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## NTU, Sembcorp develop technology to 3D-print bathroom unit within a day

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(from right) NTU Assoc Prof Wong Teck Neng; lead scientist NTU Assoc Prof Tan Ming Jen; and Er Lie Liong Tjen, team lead from Sembcorp Design and Construction, and Sembcorp Architects & Engineers; with the 3D-printed bathroom unit.

RESEARCHERS from Nanyang Technological University (NTU), in partnership with Sembcorp Industries subsidiaries, have developed the capability to 3D-print an unfurnished bathroom unit in less than a day.

After printing, the bathroom is furnished with toilet fittings - such as sink, toilet bowl, as well as concealed drains and piping - to become a pre-fabricated unit ready for use in construction projects.

The technology could potentially help firms build prefabricated bathroom units (PBU) that are 30 per cent lighter than current models using one-third less time, NTU and the National Research Foundation (NRF) said in a joint press statement on Wednesday.

The printing process also halves the total time needed in the construction of a conventional bathroom unit that uses concrete casting. The fittings, tiling and finishing will typically take another five days.

It also lowers transport costs, carbon emissions and materials wastage.

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In the past four years, the research team have focused on developing a special concrete mix that is fluid enough to flow through the hoses and print nozzle, yet can harden fast enough so that the next layer is able to be printed on it. On top of ensuring a consistent print quality, the final product also has to be as strong as conventional concrete.

The innovation was developed by a joint multidisciplinary research team led by Associate Professor Tan Ming Jen from NTU's Singapore Centre for 3D Printing, in partnership with Sembcorp Design and Construction and Sembcorp Architects & Engineers.

Sembcorp Architects & Engineers is wholly-owned by Sembcorp Design and Construction, which is in turn a wholly-owned unit of energy, marine and urban development group Sembcorp Industries.

NTU's Singapore Centre for 3D Printing was set up by NRF Singapore to conduct research and development on 3D printing technology, and speed up the adoption of such technology by companies.

Throughout the whole process, NTU researchers worked closely with Sembcorp's engineers, who gave industrial inputs and commented on research findings, as well as provided resources and materials for the 3D-printing. They also installed architectural finishes and plumbing fixtures on the two printed PBUs and aided in the overall logistics.

This proof-of-concept aims to improve productivity for Singapore's building and construction industry through the use of digital and robotic fabrication methods to reduce skilled labour and manpower requirements, according to the joint statement.

All non-landed government land sale (GLS) sites in Singapore have been required to use PBUs in their construction process since 2014.

PBUs are usually cast from concrete and completely preassembled offsite with all necessary finishes and fittings, ready to be lifted and installed in a building project.

By shifting most of the fabrication offsite to the controlled environment of a factory, PBUs will save about 60 per cent of time and manpower, compared to on-site construction. There is also better control over the materials and prefabrication process, resulting in higher quality finishes and less wastage.

"This approach (3D printing) also improves the safety of the workplace, since robots are doing the construction of the bathroom unit," said Prof Tan.

The project's technology and know-how are protected by a Technology Disclosure filed through NTU's innovation and enterprise company, and are jointly owned by the university and Sembcorp.

Moving forward, the team is looking forward to getting the required approvals for trials from the Building and Construction Authority of Singapore and to commercialise the technology through licensing or a spin-off company.