Woodburytype: A historical process resurrected by modern methods

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ABSTRACT

One of the technological achievements of the 19th century was the mass reproduction of photographic images. Woodburytype was the first commercially successful photomechanical continuous tone printing method, of unsurpassed quality until today. Along with Collotype and Goupil gravure, it used the relief of dichromated gelatin exposed to light as the basis for the printing plates. In this article we will discuss the historical printing processes and present how a) modern embodiments of the printing plates can be made by either CNC milling or using photopolymer plates and b) how optimal contrast and grayscale can be achieved by ink formulations tuned to the relief depth of the printing plate.

INTRODUCTION

The invention of photography in the 19th century was a technological breakthrough of unbelievable proportion. For the first time in human history it was possible to create true likeliness without the interpretation of an artist, just by using the 'Pencil of Nature' (Talbot, 1844). Scientists and craftsmen raced to find methods to make the images, created by the interaction between light and chemicals, permanent and to find commercially viable methods to mass produce them. In the 1850's and 1860's printing photographs in ink, that is reproducing the image by an imprint from a printing plate and not by a photochemical process, became workable. Commercially successful, photogravure, Collotype, Goupil gravure and Woodburytype were methods which translated the image information of a photographic image into a printing plate by using dichromated gelatin (Crawford, 1979). All but the Woodburytype produce flat prints. Woodburytype is a three-dimensional relief print.

In Woodburytype, contrast and greyscale are generated by a relief of pigmented gelatin. In contrast to traditional printing methods where the ink is driven into the paper by pressure, the gelatin layer sits on top of the paper surface. The pressure of the printing press has to be carefully tuned to achieve a reliable release from the printing plate without chasing the ink into the substrate. Substrate surface chemistry and porosity are parameters which have to be controlled for a successful release, and these also influence contrast and greyscale in the printed image.

In 1864, Walter B. Woodbury patented a method to print continuous tone photographic images

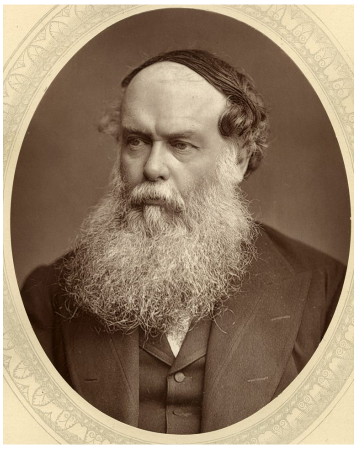

Figure 1

Figure 2

Figure 1: Woodburytype from (Whitfield, 1880): Myles Birket Foster
Figure 2: Industrial set up for Woodburytype at Goupil, at Asnière near Paris from (Tissandier, n.d.). Three printing stations are on the left

from an intaglio/relief printing plate (Woodbury, 1864). He licensed his method to different companies. When H. Barden Pritchard visited 'The Woodbury Permanent Printing Company at Kent Gardens' in 1882, he reported that 30,000 prints could be pulled in a day (Pritchard, 1882), which made them the main supplier for portraits between 'electioneering orders and orders connected with Royal marriages' (Pritchard, 1882). Woodburytypes from 'Men of Mark' printed by The Woodbury Permanent Printing Company can still be bought today (see figure 1).

Pritchard describes the steps for Woodburytype in an industrial setting, i.e. at The Woodbury Permanent Printing Company, as follows: 1.) A light sensitive gelatin film is put under a negative in a printing frame and printed in the sun. 2.) The unhardened gelatin is washed off in warm water. After hardening with alum (a hydrated double sulfate of aluminum), the film is mounted on a glass plate to dry , the film is mounted on a glass plate to dry. 3.) The dry film is stripped off and transferred into a steel tray. 4.) The steel tray is put into a press and a lead plate is pushed into the tray with a pressure between 150 to 500 tons, which transfers the gelatin relief to the lead plate. Step 4 is repeated until enough lead plates are produced to fill the Woodbury printing press. 5.) The Woodbury printing press is a table revolving on a pivot with a number of printing presses mounted at the margin (see figure 2). The printer opens each press, pours a certain amount of warm pigmented gelatin on the oiled lead plate, puts a piece of paper on top, closes the press and rotates the table to repeat the procedure until he has reached the first press again. 6.) By then the gelatin has set, the print is removed, transferred to another room where it is dried, hardened, trimmed and mounted.

