Innovation in Industry: critical for SA growth

MechChem Africa's Peter Middleton attends the Nelson Mandela University- and Altair-hosted 2018 Innovation in Industry Conference and presents a few takeaways from the presentations.

Mooted to unveil "amazing new technology being used here in the South Africa" Clive Hands of Nelson Mandela University in Port Elizabeth opened proceedings of the first Innovation in Industry Conference with the words, "You are going to love it. This conference will blow your mind and open up some serious potential in advanced production-related technologies."

His co-host, Ernst Burger of Altair, the simulation and optimisation software specialist, added: "Altair's service to South Africa is to help industry to design innovative products. This event strives to expose the new technologies that enable smarter solutions, which are essential if we are to drive our economy forward."

The companies exhibiting in the foyer presented a clear idea of the smart technologies on these gentlemen's minds: Retecon, the leading supplier of advanced metalworking tools to SA's manufacturing industry; the microCT testing facility at Stellenbosch University, an advanced testing facility dedicated to 3D printed products; RAPID 3D, South Africa's professional, production and industrial 3D printing specialist; Jendamark, the Port Elizabeth-based industrial automation systems provider; and Nelson Mandela's entire Eco Car team, displaying its ultra-lightweight vehicle that, during the 2017 Shell Eco-Marathon Africa contest at Zwartkops Raceway in Pretoria covered a distance of 184.23 km on one litre of petrol – the equivalent of driving from South Africa to New York in a standard-sized car on a single tank of petrol.

During the official welcome, Nelson Mandela University's deputy vice chancellor, Professor Andrew Leitch, noted, "too many of our people leave this province, returning only to retire or when they fall ill. We want to change this around, reduce net migration and give young people reasons to stay. With topics such as those being presented today we hope to demonstrate the capabilities within our University and the partnerships that we are building to strengthen local industry, all with a view to expand local economic development and to give people a wider range of career opportunities."

He cites one of the six recently identified key institutional research themes in support of this objective: Innovation and the digital economy. "This conference fits squarely within this theme and we hope the exciting programme will inspire ongoing support for our endeavours," Leitch says.

Testing techniques for metal AM in industry: Anton du Plessis

In an appropriate reversal of the normal rollout sequence of new technologies, the conference began with a presentation on the development and establishment of advanced testing services for products manufactured using metal additive manufacturing (AM) processes. This perhaps indicates the degree of maturity of the technology, which is clearly no longer limited to rapid prototyping.

Professor Anton du Plessis of Stellenbosch University says that although still involved in research, 90% of the funding for his microCT (computer tomography) testing laboratory now comes from commercial work. "We partner with Altair and with the CRPM unit at Bloemfontein University, who will produce metal prints on demand," says Du Plessis.

Describing the microCT scanning process, he says that an X-ray source is shone through the AM sample and a magnified image is projected onto a 2D digital detector. "The object is then rotated and thousands of 2D digital images are collected and recombined to recreate a 3D model of the object that contains micro detail of the internal structure. This then allows us to 'slice' the model in any direction to analyse for defects," Du Plessis explains, adding that this is a state-of-the-art X-ray imaging technique is ideal for materials' analysis, particularly for the porosity and delamination flaws typically associated with metal additive manufactured/3D printed products and samples.

As well as developing the testing procedures and delivering a service to additive manufacturing practitioners, the microCT unit at Stellenbosch University is also at the forefront of developing universally applicable testing standards for the technology.

"While microCT is a powerful technique, there are not yet standardised procedures for validating the build quality of a product. If 3D

Anton du Plessis.

printing service providers submit a standard sized cube for analysis, we can quickly determine whether the process parameters being used are acceptable or not. But if they are building a complex part, it is difficult to standardize the testing, so the test sample needs to be produced by the same build platform and at the same time as the product that is being built," Du Plessis suggests, adding that in these cases a rod-like witness specimen is added to the product build to give a layer-by-layer representation of the AM process experienced by the product.

"If the machine stops during a build, for example, which is known to introduce a layering flaw, or if the powder is not being spread evenly, the resulting flaws will be clearly evident in the witness specimen, regardless of how complex the part," he points out.

