

Sydney's landmark: built and monitored with Leica instruments

Millions of people have seen it in books and on post-cards; millions more have seen it at first hand during a visit to Australia. Survey engineer Steve Denning also knows it from above and below: a quarter-century after the Opera House was inaugurated, his know-how was needed to assess the effects of weather and sea-water on the structure, and fix the wear and tear. The initial task was to restore the granite promenade surrounds and sea wall of the Opera House.



Deep down...
Positioning new piles required Steve Denning and his staff to survey the existing promenade decks at sea level. From there they co-ordinated a team of divers for placement of the new piles. After piling, the divers assisted the survey team to locate and record the final position of the piles.

...and high up
Steve Denning also had to scale the Opera House, reaching areas that are normally the preserve of roofers and seagulls. The Sydney Opera House is a masterpiece of architecture and engineering. Steve Denning: "We needed to measure and record all of the building's constructional details, in order to spot shifts and deviations in good time, and facilitate repair work." As with any large

Left: Steve Denning uses his Leica TCR703 to verify the roof positions and the modular scaffolding elements in the background. Everything must be in perfect order in time for the Summer Olympics!

Above: Classic Wild T3 and T2 theodolites were used in constructing the Opera House, seen here in a picture from 1966. Steve Denning: "It is amazing that the experts of the day were able to build something this complex in the pre-electronic era." A Wild D110, the world's first infrared tacheometer, was used in the completion stages of the shell.

building, running repairs are a necessity: given the millions of visitors each year, nobody can afford to take risks.

Three-dimensional recording
Closer examination of the Opera House roof reveals that it is covered in thousands of light grey, textured ceramic tiles that trace the contours of the three-dimensional building structure like a skin. They have differing shapes, meaning that each one must be individually identifiable in order to effect a custom-made replacement. Yet gaining access is a tricky business: the surrounding space is no longer adequate for cranes, and regular scaffolding is out of the question.



Therefore, Steve Denning made a three-dimensional tacheometric recording of the outer skin and fascia beams for the roofing and fitting company. A multi-segmented scaffolding system was then developed, which could also be combined in a way that would allow work on the overhanging front façades – only highly experienced extreme climbers would be able to gain access otherwise.

Theodolite and LEICA DIOR
Steve Denning: "We also needed to identify the existing holes in the fascia beams for securing the modular scaffolding and hoist platform. The LEICA DIOR 3002 distance measure, with its visible target point, proved unbeatable: we would sight the theodolite telescope on a securing hole to determine its position, and the mount-on DIOR gave us the precise distance. Its beam ran parallel to the theodolite's, but landed five centimetres above the hole, meaning that it was reflected from the concrete surface. A combined angle and distance measuring

telescope of the kind found in our LEICA TCR703 would have measured right to the bottom of the hole, and hence always a little too far. It's one of those rare cases where a separation of angle and distance measurement instruments is superior to an integrated solution."

Service is crucial
Steve Denning has other large-scale projects under his belt, for example the constructional survey for the Anzac Bridge (previously known as the Glebe Island Bridge):
"All these projects demand a lot of adaptation to circumstances. I use Leica Geosystems instruments, because I get the accessories I need as well as first-class service right here in Sydney – even when I have to work deep underwater, at dizzying heights, or target holes that begin exactly where I want them to, regardless of their depth."
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Above: Sydney Harbour Bridge and the Opera House – international symbols of an exuberant, multi-cultural, world-class city. The most beautiful route from the city centre to the Olympic park is by water, passing beneath the "coathanger", as Sydney-siders have dubbed the harbour bridge.

Center: The Opera House's spherical elements each have their individual forms. The Swedish ceramic tiles are finely textured.

Below: Here, the ceramic tiles have just been stripped off. Steve Denning records their exact coordinates using remote measurement with a theodolite and a LEICA DIOR 3002.