

## Science

### A Bridge to the Future

In mid-October 2017 the first completely 3D-printed concrete bicycle bridge opened to the world near 's-Hertogenbosch in the Netherlands. This is an innovative first which illustrates the great potential of this new technology.

The eight-metre-long bridge is part of the new ring road at Gemert (southeast of 's-Hertogenbosch) and connects the N605 with the N272. It was not cast in situ, as is usual, in a formwork that is first constructed, then filled with concrete transported by concrete mixer trucks. The bridge was made in the experimental laboratory at Eindhoven University of Technology (TU/e), with a 3D printer which bears no resemblance to the sort of printer people have at home to print out text. It could be imagined as a small gantry crane with a computer-driven arm suspended from it, which pushes a thick substance like dense toothpaste from the opening while the print head closely follows a pattern. In this way the 3D printer layers the special concrete mortar in the specific form programmed by the software. The bridge consists of 800 sprayed layers and was assembled at the final location.

At TU/e people had been working for several years on the development of this 3D concrete printer. The research group 3D Concrete Printing (3DCP) started up at the end of 2014 as part of the Structural Design division of the Department of the Built Environment. Professor Theo Salet leads the research group in developing concrete prints into fully-fledged and broadly deployable technology for making components and buildings. The current result is the big 3D concrete printer with a print volume of 9 by 4.5 by 3 metres which can 'print out' the desired constructions thanks to a four-axle robot which applies the concrete in the right place and a mixer pump which delivers the right kind of concrete for the process.

This technology offers an unseen freedom, because it is possible to create components which cannot easily be achieved by traditional methods. Special shapes with a level of detail previously inconceivable are now feasible.

Complex components can be made more cheap-



ly and quickly with the 3D technologies, which also allow for affordable customisation in any location. The use of robots means that any design can be produced uniquely every time with a new print instruction.

The technology saves on formwork construction and materials and on the concrete itself. That is good news for the environment. 'The printer uses far less concrete. And concrete leads to substantial CO2 emissions. Reducing the quantity, along with the saving on formwork, therefore makes a serious contribution to the sustainability of a construction', Salet commented on Dutch television. Less material is needed, so there is less waste. It is also cheaper and quicker than the traditional building method, while requiring less preparation work.

TU/e has conducted several trials with printing concrete and is already dreaming of larger bridges, viaducts and other concrete constructions. Builders are considering the possibility of moving the 3D concrete printer to the construction site itself so that the desired products or parts can be made on location. Following the Netherlands' lead, people are also experimenting with printed concrete elsewhere in Europe, but in China they have advanced still further. There complete houses are built by 3D concrete printers. The walls of these houses are printed hollow, so that they can subsequently be filled with insulation and wiring.

Techniques for printing with pure metals or alloys, plastics, ceramic materials or food are well on their way. 3D printing is currently most commonly used for making prototypes, moulds, instruments and machines or machine components. The era of industrial digital production is drawing ever closer. It is already advancing rapidly in space travel and medicine. Prosthetic teeth and bones or heart valves can be printed in 3D. People are dreaming out loud about bio-printers for tissues. The company Melotte, situated in the Belgian province of

Limburg, is one of the world leaders in groundbreaking precision production.

In the future, mass-produced goods will make way for personalised products. Consumers will increasingly design, make, adapt and print their own products. That might lead to shifts in the economy. Some jobs will perish and new ones will come into being. The print technology is still in its infancy, but in combination with synthetic biology and nanotechnology it will lead to a radical transformation in many design, production and logistical processes.

GEERDT MAGIELS

*Translated by Anna Asbury*

## Theatre

### At the Heart of Society

#### *The Nation* by Het Nationale Theater

Over the last two or three years theatre makers in the Low Countries have become increasingly involved in the cultural diversity debate. In their different ways, they take seriously their mission of manifesting 'the abstract and brief chronicles of the time', as Hamlet qualifies the travelling actors who come to shake up the Danish court. In 2017 Het Nationale Theater in The Hague came out with the urgently current production *The Nation*, a five-hour marathon conceived, written and directed by the multi-talented Eric de Vroedt (b. 1972).

*The Nation*, billed as "a topical theatre thriller about the frenzy of Dutch multicultural society", begins with an apparently everyday anecdote about the search for an eleven-year-old boy named Ismaël, who has disappeared without a trace after a short visit to a police station in The Hague. The search is woven into a tense web of intrigues and whole and half-truths, repeatedly inviting onlookers to revise their assumptions. In design and style, *The Nation* unfolds as a television serial on stage: image techniques, cliff-hangers and other methods from the Netflix box of tricks serve the topical story which De Vroedt aims to tell.

The innovative aspect of *The Nation* lies particularly in the surprising way in which the world of

the stage is combined with that of modern media. From the first instant Ismaël's disappearance provides the requisite suspense and holds the viewers' attention through six episodes. All those episodes start live on stage, with a short filmed sequel on colossal screens, where credits for the characters and theatre staff are projected on vast, dynamic panoramas of The Hague. Action resumes on stage, until once again the screens support, if not annex, the dramatic course of events. This varied structure provides the viewer with an unprecedented experience, treading a middle ground between conventional theatre and binge watching on the couch, taking in a favourite series from beginning to end in a single sitting.

In terms of content this offers the public a surprising perspective on the banality of traditional norms and values. The globalised world of the twenty-first century is a complex construct, and *The Nation* confrontationally exposes both the dubious motives which determine the power of big business and the ridiculous hypocrisy at the foundation of what we think of as political correctness. It is precisely these elements which disrupt relationships and get in the way of peaceful solutions in a heterogeneously composed society: that is the lesson the production teaches us. As the audience, we get to know a multitude of characters, from a malicious, corrupt project developer at one end of the spectrum to an unbearable salon socialist at the other, who converts to Islam and starts wearing a headscarf out of solidarity with the Muslim community.

If this modern morality play conjures up any emotion, then it is first and foremost indignation. According to a standard pattern of expectation, theatre with political content appears to conform to the philosophy of a left-wing avant-garde, but *The Nation* breaks through that thinking in the directions it takes, the affiliations it exhibits and the principles it reveals, showing us society in its complete – often surprising, disruptive – multifacetedness. 'Good' and 'bad' are effectively redefined. The duplicity of the main characters, both to the left and the right of the middle in varying distances, pulls the audience mercilessly from that kind of personal bubble.

*The Nation* is built around a cast of top actors, a mixture of players with a considerable record of