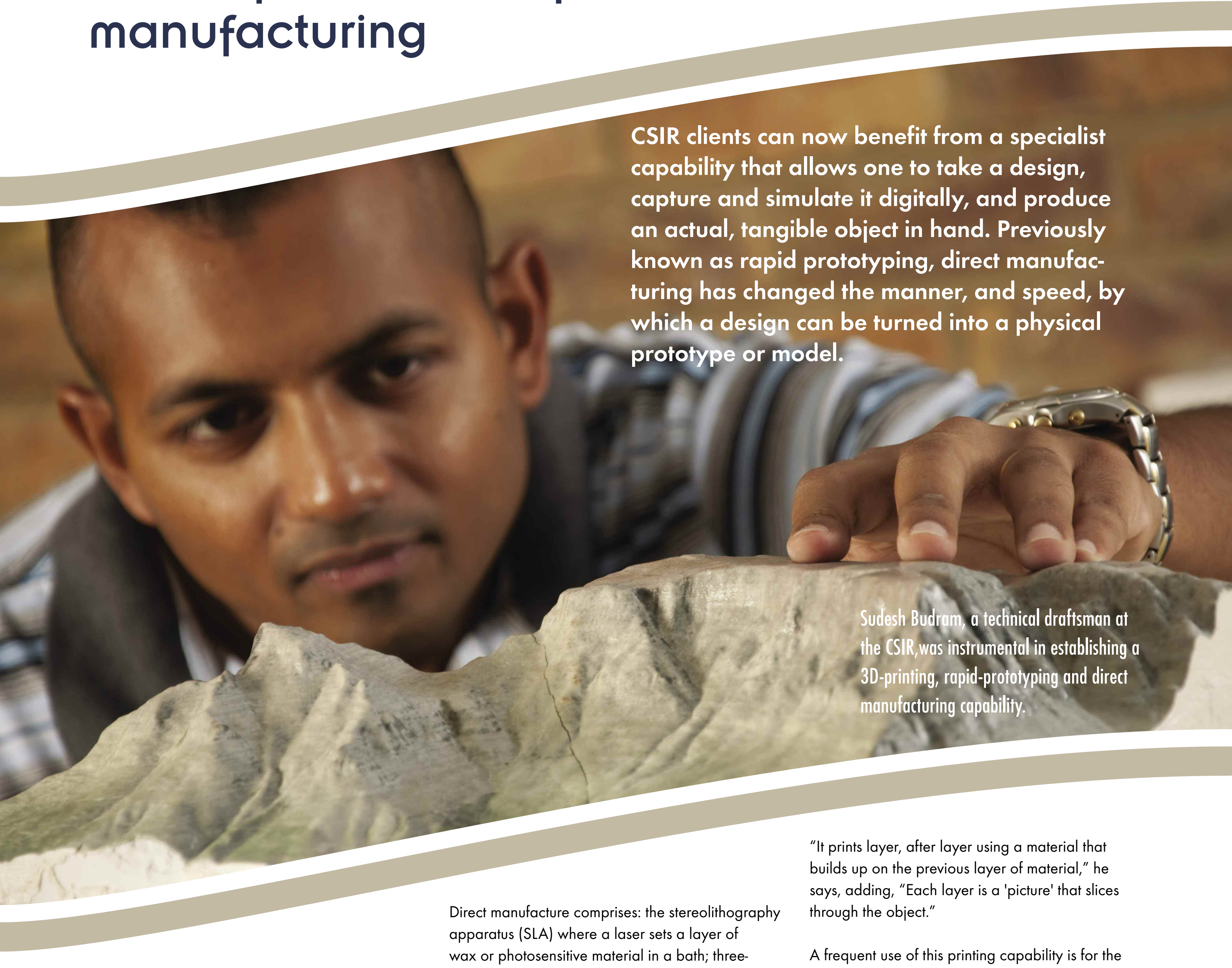
From drawing to tangible reality – The artful science of direct manufacturing



CSIR clients can now benefit from a specialist capability that allows one to take a design, capture and simulate it digitally, and produce an actual, tangible object in hand. Previously known as rapid prototyping, direct manufacturing has changed the manner, and speed, by which a design can be turned into a physical prototype or model.

Sudesh Budram, a technical draftsman at the CSIR,was instrumental in establishing a 3D-printing, rapid-prototyping and direct manufacturing capability.

Chris Serfontein heads the CSIR's Technology for Special Operations (TSO). His team focuses on technology solutions to address the unique requirements of the Special Operations cadres in the South African National Defence Force. In this field, rapidly-created, custom and efficiently-working solutions are critical. According to Serfontein, the challenge has always been the time and cost to produce the prototypes and products that can be provided to the client: "To date, manual and numerical controlled manufacture has been the options available to us," he says. "Direct manufacturing technology is now considered mature and cost effective enough to be procured as an extension to our capability."

Direct manufacture comprises: the stereolithography apparatus (SLA) where a laser sets a layer of wax or photosensitive material in a bath; three-dimensional printing (3DP), which uses injection technology to create a thermo plastic structure; and selective laser sintering (SLS) that uses a laser to fuse powder (nylon, polycarbonate, polymer and metal).

