Customising Digital Printing for Fine Art Practice

Carinna Parraman, Hong Qiang Wang, Paul Thirkell, Paul Laidler, Steve Hoskins
Centre for Fine Print Research, University of the West of England, Kennel Lodge Road,
Bristol, BS3 2JT, UK

ABSTRACT

The presentation will demonstrate how through alternative methods of digital print production the Centre for Fine Print Research (CFPR) is developing methodologies for digital printing that attempt to move beyond standard reproductive print methods. Profiling is used for input and output hardware, along with bespoke profiling for fine art printmaking papers. Examples of artist’s work, and examples from the Perpetual Portfolio are included - an artist in residence scheme for selected artists wanting to work at the Centre and to make a large-format digital print. Colour is an important issue: colour fidelity, colour density on paper, colour that can be achieved through multiple-pass printing. Research is also underway to test colour shortfalls in the current inkjet ink range, and to extend colour through the use of traditional printing inks.

Keywords: profile, artists’ prints, image quality, digital print, curves, screenprint, colour

1. INTRODUCTION

The Centre is developing bespoke approaches to digital printing that concentrate on the production of fine art prints and on the artist making them. Whilst the Centre has a close engagement with photography and photomechanical processes, this area of investigation is based on artwork that has not been created outside the computer, and could not have been generated or exist other than through digital generation. Working outside the field of new developing digital technologies, the impression is of each sector working in isolation without attention as to the effect of one technology on the other. Are current technologies associated with digital print: image creation; colour-imaging software; colour management; printers; and colour fidelity technology, developed independently by different manufacturers? The transition of data from one device to another is being addressed for a narrow sector of commercial volume printing, but not for the artist/designer, who has very different requirements from, for example, an industrial firm specialising in four-colour offset litho printing or giclée bureaus making reproductions from existing artworks.

Current print technology is neither suited nor philosophically designed for artist led methods of making, resulting in the artist making compromises on quality, which can furthermore be time consuming. Research undertaken so far, and research into the future, will consider working methods that consult the artist/designer at every step of the process.

The Centre’s research seeks to develop a comprehensive overview of the entire framework of digital imaging, from image creation to print: that incorporates how an image is captured or generated; how an artist can further develop images through digital imaging programs other than the mainstream photographic editing software, and eventually, how an image is printed and modifications to printer hardware. One main aspect of this research is to identify and incorporate artist-specific imaging procedures, techniques, qualities and standards into what is principally an industry-dominated field.

2. PROFILE, PAPER AND PRINT

As part of an academic institution, the Centre provides a service for all requirements of the artist maker; from the one-off artwork for a degree-show student, to the blue-chip artist showing work at the Tate Gallery. Turnover of students’ work is expected to be swift, production of a limited-edition-bespoke process requires more time. However, it is necessary, for the
quality of the output of all artworks to be of a high standard. Therefore preparing digital files for printing using dedicated profiles is necessary. Between 2001 and 2003, a government led project was undertaken to research into digital printing onto fine art paper and to develop a series of colour profiles for a range of fine art papers, inks and printers\(^1\). At the beginning of the project, there was a limited range of coated fine art papers. Whilst the initial objective was provide customers with ICC profiles for fine art papers, we found most of these artist customers could not use their digital devices to improve print quality. This was possibly due to traditional making of the mould-made papers, subtle changes in paper, thickness, texture and surface coatings may vary from batch to batch; consequently the printed image can also vary. Other answers might include changes in the quality of ink, printer head degeneration, or incorrect use of printer management systems when the test chart was originally printed. Furthermore, how the artist generated the image has implications for the final print\(^2\). The objective then is to consider how to use the existing digital colour reproduction devices and software to print high quality colour images, to integrate scientific and artistic working methodologies for high quality digital print output in order to develop valuable insights for both industrial and fine art applications. The project now seeks to explore the potentials of current digital reproduction devices, software and materials (media, ink) for the artist to develop methodologies more effectively, using alternative colour management systems to improve the quality of digital fine art printing.