Commercial Woodburytype printing had disappeared by about 1900 (Coe & Haworth-Booth, 1983). The labour-intensive postprocessing of the print, i.e. hardening, trimming and mounting, made it too costly to compete with halftoning prints (Ives, 1884) where no post-processing was required and text and images could be printed at the same time.

1.1. Dichromated gelatin and historical plate preparation

Gelatin (for a detailed description see 'Gelatin Manufacturers Institute of America', 2019) granules are vitreous, brittle and faintly yellow in colour and contain 8 to 13% moisture. Their density is 1.3 –1.4 g/cm3. When soaked in cold water, they swell. When warmed above 29°C, the swollen granules will dissolve and form a viscous solution. Gelatin forms thermo-reversible gels in water. The strength of the gel is a function of temperature; the presence of additives; gelatin content; its structure and molecular mass. A measure of the gel strength is the Bloom value. In 'Gelatin Manufacturers Institute of America' (2019) it is defined as the force which is required to depress a standard plunger into a gel a distance of 4 mm. The gel sample is prepared from 6.6 wt% solution at 60°C and cooled to 10°C for 17 hours. The higher the Bloom value, the stronger the gel.

Figure 3

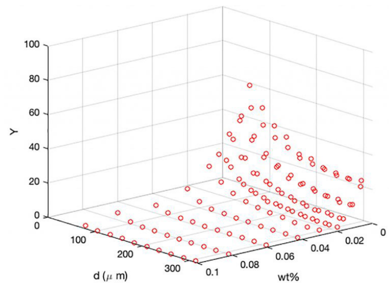

Figure 4

Figure 5

Figure 6

Figure 3: From analogue negative via photopolymer plate and silicon cast to Woodburytype
Figure 4: CIE luminance as function of carbon black concentration and optical path length in the dried gelatin layer from (Leech, et al., 2019)
Figure 5: Woodburytype on inkjet microporous photographic paper, pulled from a silicon printing plate
Figure 6: Woodburytype on silk mounted in card board

When a gelatin coated substrate is soaked in a solution of potassium or ammonium dichromate, it becomes light sensitive to wavelengths below 540 nm (Calixto, et al., 2018). Dichromated gelatin is selectively tanned when exposed to UV radiation, i.e. cross-linking bonds are formed, and it hardens. The first step in preparing a printing plate is to make a contact print of a photographic negative onto a dichromated gelatin layer. The layer is 'developed' by washing the unhardened gelatin away. A relief has formed. The highest areas of the relief are found where the gelatin was exposed to the highest levels of light, the lowest where no or little light reached the gelatin. Historic Woodburytype uses the hardened gelatin matrix as the embossing pattern for the lead plate since it can withstand pressures of up to 35 MPa (Stulik & Kaplan, 2013), equivalent to 345 times the atmospheric pressure at sea level. Pigmented gelatin is used as printing ink. The ink is prepared by mixing gelatin with minute amounts of carbon black (see section 2.2 Ink preparation). The weight concentration of gelatin is about 15 to 20 wt%. Depending on the Bloom value of the gelatin, i.e. the gel strength, the ink will set in 5 to 10 min and the paper can be separated from the printing plate, that is the print can be pulled. The time needed for the gelatin to set depends very much on the room temperature. In the heat of the summer of 2019 with temperatures of between 23-29oC, it was not possible to print a Woodburytype since the gelatin would not set, even not after 60 min.

MODERN WOODBURYTYPE

Today Woodburytype is only practiced in 3 locations: Two Palms in New York (USA), Factum Arte in Madrid (Spain), and the Centre for Fine Print Research in Bristol (UK).

