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Photomechanical crossroads - Comparing 19th-Century Chromocupography and Charles Eckstein's method from a Printmaker's Perspective.

David Lopes e Graciela Machado

Abstract: Chromocupography is a photo-etching technique developed in 19th-century Portugal under the supervision of chemist José Júlio Rodrigues (1843-1923). Very scarce literature is associated with the process, and it doesn't seem to have been widely used after being made public. At the time, the technique was presented as a variant of Charles Eckstein's (1840-1913) method, working in Hague, Holland. Eckstein's technique consisted of hatching the lithograph stone with very fine delicate multiple-point needles to produce tone variations. Chromocupography substitutes the stone for a copper plate and the needles for a special coating with resin, thus creating a granular reservation protecting the metal from the etching bath.
With this paper, we aim to present how the technical entanglements which are felt from a practical experience of the contemporary printmaker. We will be showing the various results we obtained conducting research following the descriptions found in literature around the subject of Portuguese process

Resumo: A cromocupografia é uma técnica de gravura fotomecânica desenvolvida em Portugal no século XIX, sob a supervisão do químico José Júlio Rodrigues (1843-1923). Verifica-se uma escassez significativa de literatura associada a este processo, e parece não ter sido amplamente utilizado na indústria após a sua divulgação. À época, a técnica foi apresentada como uma variante do método de Charles Eckstein (1840-1913), desenvolvido em Haia, Holanda. A sua técnica aplicada para a reprodução de cor em mapas, arrancava com um processo onde a pedra litográfica era raspada com agulhas de pontas múltiplas muito finas para produzir variações de tom. Já a cromocupografia substitui a pedra litográfica por uma chapa de cobre, e as agulhas por um revestimento especial com resina, criando assim uma reserva granular que protege o metal do banho de gravação. Neste artigo, pretendemos mostrar as complexidades técnicas que se tornam evidentes a partir da experiência prática de gravadores e impressores contemporâneos.

chromocupography, at the Faculty of Fine Arts of the University of Porto within the project of Pure Print Archaeology (i2ADS/FBAUP).

Demonstraremos os resultados obtidos através de pesquisa tecnológica, seguindo as descrições encontradas na literatura sobre o tema da cromocupografia portuguesa, nas Oficinas de Técnicas de Impressão da Faculdade de Belas Artes da Universidade do Porto, no âmbito do Pure Print Archeology (i2ADS/FBAUP).

Keywords: Photomechanical printmaking, José Júlio Rodrigues (1843-1923), Carel Eckstein (1840-1913), technological research in art, Pure Print Archeology.

INTRODUCTION

This paper is a case study centered on very concrete historical objects and technical descriptions from the 19th century. Specifically, we will discuss a copper plate produced by the Photographic Section of Lisbon under the supervision of José Júlio Rodrigues in 1876 and the prints taken from it. Such prints represent the only existing samples, which are found in the archives of the Societé Photographie Française. Additionally, we'll analyze the written description of the method by Charles (Carel) Eckstein, a printmaker from the Netherlands.

These two sets of techniques will be compared from the perspective of present-day printmakers practitioners. Firstly, because they are said to be historical derivatives of each other by the 19th century protagonists themselves, and secondly, because we believe that more details and information can be obtained from a practical and hands-on understanding of its making conducted by contemporary printmakers.

A disclaimer is necessary [to be made] as we present this analysis from a Fine Arts perspective, within the context of current artistic research methods (Arnette, 2016). Art-based research or artistic research can result in different outputs. For instance, at the Fine Arts University of Porto, artistic research can be purely theory-based, encompassing studies from philosophy, history, sociology, anthropology, politics, etc. Alternatively, it may involve a mix of practice-led research alongside theoretical work. Art-based or art-led research is the output that results from parallel research and can be presented in the form of art objects, art exhibitions, publications, etc. In the case of this paper, the authors have chosen to focus mainly on their practical understanding of printmaking and its historical research.

I. CONTEXTUALIZATION: RESEARCHING PRINTMAKING TECHNIQUES FROM THE 19TH CENTURY

The 19th century marked a period of remarkable progress across various industrial and scientific domains. In the realm of photomechanical processes, Ersnt Rebel (2008: 26-27) emphasized how the history of photography often overlooks the significance of printmaking techniques. As Rebel phrases it: "*Only the printed, mass-reproduced photo contributes to a change in public consciousness and can become a public image.*'" (2008: 28). Thus, it is crucial to recognize that discussing the origins of photography inherently involves acknowledging the role of printmaking.

Much like photography, the advancements in printmaking were fiercely driven by the pursuit of technological innovation, aligning with the era's societal push toward progress. Specifically, 19th-century printing played an important role in the dissemination of knowledge, enabling reproduction to be more efficient and cheap when compared to traditional methods. (Weisberg, 1989: 59) Both lithography and photography were introduced in the XIX century and revolutionized the scientific industry with the ability to easily reproduce any type of image, but it was the convergence of the two that paved the way for the practical application of photomechanical processes, which dominated the latter half of the 19th century (Cook, 2002).

To better grasp the subject of this paper, it's essential to differentiate between photographic and photomechanical processes, understanding their respective executions. Simply put, photography results from the direct interaction of light with a photosensitive prepared surface. On the other hand, photomechanical prints are derived not directly from a light source but from matrices that have been created using light.[1] Several photomechanical processes emerged during the second half of the 19th-century. Universal exhibitions held in Europe encouraged many to find new technical solutions for industrial printing.[2] Maps, plants, music sheets, historical prints of the past could now be photographed, enlarged or reduced, and later printed with new methods introduced.

Much of the interest in these new applications did not necessarily come from the conventional printmakers. Conventional techniques such as intaglio or wood engraving continued to thrive in established industrial contexts. However, it was the scientific and military communities that showed significant interest in photomechanical processes.

The interplay between military power and novel technology gains significance when we consider their role in territorial defense, particularly in map-making and printing. Cartography's

1. During the early days of photography, the existing technological methods fell short in terms of guaranteeing consistent reproduction of copies or the enduring preservation of images on a medium. Furthermore, these methods faced challenges when it came to large-scale or dimensional printing. As a result, it was the proficiency of printmaking skills which played a pivotal role in enabling the widespread circulation of photographs and images.

2. According to the following: https://www.bie-paris.org/site/fr/toutes-les-expositions-universelles. Only in the 19th-century, 12 "Expositions Universelles" were held around the globe in very wealthy countries. 4 of them were held in Paris, where the event gained a particular renown reputation. France represented ⅓ of the host country.

production largely rested in the hands of military surveys from its inception (Ristow, 1975: 78). Lithography garnered special attention from such departments and it was swiftly integrated into ordnance surveys during the first half of the 19th century, followed by photomechanical processes. Many inventors of new photomechanical processes proved their worth by printing maps because they were, either military men or men working for the military.[3]

Understanding the changes in the dissemination of technical knowledge accompanies the evolving status of printmakers. As elucidated by Michael Tymann (1990), specific military academies established their own lithography workshops, devised transfer papers, and incorporated drawing classes into their curriculum. The introduction of photography facilitated the chemical transfer of maps onto stone and metal matrices, simplifying the replacement of the traditional printmaker role by military personnel (Lopes, Machado, 2022). When the transmission of new printing technology remained confined within the realms of scientific and military research, these methods were less likely to diffuse into the conventional printmaking sphere. Therefore, we could admit a veil of obscurity shrouds numerous 19th-century technological techniques, including heliogravure, photolithography, photozincography, *panicographie* (also known as gillotage), and collotype.

Processes such as the innovations by José Júlio Rodrigues at the *Secção Photographica e Artística de Lisboa* (SPA) and Charles Eckstein 's chromolithography method stand as exemplars.[4] While multiple reasons contribute to their obsolescence, it appears to be closely tied to the perception of these processes as being primarily for reproduction rather than creation. Therefore, as other methods proved to be more effective, the practice and interest in learning these techniques diminished.

