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SCIENTIFIC METHODOLOGIES TO IDENTIFY ART PRINTS

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ABSTRACT

Modern photoengraving methods can generate forged prints really similar to original ones. Till recently, in order to distinguish between these fakes and original prints, art historian specialized in art prints have been using only magnifiers (magnifying lenses). The aim of the present study was to set up a scientific method based on non-invasive techniques to find out differences between photoengraving reproducing etching of the century XVIII and original etching of the century XVII, and to document them. To this aim, several devices were tested: IR reflectography, Portable X-Ray Fluorescence Analyzers (XRF) and optical microscope.

We aimed at analysing mainly the kind ink used and the lines. We chose not to analyse the kind of used paper, since for forged prints antique paper can be used as support. The IR response of the two kinds of print, was found to be not relevant. Ink components, as analysed by XRF were not to be distinguished between the ones used for photoenvravings and for the original prints. With the microscope, small areas showing lines were investigated with a 10X enlargement. Obtained macrophotographies allowed to point out a lot of differences between the two prints. The main ones were: the thickness of the ink, which is greater on originals than on fakes, the kind of light reflection: on originals light is absorbed (ink is dull) while on fakes light is specularly reflected (ink is bright and it seems without consistence), moreover thin and continuous lines in original prints can result broken in forged prints.

While the other investigation methods were considered not useful in this study case, microscope gave good results that are easy to achieve and to understand. It represents an easy way of investigation. Microscope can be considered helpful to support art historian during their investigation, and it provides a reliable and affordable way to document the differences between photoengravings and original prints.

INTRODUCTION

Photoengraving and original prints are going to be more and more similar because methods to create fakes are improving. Art historian using magnifying lenses to distinguish between originals and fakes sometimes find difficulties because of it, anyway this method is implicitly limited because it does not provide any objective documentation. Can science help to achieve objective results and document the traditional subjective judgement given by art historian using magnifyng lenses? Are non-invasive investigations helpful to this aim?

In order to broach this topic it is necessary to understand what is a print, how it can be obtained, what is a photoengraving, what may be called original. An original work of art is one that has come from the artist's own hand. Frequently artists need the expert assistance of the printer because some printing processes are complex, but artist creates the draw and superintends the printing process [3, 4].

Prints are usually on paper and created by the impression of the matrix previously covered with ink. The process is capable of reproducing multiples of the same piece. Each piece is an original because it is not a reproduction of another work of art [10]. A lot of different methodologies exist to create prints. We started studying Zocchi's engraving because his prints are very popular in Florence and neighbourhood.

Test Material

Giuseppe Zocchi (1717-1767) worked during the eighteen century in Italy. During this century, view paintings were common, they gave feelings of civic pride and sense of history but they were also souvenirs for travellers. Zocchi made two differents series of views: the "Scelta di XXIV Vedute delle Ville e d'altri luoghi della Toscana" and the "Vedute delle Ville e d'altri luoghi della Toscana". Both volumes were first published in 1744 and then re-issued in 1754. Zocchi drew, while several different engravers created the plate for printing. The designs were probably translated into prints by a process of making a tracing of the drawing onto a thinly varnished sheet of paper. This transparent sheet was then reversed on the copper plate and the design transferred, the final result was a print that did not reverse the drawing. These two works were commissioned by the Marchese Andrea Gerini. His purpose was to provide visitors with pictures to carry home and to remind them of Tuscany.

Zocchi shows an interest in realism, regularity and order, he was scrupulous in adhering to the correct proportions within the architecture. Drawings reflect clearly the life and the beauty of Florence and Tuscany as it existed during Zocchi's time [5, 11].

In order to carry out some analysis the tome X of Museum Florentinum was used. It was when original Zocchi's prints were not available since they are conserved in the Biblioteca Nazionale Centrale di Firenze. The tome was made in 1762, it contains images realized using the etching technique.