Woodburytype today is no longer printed from lead plates. The following methods describe how we have developed production of Woodburytype at the Centre for Fine Print Research; from the making of printing plates, to how inks are prepared and how the prints are pulled.

2.1. PLATE PREPARATION

The most common modern practice to manufacture a Woodbury printing plate is to CNC mill the plate. A digital file guides the cutting action of a CNC mill. The CNC milled plate can either be used as the printing plate, then the milled image has to be cut as a horizontally mirrored negative, or can be used as a mould to cast a silicon printing plate. In the second case the plate has to be milled as the positive in the same orientation as it should appear in the final print. A silicon cast is taken from it and the print is pulled from the silicon cast which gives, on average, more reproduceable results. When the printing plate is prepared by using a CNC mill, its resolution and size is restricted by the resolution and size of the machine, i.e. the dimensions of the cutting tool, the height variations allowed by the machine and the size of the bed.

An alternative method, which is faster and more cost efficient, uses photopolymer plates, like for example the Toyobo Printight Solar PlateKF95. The Toyobo KF plates have a transparent mylar backing which allows UV exposure through the substrate. In a first step the photopolymer plate is exposed from the back to UV light to create a hardened layer next to the substrate. Then an analogue or digital negative of medium density, i.e. medium contrast, and with good detail is brought into contact with the back of the polymeric plate. The photosensitive polymer layer is exposed through the transparent substrate. The photopolymer hardens from the substrate upwards and creates a relief with the transparent areas of the negative, i.e. the dark areas of the positive image, generating the highest areas in the relief. After the soft polymer is washed away, a silicon cast is taken from the photopolymer plate. The relief is now inverted and the darkest image areas are the lowest regions of the silicon plate. The relief is flatter than that of the CNC milled plate but the detail is superior. Exposure times depend on the UV unit used. We used a Natgraph Self Contained UV Exposure Unit and exposed for 90 sec without the negative and for 500 sec with the negative. After developing and drying, the plate is hardened either in sunlight for several hours or again in the Natgraph for 500 sec.

For high contrast images, for example photos taken in bright sunlight, a high printing pressure is required, which can distort the silicon printing plate. In a third method, we cast the printing plate from the photopolymer plate using Polylactic Acid (PLA). The PLA is heated to 200°C, the melt is degassed under vacuum (- 0.1 MPa) for 12 min and poured onto the hardened photopolymer plate which sits in a well. After cooling for about 30 min, the two plates are separated (the cooling time is very much a function of plate size). The relief depth is the same as for the silicon plate, but PLA is much harder and does not distort under increased pressure.

2.2. INK PREPARATION

For the printing inks we used 20wt% of Rousselot food grade 173 or 250 Bloom gelatin (used as received) or a 50/50 mixture of both in deionized water. The carbon black was XPB430 (Orion engineered carbon, used as received), a water-soluble pigment preparation with 50wt% pigment content. The carbon black concentration is a function of the relief depth of the printing plate. The CNC milled plates require a lower concentration of carbon black than the plates cast from a photopolymer plate, since the relief of a CNC milled plate is on average higher, i.e. the light path of the reflected light in the gelatin layer is longer. In (Leech, et al., 2019) we found that for 1 mm relief depth of the printing plate, a carbon black concentration of 0.02wt% gives maximum contrast and grayscale. In Figure 4 the CIE luminance Y is plotted against the carbon content of the ink and the optical path length in the dried gelatin layer. At 0.02wt% black has still a low luminance and white is relatively bright. Lower concentrations lead to a grey black. Higher concentrations make the white to dark. The gelatin was immersed in the cold, aqueous pigment dispersion and left until all the water was soaked up by the gelatin. The mixture was then put into a 50°C oven until it had melted. The ink can be used straight away. Better results, i.e. less bubble and streak formation, were reached when the ink was left in a fridge at 6°C overnight.

