

# Continuous Tone Digital Output, Using Archival Proven Printing Methods and Materials

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## *Abstract*

*Whilst the primary focus for the creation and preservation of digitally based artwork in hardcopy has relied in recent years on the gradual refinement of digital printing devices, reference points for their development often appear to follow a strictly linear, industrially led route. To broaden current possibilities for permanent, accurate digital hardcopy, the Centre for Fine Print Research, Bristol has undertaken a programme of research to re-asses some early photomechanical printing processes which were eclipsed by mainstream printing long before the advent of the digital era. Through identifying and combining the unique continuous tone printing capabilities of collotype with specially adapted digital pre-press, new vistas for hardcopy have emerged. Whilst these offer the fine artist and photographer a new digitally assisted approach to collotype printing, the principles of colour, tone and permanence exemplified by this process also hold value for the development of new, fully digital approaches to high quality print production.*

## **1. Introduction**

This paper seeks to reveal how the reassessment of past printing capabilities, long disconnected from mainstream print, may contribute new insights toward the current quest for permanent, high-resolution print. The research has been especially aimed at developing methodologies for achieving this through more flexible tone and colour systems than those currently hardwired into mainstream digital imaging systems.

## **2. Current norms inherent in photomechanical and digital print output**

One of the essential elements directing this research has revolved around identifying current norms of mainstream print and assessing them from the perspective of a fine art printmaker. These apply to both photomechanical and digital output and concern the main approaches for rendering tone, colour and ink on paper.

### **2.1 The Reproduction Of Tone**

Firstly with regard to the reproduction of tone: Currently, all pre-press photomechanical output is based on the halftone technique. Although most digital print is also based on the same principle- i.e. dots creating the illusion of tone, their structures are often somewhat different. Rather than the commonly used linear dot structures found in photomechanical print, digital print often uses randomly scattered dots. In some cases these bleed together in the shadow and mid tones to create a near continuous-tone effect. Nevertheless, both digital and photomechanical techniques print dots on paper in a fine, uniform thickness.

### **2.2 The reproduction of colour**

For rendering, prints in colour the standard four colour CMYK approach is used. To create a higher colour fidelity, some photomechanical and digital systems have recently begun to extend the standard four colour gamut by adding two or three more colours i.e. green and orange or light cyan, light magenta and light yellow.

### **2.3 Printing Papers**

A vast array of printing papers are available to the printing industry however, a vast majority of printing technology currently available is designed to achieve maximum fidelity with commonly used commercial printing papers. These can generally be described as smooth, coated, medium to lightweight stocks. Much of this paper is ideally suited to the task of fine halftone printing. This aesthetic is also reflected in digital printing.

### 3. The Origins of Four colour printing

To examine how such systems have gained their current dominance, a look back at industrial printing history reveals the logic of their origins.

The halftone approach to printing was initially developed in the late nineteenth century. It was patented in 1882 by George Meisenbach, and although the image quality of the halftone was originally coarse by comparison to earlier photomechanical processes, its high output capacity established a wider scope for high volume print production (Rooseboom, H., 1996, p.211).

During the 1890's Herman Vogel's colour theories began to offer new scope for the mass reproduction of full coloured images. While there was a strong incentive to adopt Vogel's tri-chromatic approach for the popular letterpress medium, some major obstacles were initially encountered. Because of its reliance on a halftone screen, a range of carefully selected screen angles had to be devised to prevent the dots of each colour from overlapping and creating unwanted interference or moiré patterns in the finished print.

It also became evident that when applied in practice Vogel's tri-chromatic method held further limitations. Due to the inevitable presence of impurities, even in the highest quality inks, the creation of areas of pure black in an image could not be easily achieved using a mixture of blue, yellow and red. To compensate, a fourth separation layer of black or grey was often added. This created a far richer print and as a result, the original tri-chromatic technique rapidly evolved into the four colour CMYK technique.

### 4 19<sup>th</sup> Century Continuous Tone Printing Processes

While the halftone approach has dominated commercial printing industry since the 1890's, documentation of early photomechanical print practice suggests that an altogether different approach was originally used for rendering tone in photomechanical illustrations. In the 1870s a process called Woodburytype became one of the first printing mediums to effectively reproduce photographic illustrations in large numbers.