### 2.1 Profiles for input devices

As well as generic profiles, such as, transparency film brand, colour formats, most scanner software has an option for custom profiling. Modifications to the scanner setting can significantly improve colour difference, for example, the hue angle difference between an original colour and a scanned colour can be improved and corrected by a suitable input profile. Similarly, the quality of image, captured by digital camera, is significantly dependant on the quality of the camera and the light conditions are an important consideration; the same digital camera can make varying quality digital images under different light conditions. Colour management can also be used for digital cameras, which uses the same method as for scanner profiles. For the research, a Betterlight digital scan back camera with ViewFinder 6 software is used in Mac OS X to scan a Kodak Q60R1 target using different lens settings and software settings under a same light condition. ICC profiles are generated for the different settings using a Gretag Macbeth Profilemaker 4. The unprofiled and profiled scan target images are printed onto HP glossy paper on an HP5000ps 60” printer with UV ink. Each print is measured using a spectrophotometer to compare the reference data of the Q60R1 target. The colour differences are shown in Fig. 1. The table shows how different lens settings and camera software can affect the colour quality of the scanned image. After profiling, there is significant colour parity, indicating how ICC profiling can improve the colour quality of input images.

<table>
<thead>
<tr>
<th>File name</th>
<th>Lens Settings</th>
<th>Viewfinder</th>
<th>Distance</th>
<th>Colour difference Delta E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F Filter Line time ISO</td>
<td>PPI (metre)</td>
<td>Scan image</td>
<td>Profiled image</td>
</tr>
<tr>
<td>2104-1</td>
<td>8 Tung 30 100 300</td>
<td>1.7</td>
<td>8.56</td>
<td>5.02</td>
</tr>
<tr>
<td>2104-2</td>
<td>8 20 100 300</td>
<td>1.7</td>
<td>14.9</td>
<td>5.26</td>
</tr>
<tr>
<td>2104-3</td>
<td>11 20 100 300</td>
<td>1.7</td>
<td>8.05</td>
<td>4.82</td>
</tr>
<tr>
<td>2104-4</td>
<td>11 20 200 300</td>
<td>1.7</td>
<td>16.49</td>
<td>5.09</td>
</tr>
<tr>
<td>2104-5</td>
<td>11 25 246 300</td>
<td>1.7</td>
<td>16.79</td>
<td>5.07</td>
</tr>
<tr>
<td>2104-6</td>
<td>11 25 400 300</td>
<td>1.7</td>
<td>13.39</td>
<td>5.06</td>
</tr>
<tr>
<td>2104-7</td>
<td>16 20 400 300</td>
<td>1.7</td>
<td>16.73</td>
<td>5.11</td>
</tr>
<tr>
<td>2104-8</td>
<td>16 15 303 300</td>
<td>1.7</td>
<td>16.71</td>
<td>5.12</td>
</tr>
<tr>
<td>2104-9</td>
<td>16 10 200 300</td>
<td>1.7</td>
<td>16.63</td>
<td>5.09</td>
</tr>
<tr>
<td>2104-10</td>
<td>11 10 100 300</td>
<td>1.7</td>
<td>14.78</td>
<td>5.28</td>
</tr>
<tr>
<td>2104-11</td>
<td>5.6 40 100 300</td>
<td>1.7</td>
<td>15.18</td>
<td>5.14</td>
</tr>
</tbody>
</table>

Fig. 1.

### 2.2 Profiling for output devices (inkjet printing on fine art media)

The density of colour is important for art-works that are printed onto coated fine art papers\(^3\). These papers are traditional mould-made cotton rag fibre that has a coating applied to the surface, which is either surface coated or infused into the fibres\(^4\). Uncoated papers are traditional fine art printmaking papers\(^5\) that do not have optical brighteners or any surface
coatings, the surface characteristics and quantity ink on these papers are influenced by the traditional paper manufacture process. For artists wishing to print onto both coated and uncoated fine art papers, it is important to optimise the amount of ink printed onto the paper. Ink limits are used to control the maximum values of ink, which therefore influences the density of colour; to obtain a correct maximum ink limit value, it is necessary to generate a suitable profile for the fine art media. If the ink limit is set too low or too high, either there could be an underperformance of ink density, or the ink will leak onto the media. To define the ink limits of the media, Onyx ProductionHouse 5.6 software is used. Ink restrictions are used to define the limits of each of the ink channels. For example on CMYKcm there are separate channels for each. Using the spectrophotometer the density of the colour patches are read to generate a linearisation calibration; this is used to print an ink limit swatch which is composed of 12 different CMYK colour combinations of colour patches ranging from 5 - 400%. From these patches, maximum ink limits of papers can be recorded.