Etching Way of Printing

The technique used to obtain prints is an "intaglio" printing called *etching*. In "intaglio" printing the elements of the picture are made up by indentation in the plate. Ink is held in little furrows that will result inked on paper while the rised portion remain blank. Matrices for "intaglio" are called plate, they are usually of metal. Copper is the most common but steel, brass, bronze, zinc and others can be used. The engraved plate is inked all over and then ink is wiped off the surface, so it remains in the engraved lines [8, 9, 12]. Plate is now ready to be printed.

For etching, indentation is made by chemical action. Plate is covered with a greasy material, standard etching ground is made up of wax, pitch, mastic and asphalt. By drawing, usually with a needle, artist removes the layer of wax exposing metal. When the drawing is finished the back and the edges of the plate are covered with asphalt varnish and it is placed in a bath containing acid. The appearance of small gas bubbles shows that etching is in progress: acid bites the exposed metal. The progress of the work is checked from time to time by taking the plate out of the bath, rinsing it and examining it under a magnifying glass. Lines which are considered sufficiently etched are stopped out with asphalt varnish or white ground before the plate is returned to the acid.

The exposed metal is etched to the same degree all over, so etched lines are usually of the same thickness throughout their length. The earliest etchings were on iron plate, then copper was preferred but brass and zinc were used too [4, 6, 12].

Photoengraving Methods

Nowadays reproductions of art prints are made using photoengraving methods. Photoengraving is a process which uses photographic techniques involving photosensitive material. The image is photographed and recorded on a sentitized metal plate by a photo-chemical process [3, 10, 12].

There are different methodologies to obtain photoengraving as it is for original prints. To simplify the first step is to obtain an image, by camera or by scanner, of the prints we want to reproduce, the negative obtained is put on a matrix covered with photosensitive material. Now light occurs to modify solubility and hydrophobicity of the photosensitive material exposed. Exposition to light through a photographic negative causes it to harden where the negative allows light to pass [3, 7].

With photogravure it is possible to produce good imitations of “intaglio” techniques. The image-bearing indentations in the copper cylinder are produced by photography and chemical action. The picture is then transferred to the copper cylinder in such a manner that cavities are formed in the surface. Cavities vary in depth according to the desired tone of grey.

A carbon tissue is used, it is coated on one side with a layer of gelatine and this coat must be rendered sensitive to light. The carbon tissue is now exposed to light, the gelatine is hardened according to the intensity with which the light acts upon it and thus loses its solubility in hot water. After exposure the carbon tissue is pressed onto the copper cylinder in such a way that the damp layer of gelatine adheres to the metal surface. Development is carried out in warm water. The cylinder is then turned in warm water until the unexposed gelatine is also washed away. A relief remains in the copperplate containing the image in the form of a negative; the highlights are represented by a thick layer of gelatine and the dark portions by a thin layer. A mordant is now pored over the cylinder, it penetrates more rapidly where the gelatine is thin, more slowly where the gelatine is thick. A graded printing surface is so formed with cavities etched to various depths: the darker areas of the picture are more deeply etched than the lighter ones. The printing process is simple: the cylinder is fed with ink and the paper is pressed against the copper cylinder by the impression cylinder [4, 7].

This kind of prints is considered not original when used to reproduce original prints [3]. They do not make use of the original plate. The difference between original and fake prints is the creative action of the artist which in this case has been expressed on the original plate.

The Analysis Framework

The prints field is really wide, we started working with original XVIII century prints and fakes reproducing Zocchi’s prints black and white both on antique and modern paper without considering paper age. We chose not to consider coloured prints because colour components can discriminate the age of the print by themselves. Then we decided not to consider paper age because fakes can be printed on antique paper.

Our main assumption is that we deal with a fake really similar to the original, which means that we have two prints representing the same image, having same size, same paper, same ink colour. It is not so common to have a forged prints with all these characteristics, usually it happens that the kind of paper or the image or others elements are different enough for art-historian to distinguish between a fake and an original print. With the naked eye and using magnifying lenses, generally, art historians look for broken lines and the size of the lines. On fake prints it happens that thin lines may result broken because during the acquisition of the image and the photoengraving process, these lines are lost. Sometimes in order to avoid this problem, photoengravers enlarge lines to be sure they appear on paper. However, thanks to these elements it is possible to make a first classification of the prints under analysis.

