The Connex500

Utilising PolyJet Matrix Technology and Digital Materials

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Overview

At the end of last year Objet Geometries of Rehovot, Israel, used the EuroMold exhibition in Franfurt, Germany as the platform for launching the company's latest rapid prototyping (RP) machine / 3D printer — the Connex500. Six months on, the TCT Magazine takes a closer look at this new technology and examines the implications for the RP/RM sector as it continues to drive forward into new territory.

Objet Geometries launched its first RP system based on 3D inkjet printing technology in 2000 — the Quadra; and since then has been a competitive player within the RP market with the Eden range of machines. The new Connex500 machine, not unusually in the RP industry, was launched amid a great deal of marketing hype and industry speculation with phrases such as "revolutionary process" and "breakthrough technology" used to explicate its arrival on the market. What is fairly unusual, however, is that these descriptions are proving to be particularly accurate.

The key capability of the Connex500 that makes it unique compared with any other RP machine currently available is its ability to simultaneously jet different types of model materials and therefore produce parts with different, pre-determined mechanical and physical properties — in one build. Based on Objet's proprietary PolyJet Matrix technology the machine works by jetting two distinct, Objet FullCure model materials in preset combinations. It is possible to control every nozzle in each print head, which therefore enables combinations of model materials to be jetted from designated nozzles according to location and model.

Tech Spec

Accuracy data according to the machine manufacturer permits printing of 600 x 600 dpi in both the x and y axes, with horizontal layers of 16 microns; and enables thin walls down to 0.6 mm, fine details in all dimensions and a smooth surface finish regardless of geometric complexity. Precision printing, with a maximum tolerance of 0.3 mm over large models further ensures accuracy and repeatability.

The Connex500 offers three printing modes:
- The DM mode operates at 12 mm per hour in 30-micron layers and is used for Digital Materials and multiple model material printing.
- The HQ mode builds parts at 12 mm per hour in 16-micron layers
- The HS mode runs at 20 mm per hour in 30-micron layers.

The build volume for the Connex500 is 500 x 400 x 200 mm.

The Connex500 comes with new Objet Studio Software that was specifically written to assign multiple materials to STL files and create files that include different material types, assemblies and model characteristics.

In terms of materials, the Connex500 is able to fabricate 'Digital Materials'. Objet uses the term Digital Materials to describe the composite that is produced using the PolyJet Matrix technology. Digital Materials are formulated by simultaneously jetting two model materials to create new composite materials. It is important to note that the mechanical properties of the Digital Material are different from the properties of each of the two model materials that are used to create the composite. Prior to the introduction of the Connex500, Objet offered seven materials in its FullCure range, but with the new system, it is possible to produce parts and assemblies from 21 Digital Materials, as well as the seven original materials. A material that is not yet available for the system, however, is Objet's Tango Plus. The Connex500 prints parts with specific Shore A values — the scale used to indicate material hardness in soft, flexible materials — consequently, users of the machine can match the Shore A values available to those of production materials.

Opinion

There is a real 'revolutionary' or 'breakthrough' aspect to this. As stated, the process provides the designer with the ability to fully determine the mechanical and physical properties of the jetted materials for the prototype, which will emulate the production part more closely than previously possible. Moreover, the fact that this can be achieved with multiple materials, in a variety of combinations, in one build, eliminates the need for traditional and time-consuming processes that have been used to date, such as double injection moulding or over-moulding. These processes often involve the need to design, print and glue together separate model parts to make a complete model. In terms of production and post-processing time, the advantages of this become immediately obvious.

Terry Wohlers (Wohlers Associates, Inc), after reviewing the capabilities of the new PolyJet Matrix technology, commented; "This is an industry first. The technology opens up exciting new options that before were impossible with

methods of additive fabrication. I anticipate strong interest in the technology and materials from a wide range of organisations worldwide." Indeed, at EuroMold 2007, the benefits were immediately obvious to the Innovation Award judges for the show, as the Connex500 won this prestigious award, which recognizes the most innovative developments from the broad fields of mould-making and tooling.

Furthermore, during its short history the Connex500 has already established a fairly broad user base — one that is keen to share information, a fact that is backed by recent activity on the rapid prototyping-mailing list (RP-ML). The TCT Magazine has caught up with some of the more vociferous participants to find out more.

The first machine to be set up in the UK is at IPF Rapid Prototyping, a family based company in Nazeing, Essex. Gary Miller, Head of RP at the firm is more than happy with the end results that he is seeing since the installation of the Connex500 last month.

"IPF invested in the Connex500 following the success we have had with the Eden 330. The reliability and performance of Objet's latest printer is excellent and the installation and set up experience, with Objet's support has been, as expected, a painless experience! Numerous over moulding and twin-shot files have been printed and dispatched with 100% positive feedback."

Once up and running, Gary has been faced with only one obstacle: "The only issue currently outstanding is in the software, build estimates between 'high quality' and 'high speed' are currently inconsistent resulting in customers benefitting from cheap quotes. Objet has been in constant contact with IPF regarding this software problem and an upgrade is due imminently."

Gary has been keen to point out that as an Eden user, IPF has been able to use the software from the Eden 300 machine as an interim measure, prior to the new release.

