

# Digital Printing for Artists

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## Abstract

Artists have different parameters to, for example, colour scientists, when considering the quality of the finished image. An analysis of the work is based on an artist's conception of the work and a subjective assessment of print surface, colour and image quality, which although may appear to be based on the same criteria as a reproduction, the impact on the viewer is quite different. This presentation uses The International Digital Miniature Print Portfolio as a case study, which illustrates issues relating to: implications of printing digital files from unknown sources; generating, saving of images from unknown sources; file tagging; converting unrecognisable generic colour profiles; bespoke colour profiles for artists' handmade papers and mouldmade papers; compatibility of paper and ink. As a result of working on the portfolio, a method for optimising the print workflow has included: lightfast testing on a variety of papers; bespoke ICC profiles for particular papers; a best practice for artists to generate, save and print images.

## Introduction

For the current generation of artists using image generation software and printing using inkjet printers, the majority have learnt by trial and error<sup>1</sup> and have arrived at a method of working that suits them, but perhaps is compromised by computer hardware. Asked if they have an understanding as to how it works... the majority will answer 'no'. Ask this same generation of artists how to make an etching or a screenprint; they will probably be able to explain in great detail. Similarly, the majority of artists are not wholly interested in technical details colourspace, Delta E, ICC profiles, error diffusion or file tagging (the list goes on), however the artist is deeply concerned with the production of images, colour fidelity, tonal range and ink on paper. From the experience of, for example, graphic design undergraduates who will soon enter the workspace, very few have an understanding of *how colour works* or the relationship of colour to digital printing.

This paper addresses some aspects of digital printing in relation to artists and utilises The International Digital Miniature Print Portfolio as a case study.<sup>2</sup> The paper will offer methods in which an artist can optimise print output,

which can be reduced through lack of access to specialist hardware, and will concentrate on issues relating to the generation and printing of original digital images.

## Original and Reproduction

The term *original* in this context is used to describe a graphic artwork that is generated on computer, is the intention of the artist to be an original work, which does not exist anywhere else and is then outputted using a digital printer. Furthermore, a *reproduction* in this context refers to the copying of an artefact that exists elsewhere and therefore comparisons can be made, for example, with a painting or a sculpture. The *original* digital print may be generated using various input devices using scanners or digital cameras, which are then digitally manipulated or collaged using digital imaging software and is then prepared for printing. *Reproduction*, with reference to photography<sup>3</sup> is used to describe how colours are reproduced for example from a computer monitor and/or an artefact. However for the artist the notion of a reproduction<sup>4</sup> is based on the tradition of making an engraving from an oil painting; or a facsimile of a work of art that is photomechanically printed to resemble the original as closely as possible.<sup>5</sup>



Figure 1. An example included in The International Digital Miniature Print Portfolio by Sarah Bodman

## A Background to the CFPR

An aspect of research at the Centre for Fine Print Research is an investigation into photomechanical print developments in the 19th century, and whether in the context of digital technology these processes have some relevance and are applicable today. In such cases as collotype, photogravure and Woodburytype - 19th century continuous tone photomechanical print methods - the Centre has made developments and gained success with the printing of colour images.<sup>6-12</sup> Furthermore the Centre's interest in developing inkjet technology has resulted in collaboration with HP Invent, HP labs Bristol and the Colour Imaging Institute, University of Derby to provide an alternative methodology for inkjet printing, which is a synthesis of colour science and pragmatic practice for the printing of fine art originals.

## The Miniature Print Portfolio

The idea for the First International Digital Miniature Print Portfolio was based on the Centre's annual miniature print exchange, which is now in its 17th year. The Centre has traditionally run a miniature print exchange between Art Media and Design staff and postgraduate students.

In 2000 the portfolio concept was elaborated to include the first international miniature print exchange. Thirty artists from as far as Argentina, New Zealand, South Africa, as well as America contributed to the portfolio, which resulted in around 20 exhibitions running concurrently in different venues. This portfolio and the annual in-house miniature portfolio examples traditional printmaking at its most innovative and has historically reflected novel types of print as they have become subsumed into the artist's repertoire of processes, such as photocopying, 4 colour screenprint, inkjet; and more recently the processes that have been researched by the Centre such as collotype, flexography, photogravure and heliorelief.