This factor constitutes a significant driver behind the contemporary artists' exploration of these techniques. Their endeavor aims to reintegrate these historical methods into present-day printmaking studios, with the specific purpose of fostering creative expression and inciting critical discourse in the realm of contemporary art.

3. In October 1809, Alois Senefelder was appointed as the "superintendent" of the Lithography print workshop at the Cadastral Survey, where he remained until his retirement in 1827. (Ristow, 1975). Nicephore Niépce first served in the military during the Napoleonic wars, and later pursued a scientific career.

4. See: Machado, G., Belkot , M. ., & Costa Brás, S. (2022). Gillotage. Exploring a mid-nineteenth century relief printing technique. IMPACT Printmaking Journal, 5, 20. https://doi.org/10.54632/22.5.IMPJ2

Disregarding a wealth of untapped technological options solely due to their lack of practicality within industrial settings seems unjustified. Particularly considering that even archaic and conventional techniques like intaglio processes, lithography, and wood engraving persist in practice across the globe within the confines of fine arts printmaking studios.

We argue that teenacting technical protocols is a necessary strategy, as it involves more than just theoretical comprehension; it requires the recreation of specific material and intellectual conditions, both material and intellectual, to engage with the process in a hands-on and practical manner. This experiential approach enables researchers to immerse themselves in the nuances, challenges, and intricacies of the process, gaining insights that may not be as apparent through mere observation or study.

Methodology

The research methodology employed by the Pure Print Archeology group has been developed over several years of work, under the guidance of Professor Graciela Machado (i2ADS/FBAUP). This methodology, termed as "Technological Archeology," serves as the guiding framework for the research endeavors conducted by the printmaking group at the Faculty of Fine Arts of the University of Porto. Such can be structured in the following phases:

Recovery and Mapping of Original Sources

This initial phase involves the comprehensive retrieval and identification of original sources, as well as recent publication on the matters. This includes a combination of written sources (manuals, letters, technical descriptions, etc.) and the analysis of objects within museum collections. This process aids in building a foundation of material understanding.

Availability of Material conditions

The second phase focuses on sourcing available materials required for the intended procedures. This often involves approximating rather than achieving complete reconstructions. Gathering the necessary material conditions forms a vital aspect of the research, as it establishes the predictable outreach for the technological reenactment.

Contemporary Application and Critical Reflection

The third phase is marked by a critical evaluation of how the identified process integrates within a contemporary fine art print studio context. This assessment extends to

the process's suitability for educational settings. Additionally, the methodology prompts a profound reflection on numerous interconnected themes within the realm of fine arts, such as the juxtaposition of manual techniques in an overwhelmingly digital landscape, concerns related to resource scarcity, the selection of materials in an environmentally-conscious era, the preservation of intangible heritage in the face of evolving technologies, the negotiation of economic systems dominated by industrial alternatives, the relevance of historical knowledge in contemporary society, etc. This introspective examination often serves as the initial impetus for researchers, framing their perspectives to make their art projects.

It's important to note that while these phases are laid out sequentially, they often interweave and blend together as the research progresses. The fluid interaction between these phases allows for a comprehensive exploration that ultimately enriches the research.

II. PHOTOMECHANICAL PROCESSES FROM 19TH-CENTURY PORTUGAL

Our initial focus on *chromocupography* as a distinctive historical Portuguese process unveiled a vast lineage of photomechanical techniques waiting to be reenacted. Chromocupography was first introduced to current academic publication with research of Maria Estela Jardim and Isabel Peres (at the time, a PhD candidate). Their research focused on the understanding of the history of scientific photography in Portugal and of the chemical processes involved, leading up to findings of printing of color in maps, specifically the process of *chromocupography*. Their efforts allowed for the publication of prints made using these techniques, and also identified original matrices of copper plates which are still preserved in government institutional archives.[5] They also have identified extant prints in the archives of Société Française de Photographic, an organization still active today.

Chromocupography, along with processes such as chromolithography, heliogravure, photolithography, photozincography, and collotype, stands among the array of techniques from the 19th century. These techniques were once employed by the Photographic and Artistic Section of Lisbon, signifying their historical relevance. Currently, the Pure Print Archeology Research Group is engaged in researching some of these methods developed by Rodrigues. This includes delving into the use *of thin foil metal plates* and the use of *photolithography*.[6] Back in

5. IThe historical archive of the Secção Photographica ou Artistica de Lisboa were held in the former IGP (Instituto Geográfico Português) and now belong to DGT (Direcção-Geral do Território).

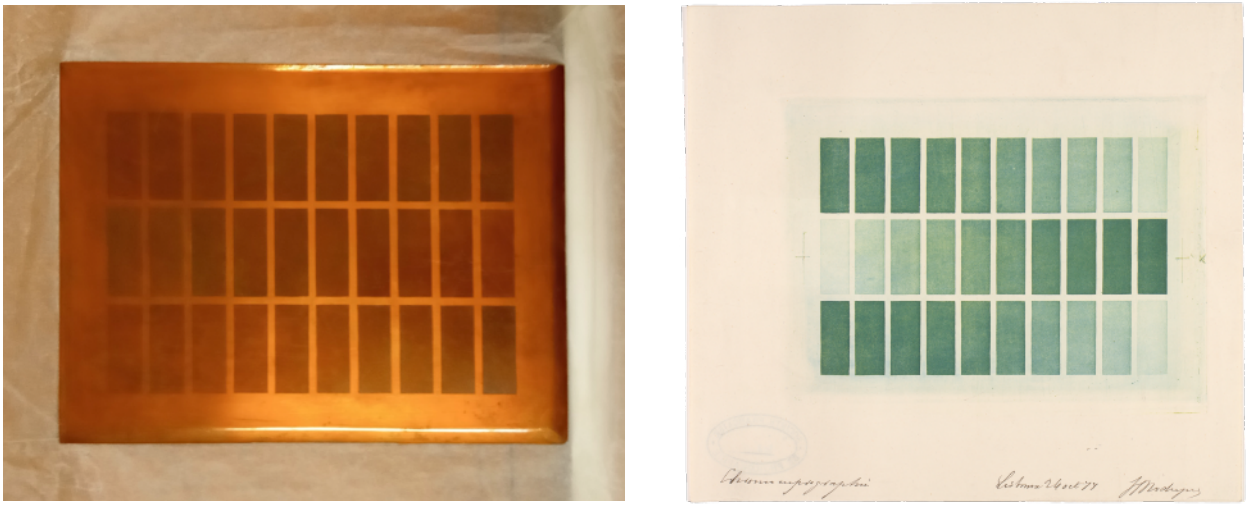

Image 1. [left] Secção Photographica ou Artistica. "Cromocupraphy". 1877. Copper plate. 15 x 20 cm. Photography by David Lopes. Source: Direção-Geral do Território: SALA 3.122 (Arquivo Cartoteca). 3º Piso, shelf 45 e./ [right] Secção Photographica ou Artistica. "Cromocupraphy". 1877. Print. (364.6 — Chromocuprographie. Lisbon, 24 oct. 1877. author's signature (green) - 22,9×25,6 cm. Source: Société française de Photographie (SFP), Paris. modelo judiciário em 1892.

the 19th-century Portugal, *chromocupography* was also referred to as "polychromolithographia", as the word appears in the Portuguese magazine *O Ocidente*. (Silva, 1892: 218).

Specific photomechanical processes developed to print maps?

An intriguing aspect for research lies in the communication that this process was specifically developed for printing colors on maps. This underscores the surge of novel processes during the 19th century. Amid this era, numerous processes touted their proficiency in map printing, with inventors strategically affiliating themselves with specific industries to gain recognition. Within this landscape, José Júlio Rodrigues, associated with the *Secção Photographica ou Artística*, received multiple awards for his contributions to the advancement of map printing technology (Jardim, 2014).

