

Reproduction of texture in digitally printed artworks

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ABSTRACT

This paper considers alternative approaches to image making and printing that moves from the on-screen representation of images and painting applications, to the physical generation and methods for surface deposition or *2.5D printing*. The research investigates the application of new materials and print processes, as an alternative to four-colour separation and halftoning. This paper describes two routes: the development of photographic continuous tone prints by varying the depth of pigment to create a surface topology, and secondly, the application of pigments that emulates a painting method to create a physical textured surface. Both methods differ from traditional halftoning screening in as much they incorporate a vector approach to image construction. In both cases, the objective is not just to apply an image to an extruded or textured surface, but where the relationship of surface deposition and image are integral.

1. INTRODUCTION

Digitally created images and objects can be printed and fabricated in two and three dimensions and will either involve pixels or vectors to create an image. Each method carries with it different ways of making and thinking, and in some cases has implications in the way the image or artefact is manufactured (Walters, 2009). Enlarging a raster or bitmapped image on screen will show it is composed of millions of coloured pixels. The size, quality and resolution of the printed image is determined by the number of pixels and bit depth: too little and the edges of objects in the print will appear jagged, too many and a large file size could hinder the speed of processing. Zooming into a vector-based file will show that lines, Bézier curves, layers, shapes or text remain smooth with no degradation.

Building on traditional computer aided design (CAD) and computer numerically controlled (CNC) cutting and machining there are more opportunities for artists to work in a vector format. Vector based digital printing technologies, such as 3D printing, additive layer deposition, and 2D design layout (Illustrator) and 3D modelling (Rhino) software means there are more opportunities for the incorporation of surface deposition, texture and more specialist colours (metallic, white, embossing, gloss finishes). With the introduction of 2D UV curing printers, it is also possible to combine colour and texture to create a surface relief.

In the light of recent developments of *post-digital* printmaking (Catanese, 2012) processes, artists' adoption of CNC technologies has increased the range and diversity of image making, artefact construction and a re-evaluation of old analogue processes by hybridising old and new processes, and hacking (earlier but now redundant) 20th century technologies.

A major component of colour reproduction is the accurate reproduction of the appearance of texture (Ashbaugh, 2009; Campisi, 2000), which is a significant area for accurate rendering and synthetic application (for example surface rendering of 3D graphics). However, naturalistic pattern rendering has proven to be more difficult. Where the human visual system is more forgiving in the perception of halftone images, texture is problematic as our visual system can discriminate differences between natural and patterned texture.

The following sections describe two approaches that explore methods for surface deposition or *2.5D printing* (Parraman, 2012, 2013). The first section describes the development of photographic continuous tone prints by varying the depth of pigment to create a surface topology (McCallion, Hoskins), and secondly, the application of pigments that emulates a painting method to create a physical textured surface (Parraman, Cohen).

1.1 The creation of continuous tone photomechanical images using CNC machining

The creation of surface deposition is rooted in 19th century photomechanical print processes, in particular the Woodburytype, which used gelatine to create a continuous tone surface topology. As the Woodburytype print does not have a grain or halftone dot the quality of the image was considered to be superior to the silver photograph. Walter Woodbury's invention came at the end of the developments of photomechanical printing during the 1860's. The concept of the Woodburytype follows the same method as a carbon print. (Anon, 1883) The carbon print process is described, as a "*photorelief of tinted gelatine, its maximum thickness being in the deep shades and this relief is ordinarily attached to the surface of a sheet of paper or a plate glass. The highlights of the picture are those points where the layer of gelatine is either altogether wanting, or possesses a minimum thickness*".

There also evolved a family of processes that either used the translucency of the stepped thickness (cameotypes, photo-lithophanes) or where a translucent glaze applied to a bas-relief stepped ceramic (photo-ceramic relief) that translated the depth into tones. (Atkinson, 2003) Methods to recreate these processes - to translate a 2D tonal range to produce a 3D stepped physical relief - by digital means have been explored by Atkinson (2004), Huson (2005) and McCallion (2012) using CNC routing and rapid prototyping.



Fig.1: Silicone duotone (2013) backlit, showing a range of tones (left) surface relief (right)

McCallion's approach has involved the translation of a standard 8 bit greyscale image into a 256 incremental gradation, where at the two extremes, 0 is visually represented as black, and 255 is represented as white. The image is processed firstly in Adobe Photoshop, and then using 3D software (Rhino) a physical height is assigned to each grey. The result is a height field that looks similar to a traditional bas-relief. Once the heights are generated, the data is output through CNC part programming software (Mayka) to a CNC milling machine. The height that is assigned to the 256 shades of grey is determined by the CNC milling machine's cutting bit. The total height of the block from its darkest (deepest) to lightest (highest) point is 1mm. Instead of the traditional 19th century gelatine, silicone was considered by McCallion to be a 21st century alternative. The material and curing qualities of the silicone means that a colour tint can be added but retains translucency, does

not shrink during curing, is non-toxic and produces no fumes when mixing. Figure 1 shows the cast image and the physical surface relief.

