

3D CONCRETE PRINTING

STELLENBOSCH UNIVERSITY

THE VISION

Our vision is the rejuvenation of the construction industry as an industry of choice that creates a collaborative new design philosophy which integrates a variety of engineering traits. The particular setting in South Africa, with an unemployment rate of over 29% in a period of societal and economic transformation, encompasses the potential enabling of technological skills development in sustainable employment and career paths. The significant backlog in formal housing presents an opportunity for labor-intensive, highly productive, industrialised construction as a strategic construction development strategy. Our dream is to facilitate the rapid realisation of infrastructure that is capable of supporting critical economic growth whilst promoting sustained development to ensure social prosperity. Furthermore, we believe that infrastructure created by this industrialised manufacturing process has the potential to yield superior structural and environmental performance whilst accentuating the beauty that resides in everyday infrastructure, freeing the world from dull buildings.

WHAT IS 3D CONCRETE PRINTING?

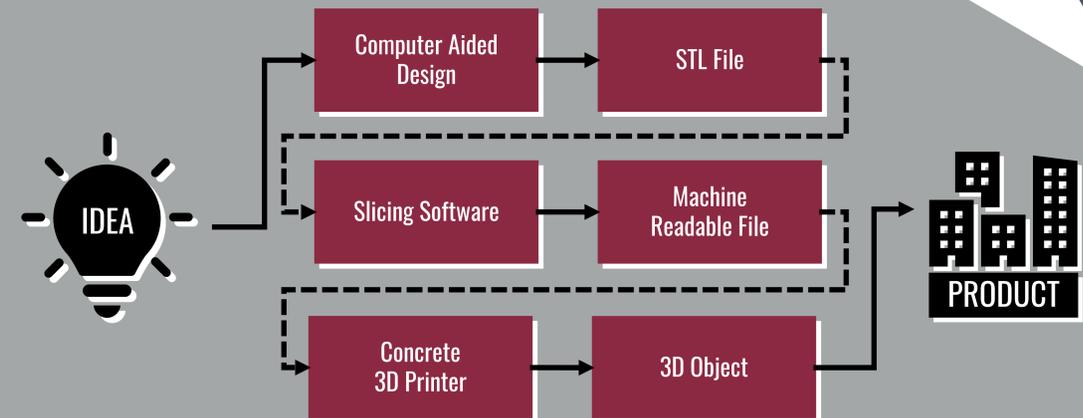
3D construction utilises additive manufacturing techniques, which means objects are constructed by subsequent deposition of material layers. Conventional approaches to construction involve casting concrete into a mould (known as formwork). However, additive fabrication combines digital technology and new insights from materials technology to allow free-form construction without the use of formwork. Eliminating the cost of formwork is a primary economic driver of 3D concrete printing. Built using materials such as timber, formwork accounts for about 60% of the total cost of concrete construction. It's also a significant source of waste, given that it is discarded sooner or later. According to a 2011 study, the construction industry generates 80% of total worldwide waste. Pouring concrete into formwork also limits the creativity of architects to build unique shapes, unless very high costs are paid for bespoke formwork. Free-form additive construction could provide enhanced design freedom at no additional charge. The cost of producing a structural component would not be tied to the shape, so construction could be freed from the rectangular designs that are so familiar in current building architecture.

THE FUTURE OF CONSTRUCTION IS DIGITAL

RESEARCH AND DEVELOPMENT

The first industrial-grade 3D Concrete Printer was designed and manufactured with full local, South African content, at the Stellenbosch University Centre for the Development of Sustainable Infrastructure. This technology has enabled a range of concrete and fibre concrete materials to be 3D printed. At roughly 1 cubic meter building volume, it is suitable for laboratory research programmes. Up-scaling to produce structural elements suitable for the construction industry is under way, in the design of a 6 DOF, 8 cubic metre 3D printer. Commissioning is envisaged for the first term of 2020. Nozzle technological research and development, and advanced geometrical designs are enabled by the new 3D printer. Innovations in surface finish and texture, interlayer resistance, durability and fire-safety enhancing technology are further research interests. The current 3D printer has facilitated research on material and geometrical modelling for shape retention and stability of 3D printed structures. Simple, practical models are proposed to avoid costly fresh state failures during 3D printing. The complex behaviour of concrete in its fresh state when 3D printed, is captured in simple models with only a small number of parameters that need to be determined beforehand. Despite the simplicity, high accuracy in predicted filament layer height and construction rate has been shown through validating 3D printing of a range of structural elements.

THE PROCESS



THE TEAM



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