Yet another captivating facet of this process is its depiction as a variant of another individual's technique (Grandidier, 1882). *Chromocupography* is rooted in the innovations of Carel (or Charles) Eckstein, a Dutch printmaker who served as the Director of the Dutch Topographical Department of the Ministry of Defense (Koeman, 1975: 146-147). This

6. Research materials were presented recently at the "Pure Print Archeology - 1st Research Meeting" 3 days dedicated to research on photomechanical and innovative printmaking practices. 18 April 2023 — 20 April 2023. oMuseu from the Faculty of Fine Arts of the University of Porto and Fundação Marques da Silva, in Porto.

assertion finds support in multiple sources: Grandidier (1882) articulates it in writing as a technical derivative, historical archives of DGT carry an engraved message on the back of the matrix copper plate, and "Polychromolithographia" is referred in writing as a technical addition to Eckstein's process by Silva (1892: 218). By approximately 1877, *chromocupography* likely marked one of the last processes to be explored by Rodrigues at the *Secção Photographica ou Artística*, given the department was closed in 1878 (Ribeiro, 1882: 129). Jardim and Peres (2007) remark that the cartographer and technician Manuel Dias dos Santos was sended to The Hague in the Netherlands to learn this process directly from Eckstein. However, Jardim (2014) remarks that the outcomes of this endeavor were rather limited in success. Unfortunately, Manuel Dias dos Santos's life and contributions remain shrouded in obscurity, with scant information available.[7]

Printing colors in maps - about Eckstein's method (an explanation)

While labeled as derivatives, we argue that Rodrigues' and Eckstein's processes diverge significantly in their technical underpinnings. We will elucidate these distinctions in the concluding sections of this paper. Eckstein's method held the promise of color reproduction through stone lithography. It is evident that Eckstein's system served a crucial purpose in the 19th century, albeit its relevance may not be readily apparent today. During that era, cartography was advancing with a focus on precise survey techniques. Manuals were published, outlining precise guidelines for drawing and prescribing specific colors to depict distinct features of the landscape. For instance, *The draughtsman's handbook of plan and map drawing* by George André details color selections for water bodies, grass, stones, buildings, cultivated land[s], and more (1874: 45-47). This comprehensive guide lists 13 different colors for various elements of the territorial landscape. Consequently, map printers adhering to these instructions could potentially employ up to 13 lithographic stones.

Godefroy Engelmann is credited as the pioneer of chromolithography: prior to the advent of lithography, mechanized color reproduction was attainable but exorbitantly costly. Consequently, maps were often manually hand-painted with watercolors following an earlier

7. It is presumed that comprehensive reports would have been generated to document the duration of Manuel Dias dos Santos's stay in the Netherlands. Remarkably, a substantial trove of significant correspondence and documents remains awaiting digitization by DGT in Lisbon.

tradition of what had already been done with etchings (Verner, 1975: 69). Although Engelmann's process presented a more feasible solution, it remained financially burdensome. The extensive use of multiple stones for color reproduction amplified the potential for misprints due to frequent adjustments. Additionally, as colors overlaid, their vibrancy would diminish (Eckstein, 1878; 1876).

Image 2. Pure Print Archeology. The printing overview of Eckstein's process. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

Eckstein's method reduced chromolithography to the strict use of four stones, and his maps were richly printed and acclaimed, as expressed in The British Journal of Photography in 1876: "*The maps of Java contain no fewer than two hundred different tints, and these and the letters were all produced with four stones*" (p. 392). The number of stones had a specific function: one stone was used to print the letters and road paths, whereas the three other stones were to be combined and printed with superimposed colors, offering all possible tints. A prepared color chart with a wide array of random tints enabled map editors to choose the colors that best suited

the elements of the territorial landscape. This eliminated the need to work with as many stones, not only simplifying the process but also achieving a broader range of colors. Eckstein's method is not different from the use of Jacques Le Blon's four-coloured system with copper plates back in the 18th century. Therefore, Eckstein's printing system itself should not be misinterpreted as an invention. Its prominence among peers, however, should be regarded as an opportunity to understand the 19th-century's perception that Eckstein recognition was earned for his contribution with a process usefully applied to print maps.

What is photomechanical about Ecsktein's method?

Using photography, Carel Eckstein (1876; 1878) presents two alternatives for transferring the map image onto the stone. A map could be subject to photographed and reproduced through an intricate procedure on stone utilizing silver nitrate or a carbon print. Both of these methods involved very time-consuming protocols (with waiting hours and even days between steps).[8]

Image 3. Pure Print Archeology. Eckstein's method: Photomechanical transferring the image onto the stone. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

8. It's noteworthy that the Pure Print Archeology research group has yet to replicate either of these processes.

However, Eckstein introduces yet another protocol: transferring the map using transfer paper. The paper's surface is initially coated with starch[9], which in itself is a technique harking back to 19th-century industrial practices for facilitating the reproduction of images.[10] This process involves placing an image on a temporary surface atop the paper, followed by transferring it into close contact with another surface. Under the influence of heat, water, and pressure, the starch would've dissolved, transferring the reserved image to another matrix, in Eckstein's case, stone lithography (1878: 5). The image of the map could be drawn in reverse or even printed from a pre-existing colorless matrix.

In summary, this step excludes the extent to which Eckstein's process could be qualified as photomechanical. In speaking of the photographic transfer of a map it merely served as a guide, as it wasn't the body for the actual printing. The tangible print, in essence, derived from a process dependent on manual drawing and etching. Once the image had been developed and fixed onto the stone's surface, the matrix would be covered with a solution of asphaltum, slightly modified to be more transparent, in order to allow one to see the transferred image beneath. (Eckstein, 1876; 1878).

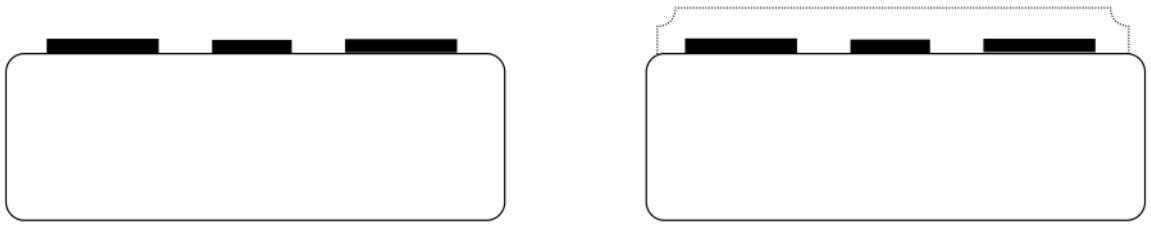

Image 4. Pure Print Archeology. Eckstein's process: 1st and 2nd step. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

9. Organic matter made from rice, potatoes, wheat, etc.

10. For Pure Print Archeology research on surface prepared papers: Machado, G., Bełkot, M. (2019). Drawing for reproduction: toward recreating surface prepared papers for making prints and exploring creative practice. CONFIA- 7th International Conference on Illustration and Animation, Barcelos, Portugal. / Bełkot, M, & M., Machado, G. (2021). Making Surfaces and Exploring Print Based Practices. The Lost History of Surface Prepared Papers. IMPACT 11– International Printmaking Conference, Hong Kong. Acesso online limitado: https://www. impact11.hk/en/

"Machine à Griser"

Eckstein's method employed a very sophisticated device in use in the 19th-century, known as a "*machine à griser*".[11] Powered by steam, it was capable of creating intricate hatching onto the surface of stones, from which could be printed a range of tones. A diamond point needle machine would pierce through the applied coat of asphaltum, creating a grid with minute parallel lines, without scratching the stone.[12]