As an indication for maximum ink levels coated, uncoated fine art papers and commercial photo papers are tested. Depending on the manufacture of uncoated papers, there is a greater variance of absorbency of ink. For example the traditional fine art uncoated Arches 88 paper requires 400% maximum, before a suitable ink level can be obtained, with the potential for further increasing ink levels; whereas for the Somerset Enhanced coated inkjet fine art paper, ink limits are set to around 300%.

3. ARTIST-IN-RESIDENCE

Fig. 2. Jennifer Yorke (2004)  
Fig. 3. Douglas Holleley (2004)

The Centre’s approach to developing digital and wideformat printing for artists is undertaken by working with artists on specific art projects. Our most recent initiative is an artist in residence scheme, for professional artists to make a wide format digital print. We have found that by working with the artist directly, a variety of problems have evolved and are resolved only during the process of the making of the print; for each case, novel solutions and print methodologies are developed as part of the art making process.

Issues relating to the residency can be separated into two categories:

The philosophical and linguistical: and an artist who is, for example, a photographer or a painter may have a different understanding, and methodological approach, when compared to a printer. This is by no means counterproductive, as each specialist has different conceptual and subjective sensibilities to problems.

The practical: digital printing, the same as any traditionally achieved print such as a screenprint or an etching, is regarded just as much as a craft skill. Each artist arrives with very different ideas, generated images and file formats, sometimes with expectations beyond the capability of the current technology, resulting in the development of novel
method for printing.

Profiles and uses of RGB, CMYK and LAB colour spaces are utilised whenever appropriate. Photoshop is used as a method for managing colour, and driving the printer from the ‘print space’. This direct method, other than through software RIPs, enables more control over how colour data is managed and sent to the printer. It also reduces other variables, that might occur when sent via a RIP. Colour proofing is rarely undertaken on screen; the impact of colour and image in relation to, for example, a velvet textured paper, photographic gloss or silk fabric, is subjective, and the dialogue between the artist and the master printer is an integral part of the print process. The following are examples from the Perpetual Portfolio.

3.1 In-put and out-put profiles for artists

As an example of uses of profiling, the work by American artist Jennifer Yorke, required accurate colour reproduction of a fall of (synthetic) blonde hair that was placed directly onto a flat-bed scanner (fig.2). The hair was scanned in LAB then colour corrected using a custom scanner profile (see section 2.1). The image was converted to RGB (Adobe ‘98) in Photoshop. To give the impression of the movement of hair, the artist wanted to print the work onto silk. This caused a problem as our custom profiles only resulted in printed hair samples that were tinged with green. Using both the HP5000ps and HP paper-backed silk media, the dedicated HP silk profile was downloaded via (only available through) Mac OS9 and uploaded to the printer. From Photoshop, the silk profile was also used in the print space. We found that we could not improve on this profile.

3.2 Multi-pass in black

Jack Youngblood trained as a painter. His recent practice has focused on generating images using digital software. He uses 3D imaging software such as Carrara, Bryce and Amorphium, which is then transferred to Photoshop, enabling as he says “an amazing depth and breadth” of image quality.

This notion of depth and breadth is foremost in how the image is printed (Fig. 5). The original image is taken from a traditional oil painting in Bristol City Museum and Art Gallery (Fig. 4). The elements that contribute to the composition of the painting are reflected in the updated version (fig. 5): the clouds are replaced by a black star-filled sky, the house becomes the space module, the river a ravine and the tree is transformed into a crystalline vertical rock structure. The profile of the surrounding cliffs are kept as close as possible to the original (fig. 4 and fig. 5). He has also integrated photos from actual moon missions, in particular Apollo 16.
The light source, from the central area of the picture, is an important aspect of the composition, creating a chiaroscuro effect. This light and dark, tones of grey and ultimate blacks is problematic when transcribed from screen to print, which is largely due to the printer capability, the density of ink on paper and the spectral reflectance of the black on a textured (velvet) paper surface. Furthermore, the use of black in CMYK printing is normally used to render small areas of tone and for printing text. From experience of printing a greyscale image using just black can result in an image looking ‘underexposed’. Initially, the same image was printed twice in order to obtain a black. However, this resulted in a too highly concentrated image were the blacks were too harsh compared to the lighter areas, with the mid tones becoming lost.

