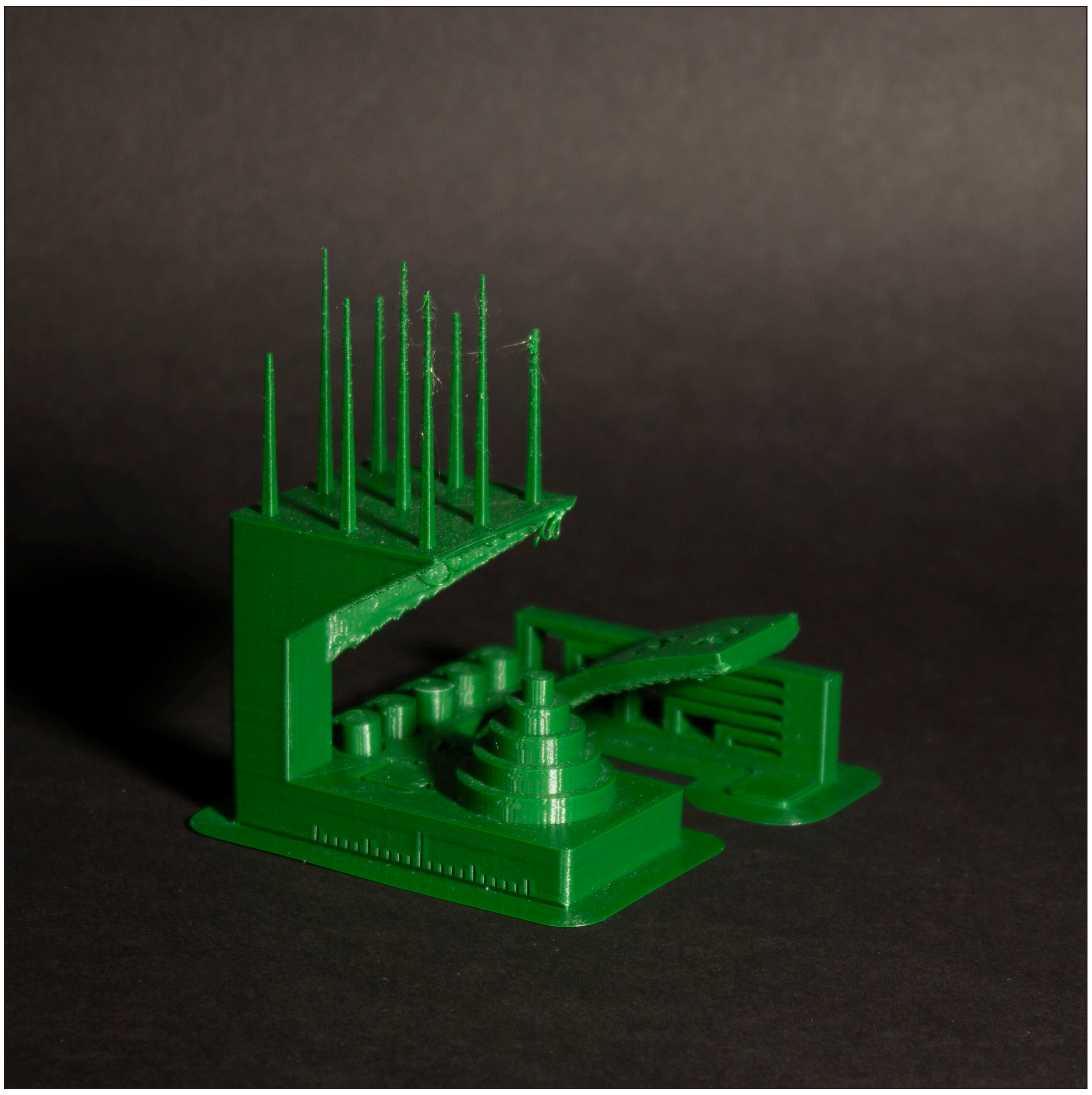
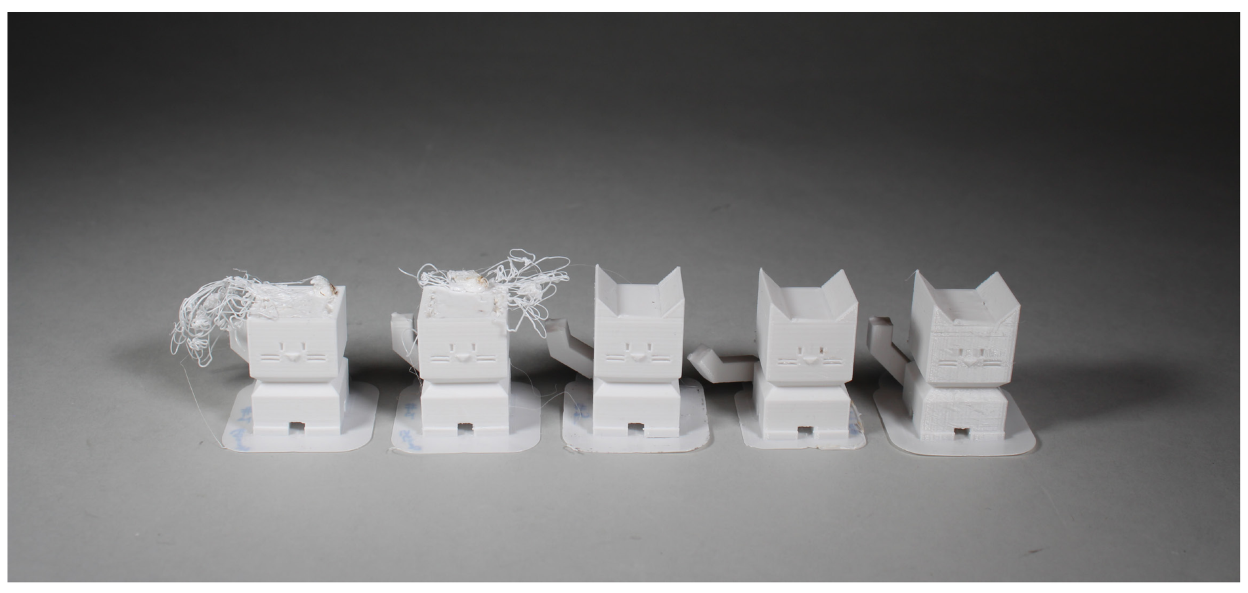
Additive Manufacturing (AM) is undergoing a radical evolution. AM businesses such as Ultimaker (UM) are speeding up industrial production through digital design and local manufacturing to enable industries to produce “what they need, where they need it, and when they need it” (“Ultimaker”, 2019), while also being cost-effective. AM is perceived as a key sustainable technology as it enables efficient design and is believed to makes less waste (“AMFG”, 2020), thus putting Ultimaker in a position to offer sustainability enhancements for their clients’ manufacturing processes. One topic of debate for AM sustainability, and the topic of investigation for this thesis, is whether bioplastics are more sustainable than fossil-based plastics for FDM 3D Printing. Although PLA- a commonly used FDM material, is bio-based, it was hitherto unclear how much using this material and other BBPs can reduce the ecological impact of the 3D printing (3DP) process.
The investigation was conducted in 3 phases- ‘Understanding’ of the context through literature review, market analysis and expert interviews; ‘Material testing’ to compare energy use and material properties; and ‘Guiding’ i.e. synthesizing the knowledge gained through the first two phases into a material guide and recommendations for end-users such as engineers, designers, and production professionals, for reducing the environmental impact of their 3DP processes.

3D Printing with Bioplastics



A variety of polymers were selected for conducting material studies- including 3 UM-standard filaments, and 5 new filaments. Both environmental and functional properties were studied. For environmental impacts, literature showed that across the different parts of the 3DP filament life cycle, electricity use of the printer is the biggest contributor to ecological impact (Faludi et al., 2015). This motivated the investigation of energy use of a UM printer while printing selected materials. For functionality, expert interviews highlighted tensile properties, dimensional accuracy, and ease of printing as the most important criteria in the material selection process- thus motivating material comparison tests for these parameters.



Images (clockwise from top): Print profile optimization of BIOPETG, a biodegradable copolyester filament; Print quality testing of a bioplastic PLA-PHA blend supplied by Colorfabb; Tensile testing of BIOPETG; ‘Apple shell’ reference part used for energy use comparison testing and printed in PLA-PHA.

References:
AMFG (2020). Retrieved 3 March 2020, from https://amfg.ai/2020/03/10/how-sustainable-is-industrial-3d-printing/
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As the final outcome of this investigation, the performance data acquired was compiled into a material guide- a visual overview containing material properties and sustainability performance indicators. This visual can be referred by end-users such as engineers, designers and production professionals to make appropriate material choices for their applications.

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