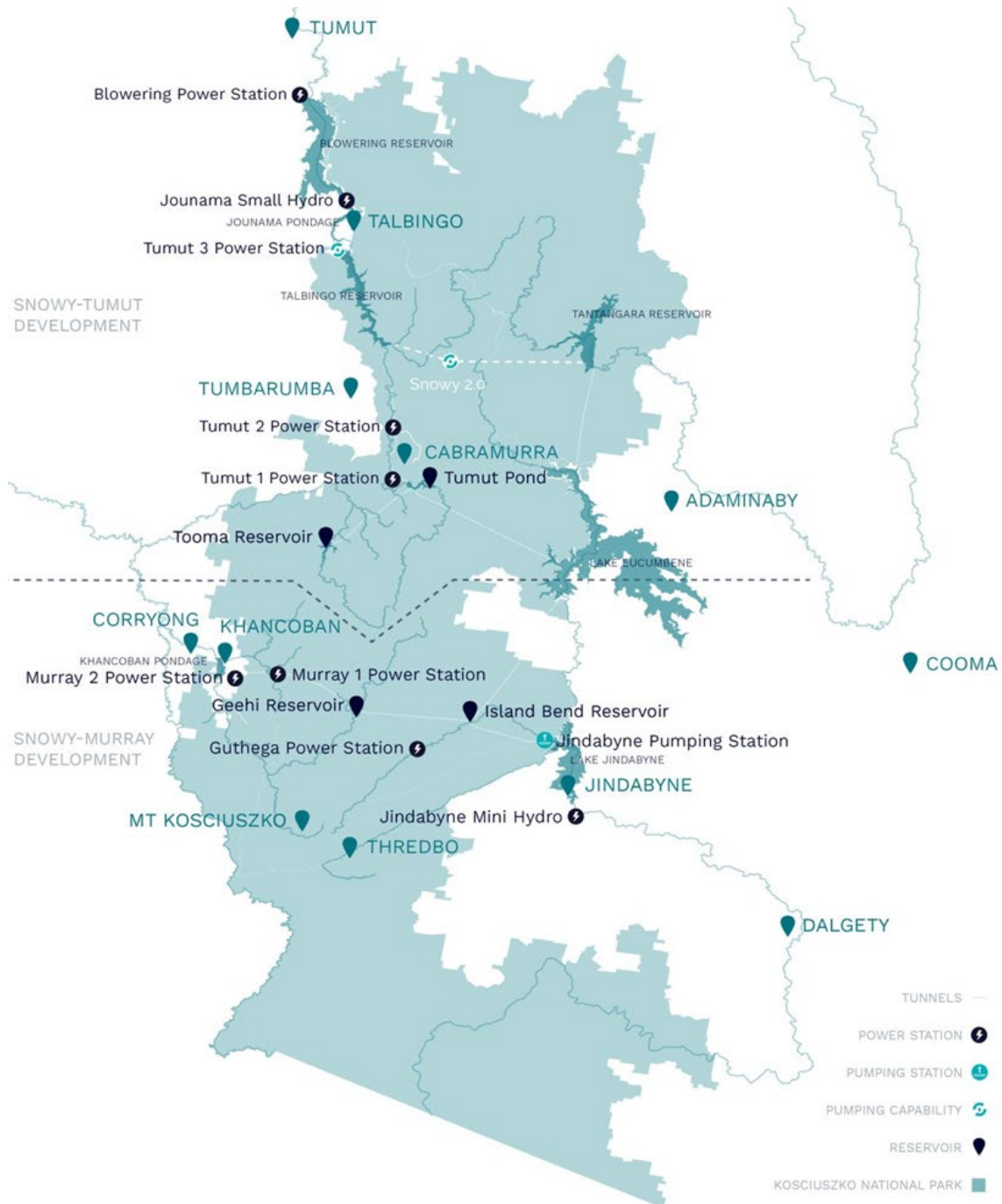


Figure 11: Map of the Snowy Mountains Scheme, showing its attributes.

