

# The digital physical artefact: a case study for digital engagement in the creative industries

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## ABSTRACT

*For the last five years the research team at the Centre for Fine Print Research, UWE have concentrated on the interface between creative design and new digital production technologies. This research developed from a three-year AHRC project 'The Fabrication of Art and Craft Artefacts through Virtual Digital Construction and Output', and has led to a patented process for a type of material that allowed the additive layer manufacture of ceramic bodies; thus making CAD and RP integral to the design, printing, firing and glazing of a finished item in a ceramic body. The primary aim of the project was to investigate the potential for designers and craftspeople to 'digitally physically' create one-off and bespoke artworks in materials they were familiar with, whilst using digital technology at all stages of the process - far beyond a virtual on-screen representation.*

*The ability to digitally print fully formed ceramic artefacts has led not only to a process of benefit to the art and design communities, but also to a growing number of industrial collaborations. Currently the team are working with, Renishaw, Denby Potteries and Johnson Matthey in the UK and Viridis LLC in the USA. The ability to print in ceramics is a fundamental shift from creating prototypes in plastic, to manufacturing actual objects, that have all the tactile qualities so essential to the definition of British design quality.*

The common perception of the digital economy concerns communication. To quote the RCUK, 'For us, 'digital' is the complex interaction of people, processes and technology to create socio-economic benefits for all.<sup>1</sup> In the digital economy, digital networking and communication infrastructures provide a global platform over which people and organisations can interact, communicate, collaborate and share information'. However there is a further function to digital technology beyond direct communication, which involves the creation of artefacts through the interface between the virtual digital technology and the actual physical output. Increasingly, these processes are being used to custom manufacture user specific items. In the past, due to the limited materials available, this was referred to as Rapid Prototyping. Now with the advent of functional materials it is more commonly known as additive layer manufacture (ALM) or 3D printing.<sup>2</sup>

This functional digital technology currently splits two ways. Firstly, as an engineering tool exemplified by companies such as EOS who use ALM for manufacturing precision parts for the aerospace industry and who have grown out of the rapid prototyping arena. Secondly, the technology is now gaining a presence in the Creative Design sphere. Consequently there is a broader mass market interest and appeal exemplified by NESTA's recent 'Hot Topic' seminar 'Personal Manufacturing, the New Look Entrepreneur'<sup>3</sup>, MIT's FabLab's<sup>4</sup>, Neil Gershenfield's TED<sup>5</sup> talk and articles in the Economist, Guardian, New York Times and Radio 4's Business Week. It is this growth area that this paper addresses.

With funding from the AHRC, the authors currently collaborate with Denby Pottery, one of the UK's best known and longest surviving ceramic tableware manufacturers. Founded in 1806, Denby are known for their high quality oven-to-tableware and their innovative glazing technology. Unusually for a UK based ceramic manufacturer, Denby control all aspects of their manufacture from concept to completion. They are already experienced users of both 3D design software for ceramics and powder deposition 3D printing systems (such as ZCorp) that print in plastic and plaster. Therefore the testing and development regimes within the project do not bother Denby - an incredibly forward looking company in a very traditional industry. The ability to digitally print directly in a compatible ceramic material that can be rapidly glazed and decorated is a quantum leap in digital printing technology for Denby. Currently they can produce a concept model accurate for size and appearance of the form, but it has none of the material properties inherent in ceramics, therefore cannot be coloured, fired and glazed. Additionally the concept model will not hold liquids or food. The project is a feasibility study to prove the viability of using 3D printed ceramic bodies as a design tool for concept modelling of tableware. The researchers need to develop an understanding of both the design considerations required for commercial ceramics and the particular constraints inherent in producing 3D printed industrial ceramic tableware.

The major problems arise from creating an entirely new manufacturing process, which no longer conforms to the rules of the process it is emulating. For example in this case it is very feasible to design a bowl in CAD software such as 'Rhino', convert it to an STL file send it to the 3D printer, (in this case a Z Corp machine filled with ceramic powder), print the bowl, remove it from the printer and de-powder, dry it and put it in the kiln for firing. So far we have produced a totally digitally designed and printed item, this is in fact the crux of the research challenge. A conventional ceramic item is bonded with water and the clay therefore has a natural adhesion as it dries, with a high degree of compaction. When it comes to firing it therefore conforms to a traditional set of prerequisites. The digital bowl has been constructed by laying down individual layers of dry powder, then bonding each layer loosely together with a very low compaction. When this is in the kiln, there is very little available to hold the clay together as the temperature increases, a very different problem to conventional ceramics.

A possible solution is to create designs that make a virtue of the differences between the two processes. However, in order to create digitally printed ceramics that are functional for Denby we need to emulate Denby's final product output. Denby want a concept model that looks and is ceramic i.e. one that can be glazed, with the ability to hold food and liquids for customer evaluation. Currently the team are collaborating with Denby on addressing these challenges by investigating how the objects can be physically supported in the kiln, by digitally printing setters and supports alongside the artefact, so the object is supported during firing and does not fall apart. Whilst this route may appear more expensive and time consuming the advantage of digital technology means that the printing of the supports takes no additional time, as they are created concurrently to the object. Furthermore, as they are of identical materials, this means they expand and shrink in tandem with the object in the kiln.

This case study is in some senses predictable, it articulates the use of newly developing digital technology, seamlessly integrating into a traditional design and manufacture environment, that creates a consumer end product that has low engineering tolerances, well within the parameters of the digital printing process.

In the last twelve months there has been much publicity of 'the internet of things' and the integration of digital technology into the artefact in order for the object to communicate with society. We are in danger however of missing the slightly more mundane but far greater potential of using digital technology for the fabrication of the everyday object. Whilst most people own at least one computer, 98% of our social environment is still made up from physically manufactured artefacts.

This case study highlights the enormous potential for the digital economy, through additive layer manufacture using real materials, to digitally custom manufacture everyday objects.

<sup>1</sup> RCUK website for the Digital Economy.

<http://www.rcukdigitaleconomy.org.uk/home/what-is-digital-economy.html>

<sup>2</sup> Bradshaw, S., Bowyer, A. and Haufe, P., 2010. *The Intellectual Property implications of low-cost 3D printing*. ScriptEd, 7 (1), pp. 5-31

<sup>3</sup> NESTA 'Hot topic' Seminar. *Personal Manufacturing: The New Look Entrepreneur?* 19th January 2011 | NESTA, London. [http://www.nesta.org.uk/assets/events/personal\\_manufacturing\\_the\\_new\\_look\\_entrepreneur](http://www.nesta.org.uk/assets/events/personal_manufacturing_the_new_look_entrepreneur)

<sup>4</sup> MIT Fab Central: <http://fab.cba.mit.edu/>

<sup>5</sup> Gershenfeld, Neil. *Neil Gershenfeld on Fab Labs*. Feb 2007 [http://www.ted.com/talks/neil\\_gershenfeld\\_on\\_fab\\_labs.html](http://www.ted.com/talks/neil_gershenfeld_on_fab_labs.html)