When neither of the above mentioned element is to be found, the identification process becomes much harder, and its relief mainly on subjective observations which are difficult to document, while it is necessary to record them in order to share them and to make them undeniable.

EXPERIMENTAL SET-UP

We used original prints from a volume of Zocchi's works "Scelta Di XXIV Vedute delle principali Contrade, Piazze, Chiese e Palazzi della Città di Firenze" conserved in the Biblioteca Nazionale Centrale di Firenze, photoengraving reproducing Zocchi's etching and other prints from the tome X of "Museum Florentinum".

As non invasive analysing devices, we used a IR reflectography scanner, a Portable X-Ray Fluorescence Analizers (XRF), and an optical microscope. All these are portable devices, they investigate the work of art behaviour in different wavebands. In literature, several other devices were tested on prints, mainly, however, not with our same goal, but in order to study degradation processes and possible conservation methodologies. For example PIXE (Particle-Induced X ray Emission), an Ion Beam Analysis technology, was tested and proved to be useful to investigate metal-gall inks. Others devices used to this aim were micro-FTIR and Raman. They proved to be helpful to investigate the kind of paper, pigments, degradations products [2, 13].

With IR scanner we investigated original and fake prints of the same size reproducing the same image, they were originals from Zocchi's volume and fakes reproducing Zocchi's prints. The device used was a planar scanner equipped with an InGaAs Photodiode: this is a digital IR B/W device with sensitivity till 1700 nm and radiation source with continuous emission spectrum and rich emission in the long wavelength range. The acquisition was performed with a standardized procedure, implying the device prior lab calibration, an on-site calibration, stable set-up, sensivity, filter system and radiation source. The acquired reflectogram has a spatial resolution of 101.6 dpi and a 12 bit/pixel resolution [14]. This device is mainly used for painting because to a bigger wavelength corresponds a lower scattering phenomenon, this permit to have information about painting's internal characteristics, e.g. the sketch on the ground layer [13].

Fakes (before) and originals (afterwards) were placed on a easel to keep them in a vertical position and at a certain and constant distance from the instrument. This device has got its source of light so it is not influenced from the surrounding.

With XRF we investigated the inks of forged prints reproducing Zocchi's etching and of original etching from the "Museum Florentinum". Energy Dispersive X-Ray Fluorescence (XRF or EDXRF) is an elementary analysis device useful to detect ink components. The atomic number (Z) of the elements determine sensibility and penetration of X-Ray. Sensibility increases with Z, penetration capacity decreases with Z, it can't reveal elements lighter than Sodium (Na, Z=11).

We used a transportable XRF system (manufacturer EIS Srl; Rome, Italy) with the following technical characteristics: tube: tungsten bulk anode, glass window of 1 mm thickness, an aluminium collimator of 1 mm of diameter was used, working at a HV from 3 to 35 kV and at a maximum cathode current of 0.1 mA; the X-Ray production system is composed of two modules: the X-Ray tube itself and the controller; detector: a Silicon Drift Detector (SDD) with beryllium window cooled by a Peltier pile; energy resolution of 150 eV at 5.9 keV at 10^4 counts/s in the total spectrum; pointing system: two laser diodes; the detector system is composed of two modules, the detector itself and the controller. The work point is defined at the intersection of the two beams from laser diodes [15].

To simplify, the device is composed of an RX source and of a detector connected with an acquisition system. An RX radiation arrives to the sample that reacts emitting photons having lower energy than incident ray. Emitted photons are called X-Ray fluorescence, they are typical of the emitting elements. A detector receives them, we can visualize a graph that will contains peaks typical of each detected element [13].

After instrument calibration, each print was posed at a certain distance from RX source and detector, the two laser diode had to be superimposed in a inked zone. Here we started the analysis, which lasted 120 seconds for each sample.