2.3. PRINTING

We used an Albion Letterpress for printing. The printing plate is wedged into a custom-made frame which fixes the plate into position and allows us to align paper. The plate was wiped with lavender oil to help the release of the gelatin ink. Any low viscosity oil can be used, but lavender oil gives the best release and does not leave streaks on the print. By packing with neoprene blankets, the pressure is adjusted in such a way that the ink is transferred to the paper surface but not chased into the paper. Higher pressure gives a whiter white, but also increases the contrast in the image. A pressure too high will drive the ink into the paper and all contrast is lost since by absorption of the ink into the scattering matrix of the paper the optical path length through the ink layer is drastically reduced and the carbon concentration in the visible layer is too low to display grey scale. A generous amount of warm gelatin ink, at about 50°C, is poured onto the plate. Bubbles on the ink surface, which occur occasionally, should be removed with a pipette. They occur less often when the ink is either degassed or has been gelled and melted several times, by heating the ink in a water-bath or oven and then cooling it in a fridge again. Any surplus gelatin squeezed out during printing can be collected, melted and be re-used.

Woodburytype can be printed on almost any paper. Traditionally, smoothly calendered paper was used. We found that microporous inkjet photopaper is suitable and gives the most photorealistic results. Papers with a structured surface introduce interesting effects, and it is up to the user how close the result should be to the photographic original. Even fabric can serve as a substrate, as Figure 6 shows.

Shrinkage of the gelatin during drying causes distortion of the paper substrate. A bigger substrate size minimizes paper distortion. Using gelatin with a lower Bloom number reduces the distortion further. After the prints had dried thoroughly, they were flattened in a mounting press at 50°. Any temperature higher than that will melt the gelatin of the print and destroy the relief.

CONCLUSION

Woodburytype was the first, and remains the only photomechanical process that can reproduce truly continuous tone, delicacy in shadow and highlight areas at the same time and a supple surface texture, premium characteristics that were sacrificed due to technology problems at the time. By using modern methods and materials Woodburytype is freed from historic obstacles and will experience a revival. As a three-dimensional print it will open up new opportunities for artistic expression. At the same time, the relief lends itself as a platform for functional materials which will allow the addition of security features to an aesthetically appealing print.

REFERENCES

Calixto, S., Ganzherli, N., Gulyaev, S. & Figueroa-Gerstenmaier, S., 2018. Gelatin as a Photosensitive Material. molecules, Volume 23, pp. 2064 – 2088.

Coe, B. & Haworth-Booth, M. (1983) In: A Guide to Early Photographic Processes. London: Victoria & Albert Museum, p. 29.

Crawford, W. (1979) In: The Keepers of Light. New York: Morgan & Morgan, p. 235 – 293.

Gelatin Manufacturers Institute of America, 2019. Gelatin Handbook. s.l.: Gelatin Manufacturers Institute of America.

Gelatin Manufacturers Institute of America, 2019. Standard testing methods for edible gelatin. s.l.: Gelatin Manufacturers Institute of America.

Ives, F. E. (1884) Photographic Block Methods. Photographic News, Issue 4, January, p. 13.

Leech, D. J., Guy, W. & Klein, S. (2019) The optical Properties of the Woodburytype – An Alternative Printing Technique based in a Gelatin/ Pigment Matrix. San Francisco, Society for Imaging Science and Technology.

Pritchard, H. B. (1882) In: The Photographic Studios of Europe. London: Piper & Carter, pp. 96 – 101.

Stulik, D. C. & Kaplan, A. (2013) Woodburytype in The Atlas of Analutical Signatures of Photographic Processes. Los Angeles: The Getty Conservation Institute.

Talbot, W. H. (1844) The Pencil of Nature. London: Longman, Brown, Green and Longmans.

Whitfield, L. A. (1880) Men of Mark: Contemporary portraits of distinguished men, Volume 4. s.l.: Sampson Low, Marston, Searle and Rivington.

Woodbury, W. B. (1864) Producing Surfaces in Relief. England/London, Patent No. 2338.

