



Land Surveying Division
Sr Paul Tsui LSD Council Chairman

Mapping of Challenger Deep in the Mariana Trench

I was invited to be a keynote speaker at the Marine Economy Summit Series – Advanced Industrial Technology held at HKUST on 12 May. The title of my speech was “GIS Empowering Marine Ecological Monitoring & Management”.

However, over 80 percent of the world’s oceans remain unexplored and unmapped. Compare that to the moon and Mars, which have both been mapped completely, so the world is woefully behind in discovering what lies beneath.

Today, ocean mapping has achieved a new level of urgency. Climate change, overfishing, and water acidification jeopardise the health of entire marine ecosystems. Biodiversity loss and the destruction of coral reefs threaten the ability of oceans to provide food for millions of people and the smooth functioning of the blue economy, which the World Bank defines as the sustainable use of marine resources for economic growth, improved livelihoods, and jobs while preserving the health of ecosystems. Understanding the ocean’s dire predicament requires the kind of clarity only a rigorous, data-driven approach can provide. For a system as complex as the ocean, that means using the most advanced mapping techniques to uncover its mysteries. Wright’s trip to Challenger Deep was a step in this direction.

Further on the details of Wright’s trip to Challenger Deep, the *Limiting Factor* is actually part of what Caladan Oceanic calls its integrated Hadal Exploration System, which also consists of the research vessel, *Pressure Drop*, with its hull-mounted EM-124 multi-beam bathymetric system supported by two small surface craft for sea traffic communications and sub deployment and three full-ocean depth landers.



During the preparation of my speech, I read an interesting story about the expedition of a marine geologist and Chief Scientist of Esri, Dr Dawn Wright, to Challenger Deep on 12 July 2022. Wright made history in becoming the first Black woman to descend nearly 11km below the sea surface to Challenger Deep, a region of the Mariana Trench near Guam and the deepest known point on the planet. The trip allowed her to use expertise in marine geology and company’s geospatial technology.

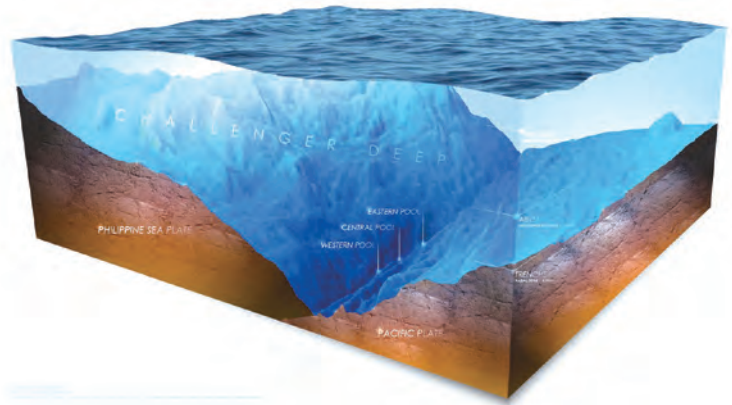
Wright was joined by Victor Vescovo, an undersea explorer and founder of the ocean research company, Caladan Oceanic. He piloted the *Limiting Factor* submersible down to Challenger Deep, while Wright served as the mission specialist. The mission was the first successful side-scan sonar mapping operation at full ocean depth. This showed that humanity now has the tools to uncover those mysteries of the deep for its benefit.

Since the ocean covers nearly three-quarters of the planet, mapping it precisely has always been important.



