Design And Manufacturing of Bicycle Frame Prototype By 3d Printing Technology

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Abstract- *The application of 3D printing in construction has been increasingly studied in recent years. This paper examines the design, manufacturing and study of a 3D printed bicycle frame produced during an Honors college project. Customization of the frame's geometry, design automation through parametric Computer-Aided Design (CAD) software with a particular focus on the current limitations and future opportunities for designers embracing 3D printing as a genuine manufacturing method. This paper reflects upon the development of a 3D printed bicycle frame developed as part of the authors' college study project. For clarity it is important to delineate that the term additive manufacturing technology can be used interchangeably with the more mainstream term 3D printing. Desktop Fused-Deposition Modelling (FDM) machine is used to manufacture a cycle frame.*

Keywords- 3D printing, additive manufacturing, layer by layer manufacturing, no waste, sustainable, bicycle, computer aided design

I. INTRODUCTION

3D Printing or Additive manufacturing techniques are used in various industries to create physical prototypes as well as end-use parts. In the Manufacturing sector 3D printing technology is playing a very important role. 3D printing, or additive manufacturing, is the construction of a three-dimensional object from a CAD model or a digital 3D model. The term "3D printing" can refer to a variety of processes in which material is deposited, joined or solidified under computer control to create a three-dimensional object, with material being added together (such as plastics, liquids or powder grains being fused together), typically layer by layer. A bicycle frame is the main component of a bicycle, onto which wheels and other components are fitted. The modern and most common frame design for an upright bicycle is based on the safety bicycle, and consists of two triangles: a main triangle and a paired rear triangle. This is known as the diamond frame. Frames are required to be strong, stiff and light, which they do by combining different materials and shapes.

A frameset consists of the frame and fork of a bicycle and sometimes includes the headset and seat post. Frame builders will often produce the frame and fork together as a paired set.

Bicycle frame can be manufactured easily by conventional methods but we have manufactured it by using 3D printing technology.

Firstly we measured the data from existing bicycle, and then created its design in parametric software. After designing, the stl file is created and uploaded it on slicing software, and then cycle frame is sliced into different layers with proper thickness. Support structure is also built in slicing software. After completion of proper slicing printing was taken place on 3D printing machine. Due to dimensional constraint on the 3D printing machine we reduced the scale of cycle frame up to 90%.

Data-Driven Design

Taken reference of old bicycle and data collected about the user to determine the geometry of the final frame. Rather than designers creating each new model from the ground up, selected dimensions are adjusted within CAD, which in this project is achieved by modifying a single dimension in parametric software. The software then rebuilds the frame automatically using the new data due to its parametric capabilities. This is where CAD software like Creo parametric creates relationships between parts or features, meaning that if one is changed, others may automatically update within given parameters. This differs over traditional modelling programs where if something changes, elements must be manually re-modelled to accommodate, requiring more time and diligence on the part of the designer. Reference cycle have furthered this automated process through the use of topological optimization software, allowing the computer to calculate where material is required in the most efficient strength-to- weight ratio given a set of known maximum forces, essentially designing the final product autonomously.

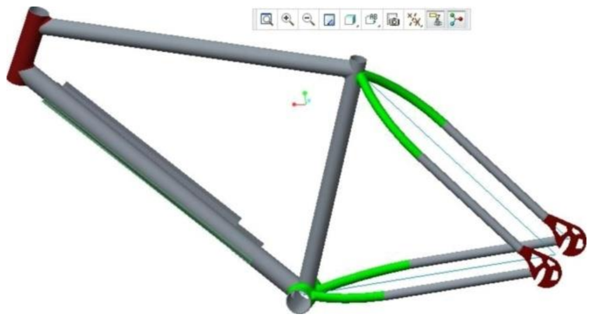

Figure 1: Design of cycle frame in Creo Parametric

Sources: Created on parametric software

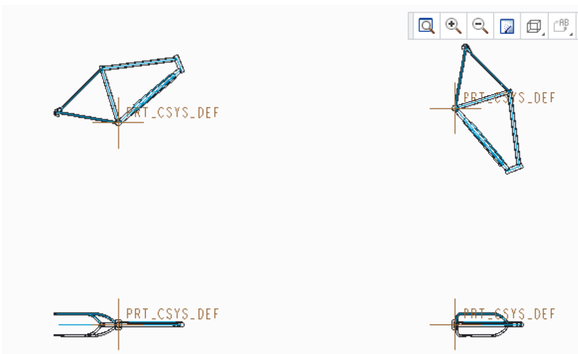

Figure 2: Different views of cycle frame

Source: Created on parametric software

Complexity

While adopting additive manufacturing technology provides numerous benefits, the third crucial driver that follows on from an automated computer process is the inherent ability to create complex geometry. Prior to additive manufacturing, the outcomes of Topological Optimization tools had limited use as the forms determined by the computer were too complex for traditional moulding or subtractive processes to produce. At this early stage of additive manufacturing the bicycle frames certainly engage with the technology, yet scope for improvement is evidenced around the key areas of customization, data-driven design and complexity. However with additive manufacturing exponentially growing in line with Moore's Law [10-12], designing for what can be achieved today leaves room for others to push the boundaries and prepare for what will come tomorrow

Frame Creation

Concurrently the design of the fixed-gear bicycle frame has evolved out of these experiments into CAD software, 3D printing capabilities and materials. An early completed model emerged after research into three-dimensional tessellation and crystalline micro-structures, with ensuing test prints of a truncated octahedron structure proving both strong and capable of printing without any support structure. However the geometric repetition of the design failed to significantly push the boundaries of complexity identified through research into practitioners like Henry Segerman. Returning to the organic lattice structures created during experimentation, the challenge became expanding this to a full-size frame that must be intricate and organic, yet structured and dimensionally accurate to allow for assembly into a working bicycle.

Frame Printing

While the frame looks towards future developments of 3D printing technology, where printing sizes and speeds will inevitably increase and a greater variety of materials will be available, it became important to compare the media hype surrounding current 3D printing with the reality of what can actually be achieved today. The trade-off is that the material is a fragile resin, which became evident over the hot Australian summer where the bicycle, despite being stored in-doors and away from sunlight, melted and distorted beyond use.

This emphasizes the material and technological limitations currently restricting designers, with rules and limitations just like any other manufacturing method. Beyond the prototype, the bicycle frame is certainly a design positioned to take advantage of the burgeoning 3D printing technology over the next decade, with numerous avenues to continue testing in preparation for the day the frame can finally be manufactured through additive means. Composite materials such as continuous carbon fiber and Kevlar are now surfacing through companies like Mark Forged, and will likely result in new opportunities to realize a functional, customizable bicycle frame unlike anything seen before.

II. CONCLUSIONS

The primary concern of this research has been to generate new knowledge and awareness of additive manufacturing through the practice of 3D printing a bicycle frame. This practice-led inquiry has addressed the core attributes acknowledged by leading theoreticians, focusing particularly on the key areas of customization, data-driven design and complexity. The opportunities these features provide signal a move away from mass production towards a likely third industrial revolution, driven by consumer desires for personalized products that meet their unique requirements. Within the world of cycling this may either reflect a level of individuality, or provide an athlete with a competitive advantage.

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