After a lengthy period of development, however two other similar processes - collotype and photogravure - were also sufficiently perfected to compete in this market. Because they were not type compatible, illustrations had to be printed separately on customised presses and either combined with pages of printed text later at the binding stage, or in the case of Woodburytype, pasted into the pages of a bound edition (Crawford 1979 pp 285-9).

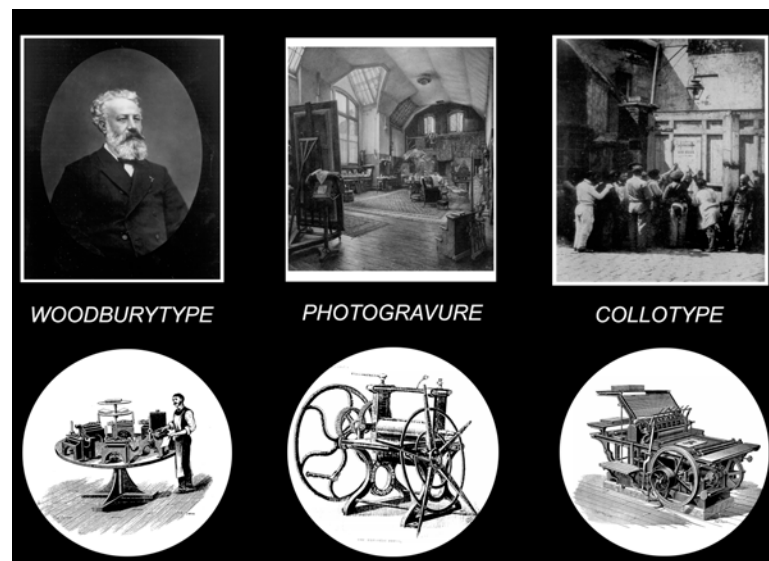


Fig 1 Continuous tone printing processes

An outstanding feature of each of these processes, even in terms of current printing standards, was their ability to reproduce, in permanent ink, an image which closely approximated the resolution and quality of a photograph. This was achieved by printing in continuous tone rather than halftone.

#### 4.1 Continuous tone and halftone printing characteristics

Essentially Mungo Ponton's 1839 observations of the light hardening properties of bichromates on colloids such as albumin and gelatine held the key to each of these inventions. Walter Woodbury's Woodburytype process used Ponton's principles for the production of a gelatine photo relief to stamp a mould from which prints could be cast. Talbot and Klic's photogravure method used it to create a photo resist for etching an intaglio aquatint plate whilst Alphonse Poitevin's collotype process also used it to create a photolithographic printing surface from which prints could be pulled.

Although each was produced in an entirely different manner, the common element contributing to their high quality could be found in their ability to lay down different thicknesses of ink on paper. This produced a printed image with a long tonal scale. The darkest tones were created by the thickest deposits of ink, the mid-tones by thinner deposits and the light tones by the finest. This mode of printing contrasted significantly with the halftone approach which lay down a single uniform layer of ink and created the illusion of tone by breaking the image's surface into dots of varying frequencies.

Despite their rich, photographic appearance, the output of the early continuous tone processes could not match the production speed and flexibility of halftone letterpress. Consequently by the turn of the century the beautiful but difficult Woodburytype had become commercially redundant and the expensive photogravure relegated to the production of special, limited, editions (Griffith, 1996, p.124). The collotype, however, despite its comparatively low output, was to develop some unique specialities which continued to validate its commercial production until well into the latter part of the twentieth century.

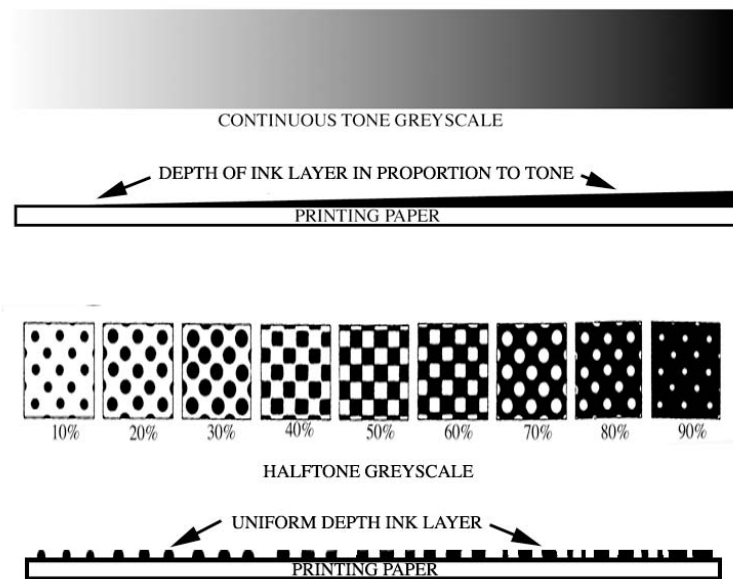


Fig 2 relationship of tone and ink in continuous tone and halftone printing processes

