GENERATE THREE DIMENSIONAL PRINTING BY ADDITIVE MANUFACTURING TECHNOLOGY

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ABSTRACT

Specifically the method used is based on the Additive Manufacturing extrusion process using direct writing of high solid loading ceramic pastes and then freeze-casting to solidify the deposited material. This new system will provide designers, potters, artists, craft makers and manufacturers with a flexible and automated way of manufacturing porcelain objects. Three-dimensional (3D) printing is a relatively new form of additive manufacturing that has the potential to induce a second industrial revolution. This technology utilizes a print head to lay down raw materials in successive layers to fabricate a three dimensional object. Testing of the printed automotive prototypes will be executed using the different technologies offered by Objet 3D printing manufacturers.

Keywords: 3D printing, Additive Manufacturing, Rapid Prototype.

1. INTRODUCTION

Industrial prototyping and manufacturing process as the technology has become more accessible to small companies and even individuals. Once the domain of huge, multi-national corporations due to the scale and economics of owning a 3D printer, smaller (less capable) 3D printers can now be acquired in minimum price. This has opened up the technology to a much wider audience, and as the exponential adoption rate continues apace on all fronts, more and more systems, materials, applications, services and ancillaries are emerging.

The earliest 3D printing technologies first became visible in the late 1980’s, at which time they were called Rapid Prototyping (RP) technologies. This is because the processes were originally conceived as a fast and more cost-effective method for creating prototypes for product development within industry. Step one of 3D printing is the generation of a 3D printable model. This model is generated using a computer aided design software or via a 3D scanner. A real life object can be set to be 3D printed by scanning it to get a 3D model that is realistically within the bounds of the 3D printer’s capability. Then the STL file is generated by running the design through converting software. Companies have also realized the potential of a consumer market for 3D printers and as such have been aggressively courting enthusiasts with cheaper and better models. There are many communities formed around these enthusiast groups which are active on the internet set up to share projects and ideas and new possibilities.

The object may take anywhere from several minutes to several hours to complete depending on the size and complexity of the model and also on the type of machine used. They can also use multiple color combinations simultaneously. In case there are projecting parts in the model, supports are used like scaffolding until the overhanging part sufficiently hardens. 3D model can be dissolved in water when the model is printed.

2. BACKGROUND OF WORK

This exegesis is primarily concerned with filling this gap of detailed architectural exploration, focused on design for construction 3D printing fabrication with the aim to tease out potentials and limitations of particular construction 3D printing techniques. The theoretical aims of this research are to explore the potentials and limitations of emerging Construction 3D Printing techniques through action research, analysis and critical reflection on the results in the form of case study projects. Different characteristics and approaches underpin each of the three case study projects that form the foundation upon which this exegesis is based, which has resulted in three very different projects. (Garnaut, 2011, Solomon et al., 2007) and diminishing natural resources (Holling and Meffe, 1996). Governments and international agencies are increasingly calling for change within the construction industry (United_Nations, 2006, Constructing Excellenace, 2009) or legislating change (Demaid and Quintas, 2006) within the construction industry to meet the challenges presented in meeting sustainability targets, legislated controls such as LEED.
(Davies, 2005). It also became apparent that many of the most famous architects of the 20th century had designed or developed a system or prefabricated buildings. Particularly famous examples of these included; Buckminster Fuller ‘Witchita House’, Jean Prouvé ‘MaisonTropicale’, Frank Lloyd Wright ‘Jacobs House’, Walter Gropius ‘General Panel System’, Charles and Ray Eames ‘Case study house no. 8’, Richard Rogers ‘Zip- Up Enclosures’, Paul Rudolph ‘Oriental Masonic Gardens’, Moshe Safdie ‘Habitat ’67’ and Kisho Kurokawa ‘Nakagin Capsule Tower’ (Bergdoll et al., 2008, Davies, 2005). The second part of this exegesis includes three architectural case studies that have been generated through applied research and are presented and analyzed in reference to the background research and hypothesis. The three architectural case studies include both speculative and commissioned architectural projects designed by me between 2004 and 2011. Each of the three projects was designed for fabrication using construction 3D printing and have been designed with the focus on exploring the potentials and limitations of this type of fabrication technique. This background research is built on broad based literature review of the abovementioned topics as well as primary qualitative and quantitative data and information obtained which apply on case studies that have been generated through research and are presented and analyzed.