The objective for the First International Digital Miniature Print Portfolio (Figure 1) was to produce a varied and portable exhibition, which incorporated as many artists, including professional artists, research staff, university students, students from higher education, secondary and junior schools. This project was on a much more ambitious scale ever undertaken before by the CFPR, over 100 artists contributed or collaborated. This digital portfolio was entirely printed at the Centre in Bristol and printed in many cases thousands of miles away from the artist. The image size and paper size remained the same as the traditional print format 7 x 10 cm on a 20 x 25 cm page. Here the similarity ended. Again under traditional circumstances the artist was required to print the whole edition, however for this portfolio the artist was asked to send a digital file and the Centre undertook the rest. Images sent by artists were initially opened in Adobe® Photoshop®, re saved and dropped into a QuarkXPress™ template that could print 16 prints on a 800 x 1200 sheet of

250gsm Somerset Enhanced Velvet paper, produced by St. Cuthberts Mill in Somerset, UK.

## Issues Relating to the International Digital Portfolio

Digital imaging and issues relating to the printing of colour files is relatively new to the Centre's research field. We felt that 70 artists would constitute a good cross section of the artist community and would therefore highlight problems relating to digital printing. In the case of the digital portfolio we had no expectations as to how the image would look. In most cases a file was sent via email or on disk, with no supporting visual image. Files arrived in many different formats including custom made RGB colour spaces, CMYK files, JPEG files that were greatly compressed to be sent via email, and images with embedded files such as camera, scanner or printer profiles. A proof print was returned to the artist for approval; it was at this point that a printed image might be returned, which may have been printed on a RGB Deskjet, or instructions to 'make the image more red'.

As a result of printing artworks for 70 artists a variety of problems were highlighted:

### *File Compression*

Images that were compressed using JPEG resulted in loss of colour and tonal data.

### *ICC*

The use of scanners, digital cameras and custom RGB or CMYK colour spaces resulted in unknown profiles. Conversion of images saved in different software packages also proved problematic.

### *PC versus Mac*

Images generated on a PC were often generated in sRGB colour space and therefore appeared duller.

### *File Corruption*

Horizontal banding resulting from corruption of files, (which was resolved by converting to LAB sending them direct from an MAC and not by a PC server.)

### *Colour Proofing*

Prints that were proofed on a RGB dye based Deskjet printer were much brighter than a CMYK printer. On receiving the proof, artists were likely to be disappointed.

### *Input Device*

Pixilation in the printed image when generated with low-resolution cameras or printers.

## A Subjective Analysis of Print on Paper

From the perspective of an artist's approach to print, an analysis of the work is often based on an a priori conception of the work, how it appears on the monitor display and when printed, a subjective assessment of the printed surface. Furthermore for the artist an initial

consideration is the substrate and how the print process can affect the visual aesthetic. There is a difference between the user who requires a general consistency of image on any paper substrate and the user who has a more subjective approach to the visual appearance of ink on paper. With the introduction of photoenhanced papers and inkjet printing, there are some implications for the user, which are: the overall visual impact, quality of the image, the relation of ink and paper, surface quality of the paper and the surface quality of ink and paper.<sup>13</sup> Whilst users who require a high turnover print production require a consistency of image, this does not necessarily mean that the image has a high subjective visual quality. By quality we mean, colour resolution, parity to the image on the screen, contrast, colour range, subtlety of tone, continuous tone, good light tone, how it interacts with the paper.

An initial evaluation of 66 fine art printmaking papers was undertaken using psychophysical testing. The papers ranged from lightweight Japanese tissues to heavyweight etching papers.<sup>14</sup> There was also a variation in the base colour of the paper, which ranged from a bright white to an antique cream.<sup>15</sup> A series of criteria were used to judge the effect of ink on paper:

*Colour clarity* - muddying of colour, brightness, and saturation

*Text* - feathering at the edges, density

*Paper* - surface quality, chalky, dull, mottling, puddling or colour drag

The selection of papers was not necessarily based on colour fidelity,<sup>16</sup> especially as there was no original to compare. In fact papers that showed brightly printed results were not necessarily chosen. Papers were chosen for qualities relating to surface texture, ink capacity and the ability to hold detail without feathering; and lastly a paper that could have the potential for further development such as ICC profiling. For some samples the colour was absorbed into the surface and showed a rich, dense quality with a very short tonal range but a high subjective appeal. Other samples such as Japanese paper for instance, showed a delicacy unobtainable in any other manner and remained remarkably tolerant to the high levels ink. Around 15 papers were chosen and included Japanese papers and samples from the Somerset, Arches and Fabriano mills, which are further being trialed in combination with enhanced papers for lightfast testing; and in collaboration with the UK's primary paper merchant for fine art papers to write colour profiles.<sup>17</sup>