#### 4.2 Continuous Tone Colour Printing

Although some experimentation with colour printing was carried out with the Woodburytype process before its demise, the many technical difficulties and high costs associated precluded it from contributing significantly to the development of colour printing. Similarly photogravure, with its inherent multi-plate

intaglio printing problems, also reduced its viability as a colour medium. Collotype however, with its easily registered, planographic printing qualities made it an ideal colour medium. The technique was in fact the first to illustrate the success of the German colour scientist Herman Vogel's trichromatic colour separation method (Vogel 1898 p 298). Full colour prints were able to be produced in collotype using specially filtered negatives which separated the blue red and yellow components of an image.

## **5 Collotype printing facsimile**

While collotype was limited in supplying the high output demands of the mainstream industry, its high imaging quality earned it something of a specialist role. This was for the production of highly accurate reproductions of drawings, photographs and paintings. These were usually found in limited edition book, portfolio and single sheet print publications.

Unlike other techniques which could only reproduce images using industrially standardised methods, collotype was able to use a combination of science and craft to print beyond their inherent limitations. Some unique qualities found in collotype prints - especially fine art facsimiles - include; their subtle tones, vibrant colour and capacity to include (especially in the case of works on paper) the exact surface quality of the original through the use of identical fine art papers.

### **5.1 Advantages of collotype as a high quality printing medium**

The collotype possessed a number of advantages over mainstream printing techniques which made it ideal for the task of accurate colour reproduction.

A significant advantage lay in the method in which it rendered ink on paper. As well as creating tone through the application of varying thicknesses of ink, its surface was also broken up into minute random grained dots. In conventional halftone terms, these often corresponded to a screen resolution of around 1500 lpi. This phenomenon was created by a microscopic wrinkling of the gelatine coated printing plates surface. The grains presence in the image allowed multiple layers of ink to be printed crisply and cleanly without any danger of moiré interference. Therefore, unlike the halftone, there were no restrictions on laying down as many colours as necessary to match the colours of an original.

Collotype prints, especially fine art facsimiles were often reproduced in eight to ten colours. These were carefully chosen to match as exactly as possible, the colour range and key of the original.

Partially due to the character of the process and more importantly due to the permanence required, collotype inks were produced with high percentages of pure, light fast pigments. This along with the use of high quality papers allowed accurate permanent records of rare, often fragile unstable artworks to be reproduced and disseminated for the study of art.

### **5.2 The craft of collotype**

Traditional collotype production offered the practitioner four distinct phases of control throughout the creation of an image. These were mainly scientifically based but also catered for the more subjective elements of image reproduction.

To create a facsimile, the actual original was often used as the direct source for the creation of pre-press negatives. Standard colour filters were used to create the primary separation negatives. Extra separations however, were also produced through the use of different film exposures to assist in extracting extra colour correction layers to accurately match the gamut of the original.

Unlike halftone printing, the fine calibration of the prepress artwork could be undertaken through working directly onto the negative. Fine retouching was done by hand to allow the medium to more precisely match the tonal curve of the original. Because of the single steps from original to negative to print, far less detail was lost than through the halftone processes where several extra intermediate steps were required.

Because the artwork was continuous tone, there was also far more latitude for varying the plates exposure to suit both varying ink consistencies and individual printers printing styles. Whilst working on the press, the printer had a great deal of flexibility in adjusting the printing character of the plate. This was done by applying various glycerine based etches to the image at the proofing stage. Through this, the tonality of specific areas of the print could be minutely adjusted to match the original.