3.OBJECTIVE OF WORK
It is not within the scope of this research to analyze and comment on the full spectrum of contemporary industrial and architectural design; precedents have been selected from a very large pool of talent. Designs that focus on exploiting the capabilities of specific fabrication techniques, performance oriented design: based on “the integral relationship between form generation, material behavior and capacity, manufacturing and assembly”, Deposition Manufacturing (DM), complete systems including multi-material components of a wide range of durometers, embedded electronics and actuators, and articulated joints can be easily produced via simple extensions to inexpensive and widely accessible AM processes. To handle more complicated geometries in single-material printing while maintaining flexibility in selecting the primary build direction, temporary structures using the same material as the model may be added, either manually in the model file or automatically by the printing software, to support features with undercuts.

4.METHODOLOGY
As the quality of the output of the Rapid Prototyping machines increased, groups around the world started to use the output of these machines for end use products, hence the adaptation of the term from rapid prototyping to ‘rapid manufacturing’. Organizations such as NASA, Boeing and the FBI began using rapid prototyping devices in the 1990’s for unique or small orders of parts (Hopkinson and Dickens, 2001, Ayers, 2009), this occurred for a number of reasons; strength of materials and dimensional accuracy/stability increased as rapid prototyping techniques were refined and rapid prototyping of end use products became cost/time competitive with fabrication by other means. Additional benefits have been realized since the early adaptation of ‘Rapid Prototyping’ techniques that can be considered as value adding significant value for manufacturing. These benefits can be summarized as the following (Wooten, 2006, Hopkinson et al.,2006b):

- **Small fabrication runs** - fabrication runs of one with no penalty, allowing for customization and individualization of products (such as individual form fitting).
- **Highly complex geometries** - including interlocking but physically disconnected assemblies (e.g. textiles)
- **Fabrication for assembly** (prefabrication) – increased ability to incorporate joints for interlocking assemblies (especially where fabrication size constraints exist)
- **Reduction of fabrication constraints** - reduction in design for fabrication items such as draft angles.
- **Part consolidation** – through reduction in fabrication constraints

The term rapid manufacturing replaced the term rapid prototyping, this term itself has since been replaced by additive fabrication although there is still little consensus on terminology as the sector continues to develop. There are a large variety of techniques used by the different additive fabrication machines; although these techniques can be broadly classified into two groups. Others have made classifications of additive fabrication techniques such as (Bourell and Beaman, 2004) and (Hopkinson and Dickens, 2006). Additive Fabrication techniques build up objects in sequential layers based on a digital three-dimensional model. The categorization by Hopkinson et al. defines categories for emerging additive fabrication systems as: solid, liquid and powder. This categorization is not particularly useful, for discussion within this exegesis, because it focuses on the starting state of the materials rather than active process that create the final objects. As a consequence a new categorization has been made. This classification is made based on listings and descriptions of additive fabrication techniques and description from the State of the industry report by (Wohlers, 2010). The categories and subcategories of techniques are listed in bold type, followed by a brief description.
as required. Representative companies who produce systems in these categories are listed in brackets.

- **Deposition** of material to build up an object
- **Paste deposition** of premixed materials – (Fabber)
- **Bonding** - Selectively adding a bonding material to a powdered material - Inkjet - jets binder onto powder (Z-corp & Ex One)
- **Selective state change** of materials in a chamber or on a platform (in some cases using catalysis), state change may be temporary (e.g. temporary melting to liquid) or permanent (e.g. solidification).
- **Melting** - Selective sintering using laser, electron beam etc (Metal – MTT, ARCAM & EOS, Stratasys, EOS)
- **Melted Deposition** - Fused Deposition Modelling (Polymer – Stratasys, HP & Makerbot)
- **Inkjet deposition** – Inkjet deposition of photopolymer and light curing (objet)
- **Light Curing** – Stereolithography (CMET, 3D systems, & DWS)
- **Chemical reaction** – Selectively adding a material to another to create a chemical transformation - D-Shape.