With microscope we investigated the inks of forged prints reproducing Zocchi’s etching and of original etching from the “Museum Florentinum”. For microscope investigation we used LOMO metallographic Metam R1, focal 23.2 with direct focus, NA 0.17. It is equipped with a digital camera Canon 8 Mpixel for visual and macro-photographic inspection of paper and ink. A 10X enlargement and grazing light were used. We chose a 10X enlargement to visualize more lines at the same time. A grater enlargement did not prove to increase the effectiveness of the method. Photographed zones have been indicated on a digital image of the print. We selected areas with many lines and areas with less lines, areas with thin and areas with large lines.

All the devices used are non-invasive and portable so the work of art could remain in its place and we were sure to not cause any stress to it. This characteristic was essential to investigate original Zocchi’s prints, owned by Biblioteca Nazionale Centrale di Firenze, since moving this work of art would not have been allowed otherwise.

RESULTS AND DISCUSSION

Reflectography (figs 1 and 2) obtained by IR scanner device did not show any difference between original and photoengraving prints. The ink behaviour was similar, both inks resulted to be absorbing the IR radiation to the same degree. Since, this device gives metrically correct images, we tried to use this characteristic to compare the two prints from a geometrical point of view. We tested the superimposition of the two images obtained by prints reproducing the same subject and having the same size. However we could not appreciate the optical distortion that could be typical of the photoengraving process if a camera was used.

Fig 1 shows the reflectography of an original Zocchi’s print: it does not show a typical ink behaviour

Fig 2 shows the reflectography of a reproduction of Zocchi's print:
it does not show a typical ink behaviour and it does not show optical distortion

Under XRF original from the "Museum Florentinum" and fake inks did not show differences: both resulted composed by light elements. It can be considered a reliable result: indeed antique paper is not damaged as would have happened if the ink was an metal-gall ink. Probably it was a carbon based ink. The hypothesis is reasonable because the carbon ink is the cheapest one and this kind of ink does not cause any damage to paper, and we indeed observed that paper condition was good [1].

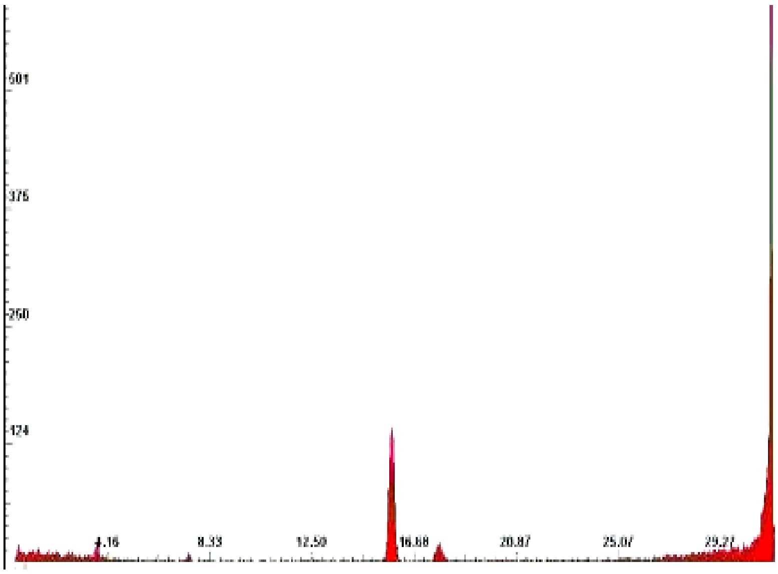

Fig 3 shows theXRF spectrum obtained on an ink sample: only device dependent peaks are visible

Macrophotographies obtained by taking photos with a camera connected to a microscope show lots of differences between original prints and photoengraving.

