CITATIONS OF WINNERS

PRESIDENT'S TECHNOLOGY AWARD 2017

Professor Ng Wun Jern
Professor, School of Civil and Environmental Engineering, NTU
Group Lead, Environmental Bio-innovations Group (EBiG), NTU

"For his outstanding research and development of a space-efficient, transient-state cyclic bio-system, and realisation of the contiguous value chain from research to industry full-scale deployment for wastewater management and resource recovery"

Professor Ng Wun Jern is recognised for his outstanding work in environmental engineering and in particular, the development of transient-state cyclic sequencing batch reactor (SBR) technology. This technology facilitated the design and construction of compact, efficient wastewater treatment plants, significantly reducing the size of reactor systems by more than half. His research provided the scientific understanding of the transient-state condition, while his translational engineering resulted in three generations of technologies which have been deployed at full-scale internationally and domestically. The research, engineering, and subsequent industry applications have helped to establish Singapore as a key player in the world of cyclic bioreactors and environmental engineering. His technologies have since been tailored for sustainable energy generation through biogas production and resource reclamation of chemicals beneficial to crop yields in agriculture.

The origin of this technology was Professor Ng's realisation as a young researcher, that a simple serum bottle used in cycles of microbial culture events was a cyclic bioreactor. Conventionally, wastewater was treated in multiple tanks through a linear series of processes. The critical treatment process would be done in a large tank containing the steady-state activated sludge and a settling tank, therefore this conventional treatment method typically required larger amounts of space to accommodate arrangement of the tanks.

However, Professor Ng demonstrated in the laboratory and subsequently in large scale plants that this conventional method could be replaced with a single smaller tank that could run processes in a time sequence. Such definition by time instead of space was a radical concept in the 1980s. Professor Ng's understanding of the transient-state condition and process control allowed him to develop a new wastewater treatment method which was then highly space-efficient.

Instead of having a large tank of activated sludge and settling tank treating wastewater that constantly flows through, the SBR treated the wastewater in a sequence of

batches. This resulted in new designs of treatment plants that were only half or a third of the sizes of conventional plants. Through unique software algorithms and automated control, the smaller SBR plant could still treat the same amount of wastewater as conventional treatment plants twice its size, while being more stable and able to produce output suitable for water reclamation. Effective automation also meant reduced manual labour and hence higher productivity in operations.

The engineered SBR system has since been scaled and implemented at full-scale, from package to very large plant sizes in Singapore and Asia. The core technology, known as the first generation aerobic aeSBR, has been deployed at full-scale by industry partners in Singapore, China, Malaysia, Sri Lanka and Taiwan. Since its introduction 30 years ago, Professor Ng has developed the second generation of technology in the form of the anaerobic SBR (anSBR) and the third generation aerobic membrane SBR (aeMSBR). When aeMSBR first entered service, it was the largest in ASEAN and could treat wastewater equivalent to that generated by 1.2 million people.

All three generations of technology have been used for effluent management and, with appropriate modifications, increasingly for resource reclamation which can include water, energy (from biogas), enzymes, phytohormones and chemicals such as nitrogen, phosphorus and potassium. The cyclic reactor has become a bioprocessing reactor for production of high value compounds.

Professor Ng has achieved high levels of research outcomes application, with some 120 full-scale instances. A well respected engineer and cited academic in the field of environmental engineering, Professor Ng has created some 30 intellectual properties including patents and technology disclosures, and authored close to 400 publications in the form of journal and conference papers, and books.

Lux Research ranked him among the top 25 environmental engineering thought leaders in 2013, and the Nanyang Environment & Water Research Institute (NEWRI) which he founded and led till July 2017 was then among the top 10 globally. His work has been recognised through honours such as the ASEAN Engineering Excellence Award (1997), Outstanding University (NUS) Researcher Award (1999), Chevalier dans l'Ordre des Palmes Academiques (2002), inaugural Tan Chin Tuan Centennial Professorship (2008), Fellow Singapore Academy of Engineering (2012), the IES Prestigious Engineering Project Award (2017), and the Singapore Energy Award (Innovation) 2017.

Professor Ng led and established NEWRI as a platform where research, education, engineering, and deployment could be performed as an integrated value chain. This significantly aided colleagues and PhD students in understanding the relationship between the need for deep scientific understanding and rigorous engineering, and for generating solutions to environmental issues encountered in the field.

In addition to his excellence in R&D, Professor Ng is also a serial entrepreneur, having established a cluster of spin-off companies, such as Anaesys and Phytosys, to commercialise his technologies. Anaesys is in biotreatment systems while Phytosys is in bioactives for soil remediation. Both Singapore based companies are presently pursuing projects in China and Indonesia.

For his outstanding research and development of a space-efficient, transient-state cyclic bio-system, and realisation of the contiguous value chain from research to industry full-scale deployment for wastewater management and resource recovery, Professor Ng Wun Jern is awarded the 2017 President’s Technology Award.