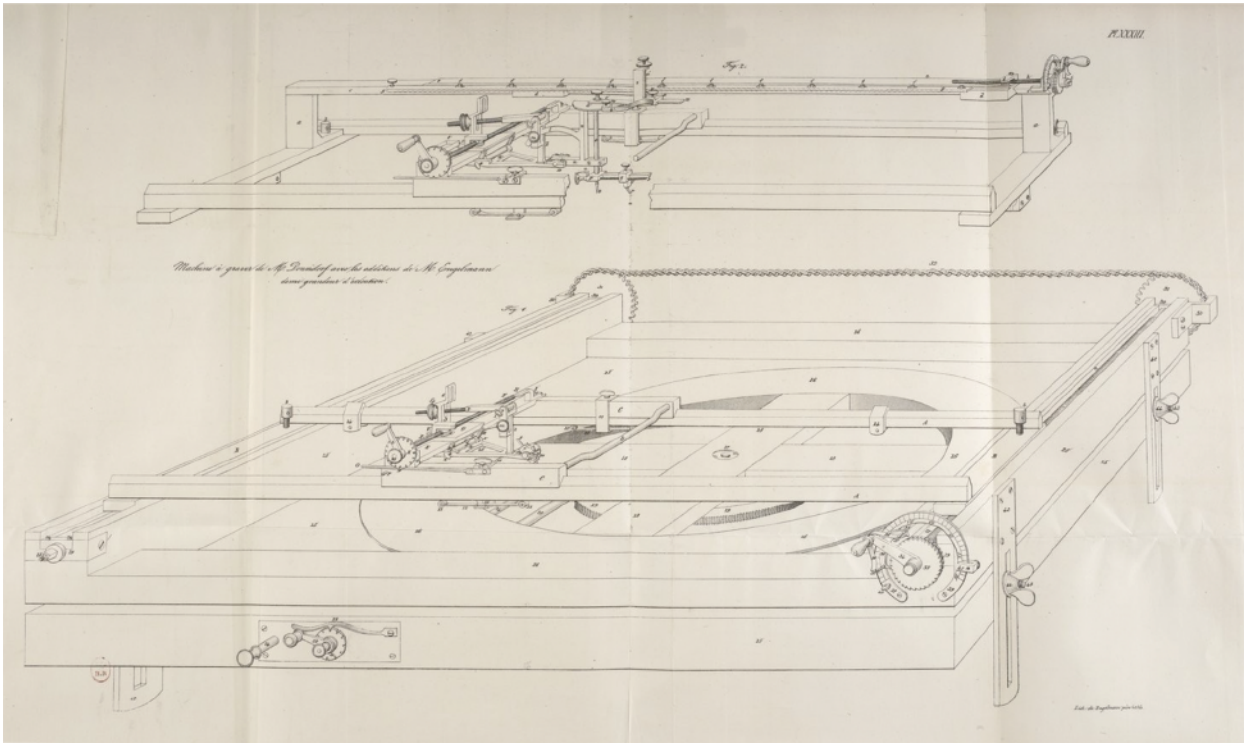

Image 5. Godefroy Engelmann. Plate XXXII. 1839. In: "Traité théorique et pratique de lithographie." Mulhouse: Haut-Rhin, 1839..

Eckstein's "machine à griser" represented the pinnacle of sophistication, capable of generating 8 to 20 lines per millimeter. To contextualize this for those unfamiliar with the printing industry, it's worth noting that modern printers typically operate at a resolution of 300 dots per inch (DPI), equivalent to a maximum of 12 dots per millimeter.scratching the stone.

11. According to dictionaries of the time, this could be called "machine à griser, à graver or machine à sculpter." (Adeline, 1884: 274).

12. The Minister of War of France published the exact same process without referring to Eckstein's name. In a small communication the text talks about the use of the "machine à griser" to make parallel lines, the use of 4 stones to obtain any desired tint.

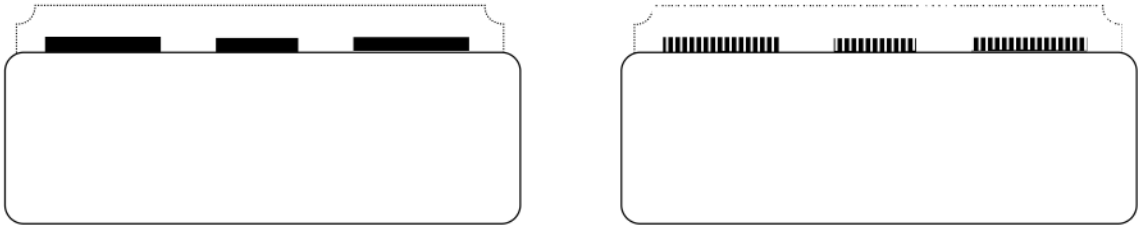

Image 6. Pure Print Archeology. Eckstein's process: 3rd and 4th step. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

Aqua-fortis "or etching" applied to stone lithography

Upon completion of the "*machine à griser*" drawing on the stone, the next step involved preparing a series of diluted acid solutions. Although the instructions lack clarity on this aspect, they do emphasize that etching of the stone should follow the prior transfer. Presumably, brushes were employed for this purpose, with the etching process confined to the areas matching the transferred drawing.

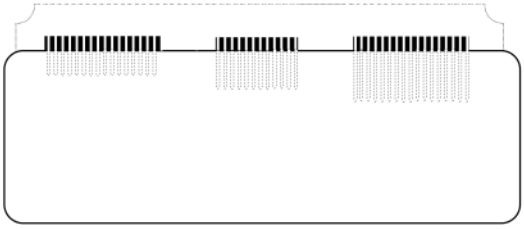

Image 7. Pure Print Archeology. Eckstein's process: 5th step. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

To understand how an image is printed, four distinct models warrant elucidation: relief, intaglio, planographic, and stencil. These categories align with prevailing printing methods of today. Relief printing often utilizes woodcut or wooden matrices, intaglio primarily usually involves metal and processes like etching and engraving, stencil is associated with screen printing using fabric, and lithography (derived from "litho," meaning stone) is predominantly practiced today in a planographic manner.

Viewed from a current perspective of printmaker practitioners, the classification of Eckstein's method aligning lithography within an intaglio framework is perplexing. The term "intaglio," originating from the Italian "intagliare," implying sculpting, stands in contrast to lithography's primary characteristic: a chemical interplay between water and grease. Nevertheless, insights shared by Michael Twyman, as conveyed through Walter Ristow (1975), suggest that while the planographic method was commonly linked with lithography in that century, an intaglio adaptation was employed on stone for intricate tasks like lettering, maps, or architectural plans. This choice emerged due to the intricate nature of this kind of drawings, leading practitioners to adopt an etching or engraving technique on the stone's surface (Woodward, 1975: 80).

These historical methods can be enigmatic for contemporary printmakers, as they amalgamate different families of today's printing processes. A more effective approach to fostering understanding and facilitating communication about these techniques is through research that reenacts the processes, creating an experiential understanding.

Following the etching, the stone would be coated with printing ink and then subsequently rubbed to ensure the filling within the acid-created hollows. After which, all layers of asphaltum and transfer material would be removed using turpentine, rendering the stone ready for printing.

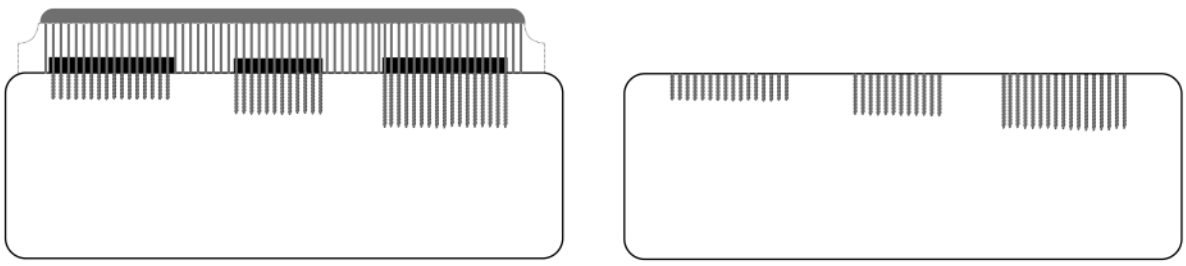

Image 8. Pure Print Archeology. Eckstein's process: 6th and 7th step. 2023. Digital illustration by David Lopes. Source: i2ADS/FBAUP.