Designing for Rapid manufacturing: Bryan Bullock

Following Du Plessis to the podium was Bryan Bullock of Rapid 3D, with a talk urging engineers to recalibrate towards a different approach when adopting additive manufacturing.

"Few are aware about how long this technology has been around. We have been going since 2004 and have been exposed to all of the different technologies and materials. We have gone through some pain with inadequate and expensive machines and we now pride ourselves on knowing what works and what to avoid," says Bullock.

Giving an example of the need for different design rules, Bullock explains how the orientation of an AM build affects strength. "This depends on the technology used. With FDM (fused deposition modelling) the x and y strengths are similar but the z strength is a fraction of these, but if talking about the powder bed fusion technologies, SLS (selective laser sintering) or (DMLS), direct metal laser sintering, then the properties in the z direction are far closer to the x and y strengths," he notes.

He cites some excellent examples of what can be achieved using AM, one being

Bryan Bullock.

a robot gripper design. "These are sensitive instruments that get attached to a robot and can weigh 1.5 kg. This guy was interested in making a lightweight pneumatic gripper to increase the payload of his robots.

"This ticked all of the boxes for 3D printing: While mass reduction was the original intent, this guy took it a step further," Bullock reveals. By using the inherent properties of the SLS polymer material and weakening the inner surface relative to the outer, he was able to induce the gripping movement required under pneumatic pressure, resulting in a 19 g gripper with no hinges or connections.

"We tend to think of a hinge as a connection between two things, with holes on each connected by a pin. This gripper has the hinge built into the structure of the gripper material," says Bullock.

He goes on to describe an initiative by Daimler Chrysler, which is in conversation with EOS to meet low volume demand spares for vehicles. He says that injection moulding processes are volume dependent and in many cases 10 000 units is the minimum viable quantity to manufacture. For some vehicles, however, only 10 to 20 of these parts will ever be used.

While 3D printing is not an inexpensive process, it can be a lower cost option for these parts. "Once the build programme has been established, the machine can be loaded to build any additional parts required at a very low incremental cost – and it is possible to make the number of parts required on demand," he says.

Optimisation & lightweighting in composites design: Martin Badenhorst

In this presentation, Martin Badenhorst described the process of topology optimisation and manufacture of the carbon fibre composite wheels which are now installed on Nelson Mandela University's 2018 Eco Car.

The original weight of the spoked aluminium wheel and hub was 723 g and Badenhorst managed to get this down to around 500 g by using topology optimisation as the design

Martin Badenhorst.

starting point.

Describing how topology optimisation works, he says that the software establishes the optimum distribution of materials and voids within the defined space so that required objective functions, such as maximum deflection and strain, are satisfied.

"The software runs through a finite element analysis-type process and assigns a material or a void indicator to every element depending on its contribution to meeting the specified requirements. All unnecessary material – and therefore weight – is systematically removed until the remaining form closely matches the product performance requirements," he says.

The final product then needs to be 'tweaked' to ensure that it is practical to manufacture, but by keeping an open mind and starting with the widest possible volume window, excellent results can be achieved.

Badenhorst's paper details the specific steps and decisions taken during the wheel design and manufacturing, which, in the end, involved hand cutting and laying of the carbon fibre matting using manual-only processes.

One of the exhibitors at the Innovation in Industry conference was RAPID 3D, South Africa's professional, production and industrial 3D printing specialist.

No 3D-printing here, just innovative design.

Presentations from Jendamark's Yanesh Naidoo about how the IIoT and Industry 4.0 can be applied and by Jaco Heunis about Theia, Jendamark's virtual and augmented reality (VR & AR) platforms followed.

Michael Stephen presented on Data Analysis and Telemetry; Nic Minnaar on Next Generation Manufacturing Simulation Solutions; and the conference closed with a presentation delivered by Altair's Dr Royston Jones on automotive design and lightweighting in the UK automotive sector.

Nelson Mandela would be proud of his namesake University. Like him, may it come to be known, respected and unique, for its niche industrial focus, its geographical advantage and for championing innovation. ❑

Nelson Mandela University's 2018 Eco Car, which incorporates new lightweight carbon fibre composite wheels, which were developed using Altair's HyperWorks design software with its OptiStruct topology optimisation solution.