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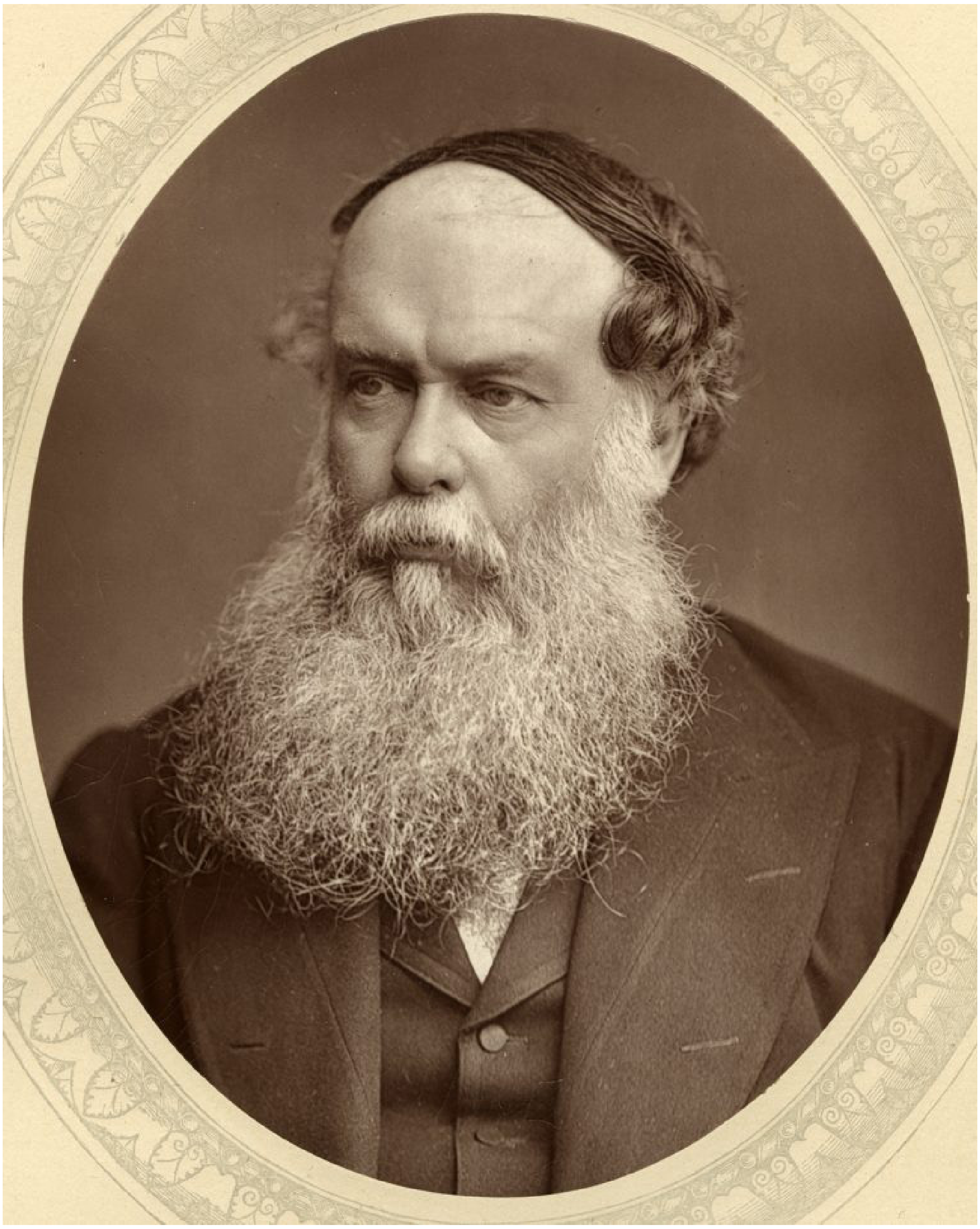
IMAGE GALLERY