8 1956 AND 2000 OLYMPIC TRACKS LAID OUT BY AUSTRALIANS

Before Melbourne, Australia, hosted the first International Federation of Surveyors (FIG) Congress in the southern hemisphere in 1994, it hosted the first Olympic Games held in the southern half of the world in 1956. To make Australia even prouder than just being the host of this prestigious event, it was an Australian surveyor who controlled the set-out of the athletic track upon which the world's best athletes would compete for glory. His name was Archibald Hugh Campbell, who was a Lands Department surveyor in Victoria, having worked on the survey for the trans-continental railway from Sydney to Perth, along with some other lines constructed during his tenure.

When the Boral Asphalt company won the contract to lay the bitumen sub-base under the main athletic 400-metre track for the 2000 Sydney Olympics, it engaged the company I was working for in Blacktown (Rose, Atkins and Associates) to set out the construction work. At the first stage of the track lay-out, the Sydney Olympic Committee saw our firm as the logical expert to ensure the precision of the final track set-out along with the linework. Our company director, Tony Atkins, entrusted the calculation of the track geometry to Peter Anderson, our computations specialist, and I was given the responsibility of dealing with the bureaucrats and certifying the trackwork as laid (Figure 12).

There have only been two surveyors who have certified Olympic tracks in the southern hemisphere in the 20th century – A.H. Campbell and me (as the track lay-out was completed before the end of 1999). These two events produced new world records, and in Sydney the most memorable achievement was Cathy Freeman's win in the 400 m final to become the first Indigenous athlete to win an individual Olympic gold medal. To more fully appreciate the exclusivity of being the surveyor for an Olympic track, the world population in 1999 was 6.1 billion, and there was only one person chosen to carry out this work!



Figure 12: Shot of 400 m track from grandstand by me and Andy Hickey on one of the concrete blocks at the centre of one of the circular sections of the track (inset).

9 AUSTRALIA'S LAST EXPLORER/SURVEYOR SURVEYS A ROCKET RANGE

Described as Australia's last explorer, Len Beadell (Figure 13) was a true character of Aussie surveying (Len Beadell Publications, 2023). I met Len at a 4WD lovers convention in Brisbane in 1992 where, apart from us, there were no other surveyors amongst the 400 strong audience. He autographed all his books for me and then sent me a slide of the first atomic explosion on mainland Australia at Emu Field on 15 October 1953. Wandering around the desolate wilds of the country surrounding the site selected for the Woomera Rocket Range (Figure 14), Len was

an incredible bushman, single handedly setting out and naming the many access roads leading to and from the rocket launching base. He was even tasked with the designation of the trajectory line for the fired missiles through the outback regions of north-western Australia. When an uppity British scientist requested that Len provide a name for the site from an Aboriginal dictionary, Len retorted that the Aboriginal language was not written, but did say the most appropriate name was “Woomera” because this device was used by the First Peoples to launch spears just as the base would launch rockets. The Gun Barrel Highway was surveyed and named by Len, with Mt Beadell named in his honour. It was Len’s task to choose the trajectory site for the passage of any rockets launched from this base, with the express intention and instructions to ensure that there were human inhabitants along this corridor which would be impacted by these supersonic exercises.



Figure 13: 1953 atomic bomb explosion at Emu Field (left), Len Beadell (centre) and Len’s grave at Woomera (right).



Figure 14: Site of the Woomera Rocket Range (left) and details at the range (right).

10 THE GENIUS OF THE SYDNEY OPERA HOUSE

With many publications and voluminous books about the Sydney Opera House (SOH), there are none who pay tribute to the surveyor genius, let alone give his name, without whose input the vastly complex spherical geometric structure could ever have been erected. As stated in Maguire (2024), the real story behind the genius of the SOH can be found in the form of NSW Surveyor Michael Elfick from Newcastle. Once again UNSW Professor Henry Werner was consulted in the control network creation for the precision of this major project (Figure 15), and APAS's own Henry expert, Warren Thomas, once again can be mentioned as he carried out some checking of this network from atop of one of the sails of the SOH in the 2000s.