III. Reenacting Rodrigues's Process of Gelatine-based Emulsions

«**Chromo-cuprographie**

73- Examples of chromocuprography. Shades obtained by graduated bites with iron perchloride; grain obtained by the resin previously deposited on the plate in very fine powder. Post-heating to retain and consolidate the resinous grain. Through this system, it is possible to obtain a large number of shades of the same color and, through superimposed prints, a considerable number of different colors. (This process was described in the French newspaper --Le Bulletin de l'Imprimerie) In the exposed painting we see a copper plate before the resin deposit, an engraved and inked plate and a monochrome proof on paper in various shades.

74 - Same process as above. Graduated blue tints. (...)»[13] (Exposition Universelle de 1878. 1878: 13)

Chromocupography is recognized as a Portuguese printing technique, yet there exists limited written documentation about it. A description, originally in French, was translated and published in Lisbon by the *Secção Photographica ou Artística*. Presumably authored by Rodrigues himself, this text sheds light on various other processes showcased at the 1878 Exposition Universelle de Paris. These descriptions raise numerous technical questions, as they lack specific instructions, including material quantities, measurements, and manipulation techniques. Notably, the department fails to mention the presence of iron oxide (III), information found only in footnotes within Grandider's Reports of the Universal Exhibition of Paris of 1878.

«Mr Rodriguez seems to have obtained a softer and finer granulation with a sensitive layer containing an opaque substance in powder form, such as calcined red clay or iron sesquioxide which do not attack either the dichromate gelatin or the iron perchloride.» [14] (Grandidier, 1882: 371)

In order to reenact the process, the reader must understand that prior knowledge of photosensitive emulsions using bichromate gelatine as a protective coat to etch plates was yet to be systematized in the research context of FBAUP.[15] First and foremost, chromocupography is an end-game goal for research regarding the complexity of printing color but such had to be

13. Translated to english by the authors of this paper.

14. Translated to english by the authors of this paper.

delayed in order to technically acquire the base knowledge for making heliogravures. It was required to go back to simpler challenges, which was to etch photographic images using bichromate gelatine emulsions.

Following instructions

Traditionally, copper has been the metal of choice for intaglio printing, a fact reinforced by the alternate term used to describe intaglio processes, "calcography," where "calco" derives from the Latin "chalkos," signifying copper or brass (Easthope, 1835: 56). However, in contemporary printmaking, a wide array of other metals are employed, driven by price fluctuations and accessibility. With copper being expensive today, metals like zinc or aluminum have taken on a greater role in intaglio printmaking practice.[16] In our current research context, we make use of different metals, not necessarily to pursue altered conclusions, but rather to facilitate extensive experimentation, due to the cost-effectiveness in initial trials.

Grandider (1882) elucidates that in Rodrigues' description, the matrix is created through a photomechanical process involving a solution of dichromate gelatin. At some point, iron oxide (III) is introduced as coat added to the plate previously applied as per Grandider's explanation:

> «(...) *on a plate previously coated with very fine resin dust*». (p. 371)

The application of the previous coat of resin is used commonly today by printmakers to create tone in their plates; it's a technique developed in the XVIII under the name of the aquatint process. (Fielding, 1841: 39-56). We find ourselves an aquatint box in a current printmaking workshop. It's a wooden structure with a high ceiling: on the bottom, there will be a simple rotative device activated manually, by spinning an outside handler, making the dust resin (which sits inside), to spread all over the box. The dust will float and occupy the upper space. When one stops spinning, a dust cloud will slowly fall down to the bottom. In the middle

15. Graciela Machado first researched Marques Abreu's technique with undergraduate MA student Isabel Penedo, on zinc plates and on the work back in 2015. Recently published new material with new researchers is presented in: Arquivo Aberto FBAUP: I2ADS. (Edited by Graciela Machado & Rui Vitorino Santos. ISBN: 978-989-9049-40-6

16. There are studies that remark the rise of the price of copper in Europe since the 19th-century. However, we are not in the position to present evidence on the price fluctuations of copper in Europe or in the global market. From the perspective of the educational framework in Fine Arts, we can only remark that there's a generalized understanding that copper plats are the most expensive of options a printmaker can use today.

of the structure, there will be a grid drawer, where the metal plate for print is placed and will sit still, receiving a fine layer of dusty resin.[17]

Grandidier 's descriptions of the process opens rooms to consider that iron oxide is added to the bichromate gelatine. "(...) *obtained a softer and more finished granulation with a sensitive layer added with an opaque substance in powder.*" (1882: 371)[18] There is a plausible basis for this proposition, as Jan Pettersson, a contemporary expert in photogravure, expounds that the inclusion of red pigment in a photomechanical process serves a dual purpose. Not only does it infuse color into the transparent gelatin, but it also obstructs the blue spectrum of UV light (Pettersson, 2007: 66). Due to the scarcity of technical instructions, both possibilities were considered and experimentation with various formulations was undertaken.

Emulsion preparation, and exposing the image

In the absence of any technical documentation detailing the formulation of the emulsion-based gelatin for *chromocupography*, we have resorted to adopting the same quantities and procedure that Rodrigues published for the preparation of bichromate gelatin intended for thin-foil metal plates (1874, p. 150). This source serves as the foundation upon which we prepared the photosensitive emulsion.

40 grams of "good gelatine"	—	500 cm3
20 grams of "dichromate of ammonia"	—	500 cm3

We acquired both *bichromate of ammonia* and *bichromate of potassium,* and, as confirmed by various sources, determined that both substances function similarly. To ensure optimal results, we obtained technical gelatine from chemical laboratories.[19] Due to our uncertainty about the appropriate quantity of iron oxide, we conducted tests using different amounts. After

17. Experience will serve as the determining factor for achieving the optimal amount of dust. The objective is to generate a uniform coating across the plate with a 50% density, enabling the acid to etch recessed cavities. The resin responds to heat, permitting the practitioner to gently warm the plate, causing the dust to fuse into small spheres that adhere to the metal surface. Due to the acid-resistant nature of the resin, these fused particles remain intact during the etching process.

18. Translated to english by the authors of this paper. Original in french: "(...) obtenu une granulation plus douce et plus finie avec une couche sensible additionnée d'une substance opaque en poudre" (Grandidier, 11882: 371)

19. From a company named GMW - a brand of Wilhelm Leo's Nachfolger GmbH. Kasseler Str. 84b, 34246 Vellmar, Germany.

Image 9. Pure Print Archeology. Heliogravure by Rodrigues — preparing the photosensitive emulsion. 2022-2023. Digital illustration and photography by David Lopes. Source: Machado. G. (2023) Reserva Tecnológica nº. 1. p. 59.

experimentation, we established a consistent procedure of using 1 gram of iron oxide per 20 to 30 grams of gelatine, constituting approximately 5-10% of the pigment in the mixture.

