3D Printing Processes De-mystified

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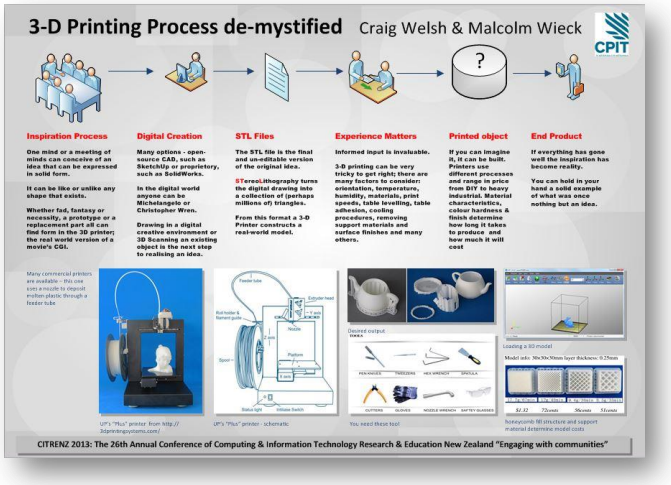
ABSTRACT

This paper reports on a project carried out at CPIT in Christchurch to investigate the set of processes involved in converting an idea or concept into a solid object. After the initial thought, an appropriate file for interpretation by 3D printer is created, followed by inputting that file to a suitable printer which then fabricates the required solid, three-dimensional object. The poster shows a schematic that documents an ordered approach to tackle practical issues found while recording the procedures. Those that have been noted either appear to impede progress or affect the quality of the required, expected outcome. In the next phase, suggestions for improving the smooth transition and improving quality will be made.

Keywords 3D Printing, Process Documentation, Quality.



Schematic of 3-D printing process

1. INTRODUCTION

This poster describes a process improvement project being conducted by a third-year Bachelor of Information and Communications Technology (BICT) student in the Department of Computing at CPIT. 3D printing has its roots in Stereolithography (SLA), a process patented in 1988. Typically it now refers to the direct fabrication of physical products from a drawing made using Computer Aided Design (CAD) software. Specialised software effectively slices the model into thin layers that are interpreted by the printer to create the finished object one layer at a time.

Three-D printing is as diverse as the human imagination. Printer capability is rapidly increasing while costs are reducing as economies of scale become evident. Using high fidelity prototyping, the traditionally expensive and impractical production of optical elements, for example, is also now more affordable [6]. Surgeons can order human body replacements for surgical implants; architects can easily show their 2D plans as solid buildings, interior designers can print fittings and furniture, (see Fig 2),

Figure 2. Freedom of Creations' Macedonia Space Divider

cabinet-makers can trial special handles and light industry can develop parts either to use without modification or else for subsequent mass-manufacturing. [3] 3D printing can also make ecological sense - the additive process involved results in significantly less material wastage than traditional manufacturing techniques. [1]

Since the manufacturing process is "additive", often extruding a thermoplastic material through a nozzle, it builds the required object upward, in slices, from a flat surface. Conventional manufacturing methods contrast with this since the process typically works the other way around; a regular block of material with cuboid dimensions is the starting point and material is removed until the required shape remains. Machining processes are severely limited by physical access to the block, so if complex shapes are required they are often made in pieces that are subsequently fixed together. The many advantages are not without

This poster paper appeared at the 4th annual conference of Computing and Information Technology Research and Education New Zealand (CITRENZ2013) incorporating the *26th Annual Conference of the National Advisory Committee on Computing Qualifications*, Hamilton, New Zealand, October 6-9, 2013. Mike Lopez and Michael Verhaart, (Eds).

a new set of problems, however. One problem is that as the hot substrate cools, it shrinks and distorts in often unpredictable and undesirable ways, see for example [2, 4]. When printing, some objects need to be printed using some means of dimensional compensated due to this shrinkage. See Willis et al [5].

2. THE PROJECT

Like many large learning institutions, CPIT aims to prepare graduates for the future as well as current needs of industry. The early adoption of new technologies that offer unprecedented opportunities for local industry to speed and refine the development process is a requirement to maintain a position of leadership in the IT community.

3D printing has been tried for over 3 years within CPIT in one form or another - one of the intentions has been to offer a service to any local light industry keen to investigate the possibilities this relatively new technology affords. Some small-scale "desktop"-sized machines have recently been augmented by two more modern and more capable machines. With new technological capability comes a learning curve and problems of all kinds.

In 2012, CPIT purchased a large powder-based printer and together with the provision of a smaller wire-fed printer has provided extended capabilities and allows for finer or more cost-effective work to be carried out. A number of problems have occurred with the machines and this project is an attempt to help solve them, once they have been comprehensively documented.

The challenge addressed here is making this technology more accessible to a wider audience by identifying and removing existing barriers.

Currently, many issues are bound in the details; between novel idea and solid object, there are a number of potential problems, including:

- Choice of authoring language to generate required file format required
- Handling errors thrown up in the production process such as objects sticking to the platform, support material removal
- Material costs and time to manufacture; learning curve regarding process optimisation
- Quality of finished item - e.g., from mechanical suitability and fitness-for-purpose to surface finish and aesthetics
- Management of the printer and ancillary preparation and finishing machines

Initially it was decided to engage the people with some experience in order to discover and record as much of the process as possible in text and diagrammatic form. An error log was started; so many errors were entering the system that adequate tracking, let alone their resolution, was becoming unmanageable. It was hoped that a methodical, process-focussed approach might reveal some improvements that could be made.

3. DISCUSSION

The research project is still in its infancy but already has shown that improvements could be made by adopting modified procedures. One improvement might be obtained from disseminating up-to-date, comprehensive, working documentation written in plain English accessible by any potential users of the process.

So far, the authors have learned a lot about this emerging industry technology and have begun to develop some understanding of the issues faced when attempting to deploy them to good effect while meeting defined needs.

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