### Lightfast Qualities of Ink

Artists are demanding accurate colour that is also conservable, which has a direct relation to both paper and ink. There have been many lightfast tests undertaken into the longevity of dye-based inks for inkjet printers, and acknowledgement is given to Wilhelm Imaging Research<sup>18</sup> who has provided a series of useful ratings for lightfast testing. Our report made in 1999<sup>19</sup> revealed exaggerated

claims by printer manufacturers, although more recent estimates on the longevity of digital prints are more circumspect, our tests showed that some prints might show some shift in colour and fading beyond acceptable levels as early as a few months.

In order to ensure that the Digital Portfolio lasted, we undertook an accelerated exposure on a small range of enhanced or coated papers. Whilst these tests indicated pigmented inks were more stable on enhanced papers than dye based inks, we wanted to obtain a better understanding as to how ink faded, to look at the relationship between paper and ink and to undertake a record of fading characteristics. In 2002, lightfast tests on a range of papers were made, and in December 2002 a more detailed investigation commenced, which involved the use of colour measurements and the documenting of the surface of the paper through microphotography as exemplified in Figure 2.

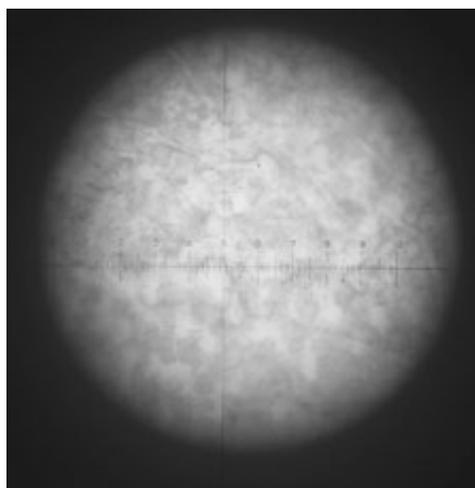


Figure 2. Microphotograph of Cyan ink

Lightfast tests were undertaken using dye and pigmented inks onto artist's cotton based handmade, uncoated and enhanced inkjet papers. Thirty papers were tested, including six enhanced papers - some of the more popular artists' printmaking papers - to which an ink receptive coating is added. The printed tests were exposed to light conditions that simulated a gallery or home environment. Colour samples containing Cyan, Magenta, Yellow, Black and CMY patches at 5% increments were printed using Hewlett Packard UV (pigment) inks and dye-based inks on a 42" HP5000ps. After 10 months, measurements were made on patches containing 50% ink coverage.  $\Delta E$  differences were recorded between the exposed samples and recently printed samples.  $\Delta E$  averages are calculated here showing the average difference in fading rates between CMYK, enhanced and coated, dye and pigment.

The results suggest when printed on enhanced papers the magenta in the dye samples appears to be particularly

fugitive resulting in, overtime, a greenish blue cast to the prints. Similarly for the uncoated papers the cyan is resistant to fading and therefore creates a similar greenish-blue result. However for pigmented inks the fading rate appears to be more consistent for both enhanced and uncoated papers.

#### Average $\Delta E$ Differences After 10 Months:

Dye	Cyan,	Magenta,	Yellow,	Black
Enhanced	19.8	66.45	25.3	39.7
Uncoated	3.59	21.51	21.86	16.02
Pigment	Cyan,	Magenta,	Yellow,	Black
Enhanced	10.4	10.4	5.7	6.66
Uncoated	10.7	9.82	5.71	5.51

The subsequent colour trial, begun in December, is a more visual analysis of paper and ink.<sup>20</sup> The printed samples include cyan, magenta, yellow, black, composite black and red, green and blue patches (Figure 2). Early results showed significant fading in dye based inks on enhanced papers only with an average of 10  $\Delta E$ , compared to dye based inks on uncoated and pigment based inks on enhanced and uncoated with an average of 1.5  $\Delta E$ .