## **6 Focus of Investigation Into Continuous Tone Printing**

In searching for ways to implement new approaches for artists to create permanent prints in hardcopy from digitally generated artwork, our initial reassessment of the collotype process appeared to offer valuable advantages. In comparison to the range of photomechanical processes traditionally appropriated by artists from the printing industry for use in a fine art context, the technique suggested that.

- a) a far more detailed image quality could be achieved when used in conjunction with traditional, fine art studio printing equipment.
- b) the mode of colour production also appeared to offer more flexibility than current standard four colour halftone methods.
- c) the examination of a range of collotype prints suggested its ability to print highly detailed images on a broad range of fine art papers.
- d) rich vibrant coloured images could be printed using highly light stable inks.

Therefore, the tasks necessary for integrating the imaging flexibility of digital technology with the printing possibilities suggested by collotype, centred around

- a) adapting it for use in a fine art studio environment
- b) adapting digital technology to suit the demands of the traditional process

Our research has consequently involved;

- gaining technical insights into the traditional process,
  - locating suitable digitally generated continuous tone output for reproducing the characteristics of traditional analogue films
- and
- accessing software for re-creating collotypes multiple, customized colour separation techniques.

### **6.1 Adapting the collotype process for use in a contemporary print studio**

Through the study of 19<sup>th</sup> century technical literature and later by working with one of the worlds few remaining collotype studios in Leipzig, Germany (Lichtdruck Kunst), a sufficient practical insight into the process was initially gained. This enabled small collotype facility to be developed and installed at the Centre for Fine Print Research. This consists of a basic plate-drying oven allowing the plate glass printing plates to be warmed to 50 degrees centigrade, coated with warm bichromated gelatine and cured for several hours.

The negative artwork produced to generate the print is exposed through the use of a conventional plate exposure unit. Exposed plates are then developed in cold water and dried at room temperature. The plates are then locked on a converted a relief proofing press. Before inking they are soaked with glycerine for 30 minutes, sponged dry, rolled up with printing ink and then printed onto paper.

### **6.2 Collotype ink**

In undertaking this research, it became clear through contact with the handful of surviving collotype practitioners that changes in the manufacture of printing ink had led to a shortage of ink suited to the

process. This instigated a related project which has been carried out in parallel with our research and involves the collaboration with Cranfield Inks. Using, old ink recipes and updating them for modern production, the project has been able to recreate the densely pigmented inks necessary for assisting and maintaining collotypes production.

### 6.3 Digital Prepress

One of the main obstacles in creating a suitable interface between the flexibility of digital imaging and the traditional printing quality of the collotype has been in locating compatible prepress output. Although very finely screened halftone images can be obtained from conventional prepress image setters, their use in conjunction with collotype doesn't allow the traditional qualities sought from the medium to be achieved. For this reason, a search outside the regular realms of prepress output was undertaken. Eventually a source located within the field of digital photographic output was discovered. This involved the use of Laser to Film printing devices such as the Durst Lambda Printer for outputting continuous tone images onto clear-based films. Through this, digital images could be created and output in a form ideal for the traditional process. An added bonus of this approach allowed tonal corrections to be undertaken digitally rather than manually as was previously necessary.

### 6.4 Multiple Digital Colour Separation Methods

To regain the flexibility of the non-standard colour separation techniques traditionally used by collotype printers, alternatives to the standard CMYK digital colour separation technique were sought.

A suitable solution was eventually discovered in the form of a Photoshop™ plug in Photospot™ct. This software enables an image to be separated into spot colours rather than process colours. Any colours that dominate the image can be selected and separated in continuous tone. The programme also allows as many separations as is necessary to be created. These are then saved (in the case of this research) as unscreened DCS negatives and output using the continuous tone media described.

This approach has enabled the possibility of printing an image in much the same manner as a traditional collotype facsimile. For the fine artist however, it also allows the onscreen images interpretation in hardcopy, to print beyond CMYK gamut thus enabling the artist to break free of what could be termed as the current homogenised approach to colour reproduction.



Fig 3. A six colour digital collotype by Paul Thirkell

## 7 Conclusion

While this research does not offer -due to the relative difficult nature of collotype printing- a widely accessible approach for the output of digitally generated hardcopy, it demonstrates the possibility of adding a degree of permanence fidelity and flexibility not easily achieved through many current print options. Although undertaken from the perspective of a fine artist, the principles examined by the research also hold value for other applications where high fidelity, permanent print output is required.

## References

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