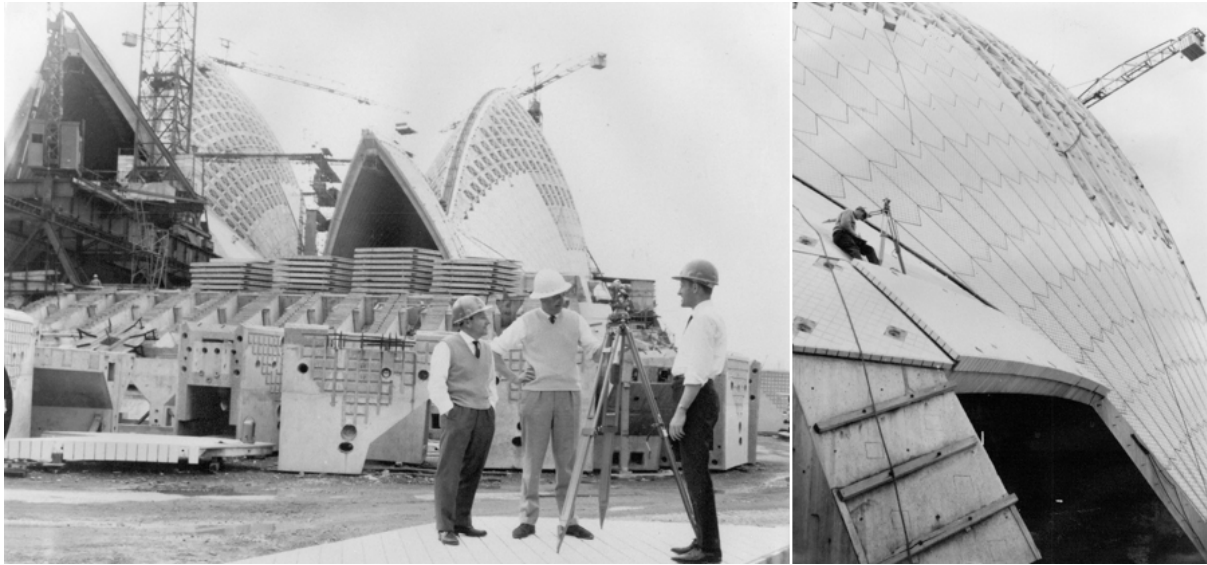


Figure 15: UNSW Surveyor Henry Werner consulting on site at the SOH (left) and Ingleburn Surveyor Joe Veness set up on the outside of one of the SOH shells to carry out some observations (right).

During the survey of the SOH in the second half of the 1960s, Michael Elfick did not have the convenience of modern computing power. To enable the calculation of the complex geometric set-out data to be processed, he needed to put the data on punch cards and transport them by taxi to a Sydney shop, which housed a computer the size and weight of a small hatchback sedan, then wait for the solutions to be driven back within the hour (Maguire, 2024).

The world renown of the Sydney Opera House was formally acknowledged with UNESCO World Heritage listing taking place on 28 June 2007. To further enhance knowledge of the incredible surveying expertise exercised by Michael Elfick and inform the general Australian public about this superb achievement, the historical journalist Mercedes Maguire published an article (Maguire, 2024), which has been reprinted with permission in Azimuth.

11 WORLD'S TALLEST BUILDINGS SURVEYED BY AUSTRALIANS

The Petronas Twin Towers in Kuala Lumpur (KL), the capital city of Malaysia, were opened in 1996, at that time being the tallest buildings in the world. The twin towers were surveyed by two Australian surveyors, Ian Sparks and Rob Fulloon (Figure 16). During the hosting of the 5th South East Asian Surveyors Conference held in KL in 1995 in conjunction with the Institution of Surveyors Annual Congress (held for the first time overseas in partnership with the South East Asian Surveyors on a trial basis), Ian organised for some of the conference

attendees to go up to the 66th floor of the unfinished towers to have a group photograph, which nearly had us blown from the top of the structure. The walkway linking the two towers by a skybridge is at level 42. When the next assignment for an even taller building came up in Dubai, Ian was given the contract to survey the Burj Khalifa, which is currently the world's tallest building at 830 m in height, equivalent to over 200 storeys with 160 habitable levels. Before the completion of the Petronas Towers, the world's tallest building was the Empire State Building in New York City which had stood since 1931, but in more recent times there have been others which have surpassed the Malaysian pair until the Burj Khalifa soared higher than them all (Figure 17).