![Fig. 6. Curve adjustment](image1.png) ![Fig. 7. First pass](image2.png) ![Fig. 8. Second pass](image3.png)

In this instance, Photoshop is used to print the image as two separate layers, using the tolerance tool in curves to enable a more subtle tonal gradation of mid-tone areas, thus building up the mid to dark tone. For the first pass (Fig. 7), the image is then edited using curves in Photoshop (Fig. 6) and printed. The second pass is printed as the full image (Fig. 8). In order to keep control of the entire process, corrections are only made to the first, lighter pass. A method of duplicating the layers, making selections within parts of the picture, results in a composite of many sub sections to define opacity and translucency, corrections to curves and proofing, resulting in the two passes. Similar to traditional printing techniques, the separate layers do not work in isolation. The process depends on editing in Photoshop, proofing through printing, and then to subjectively assess the quality of the work. Decisions are only arrived through printing both layers and through the physical relationship between the composition and printing of the work. The final decision could not have been made by just looking at the image on screen.

3.2 Multi-pass in colour

One Paul Thirkell’s areas of research has centred around the quality and practice of the collotype print process. Through reviving and translating some of its former achievements into the field of digital print Paul has developed a number of methodologies for increasing the colour saturation and resolution of artists digital prints. The collotype process uses highly pigmented inks, with the resulting images charged with saturated colour in the denser areas and more detail and translucency in the light tones.

For digital printing he seeks to achieve the density of colour previously gained through collotype or screenprint. To do this a similar methodological approach has been adopted when preparing and proofing a digital image. In order to retain a solid black and increase the density of colour, the curve of an image is adjusted to match those used for collotype duotones. In the collotype process the curve can be adjusted by using special fountain solutions on the printing plate to facilitate an increased image density through double printing. This process is mimicked with onscreen manipulation and multi pass digital printing. Another method used to gain enhanced colour intensity is through the use of LAB files. Although these often do not accurately reflect the image on screen, they often increase colour intensity. Therefore, a rigorous proofing stage becomes the main counterpart in producing the image. Rather than matching the print to the screen, the quality of the proof is used in shaping the image.
A similar method for the colour printing is undertaken utilising curves, as in multi-pass printing for greyscale images. To increase colour saturation of the central red area and to improve definition in the mid-tone area, adjustments to the image using curves are undertaken resulting in a reduction in the dark areas and mid tones (Fig. 10).

4. COLOUR FOR ARTISTS

Traditional pigment colour mixing involves the combination of a single or a mixture of hues, or with white or black to obtain the desired colour, tint or shade. For on-screen digital colour mixing, working in an RGB or LAB colour space, provides the artist with the potential of a million-colour palette. If an artwork is generated through drawing, or painting using a software in which there is no source material other than what is generated on screen the artist therefore has other concerns: how colour is mixed, rendered, layered and how secondary colour mixing operates on paper; these are the more traditional concerns for the printmaker. In addition, for the traditional printer, proofing is undertaken, as part of the subjective process of making, on the print machine, this also seems to be the case for the digital artist (section 3).

Currently, inkjet printing has only a one-pass function; all colour information is rendered in one movement, resulting in a smooth uniform surface. Furthermore, current inkjet technology does not enable an artist to print a light colour on top of a dark colour, or a translucent colour over another, or to mix, print and multilayer individual colour. Inkjet usage by artists has concentrated on digital printing primarily as a means of photographic or screen reproduction; the technology so far has not enabled the artist to use it in more innovative ways. The objective therefore is to solve some of these problems through the combination of traditional printmaking and inkjet, and to provide a theoretical and practical solution for the development of inkjet technology.