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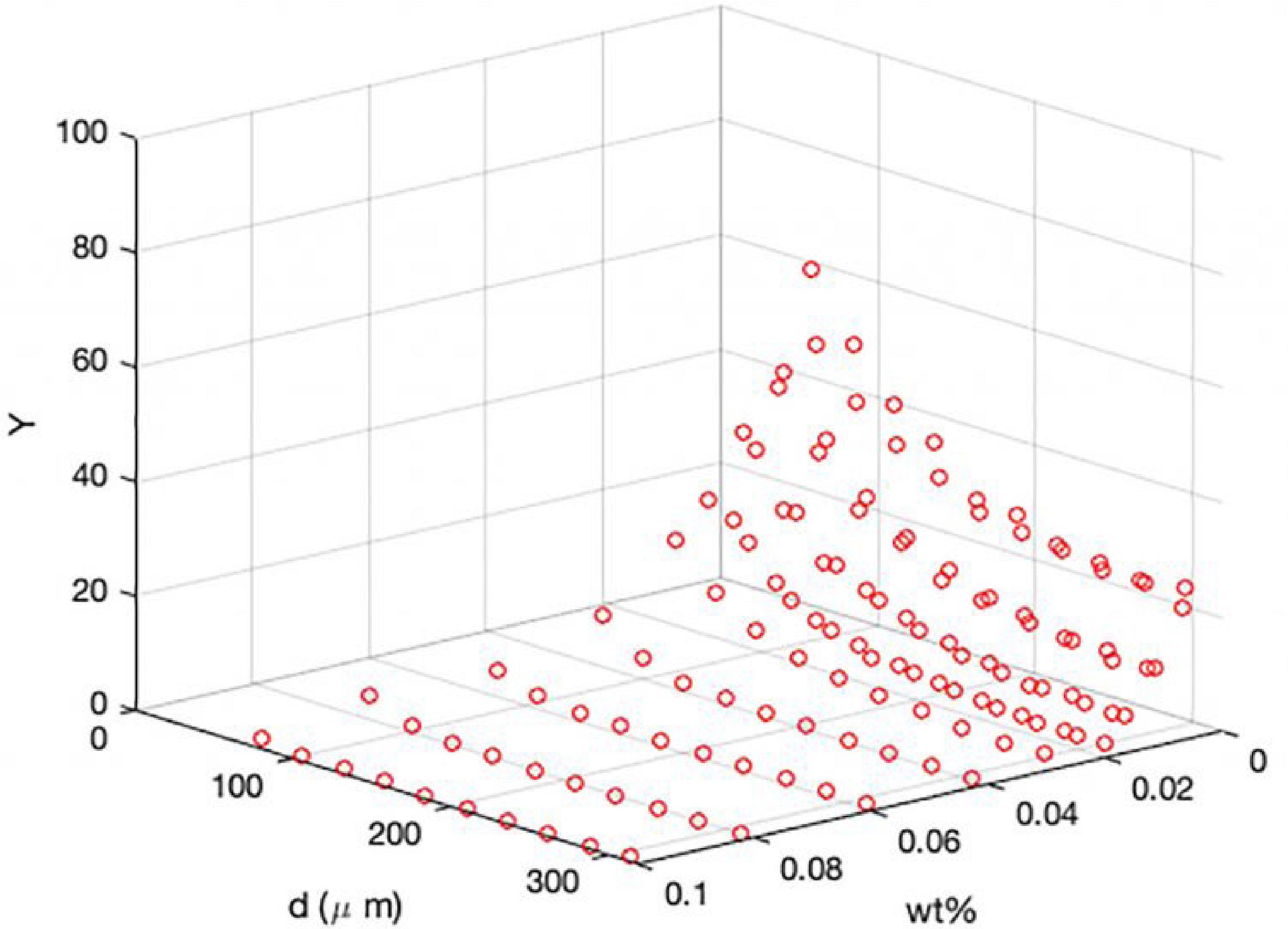

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