

## The Role of Science in 3D Printing for Clothing Textiles

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The origins of textile manufacture are lost in antiquity. Before history began, men had discovered the secret of twisting fibres together and interlacing the resultant yarns to produce strong and flexible coverings. So valuable did these products prove to be, not only for clothing but increasingly for all kinds of industrial purposes, that the world began eagerly searching for raw materials for the textile industry (Jenkins, 2003). Throughout history, the craft of the tailor and the cloth designer was often supplemented by the skill and resources of the scientist (Dorkin, Munden and Whewell, 1973). For example, the larger portion of the world's textile until recently was a matter of agriculture, but the further development of artificial fabrics was stimulated by the demand for filaments for use in the new electric-light bulbs by Sir Joseph Swan (Park and Shore, 1999). However, in the past twenty years, the relationship between clothing design and science has changed. The increased consumption surfeited the market with inexpensive, low-quality clothes (Dana Thomas, 2019). Research indicates that our planet cannot sustain this model as the fashion industry pollutes without accountability with heavy water use and contamination, toxic dyes, CO<sub>2</sub> emissions, soil depletion, and textile waste (Niinimäki *et al.*, 2020). In a world hungry for textiles, a more imaginative approach to designing clothes is needed. Therefore, it might be that the future will see a reduction in the quantity of natural fibres used and their replacement by fibres derived from new synthetic and sustainable methods (Sanders, Grunden and Dunn, 2021). 3D printing offers an opportunity to unleash the vast potential of new materials and manufacturing processes and enable fabrication at high speeds with high precision over large build volumes (Chatterjee and Ghosh, 2020). Additive manufacturing provides a strong economic driver for the adoption of textiles, providing the ability to make products on-demand in low production runs and with customized form factors (such as size and shape) (Papadopoulou, Laucks and Tibbits, 2017). Yet, the patterned features and complexity of 3D printed designs do not match those found in natural textiles (Chakraborty and Biswas, 2020). This study evaluates state of the art in additive manufacturing for clothing and discusses existing barriers with an example of the 3D printed garment based on the SLS printing and TPU material. Nature has had billions of years to evolve elegant solutions that are well adapted to textiles. The analysis of these structures and processes can serve as a powerful source to guide the work of scientists and designers alike, inevitably changing the way we design products and structures to reflect outstanding achievements in physics and chemistry.

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