David Gurrola, President of GROWit LLC, has overseen the installation of the first Connex500 in the US. Since its arrival David has seen first hand the impact of the advantages the system brings to his business:

"With the constant concern of shorter product development cycles, there's not much that can compare with the Connex500's speed and quality in producing multi-material parts. Comparing a standard 1–3 day turn around for parts on the Connex with 1–2 weeks for a silicone mould, one can see how the total design timeframe can be shortened substantially. The cost per part is usually lower than the cost for silicone moulds for quantities of 5–10. In addition, the comparative cost becomes much lower when a part is made of more than two materials. The cost of adding an additional material to a part on the Connex is almost negligible, whereas a moulded part will incur substantial additional costs associated with each new material that is added. There is a general perception that because the Connex can only load two different build materials, it is limited to only those two materials during any given build. However, with the option of creating 'digital materials', a part can currently have up to eight different material distinctions at one time. The machine is designed to mix these digital materials 'on-the-fly', so the material options will only continue to expand as more research and testing is done.

"Since the Connex's Polyjet Matrix technology is still in development, there are a few limitations that make it less suitable for some applications. The Connex still uses the same gel-like support material that has been the trademark of producing Objet parts. In some applications where excessive amounts of support material are needed, the additional costs incurred begin to out-weigh the benefits of its multi-material capability. When multiple parts are being grown that use substantial amounts of support material, the argument for using a silicone mould becomes much stronger because of the per-part cost increases. Another temporary limitation to producing multiple-material parts on the Connex, is that there are currently only a few shore A values that can be used to simulate production applications such as overmoulding. This will soon change when Tango Plus is added to the list of digital materials and mixed with the other Tango and Vero materials to fill in the range. Although Tango Plus is not currently available on the Connex, it very well may be by the time this article is published!"

Beyond the realities of what David and his team are able to achieve today, however, he is also able to look at the future possibilities of where this new technology could lead, and it is exciting to say the least:

"One of the most remarkable aspects of the Connex is that it is the beginning of a new era in additive technologies. There are still many issues with additive technologies that need to be resolved/further developed before some critics will accept it as truly more than just prototyping. When you look at the possibilities for production applications when using multiple materials, the benefits become much more appealing. Take for instance material optimisation, or selective material placement. The future of multiple materials in additive technologies will allow designers to grow structures with lighter materials in areas where less strength is needed or more heat-resistant materials where a harsher environment is present. Being able to do this will allow for much more efficient systems and even the possibility of products that are not conceivable today.

"Another possible use of multi-materials in additive technologies is in electronics. There are already machines that can print circuit boards on to a 3D surface, the catch is that the surface already has to exist and there isn't an easy way to do this in multiple layers. Consider the possibilities of "printing" conductive materials directly onto another material by using an additive technology. The electronic circuit can now be embedded in the part and multiple layers can be created allowing for more usable space.

"The possibilities and benefits of additive technologies begin to grow exponentially when we move out of the realm of single materials and into the new era of multiple materials." Both of the limitations as highlighted by Gary and David have also proved problematic for Stefano Saleri, who has recently managed the implementation process of a Connex500 system at FAST 3D in Italy. He, like Gary, is "eagerly waiting for the new release of the software." Moreover, in accordance with David, Stefano is anticipating with some relish, "[the] big breakthrough when the Tango Plus and another Vero or FC720 materials can be combined and used," on the Connex.

Mr Saleri also articulated a couple of other minor problems experienced with the Connex500, including the difficulty in coveying the machine's capabilities to his market, however his feedback, like his contempories, was certainly positive.

Another certainty is that in the years to come, when this technology has evolved almost beyond recognition, which it surely will, Objet will be the company that is remembered as the pioneer in this area.

CONNEX500 — At a Glance

Tray size (X/Y/Z):	500 x 400 x 200 mm
Net build size (X/Y/Z):	490 x 390 x 200 mm
Layer thickness (Z-axis):	Down to 16-micron
Build Resolution (X/Y/Z):	600 x 600 x 1600 dpi
Printing Modes:	High Quality (HQ) High Speed (HS) Digital Material (DM)
Accuracy:	0.1–0.3 mm typical.
Materials Supported:	FullCure©720 Model transparent VeroWhite Opaque material VeroBlue Opaque material VeroBlack Opaque material TangoGray, rubber-like flexible material TangoBlack, rubber-like flexible material.
Digital Materials:	21 types of composite materials.
Support Type:	FullCure705 Support.
Materials Cartridges:	4 sealed 3.6 kg (7.9 lb.) cartridges 2 different model materials loaded front loading for quick replacement.
Power Requirements:	110–240 VAC 50/60 Hz/1.5 KW single phase.
Machine Dimensions (W/D/H):	1420 x 1120 x 1130 mm
Machine Weight:	Net 500 kg.
Input Format:	STL, ODF and SLC File
Operational Environment:	Temperature 18–25°C Relative Humidity 30–70%
Jetting Heads:	SHR (Single Head Replacement), 8 units.
Network Communication:	LAN - TCP/IP.
Compatibility:	Windows XP, Windows 2000.