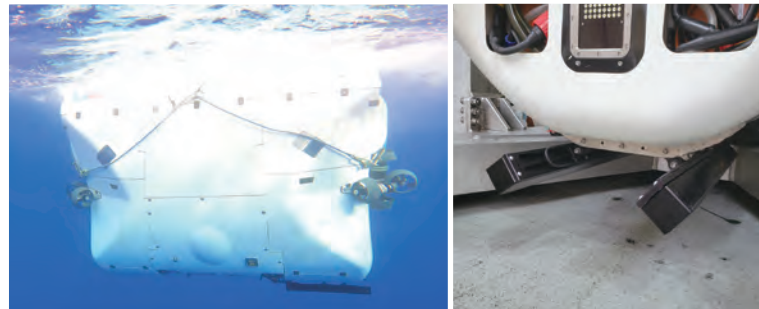
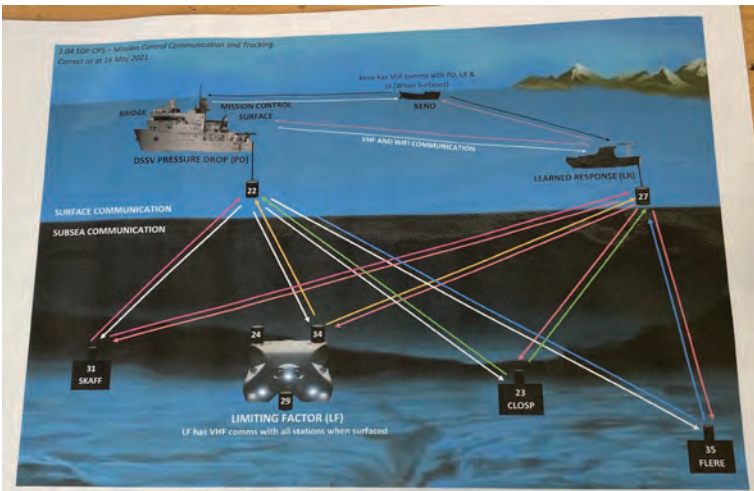
Limiting Factor, a Triton (Submarines) Model 36000/2 submersible, remains the centrepiece of the system. It is named for its full-ocean depth certification and crew capacity of two. For a submersible, it is compact (4.6 X 1.9 X 3.7 metres), lightweight, and designed to travel vertically through the water column as quickly as possible at speeds of up to 3.5 knots vertically or 2-3 knots laterally at depth.

The diagram below shows a 5X vertically-exaggerated cube extract of the deepest part of the Marina Trench made with 3D GIS. Within Challenger Deep, Vescovo set the ultimate dive record to its Eastern Pool at 10,935 +/- 6 metres. But on this trip, he and Wright explored the less-visited Western Pool.



As a land surveyor, one of my key interests in *Limiting Factor* is how it can function at such great depths. For underwater navigation, it employs a system of acoustic modems (GPM300 and L3 Oceania) that can be tracked by modems on *Pressure Drop* and support vessel *Learned Response* on the surface, which allows for triangulation by the landers. For this dive, only the *Closp* lander was used, even though *Closp* had, unfortunately, drifted 630 metres away from its planned position due to bottom currents.

The primary objective of the dive was to operate a portable side scan sonar on a submersible at full ocean depth (FOD), which was well beyond the standard commercial limitation of 6,000 metres FOD, for the first time. The sonar was installed on the starboard side of *Limiting Factor*. Wright's primary mission was to conduct the first-ever side scan sonar survey at FOD. Caladan Oceanic contracted with Deep Ocean Search of Mauritius to customise a full-ocean depth side scan sonar instrument capable of operating at unprecedented depths.





The diagram below shows the 3D model of Challenger Deep and the path of the side scan data collection.



Finally, the success of this mission not only gives the world a much better understanding of a part of Earth that was unreachable, but also proves that humans are capable of overcoming some of nature's challenges using technology.

CPD Highlights



“Land Surveyors and Surveyors in Land Boundaries”

On 24 May, Sr LAU Chi-kwong, an authorised land surveyor and Chairman of the HKIS Land Boundary Working Group, delivered a CPD to

members from the different surveying disciplines. The talk decoded the seems-like “mystery” of land boundary issues with principles explained and cases studied.



Sr Lau started his talk by introducing his “5W+1H” questions. The question set was intended to allow members to acquire an accurate understanding of the land boundary issues that needed to be solved. He then demonstrated his “decoding” toolbox with experience-sharing on land searching, survey guidelines, survey procedures, survey results, and follow-up actions.

Prior to the Survey 6 Questions to be Asked:

- **Who request ?**
 - E.g. Registered Lot Owner or Government ...
- **Where the lot is ?**
 - E.g. Urban or NT ...
- **What the lot is ?**
 - E.g. Old Schedule or New Grant or Licence or STT ...
- **When the lot was granted ?**
 - E.g. Pre-war or Post-war ...
- **How ?**
 - E.g. BGL or Public Auction or PTG or Re-grant ...
- **Why ?**
 - E.g. Subdivision or Rebuilding or Development ...

Sr Lau also explained selected boundary re-establishment cases to demonstrate the involvement of land surveyors in different land development projects and their collaboration with other professionals and stakeholders.

The follow-up Q&A session was co-chaired by Sr Prof Leung Shou-chun and Sr Dr Conrad Tang. Questions from both public and private sector surveyors were answered and discussed, while Sr Lau highlighted the need for close collaboration between land surveyors and stakeholders.

