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Floating into the future:

creating cities on the sea

Urban sprawl, rapid population growth, rising sea levels: when it comes to tackling the problems of tomorrow, science fiction often has us looking to the stars for solutions. But UQ Professor Chien Ming Wang has been floating an idea closer to home.

Cities on the sea. That is, floating structures on a scale large enough to support urban populations and all the industry and infrastructure that comes with them is not just a research topic for the Transport and Main Roads Chair and Professor in Structural Engineering, it's a way of life. One that has seen him become the world's leading authority in Very Large Floating Structures (VLFS).

It's a passion sparked almost 20 years ago when he was introduced to Japan's groundbreaking Mega Float project. Headed by the Technological Research Association of Mega Float, the project was the first of its kind in the world and sought to determine if a large-scale floating structure could function as an airplane runway at sea.

A one kilometre-long structure was built on location in Tokyo Bay between 1995 and 2000, where it was concluded that the ocean's movement had minimal effect on sensitive navigation equipment due to the sheer mass of the structure. This meant such structures were not only viable, but potentially liveable.

With an estimated 4.9 billion people set to be living in cities by 2030, and the geographical limitations of Earth's landmass, the world's oceans seem like the next logical step for human habitation to Professor Wang.

Covering 70 per cent of the Earth's surface, Professor Wang says it's time to make the most of our oceans.

"We have created entire civilisations on land, but we have not utilised the ocean anywhere close to our capability," Professor Wang said.

"Right now, scientists say only five per cent of the ocean has been explored. It's just a speck."

And oceans can provide everything we need to survive.

"We can harvest energy from waves, wind and tidal currents. There's also abundant solar energy stored in the surface of the water. We can treat sea water to produce potable water, and we're even developing optimised commercial fishing methods that would allow us to not just survive on the sea, but thrive."

Throughout his career, Professor Wang has been no stranger to testing the limits of structural engineering.

Before joining UQ in 2017, he worked as a consultant for the Defence, Science and Technology Agency of Singapore on the country's Marina Bay Floating Platform – the world's largest floating stage.

This time around, it is the sheer scale of his proposed projects and the economic feasibility for mass construction that has Professor Wang and his research team at the forefront of floating structure innovation.

"We're looking to create a standardised modular system. In the same way shipping containers revolutionised the way we transport goods, we can also have a floating module with a standardised connector system that would make the manufacturing process cheaper and easier," he said.

"So it is just like a LEGO set, we want to pick and choose, and have a play around with the pieces."

But before interchangeable ocean cities can take shape, first must come the 'land'.

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PROFESSOR C.M. WANG

It's a challenge that takes Professor Wang and his multidisciplinary team of researchers around the world, collaborating with institutions in Norway, Japan and Singapore.

Together they are set to explore everything from functional, cost-efficient systems of manufacturing to optimal shape and sizing of floating modules. Also crucial is the development of inter-modular connector systems and new concrete composite materials with high durability in marine environments. Then there's flexible systems for mooring solutions, construction, installation and structural solutions adapted to changing loads.

According to Professor Wang, technological advances are just now giving us the ability to focus on VLFS.

"We have recently seen rapid development in the construction materials available in the market that are suitable for construction of this scale on potentially remote, salty sea water," Professor Wang said.

"Not only are the materials and technical innovations catching up to our dreaming, we now also understand how to do sophisticated hydrodynamic analysis, even for very complex structures.

"The world is more open to the idea of moving towards the ocean now, more than ever before, because we are discovering we have problems.

"I can't imagine why we would move our land-based civilisations off our shores unless we had a serious problem. But tough times lead to innovation. We've been forced to think outside the box."

According to the World Economic Forum, the biggest challenges facing humanity over the next 50 years will include energy, water, food, poverty, environment, war

and terror, disease, education, democracy and population. Of these 10 major challenges, Professor Wang believes VLFS's will solve at least eight.

"These structures can be used for climatic refugees for example," he said.

"Think about the Maldives, Marshall Islands, Solomon Islands, French Polynesia – if we continue to see a rise in sea levels, there will come a time when they will lose so much of their land that to accommodate their people they will either need to reclaim or use very large floating structures."

Professor Wang and his structural engineering research group from UQ's School of Civil Engineering are exploring the full gamut of sustainable life at sea, as they develop large-scale offshore floating fish farms that could form the main food sources of these new-age communities.

The team's Floating Forest project will see an offshore break wall protect sensitive coastlines from wind and wave erosion.

Professor Wang and his team have received support from the Australian Research Council to the tune of $688,000 to further develop these break wall systems, showing the Australian Government's confidence in these new approaches to everyday living.

Whether VLFSs are used for industry, environmental crisis, farming or population expansion, Professor Wang's imagined future is one of sustainable energy, organic living and ever-changing borders.

"First of all, the world map will be very, very different with floating lands," Professor Wang said.

"We will be much richer in terms of new energies available, living will be clean, and farming could change in ways we never thought possible."

Professor Chien Ming Wang

C.M. Wang joined UQ's School of Civil Engineering, in January 2017 as the Transport and Main Roads (TMR) Chair and Professor of Structural Engineering. He is a Chartered Structural Engineer, a Fellow of the Academy of Engineering Singapore, a Fellow of the Institution of Engineers Singapore and a Fellow of the Institution of Structural Engineers. He has provided consulting services and served as an expert in structures and very large floating structures to many public and private organisations, including JTC Corporation, Maritime and Port Authority of Singapore, Housing Development Board, Defence Science and Technology Agency, Jurong Consultants, Surbana International and Singapore Cruise Centre.