We note that inks have different thickness: ink from originals is raised on the paper, in a relieve structure, it is thicker than the one from fakes because the plate from which fakes are obtained has not deep lines, contrary to the original plate, grazing light brings out this characteristic (figs 5 and 6). Due to the intrinsic plate characteristics, on original prints ink permeates paper while on fakes ink remains on the surface (figs 9 and 6). The kind of light reflection is different. Original ink is dull because light is absorbed (fig 5), on fakes ink seems without consistence and it is bright: light is reflected (fig 6). Lines that should be continuous result broken on forged prints (figs 7 and 8), it happens especially for thin lines and it is due to the process to obtain photoengraving: because of the several necessary passages to obtain the plate, lines may result without the original depth. Several times, on originals, it is possible to observe lack of ink, which is well visible with macrophotographies, because empty spaces are really tiny. It may depend also on paper composition: impurities may give this effect (fig 11). On originals ink is granular while on fakes it is watery (figs 5 and 8). Granularity is also due to the plate from which print comes: in etching the plate is bitten from the acid that creates spots, it is here where ink goes and it is here where paper takes ink during printing processes. It is also important to observe margins: on fakes they are clean (fig 10), on originals they are surrounded by tiny spots (figs 5, 7 and 9) not visible to the naked eye because of their size. They are due to the process to obtain prints: when the plate is placed in a bath of acid small gas bubbles appear, they create the little spots around the line visible on our macrophotographies. The printer removes only the bigger spots, the ones he sees with the naked eye.

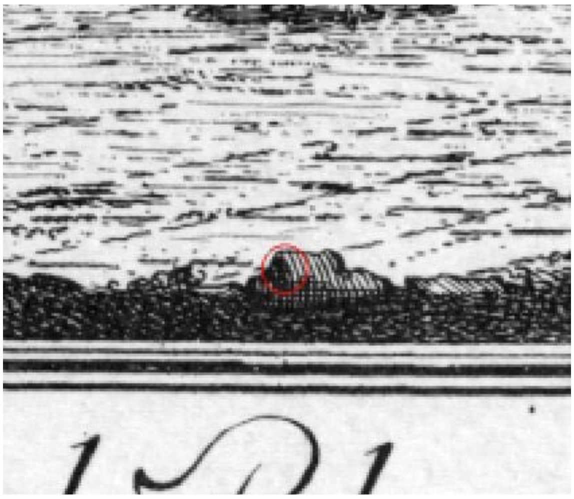

Fig 4 shows a part of a photoengraving in a full-size scale. The red circle signals the place were the macrophotograph of the figure 10 comes from in order to better understand the enlargement of the lines in the following figures

Fig 5: macrophotograph from an original etching of “Museum Florentinum”: the ink is raised on the paper and it is dull and granular

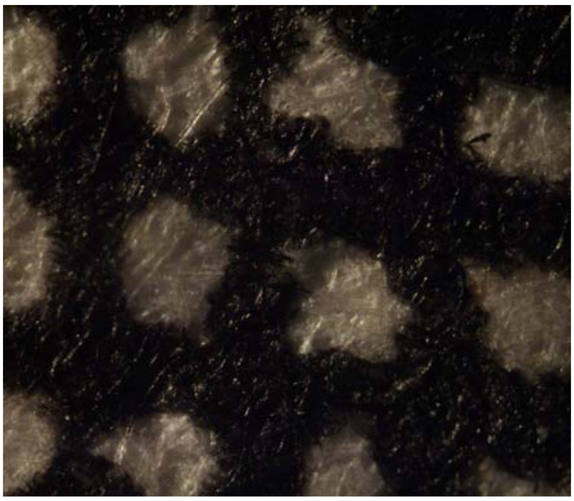

Fig 6: macrophotograph from a reproduction of Zocchi’s print: ink is not thick, it does not permeate paper and light is reflected

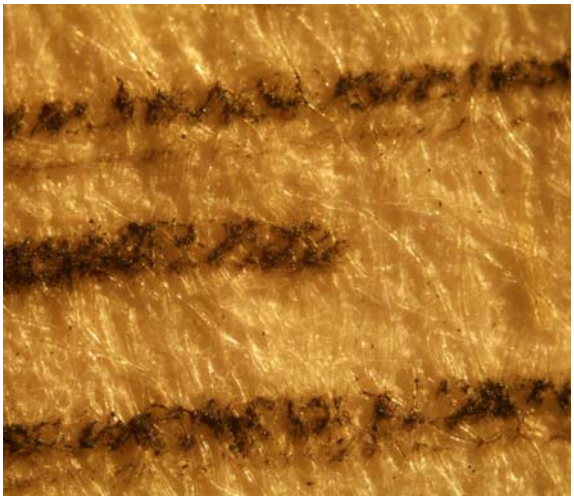

Fig 7: macrophotograph from an original etching of "Museum Florentinum": the line in the middle is intentionally broken