Although the *Secção Phographica ou Artistica de Lisboa* had a mechanized gelatinizing machine (referred to as "machina de gelatinar", (Rodrigues, 1876: 21), equipped with a horizontally rotating disc onto which the metal plate was placed for the application of gelatine

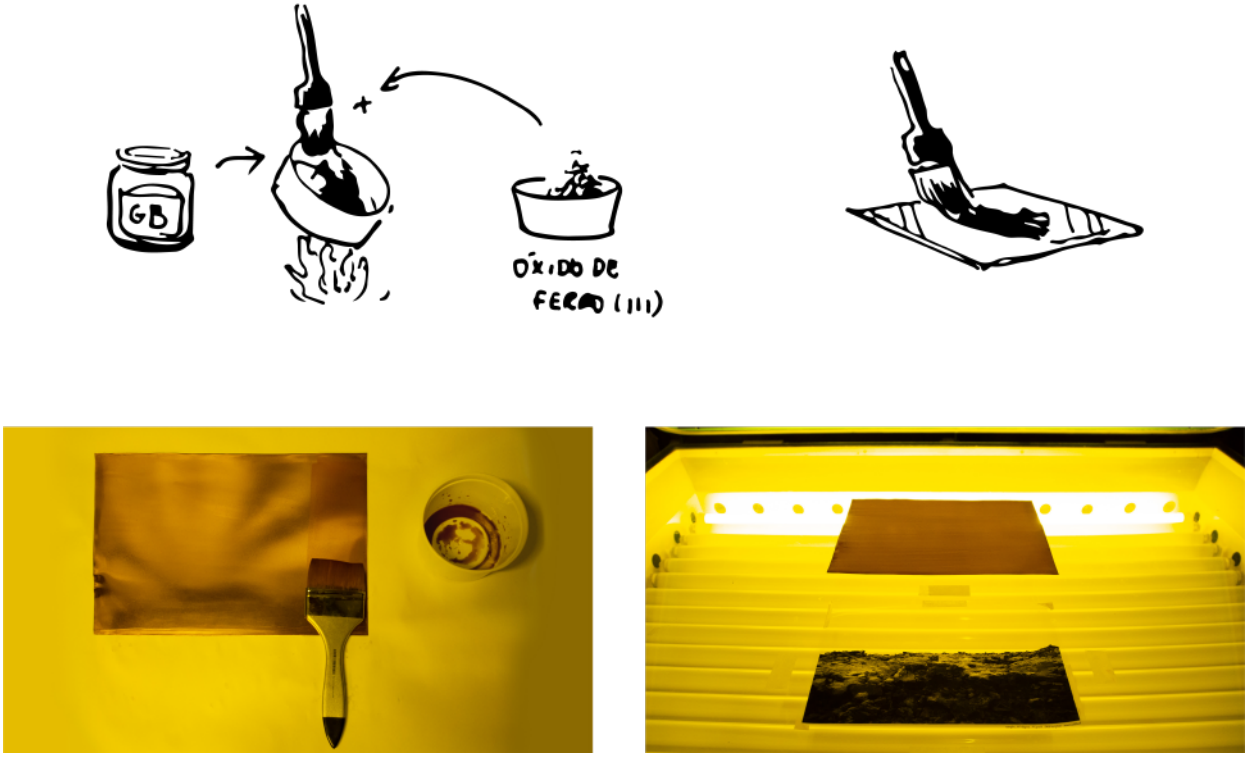

Image 10. Pure Print Archeology. Heliogravura by Rodrigues — apply the photosensitive emulsion on metal. 2022-2023. Digital illustration and photography by David Lopes Source: Machado. G. (2023) Reserva Tecnológica no. 1, p. 60.

emulsion, we lack this specific device in our Porto-based studio. In the printmaking workshop, we manually apply the gelatine-based emulsion using a soft paintbrush. This approach might not differ so much from the original method, as it closely follows Rodrigues' own description of using a brush to coat thin foil metal sheets. Our experience has shown this process to be both uncomplicated and efficient.

Certain challenges arose in achieving consistent and uniform coats on metal surfaces, but through systematic and incremental practice, any practitioner can eventually achieve favorable outcomes. A crucial step is to promptly dry the gelatine coating as it is applied to the metal or chosen surface. Allowing it to air dry can lead to the formation of crystallized marks, [see image 11] as observed and noted by Rodrigues himself (1874: 151). In the 19th century, it was necessary to have a nearby oven for drying the plate.

Image 11. Pure Print Archeology. Book of specimens recreating Rodrigues' photomechanical application on top of tinfoil. 2022-2023. Photography of specimens. Source: i2ADS/FBAUP. / Image courtesy: Graciela Machado/ Practical work: David Lopes (FCT. 2020.09546).

Image's development and the etching of heliogravure

Rodrigues extensively documented the working methods employed at the *Secção Photographica ou Artista de Lisboa*. While describing the process of creating a heliogravure, he presented a simplified version of what we believe the actual process entails. During our tests

with gelatine-based emulsions, we experimented with two types of gelatines[20] that hardened with potassium dichromate under the influence of UV light. We successfully developed image samples on metal; however, these did not remain solid when immersed in acid baths. Our findings indicated a general inability of the gelatine to adhere firmly to the metal surface or prevent the acid from reaching unintended areas. [21]

Despite our exploration of Rodrigues's claims and writings, it is evident that other sources similarly suggest that gelatine alone should suffice to withstand a reservation under immersion in an etching bath. Nonetheless, it appears that a modification to the process was necessary, though it was not explicitly detailed.

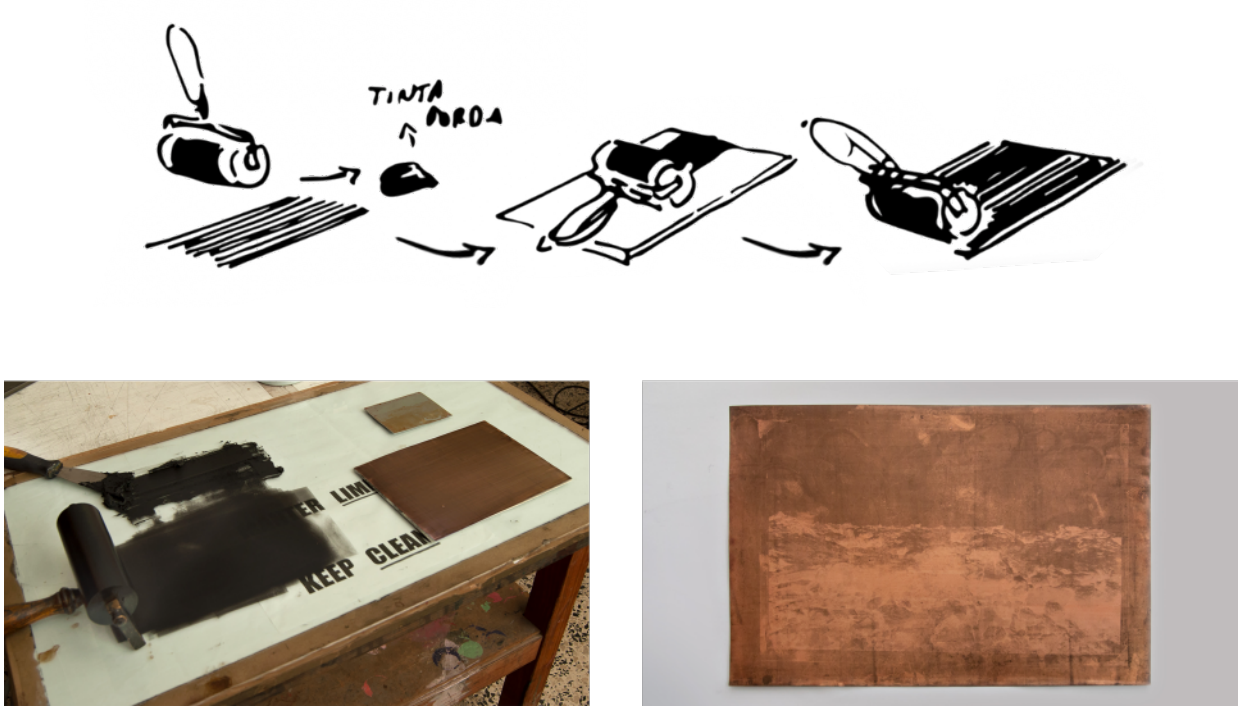

Image 12. Pure Print Archeology. Heliogravure by Rodrigues — inking the plate after exposure. 2022-2023. Digital illustrations by David Lopes. Source: Machado. G. (2023) Reserva Tecnológica no. 1, p. 60

20. "GELATINE Type Novo Tec GP" and "Photogelatine Type Restoration" from the active company GMW.

21. At our printing workshops, we have access to three types of acids, traditionally used in intaglio processes: nitric acid, iron perchlorate, and a commonly used mordant less toxic called copper sulfate solution. All of these proved unsuccessful, using images developed with gelatine only.