### A Question of Colour

For the Digital Miniature Print Portfolio images sent by artists were initially opened in Photoshop 6, re saved and dropped into a QuarkXPress™ template, which was saved as a Postscript file and sent via a software RIP. A complete ICC colour profile was made for the Somerset Enhanced paper, which included setting of ink limits, tonal scale and colour patch measurements. The RIP worked particularly well if the digital image had been generated and saved in an RGB colour space and which had no occurrence of profiles or tagging. For problem images, such as files that had unknown colour spaces or tagging; corruption of files resulting in horizontal banding; sepia images that when printed had a greenish blue cast; these files were opened and saved in CIELAB, which overcame conflicts. The Quark document was then sent directly from the G3 to the HP5000. Conclusions that were drawn from the printing, and provided us with initial answers as to how to process colour suggested there was no simple rule for all, but the use of LAB colour space suggested a useful method to save and print.

Colour and colour space and methods for describing colour remains a constant area for debate.<sup>21</sup> There will be always a compromise between colours that the human eye can see, and colour that appears on paper. Or as the photographer E.J. Wall suggested, "Theoretically perfect inks are still a desideratum".<sup>22</sup> As Philip Ball points out the quality of the colour is determined by the quality of the inks: "You can judge for yourself from any colour prints in

old books how effectively (or otherwise) printing inks have coped with these shortcomings. For those too young to have first-hand recollection, it is hard to escape the notion that the events of the world in years after the Second World War took place in an overcharged Technicolour glow of ruby-red lips and phthalocyanine-blue skies, just as the First World War was conducted in monochrome."<sup>23</sup>

L\*a\*b colour is very close to the way the human eye sees colour. In the 1930s the Commission International de l'Eclairage undertook experiments with human subjects to produce a colour gamut that closely matched human vision, which resulted in the CIE 1931.<sup>24</sup> In 1976 CIE developed LAB further to CIE LAB, which is used widely for the accurate measurement of colour and colour differences ( $\Delta E$ ). It is intended to be device independent therefore creating consistent colour whatever the device such as a monitor, printer, computer, or scanner. Photoshop uses LAB as a means of reference when converting to, for example RGB to CMYK.<sup>25</sup> For RGB colour space, the two most useful for artists are Adobe® RGB (SMPTE-240M) and ColorMatch® RGB. Adobe has the widest colour gamut but has a white point set to 6500° Kelvin, which could be considered to be too bright for fine art printing. ColorMatch® has a smaller colour gamut than Adobe® RGB but larger than sRGB and Apple® RGB but has a white point set to 5000° Kelvin, which has a warmer colour gamut and reflects the type of image quality when printing onto artists' paper. A description of RGB and CMYK colour space is well described in Haynes book on Photoshop.<sup>26</sup> LAB has the largest colour gamut, encompassing all colours possible in RGB and CMYK colour space and beyond, which means when printing from LAB, the conversion to CMYK is likely to be disappointing. However for the purposes of archiving images for future printing, as and when a printer colour rendition gamut might become wider, or for sending image, LAB is a very useful colour space.

LAB can also be used for generating basic but useable colour profiles. An investigation was undertaken into alternatives to make full ICC profiles. Whilst the making of an ICC profile might be of use for a particular printer/computer combination it is unlikely to be compatible for another system even if it is similar. Furthermore artists are unlikely to have specialist equipment such as spectrophotometer or profile making software. However artists are likely to have a flat bed scanner and Photoshop. With reference to the Photoshop guidelines for profile generation using LAB<sup>27</sup> and cribbing from detailed technical notes written by Johan Lammens and Pau Soler of HP Labs Barcelona, we devised a method for making Lab colour profiles through Photoshop 5, a Gretag Macbeth Eye One® spectrophotometer and the use of a Canon® flat bed scanner.

### Method

A test print was generated in Photoshop 5.5®, comprising 9 patches at 100% levels of C, M, Y, MY, CY, CM, CMY,

W and K. The patches were printed in an untagged CMKY space, print space same as source to the HP5000ps CMYK-native. The patches were then measured either using a spectrophotometer GretagMacbeth EyeOne® or a Canon flatbed scanner and Photoshop 5.5 using the colour dropper; CIE Lab values were then recorded.

