Underglaze Tissue Printing for Ceramic Artists, a Collaborative Project to Re-appraise 19th Century Printing Skills

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Abstract. Under-glaze tissue ceramic transfer printing first developed circa 1750 and involved engraved or etched copper plates, from which tissue was printed with cobalt blue oxides. Under-glaze tissue has a very distinctive, subtle quality - it is an integral part of both English ceramic history and the history of copperplate engraving. The process was common in the UK ceramics industry until the 1980s. However from the 1950s it began to be supplemented by screen-printing, because underglaze tissue transfer was relatively slow and required skilled artisans to apply the transfers. The authors are collaborating with Burleigh Pottery in Stoke-on-Trent, the last remaining company to produce ceramic tableware decorated using the traditional printed under-glaze tissue method. The pottery was recently saved from closure by the HRH Prince Charles Regeneration Trust, who wish to maintain the traditional manufacturing skills for the next 25 years. The Centre for Fine Print Research (CFPR) in Bristol has been reappraising the use of these traditional 19th Century skills with modern materials and methods for producing engraved plates. The project seeks to demonstrate how those 19th Century methods can be applied by contemporary ceramic artists. The paper will explain the process of ink manufacture, heating the plate for printing, digital methods of making plates and the use of potters tissue.

Introduction

Underglaze tissue uses an engraved or etched copper plate or roller, from which a wet strength tissue paper is printed with an oxide (commonly cobalt (Co) in order to create the distinctive blue colour. The process was first developed to emulate the distinctive blue and white pottery imported at that time from China, the famous 'Willow Pattern' being the best known example (see Figure 1). The copper plate or roller is inked intaglio, therefore into the engraved lines rather than on the surface, when the surface of the plate has been wiped clean of ink, the plate or roller is printed under high pressure onto the tissue. Underglaze tissue has a very distinctive, subtle quality – it is an integral part of both English ceramic history and the history of copperplate engraving.

The process was used extensively for over 200 years in the UK ceramics industry from the 1760’s until the 1980s. However from the 1950s underglaze tissue transfer printing began to be supplemented by screenprinting and has now been replaced by pad printing because underglaze tissue was relatively slow and required skilled artisans to apply the transfers. The authors, funded by the UK Arts and Humanities Research Council are collaborating with Burleigh Pottery in Stoke-on-Trent, the last remaining company to produce ceramic tableware decorated using the traditional printed underglaze tissue method, in order to develop faster methods of printing underglaze tissue without losing the processes historic qualities. The pottery was recently saved from closure by the Princes’ Regeneration Trust, who wish to maintain the traditional manufacturing skills for the next 25 years.

The fundamental problem is a long-term issue with both the maintenance and production of printing hand-engraved rollers and plates. The project addresses that issue by introducing the potential for printing the traditional potter's tissue and applying it in the same way as the late 18th Century process, but creating the plate from a digital file. By creating a combination of the digital capabilities of flexographic printing technology and the earliest printing process developed for the ceramic industry. The aim of the project is to reduce the time from one month needed to engrave a...
roller to less than a day to create a digital equivalent, whilst retaining the integrity of the final product and reducing the cost of plate manufacture by up to ninety percent.

The process and its history

The initial transfer printing process from 1750 developed through an appropriation of printing plates from the commercial etching and engraving industry and involved engraved or etched copper plates, from which tissue was printed with an oxide - commonly cobalt (Co), but manganese (MnO₂) and copper (CuO) were also used. Whilst both underglaze and on or over-glaze printing occurred at this time, the first patents seem to suggest that enamel transfer printing on metal with on-glaze colour may have occurred earlier than ceramic transfer printing [2]. By glaze, we mean a coloured glass fired at a high enough temperature for it to liquefy and spread across the surface of the artefact being fired, which will re-solidify when cooled, thus producing a permanent vitrified surface. On glaze or enamel refers to a coloured glass that is fired on top of the initial glaze.

There are three primary methods of applying printed decoration to a pot. Underglaze is applied after the raw pot has been fired to a state known as biscuit, the coloured decorative element of the glaze is printed onto a tissue, then low fired to the pot, the pot is then glazed with a transparent glaze and refired, so a total of 3 firings in all. The Underglaze process also requires a white ceramic body so is limited in the range of bodies it can be applied to. In-glaze is applied to the pot before glazing and the glaze is applied immediately after, but before both the in-glaze and the final glaze are fired together, so two firings. On glaze is applied after the pot has been both biscuit fired and glazed, then a further on glaze coloured decoration is applied and the pot is fired for a third time. On-glaze has been the dominant method since the late 1950’s, the contemporary process uses either screenprinted water slide transfers or decals, or is pad printed, by a silicone bombe or teat, from a flexographic plate onto the pre-glazed ware. The limitations of pad printing are that it will only print onto flat or concave surfaces, it will not print compound curves or convex surfaces.