None of these, however, can be used for colour terrain models. The CSIR therefore procured a 3D printer that uses colour ink jet technology. Serfontein says that the printer works like the normal printer that one would use to print a photograph, except that it does not print one layer per sheet of paper.

"It prints layer, after layer using a material that builds up on the previous layer of material," he says, adding, "Each layer is a 'picture' that slices through the object."

A frequent use of this printing capability is for the final production of 3D terrain products, based on the input data from TSO's Geographical Information Systems (GIS) experts, clearly showing all aspects of a terrain, as well as any specific information required by the client, in colour.

The input into the 3DP has to be created either in computer aided design (CAD) software, or by using a 3D scanner to capture all dimensions of a particular object or shape.

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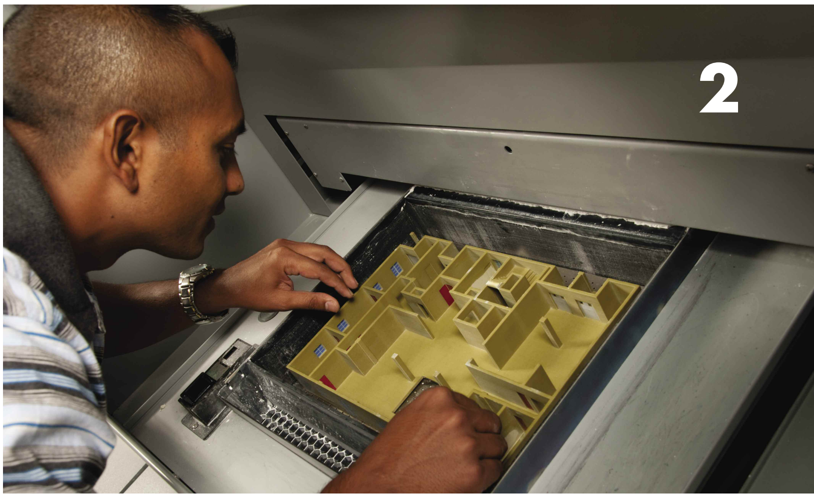
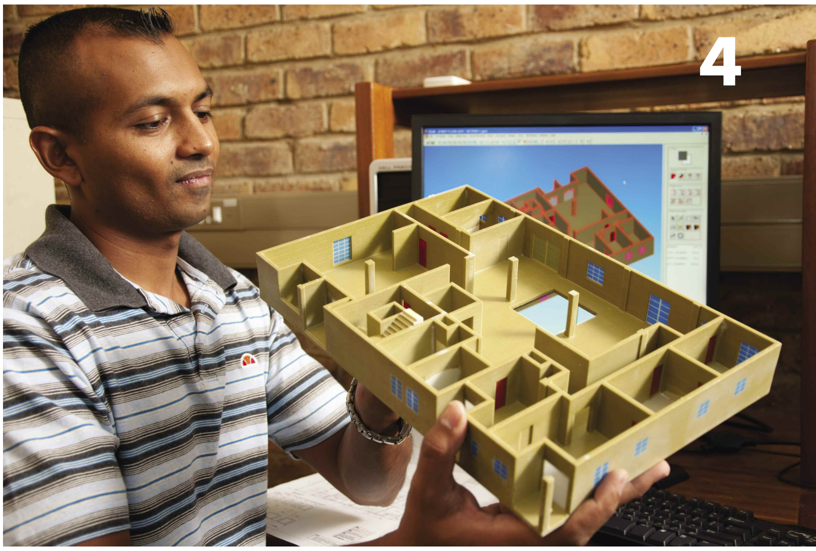
Data from 2D sketches are used as input to create a 3D model



A model is built from a high-performance composite powder, after which post-processing commences.

Removal of powder allows for final preparation of the model.



The 3D model is inspected after the post-processing phase.

"CAD has for many years been able to turn the designer's dream into a computer model that can be viewed on a PC. This has aided the design process significantly, but direct manufacture now gives the designer the ability to produce a complex model quickly and affordably," he says. This also enhances the advanced mechanical engineering capability, especially when complex mechanical engineering solutions are required. The technology thus has obvious benefits in terms of time-saving. It also reduces material waste associated with conventional forms of manufacture; lowers energy use, and allows for the design of unusual and more organic shapes and forms.

The designer can use direct manufacturing to produce the following: scaled models of actual structures, terrains, areas, prototypes of parts, actual items (if a small volume is required and the material is acceptable), and as a high production volume input to investment casting (for patterns), injection moulds (for hard tooling), sand moulds, and soft tooling (for cores).

Plans for the future are definitely to expand collaboration in this field and make the expertise and facilities available more widely.

Serfontein says that the CSIR is also working closely with the Central University of Technology (CUT), the University of Stellenbosch and SoSolid in Cape Town to build a national rapid prototyping and direct manufacturing capability. "CUT has shown interest in collaborating with the CSIR in rapid manufacture research, and sharing knowledge and capability," he says, adding that CUT has an extensive capability of SLA, 3DP and SLS.

"We want to create a shared direct manufacture capability and service, including training, within the CSIR and with our national partners," Serfontein concludes.

The capability is not restricted to R&D efforts. It can be used by anyone who needs a design turned into an actual object as a prototype, scale model or test version. The team can, for example, create novel shapes for artistic use, ceramic design and models for architects or sculptors.

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