1.2 The development of vector based 2.5D print methods for a painting machine

The project, led by Parraman, was motivated by painting and rendering programmes and the need to providing meaningful interaction between software, the printed output and the viscous properties of the medium. Software such as Corel® Painter™, Autodesk® Sketch Book Pro for iPad, Brushes by Taptrix inc. simulate the appearance of drawn marks and brush strokes, paper and canvas textures, oil or watercolour. These examples highlight opportunities for manipulating virtual paint. Tangipaint is an interesting touch-screen paint mixing application, developed at RIT that creates the appearance of gloss, wetness and the texture of paint. (Ferwerda, 2012) By *painting* on touch-screen devices or drawing tablets the user can scroll to select colours and brushes and manipulate paint. The assumption is that images remain screen-based or are shared between mobile platforms.

Inspired by the meticulous painting methods by artists such as Van Gogh and Seurat, the objective for the experiment was to create a vector-driven painting machine that applies a brush loaded with paint to paper in a methodical and mechanical way. The difference was that although the vector marks (digital) could be created in the same way, the resulting painted brush strokes (analogue) were not. Based on the placement of the brush on the paper and the flow of paint, that each painted brush stroke was similar but not exactly the same, thus creating a non-uniform but harmonious effect across the paper surface.

The paint deposition experiment was performed on a modified Roland GX24, CAMM-1Servo. Originally designed as a plotter for cutting vinyl, it has an x and y-axis and solenoid to obtain z-axis. The cutting blade was replaced with a prototype brush holder with a screw-thread for accommodating brushes of different sizes.



Fig. 2: Selection of paint brushes and nibs (left). An example of a 7mm cork stylus (right).

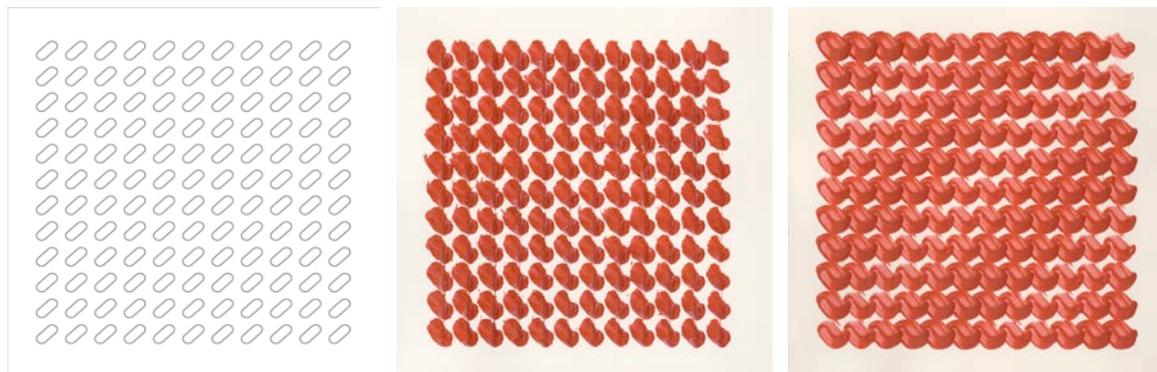


Fig. 3: Vector template from library (left), showing two different variations, using a brush (centre) and the 7mm cork stylus (right) as shown in figure 2.

A series of different shaped brushes and nibs (figure 2) were formed around a hollow 14-gauge tip (more commonly used for dispensing glue) that has a Luer thread lock. Each brush could easily be removed and interchanged. The hollow centre meant that paint could be pumped through a rubber tube and the brush then applied the paint to the paper. The paint was dispensed from a syringe under vacuum and pumped through flexible rubber tubing to the paintbrush at the other end. In order to ensure a smooth continuous flow, the paint was pumped using a peristaltic variable flow pump.

As demonstrated in figure 3, a library of vector lines were created in Adobe Illustrator, where each component could be modified, enlarged, rotated or removed. This example is part of a library of hand-drawn or imported vector-based patterns that could be copied, cut and pasted into a drawing. In figure 3, the test is used to compare the character and behaviour of paint, brush and mark at different flow rates. The speed and pressure of the brush remained constant, but for each test the flow rate could be modified.

2. CONCLUSIONS

As more images and objects are constructed in a vector format, there is an increasing requirement to develop universal file formats that assists in the conversion between analogue and digital, raster and vector, two and three dimensions, that works towards standards in additive manufacturing. (<http://www.astm.org/Standards/F2915.htm>). This approach could lead to improved opportunities for file transition between 2D and 3D formats in both directions.

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