Two profiles were generated in the Custom CMYK menu in the Photoshop® Colour Settings: Open File – Colour Settings – CMYK Setup – select Built-in CMYK model – Select Ink Colors – Custom, check the LAB coordinates box, uncheck Estimate Overprints box and input the 9 values in LAB (Figure 3). For the section on dot gain, Lammens suggests 15% for glossy papers and 20% for coated papers. For separation options he suggests Separation Type: GCR; Black Generation: Medium; Black Ink Limit: 100%; Total Ink Limit 240% for glossy bi-level, 200% for native coated bi-level 400% if the ink limits are applied through the printer; UCA Amount 0; then lastly save as ‘xxxx’s new profile’.

	L*	a*	b*
C:	47.8	-23.0	-59.6
M:	48.2	70.4	-9.2
Y:	90.5	-9.8	86.6
MY:	54.3	56.3	34.0
CY:	49.3	-65.8	8.1
CM:	30.4	17.6	-53.5
CMY:	35.6	-12.0	-11.9
W:	99.0	0.0	-1.7
K:	19.3	1.0	0.7

L\*a\*b\* Coordinates  
 Estimate Overprints

Figure 3. LAB values in Photoshop®

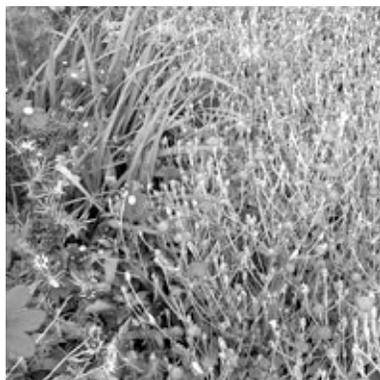


Figure 4. ‘Pink Flowers’ – test image for Lab ICC profiles

To print using the profile: open the printer dialogue box and pull down the Adobe print settings; in Working Space check Untagged CMYK; and in Print Space check Working CMYK ‘xxxx’s new profile’; for Rendering Intent select Perceptual – Print.

An image entitled Pink Flowers (Figure 4), generated in RGB, was printed along side the colour patches. Although the Working Space in the Printer Dialogue Box remained an Untagged RGB, in the Print Space, Working CMYK ‘xxxx’s new profile’ was used.

The colour content in ‘Pink Flowers’ included a variety of shades of green, including a bright green and a greyish green. The colour range for the flowers included a bright pink, magenta, bright orange and ultramarine. The intention therefore was to test the visual colour changes that might occur. The two profiles from the scanner and the spectrophotometer were then used to provide the Print Space. The values recorded using the spectrophotometer gave very good results for the magentas and oranges, but tended to make the greens darker and grey-greens more blue. There was a loss of detail in the mid tones, resulting in a more high contrast image. With reference to the scanner profile, the image had a blue cast, creating a slightly duller version of the initial print. Although the colour rendition is not entirely accurate for both, the process provides a useful starting point for investigating alternative profiles and investigating alternative colour sets for printing.

## Conclusion

Many of these issues relating to the printing of a digital image has a resonance for many aspects of colour science and electronic imaging, however artists who print digital images are less concerned with what is correct and more interested in the subjective aspects of the print. Whilst this paper reflects work undertaken at the Centre for Fine Print Research, it is also intended as a means to offer an alternative approach to developing the technology. It is hoped that a more pragmatic approach to the relationship of digital imaging, colour science, colour and paper will be addressed.

## References

- 20 artists were asked in a questionnaire, how they learnt to make digital prints, and most replied that it was through trial and error and with no formal training. See Introduction (pdf) to “2020 a Documentation of Artists Making Prints” at: <http://www.uwe.ac.uk/amd/cfpr/exhibit.htm>
- [uwe.ac.uk/amd/cfpr/digmin.htm](http://www.uwe.ac.uk/amd/cfpr/digmin.htm)
- Frizot, M (Ed.) *A New History of Photography*, Könemann, Köln, pg. 422 (1998)
- Gilmour, P. *On Originality*, Issues in Architecture and Design Vol2, No1, Winter 91-92, pg. 4
- Turner, S. *About Prints*, Estamp, London pg.14 (1993)
- Parraman, C. *A Survey of Photomechanical Prints*, Impact Press, Bristol (2000)