In this project we are interested primarily in tissue transfer printing, which involves printing an engraved copper or steel intaglio plate onto a dry tissue, known as potters tissue. This is a wet strength tissue, (the nearest equivalent today being the paper used for hand rolled cigarettes), which has long fibres, that allow the tissue to retain its shape and strength when wet for comparatively long periods of time. The tissue used in current production is manufactured by Republic Tobacco LP in Perpignan, France under the brand name Job. The process has some similarities to contemporary artists’ intaglio printmaking, but the difference lies in the press and plate and the method of printing. The press consists of a top and bottom roller - as in a conventional etching press, but without a press bed. In addition the top roller of the press consists of a hand engraved, chrome faced copper roller. This roller has a heating element inside to enable the ink to release easily onto the tissue. The ink is made primarily with a linseed oil medium and a metal oxide, such
as copper, cobalt or manganese as the pigment. The ink is deposited onto the roller from an ink duct and then a metal scraper bar cleans the surface of the roller, leaving the intaglio ink in the engraved lines of the roller (see Figure 2). Tissue is passed through the press in a continuous roll, which enables the pattern to be cut as necessary and keeps production flowing.

![Fig.2. Section of engraved roller and doctor blade on printing machine](image)

The process traditionally also involved printing from a flat copper plate that had been chrome or steel faced to aid printing and protect the copper surface (see Figure 4). Chrome also stopped the printing ink oxidising on the plate and changing the final fired colour. The flat plate printing press consisted of a half round top roller and plank positioned between the top and bottom roller. The plate was placed onto felt blankets on top of the plank for printing and rolled in and out of the press.

**The Company**

Burgess and Leigh (Burleigh) were founded in 1851 and moved to their current site the Middleport Pottery in 1889. From its heyday of over 200 factories in Stoke on Trent, Burleigh are probably the last continuously working pottery to inhabit the same factory site. In 2009, the Princes Regeneration Trust, founded by HRH Prince Charles purchased the physical site to retain the skills and heritage of a Victorian working pottery. Meanwhile the actual pottery company was bought by Denby Potteries, who agreed to continue making ceramics on the Middleport site for at least the next twenty-five years. They currently employ forty workers of whom approximately fifteen are employed in the tissue printing and application process with two machines that print from the hand engraved etched rollers (see Figure 3). They only employ one trained engraver currently in his mid-seventies who was brought back from retirement to continue the tradition. Currently Burleigh have no plans to train a new young generation of hand plate engravers.

The factory site itself retains all of its Victorian characteristics and splendour, from the offices with their Victorian signage, through to the old processes in the factory. The site still retains the old bottle kilns (no longer in use) and it is only in the last few years that it has ceased to use its 19th Century drying systems. Burleigh still retains an extensive mould store of all of its original patterns and in addition has a full store of all its hand engraved copper flat printing plates alongside the hand engraved roll store with patterns that go back as far as the founding of the company.

The company had been purchased previously - in 2000 - by the Dorling Family, who recognised even then, that the pottery was facing closure, potentially resulting in the loss of an important aspect of Britain’s industrial heritage. This purchase enabled the companies survival until the collaboration between the Princes Regeneration trust and Denby created a long-term strategy for the future. In
2013 the company faces a secure long term future but has the problem of how to make a 19th Century process fit a 21st Century commercial environment.

The Project

The biggest problem facing the company is the need to quickly respond to changing customer demand expected by contemporary business culture. This is a particular issue as it takes up to three months to engrave a new copper roller. Once engraved the copper roller is chrome faced but printed using a scraper bar. The abrasive properties of the metal oxides in the ink, combined with using a steel scraper against the chrome means that the chrome coating will only withstand a weeks continuous printing before the roller needs recoating. As each roller takes three months to engrave, and even just re-chroming a roller takes a week - it is not currently possible for Burleigh to quickly produce a few trial prints to test the market and quickly respond to customer demand. In addition Burleigh’s extensive historic pattern books, cannot be commercially exploited as it would take decades to work through even the existing patterns, notwithstanding the added ability to create new patterns. Initially the Centre for Fine Print Research aimed to create a new intaglio process using a flexographic relief plate that had been processed for intaglio printing that could be wrapped round an upper printing roller blank. Many trials were undertaken to test the potential of intaglio processing, 90 shore flexographic relief plates to wrap around the roller blank, but after further research we are now trialling a Laser engraved 90 shore flexographic roller, that will replace the upper cylinder of the press. The roller can be made commercially by a flexographic plate making bureau service. One of the primary issues is creating a plate or roller with sufficient depth of intaglio to hold enough oxide and printing medium to stick to the biscuit ware.