5. **RESULT AND DISCUSSION**

The 3D construction system is designed around a core Construction 3D Printing fabrication capability, utilizing a modified Contour Crafting technique. The hypothetical modification of the Contour crafting technique was largely to allow for standard Jointed Arm Industrial Robots to be used instead of the proposed gantry system and to locate these robots within a factory environment on a production line. The Jointed Arm Robot has a proven capability to undertake a wide variety of tasks, the accurate deposition of material was considered, by me based on its capability to perform other tasks such as milling and polishing to be, well within the capability of the large heavy duty jointed arm robots. The benefit of using such robots is that they can be fitted with any number of tools and programmed to perform a wide variety of tasks. The main constraint within this context of these robots is reach, which could on further reflection be extended if the robot were to be hung above the work area rather than being placed to one side.

Applied our method to models of varying geometrical complexity and printed model can be shown in Figure 1 and Figure 2, where always show the input model, the model fitted with joints, and the final 3D-printed model. The first model is an arm with shoulder, elbow and wrist joints demonstrating a simple kinematic chain; thus this model contained only joints that are considered limb joints. Band thickness heavily influences the ease of excess material removal and implicitly affects unblocking the joint. As the band size increases, the friction surface also becomes larger requiring much greater force to rotate the joint. A more complex example is the model of a hand, which apart from the limb joint in the wrist and finger articulations, this model contains attachment joints, showing that our system can handle articulating more than cylindrical geometry. Our final example is an elephant model, which has attachment joints at the base of its legs, with the rest of its articulations being classified as limb joints. Depending on the printing process, continued manipulation of a joint can lead to reduced friction due to wear and tear.

6. **CONCLUSION**

Tactile models are particularly helpful to analyses the aesthetic look of job. As early possible to make prototype of any object which is drawn in 3D software and analyses the problem in job. AM offers great potential for physically realizing designs of greater optimality than possible with traditional manufacturing routes. This is enabled by there being no need to penalize complexity due to the layer-by-layer manufacturing approach. This increase in topological complexity does have implications for the design process, namely the large number of design variables required to represent thin members and the difficulties in handling the geometry through the stages of modification, reanalysis and refinement of the design prior to final manufacture. The requirement for several AM processes to use support structures for large overhangs provides justification for investigating methods for including this measure into the optimization process to reduce material usage and subsequent post processing.
REFERENCES

[10]. Kelly McCarthy” IMPROVING RAPID PROTOTYPING THROUGH THE INSTALLMENT OF 3D PRINTERS IN AUTOMOTIVE COMPANIES” 11-29-2012 Western Michigan University Scholar Works at WMU pp.1-29
[12]. Dr. Carl R. Seaquist, Dr. Brock Williams, Dr. Mark Sheridan” BUILDING A MATHEMATICS LABORATORY FOR TACTILE LEARNERS” Texas Tech University, Mark R. McVay, May, 2014 pp.1-70
[13]. Cany Mendonsa, Vyam Darshan Shenoy” Additive Manufacturing Technique in Pattern making for Metal casting using Fused Filament Fabrication Printer” Journal of Basic and Applied Engineering Research Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 1; September, 2014 pp. 10-13
[14]. Magali Noemi, Peria del Olmo” ADDITIVE MANUFACTURING OF NON PLASTIC PORCELAIN MATERIAL BY DIRECT WRITING AND FREEZE CASTING” De Montfort University for the degree of Doctor of Philosophy pp. 1-255
[15]. Xiaoming Luo” Process planning for an Additive/Subtractive Rapid pattern Manufacturing system”Iowa State University Digital Repository pp.1-173
[18]. Victoria Townsend” Relating Additive and Subtractive Processes Teleologically For Hybrid Design and Manufacturing”University of Windsor Scholarship at UWindsor July 8, 2010 pp.1-156

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