7. Parraman, Hoskins, *In Search of the Organic Dot*, CADE 99 Digital Creativity, 7th-9th April 1999, University of Teeside, pg.185 (ISBN 0907550665)
8. Parraman, C. *Digital Print Traditional Print*, CADE 2001 Digital Creativity, April 9th-12th 2001, Glasgow School of Art, pg. 281
9. Thirkell, P. *A Reappraisal of the 19th Century Woodburytype Process for High Quality Digital Output*, IMPACT 2nd International Printmaking Conference, September 2001, University of Art and Design, Helsinki, UIAH, Finland
10. Thirkell, P. *Collotype in a Digital Age*, Lichtdruck Kunst, International Collotype Conference, 26th-28th April 2002
11. Parraman, C. *The Practical Application of an Artist's Colour Model as an Alternative to CMYK*, 15th Electronic Imaging Santa Clara, California, 20-24th January 2003
12. Hoskins, Thirkell, *The Relevance of 19th Century Continuous Tone Photomechanical Printing Techniques to Digitally Generated Imagery*, 15th Electronic Imaging Santa Clara, California, 20-24th January 2003
13. Parraman, Hoskins, *The Impact of Ink on Paper*, 9th Colour Imaging Conference, Scottsdale, Arizona, 6th-9th November 2001
14. A Useful description of artist's papers can be found in: Turner, S. *Which Paper? A Review of Fine Papers for Artists, Craftspeople and Designers*, Estamp London (1991)
15. Papanagiotou, C. *An investigation of the use of digital colour matching for the toning of paper using ink-jet printing*, The Paper Conservator volume 20 2002 pg.77
16. Farnand, S. *Using •E Metrics for Measuring Color Difference in Hard-Copy Pictorial Images*, 15th Electronic Imaging Santa Clara, California, 20-24th January 2003
17. The research is supported by the TCS (<http://www.tconline.org.uk/>) a government-funded scheme that enables business to access the skills and knowledge from academic partners to develop structured research projects. This particular project is with University of the West of England Bristol and John Purcell Paper, London. See also: Wang, H. *The Application of Colour Management Systems to Improve the Quality of Ink jet Printing on Fine Art Paper*, Preservation & Conservation Issues Related to Digital Printing & Digital Photography, Heriot-Watt University, Edinburgh, 24th-25th March 2003
18. <http://www.wilhelmresearch.com/DisplayPermanenceRatings> and Dark Storage Ratings (Years Before Noticeable Fading and/or Changes in Color Balance Occur)
19. Parraman, C. *The Inkjet in Question*, Printmaking Today, Summer 2001
20. Parraman, C. *The Fading Characteristics of Dye Based and Pigment Based Inks on Artist's Uncoated and Enhanced Printmaking Papers*, Preservation & Conservation Issues Related to Digital Printing & Digital Photograph, Heriot-Watt University, Edinburgh, 24th-25th March 2003
21. Yaguchi, H. *2001 Colour Categories in Various Colour Spaces*, 9th Colour Imaging Conference, Scottsdale, Arizona, 6th-9th November 2001 pg.6
22. Wall, E.J. *History of Three Colour Photography*, American Photographic Publishing, Boston, p.9. 1925
23. Ball, P. *Bright Earth The Invention of Colour*, Viking Press, London, pg.333-334. 2001
24. <http://www.colorsystem.com> also [http://www.datacolor.com/color\\_experts\\_004.shtml](http://www.datacolor.com/color_experts_004.shtml)
25. Adobe® Photoshop® help section
26. Haynes, B. *Photoshop 5 and 5.5*, New Riders, Indiana pg.102-112
27. Adobe® Photoshop® help section

### Acknowledgments

Thanks to HP labs Bristol and the HP Art and Science Funding Programme. Thanks also to Paul Laidler, UWE and Hong Qiang Wang JPP/UWE.

### Biography

**Carinna Parraman** is Research Fellow at the CFPR. Her research encompasses fine art practice, digital imaging and colour science. She is involved in the HP Invent Art & Science Programme and is collaborating with HP Labs Bristol and Colour and The Imaging Institute, Derby to write seminars for wideformat inkjet printing. She is also working with Tate Britain London to write a database that catalogues the 20th century print collection by process. Some recent works in the collection are digitally printed.