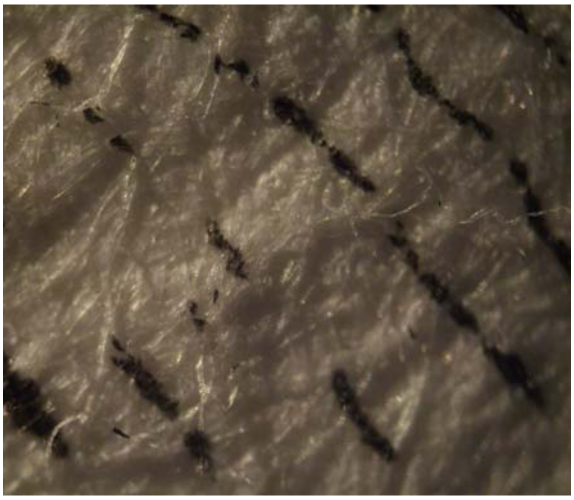

Fig 8: macrophotograph from a reproduction of Zocchi's print: lines are not purposely broken and they are watery

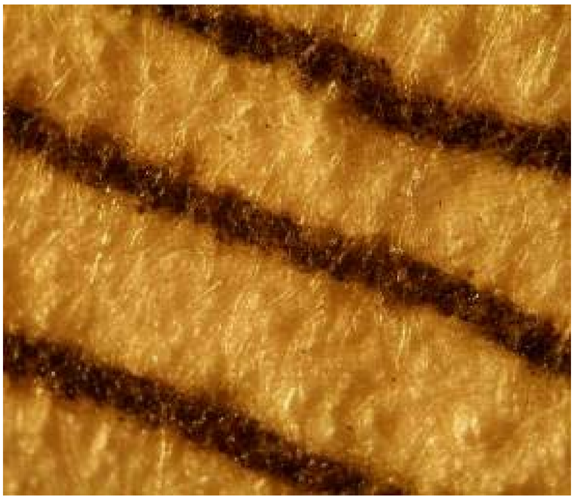

Fig 9: macrophotograph from an original etching of "Museum Florentinum": ink permeates paper, each line is surrounded by tiny spots

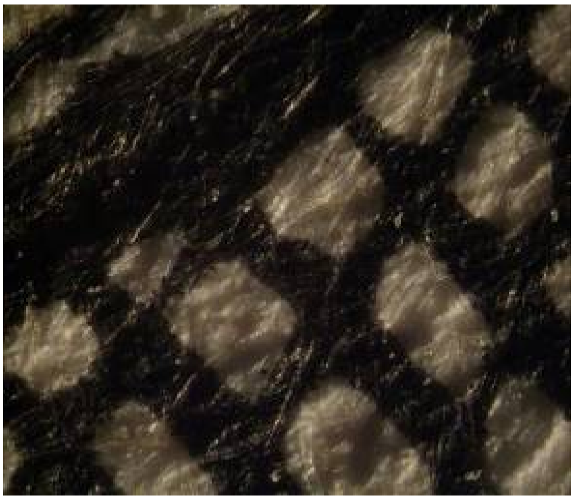

Fig 10: macrophotograph from a reproduction of Zocchi's print: margins are clean

Fig 11 shows lack of ink due to impurity of paper

CONCLUSIONS

This study has shown that microscope, a simple device, gives the best results in order to detect forged photoengraved prints, in an unobtrusive way. Macrophotographies are simple to obtained, the result is also similar to what an expert can observe using magnifying lenses. However, they have the advantage that they can be easily stored and they are easily accessible, also for the layman.

We hope that the most art historians start using this device in addition to magnifing lenses in order to give the most reliable and lasting results.

This is only the beginning of an extensive work that aims at including all kind of prints to give an answer to the many questions the evaluation of prints poses.

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