Figure 16: Architect drawing of Burj Khalifa, Dubai (left), Ian Sparks, surveyor of Petronas Tower A & Burj Khalifa (above right) and Rob Fulloon, surveyor of Petronas Tower B (below right).

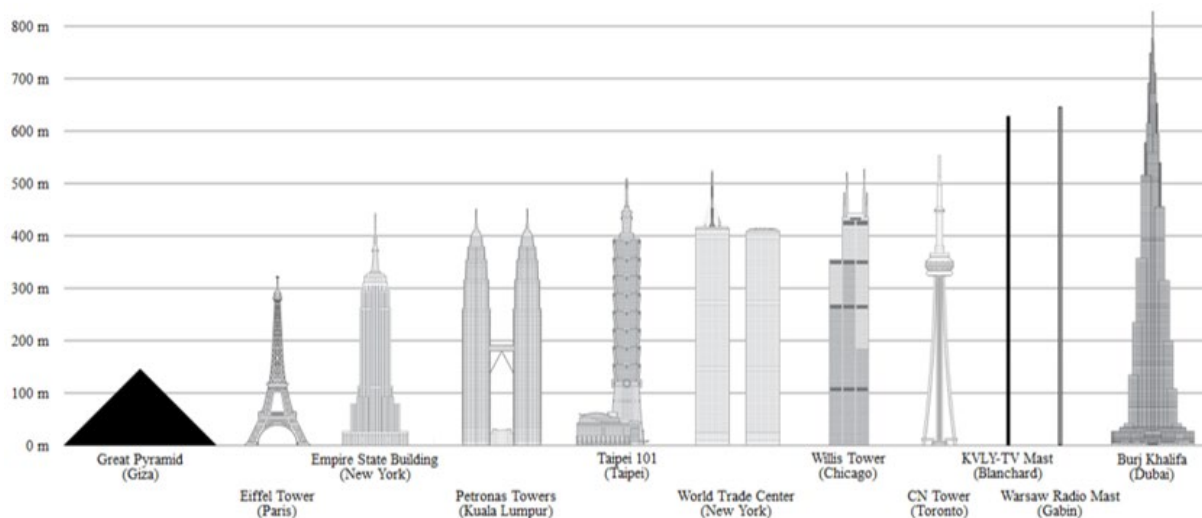


Figure 17: Comparison of the world's tallest constructions.

12 CONCLUDING REMARKS

This paper has outlined how our world has been changed by the surveyors who came to the southern hemisphere to chart our unknown coastlines as well as some of our own home-grown heroes without whom edifices and structures like the world heritage listed Sydney Opera House and Harbour Bridge or the world's tallest building could not have been erected to such precision.

Being a surveyor is not just a remarkable profession steeped in historical greatness, it is a lifetime career offering those most fortunate enough to have become qualified a world-wide forum to participate in events that highlight and promote the absolutely essential nature of the work surveyors carry out in a multitude of fields. With a mind finely tuned and honed to solving problems with practical and effective solutions, it is not hard to understand how such astute individuals can redirect their skills and brilliance to areas outside their immediate activities, providing them with the intellectual tools and acute insight to create and develop feats of engineering, hydraulics and natural phenomena to formulate some of the most incredible achievements on our planet. Be proud and forthright with your excellence all of you surveyors, young and more mature, because you are the functioning nervous system of the Earth with the ability and skills to change the world in many and varied ways for the improvement and future survival of the human race!

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