A project is underway to develop a method for printing that enables an artist to alternate between inkjet and a traditional printmaking techniques - screen printing, offset litho - that can be utilised to under-print or overprint other colours not as yet included in the inkjet colour range. The intention is to engage with inkjet printing on a variety of levels through the development of: artistic practice, surface qualities, the addition of new colours, to widen the available printer colour gamut, enable secondary colour mixing, and additive and optical colour mixing. Whilst this is still in its preliminary stages, comparative data of inkjet prints and multi-colour screenprints are detailed in 4.1; and indicates by combining inkjet inks and traditional printing inks an increase in colour range can be obtained.
4.1 Colour circles

Based on research into colour circles and historical models for arranging colour, a colour circle is useful as a means of testing colour relationships and identifying shortfalls in the current available printable inkjet colour range. Silk-screen pigment inks are used to print the colour separations, to investigate how colour mixes and assess the suitability of methods of multi colour stochastic half-toning. A colour circle is generated in Photoshop using the HSB (Hue, Saturation and Brightness mode) and working in a CIE L*a*b* colour space. HSB is useful in this instance as a means of generating a 360° colour circle, mathematically dividing the circle into equal segments; and modifying the hues using saturation and lightness, similar to a way an artist would add black or white. Two colour circles are generated (Fig. 12): twenty-four segments of equal degrees form the basis of the colour wheel, the first working from 100% (saturation and brightness) using the saturation slider to add white by 10% increments to 10% near white; then from 100% (saturation and brightness), using the brightness slider to make of 10% increments to near black (Fig. 11).

An eight-colour, stochastic separation, suitable for screenprinting, is made using a custom CMYK profile in colour settings in Photoshop. Colour measurements from screenprinted ink patches (unmixed screenprint ink hues), are inputted as LAB data and a new CMYK profile is generated. From this profile, a wider gamut CMYK colour separation is obtained,
PhotoSpot, a plug-in to Photoshop that enables multi-channel separations suitable for litho or screenprint, is used to make an eight-colour separation; the same screenprint inks as the custom CMYK profile in Photoshop are used to make the separations. The separations are converted to bitmaps using a diffusion dither setting at 200dpi. The separations are printed on an HP 5000ps 60” onto transparency film, with ‘print colour as gray’ option and ‘print quality at maximum detail’ and ‘maximum quality’ options checked. The printed transparencies are used as photopositives for screenprinting. Screenprint hues of: process cyan, magenta, yellow, cadmium yellow, cadmium red, cadmium scarlet, ultramarine, leaf green, phthalocyanine green are used, with altered colour combinations for the different screenprint tests.

Colours used for each print are as follows:
- Inkjet: cyan, magenta, yellow, black, light cyan, light magenta.
- Screenprint (3): cyan, magenta, yellow, cadmium red, cadmium scarlet, ultramarine, leaf green, black.
- Screenprint (4): cyan, magenta, yellow, cadmium scarlet, ultramarine, leaf green, phthalo green, black.

The graph in Fig. 13 illustrates measured L*a*b* data from the twenty-four hue patches, calculated and printed at 100% saturation and 100% brightness, colour patches that appear on the perimeter of each colour circle. The data for inkjet, reveals that whilst inkjet provides a better colour range for deep red and bright red, and in the turquoise and greenish-turquoise regions, the screen-inks are useful in extending the ultramarine, violet-magenta range, bright orange and bright green colours. The hypothesis is that colour can be further improved by using screen-ink with higher pigments, that can increase the density and saturation of colour.

From investigating artists’ colour screen prints made in the 1960s and 70s\textsuperscript{11} the next objective is to concentrate on increasing the density of colour through overprinting of translucent colours and glazes, patterns and tones to produce secondary and optical colour mixing. Based on Le Blon’s notion that the entire colour range can be obtain through just three colours\textsuperscript{12}, so the artist can produce visual effects using different tones, patterns and translucencies of ink to increase density of colour and colour range.

5. CONCLUSION

The process of printing an artist’s digital image is not straightforward. No artist is the same, therefore methods in achieving the end image are not the same either; however there are similarities, which are being documented. It is hoped that working collaboratively with artists and furthermore with industry, and through the Centre’s research, we can highlight new areas and alternative methods of working that has benefits for all areas of the sector and not just for art and design.

REFERENCES

\textsuperscript{4} The site \url{http://www.mwords.co.uk/pages/FAQ/articlePaperTypes.htm} gives a useful outline on methods of coating papers.
\textsuperscript{6} Earlier projects have included the “International Miniature Digital Print Portfolio” see: \url{http://www.uwe.ac.uk/amd/cfpr/exhibit.htm}
\textsuperscript{7} \url{www.jackyoungblood.co.uk}