In order to create a digital file the CFPR have been using a relief printing process to take an image from flat copper plates in the existing Burleigh copper plate collection. The resultant negative prints are then scanned and a digital file created. Once inverted the file is then cleaned up to retain the crisp edges and appearance of the original engraved plate (see Figure 6). The file is then sent to the plate maker for laser engraving.

The initial project aim was to create a flexographic printing process, however this cannot occur without a reappraisal of the printing ink. Currently Burleigh use an ink that contains pine oil. This has a problem, in that when heated to the required 40 degrees Celsius for printing the ink gives off unhealthy Volatile Organic Compounds (VOC’s) [3], secondly the ink will vary in printing quality dependent upon the oxide that it is mixed with. Each oxide has a different molecular structure that creates a different surface topography to the oxide particles. Therefore to make an individual ink each oxide requires different oil volumes to coat the surface topography of the particles evenly. For example some paler blues can print easily and crisply and in addition be easy to apply to the biscuit ware. The darker Cobalt blue prints easily but is hard to apply as the ink bleeds and rubs off onto the hands of the applicators. Other colours such as black can be very hard to get to stick to the biscuit. Traditionally the ink medium was a very heavy linseed oil measuring around 400 poise in
the UK measurement scale for viscosity and number 7 in the American measurement scale [4]. In order for the ink to be tacky enough to stick to the ware, tradition dictates that the ink and the plate are heated to loosen the viscosity of the ink to a stage that is akin to traditional intaglio printing ink and to enable the process to take place without using damped paper. Once printed dry onto the tissue, the ink (as it dries) becomes very viscous and sticky thus creating an optimum transfer ink. Currently we are investigating replacing the pine oil (also known as potters tar) with either traditional linseed, which would have been used historically or with newer synthetic polymeric oils.

![Fig. 4. Engraved plate, printed tissue and final glazed plate](image)

Once the plate has been printed the tissue has to be applied to the pot. Applying potters tissue is an extremely skilled process, most of the Female employees who apply the tissue at Burleigh have worked in the factory for many years and are highly skilled. In fact it is clear that a good applicator requires several years continuous training on the job, before becoming very proficient in the process. Once printed the tissue is cut to size and applied to the pot with a stiff brush and soft soap. However this is only part of the story. First the applicator rubs the tissue to the pot to get the tissue to stick to the biscuit surface initially, then a small amount of soft soap is applied to the brush and the tissue is vigorously burnished onto the biscuit surface to transfer the maximum amount of print to the surface and allow clean release of the tissue. For this stage of the process the tissue applicators use very stiff brushes and hard toothbrushes for the compound surfaces such as the complex cow creamer jug - a popular Burleigh item (see Figure 5). The object is then allowed a few hours for the print to dry on the surface of the pot before the tissue is washed off, leaving the print (printing medium and underglaze oxide) attached. The biscuit ware pot is then fired to approximately 600 degrees Celsius to remove the printing medium and fuse the oxide to the biscuit surface. The pot is then dipped into the transparent surface glaze and only fired in the kiln for the third and final time when the glaze has dried.

**Summary**

The project called for an unusual combination of skills. First we had to have a standard set of printmaking skills including knowledge of traditional copperplate engraving, knowledge of the steel and chrome facing of copper plates, printing of both flat plates and engraved rollers using both traditional etching inks and underglaze oxides. We also needed a comprehensive understanding of ceramic glazing and firing. Finally it is necessary to understand the commercial flexographic printing industry and the commercial constraints and needs of a large commercial pottery company. It is the combination of all of these elements that makes the project so interesting. The process has largely been neglected by contemporary ceramic artists because of both the difficulties of learning copper plate engraving and the secrecy that has traditionally prevailed within the industry about the methods of printing and the ingredients of the ink. Very little information regarding the process has ever been technically published. One of the results of this project will be technical information as to
how the process was used and how an artist can circumvent the lengthy process of plate engraving in order to produce a underglaze transfer printing plate.

Fig. 5. Cow creamers with tissue applied before firing

Fig. 6. Section of image after digital scanning

References: