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Introduction

Additive Manufacturing (AM) or sometimes also called as Three Dimensional Printing (3DP) is the process of joining materials to make parts directly from 3D model data, usually layer upon layer, as opposite to subtractive manufacturing methodologies. Integrating AM/3DP into product design provides a new approach that can remove many limitations imposed by current design for manufacturing and design for assembly activities. If a sub-system/part of a complex product can be manufactured completely in one process without using additional tools, dies or fixtures, this will lead to a reduction in manufacturing costs (some examples are illustrated in Figure 1). Furthermore, because the whole sub-system/product is made of one material, it is possible to recycle fully without partial or complete disassembly.



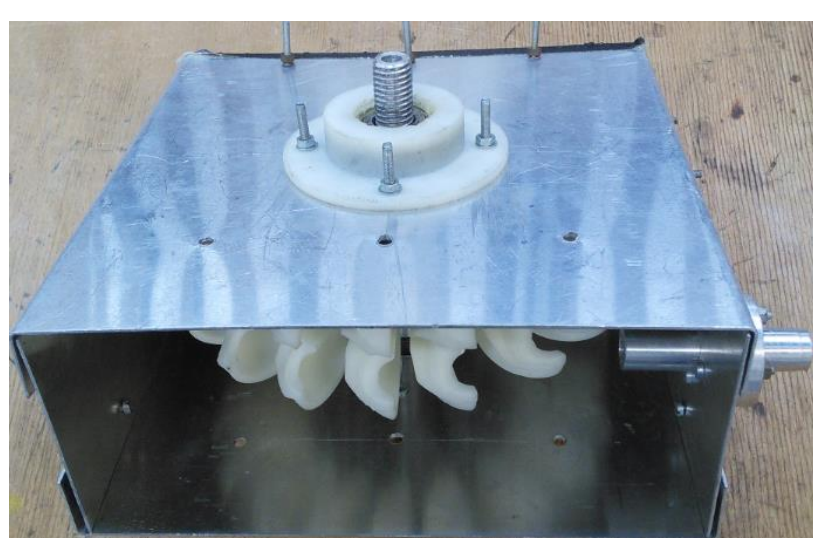
(a) GE jet engine nozzle

(b) Venturi nozzle

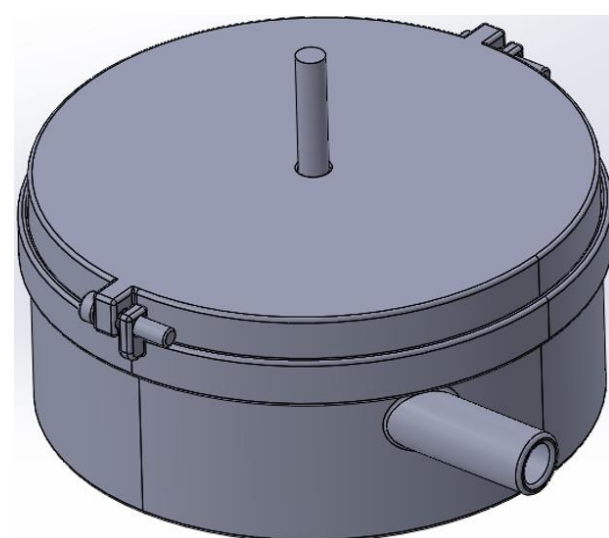
Figure 1. The 3D printed metal parts

Research Aim

The aim of this research is to construct a feasibility study on integrating AM/3DP into product design to determine what possibilities and to what extent AM/3DP can assist product designers wishing to simplify assembly operation (reducing times/costs) and to improve recyclability (minimising waste/costs) of the product.



(a) Hand-made test model



(b) CAD design model



(c) Test model made by AM

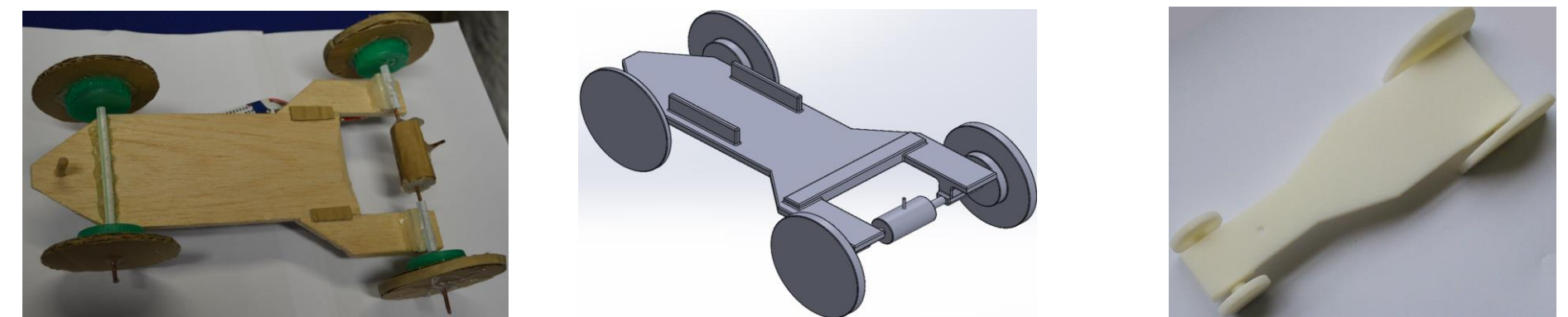


(d) Structure of a water turbine

Figure 2. A water turbine design and manufacture

Research Methods

- Comprehensive literature survey/evaluation on design for manufacturing, assembly and recyclability (see examples in Figure 1)
- 3D computer modelling of test case parts in a 3D solid modelling package (see examples in Figures 2 and 3)
- Analysing test case parts in a process simulation environment to determine the assembly and shape structure which will be featured with simple assembly and less material waste (see demonstration examples in Figures 2 and 3)
- Producing suggested design guidelines and/or regulations to improve recyclability (minimising waste/costs) and simplify assembly operations (reducing times/costs)
- Disseminating research results via academic publication



(a) Hand-made model

(b) CAD design model

(c) AM/3DP model

Figure 3. A student mini-project: a racing car design and make

Research Outcomes

The research will present a novel application of AM/3DP which may demonstrate that AM/3DP will be the technology of the future in the production of mass customised complex parts (see an example in Figure 4).

The research will lead to the generation of further knowledge in this area of design for manufacturing, assembly and recyclability, thus make a significant contribution in the optimal use and advancement of AM/3DP technologies.

The research will generate effective design and manufacturing guidelines and/or regulations for complex products, leading to deliver a new concept of 'Better (improved performance and quality), Quicker (reduced lead time/time to market) and Cheaper (decreased production cost)' plus extra value-added features such as product simplification and recyclability.



Figure 4. Multi-functional multi-material prosthetic arm