Poteivin's (1862) discovery of gelatin's affinity for greasy ink when hardened by light proved instrumental in addressing this challenge. We experimented with rolling ink onto the freshly developed gelatine before submerging it in water, yielding promising outcomes. Subsequently, we refined the technique by applying greasy ink in the dark, after UV light exposure and prior to development. Specific time was established with protocols using various ink types, achieving successful results with Charbonnel printing inks, offset ink, and lithographic inks. Essentially, any greasy ink adheres readily to the gelatine emulsion, offering the advantage of visualizing the development results through the addition of color.

Following a brief waiting period (typically between 15-30 minutes), the plate is placed horizontally under hot water with the intended image facing upwards. Empirical observations have led us to recommend such necessary waiting time that allows the ink to stabilize upon the gelatine surface. Deviating from this timeframe, whether shorter or longer, risks unintended ink displacement or delayed image development.

The effectiveness of freshly prepared gelatine remains consistent regardless of the water temperature during the development process. According to Jan Pettersson (2007, p. 67), storing gelatine in a refrigerator enhances its chemical stability. Otherwise, tests have shown that storing the material in a glass container renders it viable for no more than a month.[22] As the month progresses, the gelatine-based emulsion gradually loses its ink receptivity. During this stage, rubbing the plate under water is ill-advised, as it may cause ink smudging and detachment from the coating. Instead, it is recommended to ensure partial image visibility during the initial development phase. Subsequently, the plate can be subjected to additional hot water treatments, followed by gentle circular rubbing with a lithograph sponge under running warm water. The rubbing process is concluded once the image contrast reaches a satisfactory level.

The printed image is obtained by the pulling ink from these recessed holes, requiring the classical wiping process, in use since the very beginnings of intaglio practice. A dampened paper

22. In order to conclude this we diligently recorded our daily procedures for preparing gelatine dichromate, providing detailed descriptions of gelatine behavior throughout each step. Our systematic approach included precise measurements of temperatures and quantities employed. While our documentation encompassed various aspects, the humidity of the working environment was regrettably omitted. Nonetheless, it's important to note that, as emphasized by Jan Pettersson (2017), humidity stands out as a significant factor influencing the optimal working conditions for gelatine-based processes.

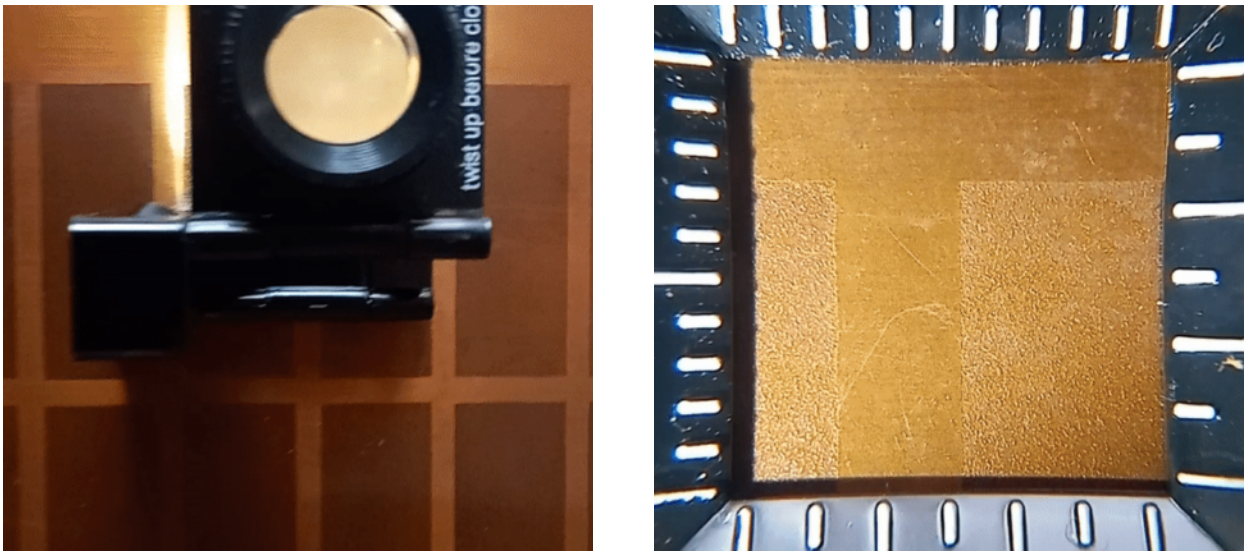

Image 13. José Júlio Rodrigues. Cromocupography's coopper plate. 1877. Photography by David Lopes. Source: Direção-Geral do Território, Lisbon. This image showcases an etched structure characterized by cavities, resembling the pattern commonly seen on aquatint plates. The dots on the metal surface are not fully contiguous; when subjected to heat, they affix themselves to the plate. When the etching process takes place, the acid selectively spares these dots, resulting in the removal of the adjacent metal area.

is positioned atop the metal surface, and when pressed under the force of a printing press, it lifts the etched image from the plate. What we have described so far, is a brief description of any intaglio metal printmaking method. In the 19th-century, photo-etchings were produced and printed in the described manner.

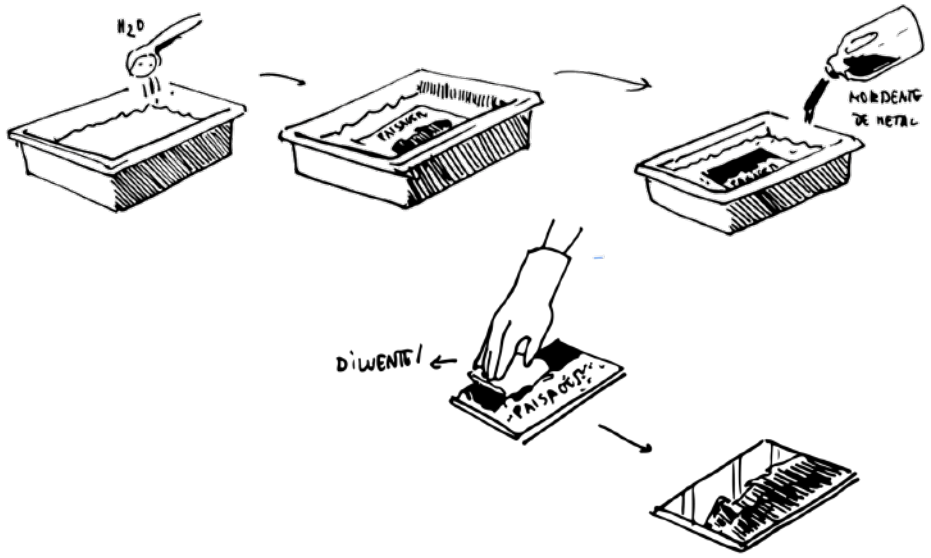

Image 14. Pure Print Archeology. Heliogravure by Rodrigues — Developing the plate in hot water and etching after. Digital illustrations by David Lopes. Source: Machado. G. (2023) Reserva Tecnológica no. 1, p. 61

Image 15. Pure Print Archeology. Heliogravure by Rodrigues — Image courtesy of Graciela Machado. Plate making and print by David Lopes. Source: Machado. G. (2023) Reserva Tecnológica no. 1, p. 64.

Comparative understanding of Eckstein and Rodrigues's processes

Eckstein and Rodrigues's processes reveal a distinct practical difference. Although both were showcased at the *Exposition Universelle de Paris* and share similarities, they vary significantly in their execution and material outcomes. Eckstein's method, while moving closer to intaglio by etching cavities on stone, remains rooted in a lithographic framework. It leverages the repulsion between water and grease during printing. In contrast, Rodrigues's approach involves the application of ink on metal, a hallmark of classical intaglio practices. Even in the etched manner, lithography proves less time-consuming in terms of the printing process. Chromocupography, due to its reliance on ink wiping akin to intaglio, may not be easily assimilated into industrial printing as it cannot compete with more efficient photomechanical processes emerging in Europe during that period.

The similarities between chromocupography and Eckstein's method are not entirely clear. While Eckstein's process introduces the concept of half-tones, utilizing the "machine à griser" capable of producing evenly-spaced lines, *chromocupography's* reliance on acid concentrations or light exposure for varying shades raises questions about its technical aspects.

The lack of evidence for *chromocupography's* widespread adoption, particularly within the *Secção Photographica ou Artistica de Lisboa*, raises doubts about its practical viability. The dissolution of the *Secção* shortly after its introduction could have impacted its further development. Rodrigues's ambitious endeavors, aimed at contributing to industry, technology, and science, might have been hindered by the lack of sustained government support.

Certainly, this research also highlights the considerable gap in our technological comprehension of past protocols. As we tread the path of diligently following instructions with the expectation of achieving the results as described, we inevitably encounter fresh sources and unfamiliar concepts related to the practice of photomechanical printmaking.

IV. CLOSING NOTES: WHAT POSSIBLE PERSPECTIVES ARE THERE FOR CONTEMPORARY ART AND RESEARCH ON TECHNOLOGICAL KNOW-HOW

Reacting to the overload of digital and the experience of manual

Contemporary debates have been consistently concerned with the effects of technology on contemporary and visual culture. As technology advances at a rapid pace, those engaged in

visual culture face a multitude of questions, challenges, advantages, and warnings in the realm of creative practices.[23] Amidst reactions to digital saturation and artificial replacements, a recurring inclination emerges—people are drawn back to the tactile and manual. This phenomenon appeared in the 1980's as identified by Rebel, as she characterizes it: "*One could term it as voluntary restraint, a conscious return to manageable order of crafts, rules and respect for material*". (Rebel, 2003 (2008), 31).

Throughout its history, printmaking has demonstrated a remarkable ability to adapt and respond to the challenges posed by obsolescence. Miguel Ángel Hernandez delves into the concept of the "destruction of function" as a catalyst, in which we could add printmaking's ability of liberation and expression within an uncharted realm of creativity (2023: 28). Even in the face of evolving technological landscapes, many artists continue to practice traditional techniques such as intaglio, etching, engraving, and woodcut—as well as other methods that may appear less trendy or unfamiliar. These persistent practices stand as a testament to the artists' resilience and an acknowledgment of the intrinsic value they place on processes that, while not necessarily quicker or more efficient, hold a unique significance.

In today's artistic landscape, contemporary printmakers and artists navigate a delicate balance between tradition and innovation, employing sensitive approaches to convey the essence of printmaking through their chosen materials and processes. This distinctiveness sets their work apart from more industrialized outputs, accentuating the significance of the creative journey: from embodying a specific protocol to the time invested in each piece. Academic discourse reverberates with arguments advocating for the preservation of these disciplines, akin to Miguel Ángel Hernandez's argued that the analog video's presence in museums, as if museums were places of healing. (p. 26).

The will to engage in printmaking, one might argue, is not rooted in rationality but rather an intuitive urge — a desire to connect with a lineage of craftsmanship and expression

23. Let us consider the recent phenomenon of AI art: in which professionals or programmers are now being employed replacing digital artists. With ever new technology coming forward in an economy that prioritizes profit over human values, companies are therefore more willing to hire AI artists. While past debates have revolved around the dichotomy between digital and manual artistry, delving into the ways in which these approaches either distance or integrate artists from "manual labor," the emergence of AI art introduces a more nuanced and expansive inquiry. (Cait Kelly, 11st of December 2022, Australian artists accuse popular AI imaging apps of stealing content, and call for stricter copyright laws. theguardian.com/)

that transcends the digital age. Ernst Rebel uses the term "marginal" to describe traditional printmaking's coexistence with its digital counterpart, highlighting the enduring vitality of these practices (2003, 2008: 31). In the author's perspective, manual labor serves as an indispensable declaration, affirming the enduring relevance and creative essence of printmaking.

Image 16. Pure Print Archeology. Heliogravure by Rodrigues— Failed attempts of photomechanical developments with iron oxide on metal surfaces (aluminum, brass, zinc and copper). Plate making David Lopes. Source: i2ADS/FBAUP.

In defense of ineffective results - embracing the unpredictable in photomechanical processess

Regarding photomechanical processes, we found ourselves with what many would consider as incompetent research results. The failed attempts of coating metal with gelatine-based emulsions, improperly inked images, over-dusted photographic developments on metal, and eventually somewhat accomplished reproductions are sequential in what technical research entails. Within industrial contexts, printmaking has been intrinsically tied to the pursuit of replication. Before the advent of photography or the digital, it was solely the quintessential medium of reproduction. In the past, a strange concept was used to describe printmaking as "stampa di traduzione."[24], *or print of translation*. What is meant by *translation*? From a historical perspective, printmaking has consistently functioned as a conduit for rendering other artistic mediums into tangible form - drawing, painting, or sculpture. It's also interesting to notice how certain techniques were invented to emulate the qualities of other mediums. Therefore, the notion of ***translation*** refers to print's ability to become a synthesis of other mediums: a photomechanical print is as much as a translation of the photographic syntax, as lithography can render the gesture of drawing.

Pelzer-Montada's critical theorization (2013) proposes a fresh reinterpretation of the concept "translation" in printmaking. The author proposes a full acceptance of printmaking's close affinity with the idea of translating and of copying, in which several mediums' syntax may overlap or be even combined. It's similar to what Ernst Rebel's advocates in the name of "transmedialization", which printmaking underscores the potent interplay between diverse media and its intrinsic aspects. Speaking specifically about the photomechanical processes, Rebel explained that ""(...) *by means of a single technology that integrated all media and effects - the industrial halftone printing (...)" the public can be introduced to different aesthetic manifestations which appear to collapse in one medium*. (2008, (2003): 29). "*A multiplication of the multiplication - the potentiation of the image*."

Here, it could be also appropriate to extend our reading to Hito Steyerl's reflection on the ' In Defense of the poor image." "*The poor image is a copy in motion*", Steyerl defines it (2009: 1). Steyerl's concept of the "poor image" is an interpretation on how digital imagery circulates,

24. See: "II valore critico della 'stampa di traduzione" published in 1857 by Giulio Carlo Argan.

so in a way it is said that digital media contributes to the entropy of information. The author's analysis is both a political statement and a reflection of contemporary art's trajectory of image-making, and such encapsulates a current inclination towards visual incompleteness and a nuanced interplay between abstraction and fuzziness. Thinking of relevant names in contemporary culture, such as in the unfocused photogenic paintings of Gerhard Ritcher or Thomas Ruff's blurred photographs, the opposite intention towards creating high-resolution images, is perhaps caused by the discussed overload of highly-technological advances of the digital world.

Likewise, research results from 19th-century protocols may be interpreted as "poor images." But to characterize these results as ineffective is to stress judgment over the image's visual qualities: its incapacity of conveying a hyper resolution result without creating visual disturbance. In our research conduct, ineffectiveness is instead foreseen as an opportunity to pay attention to process-making: its particularities, and the will to let it produce a mark which can be identified. Photomechanical ineffective results enhance the direct consequences of manual process-making: the combination between metal-working, print, and light.

From Ruth Weisberg's perspective, we can understand that is part of how artists have been approaching printmaking as a creative practice: "*I was taught to believe in printmaking as a process which allowed one to wrestle from incalcitrant if seductive materials one's personal vision*." (Ruth Weisberg, 2003, (2008): 65). She explains how artists strengthen the relationships between material and meaning by understanding its cause-effect qualities, even if these are accidental. In accepting ineffectiveness, one does shy away from error, it chooses to empower it as an expression of human gesture.

In conclusion, the dynamic interplay between photomechanical prints, the digital media, and an evolving notion of "translation" in printmaking underscores a rich tapestry of influences shaping contemporary artistic discourse. Amidst the ever-accelerating technological world, the role of the artist becomes one of navigating the delicate balance between creative interpretation and replication.

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