Contributions of material culture studies to scientific instruments: a possible biography to a Camera Lucida

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This essay presents a possible biografy of an object in the collection of the Deutsches Museum (code DMM-2011-1157Z22), posteriorly identified as a Camera Lucida. The biography emphasizes the Camera's modifications in three models – from 1807, 1819 and 1860 - using a material culture approach. By comparing the different models of Camera Lucida, it was possible to perceive that instruments are in constant change in terms of materials, tacit knowledge, function and utility.

Keywords: Material Culture, Camera Lucida, Scientific Instruments, Biography of objects.

Introduction

A material culture approach (or material culture studies) to looking at an object is an interdisciplinary one, which draws on the fields of ethnography and anthropology. This approach not only provides a scientific and technical viewpoint, it also gives information about the object of a social and cultural nature. As result the biography will provide information about the object's conception, production and functionality, as well as the people who made, sold, and use(d) it.

In this essay, using a material culture approach, I will present a possible biography of a Camera Lucida which was donated to the Deutsches Museum in Munich in 2011 by the Meldahl family. At the time I first looked at the Camera, I did not know what it was. My first intention was to find out what the Camera actually was. Having done this, I wanted to find out when it was produced, how it works, why the Meldahl family had it and why it was donated to the Museum.

All of the answers were considered on the perspective of the process of improvement of Camera Lucida between their invention in 1807 and the appearance of the photographic Camera around 1860. In order to emphasize the modifications, I will describe and compare three models of Camera Lucida in a time line: 1807, 1819 and

1860. These models present significant changes and were constructed and sold by different instrument-makers during the 19th century. It is not the task of this essay to examine all the models of Camera Lucida. A complete review on the subject can be found in Hammond & Austin (1987) and Fiorentini (2006).

After the description of the models and the role of the instrument-makers in their modifications, I will present a possible narrative to explain how this object reached its place at the Museum. The narrative depends on details that are not present in the evidences, but on deductions from the historical research and the contemporary context. Therefore, the narrative is subjective, guided by the intentions of the author and the perspective adopted, as argues Fleck (1986: 144) on the scientific work.

On Material Culture Studies and its Methodology applied to scientific instruments

Prown (1982) defines material culture as “the study through artifacts of the beliefs-values, ideas, attitudes, and assumptions of a particular community or society at a given time”. This definition will be adopted in this essay. This definition is very similar to the assumptions of the constructivist historiography of science. As argues Olesko (2003), to the constructivist historiography of science the scientific knowledge should be considered from the local it was created, produced and situated. Thus, the study of a scientific instruments from material culture approach allows to contextualize the scientific knowledge to a particular community or society at a given time through an object (or instrument).

In 1974, in order to establish the objectivity of the scientific method, Fleming (1982) published a method to analyze an object using the material culture approach. Prown (1982) and Pearce (1994) reinterpreted Fleming’s method, including their own assumptions. Anderson et. al. (2013) summarize the ideas of Fleming (1982), Prown (1982) and Pearce (1994) and describe this method as constituted of four analytical operations. The first operation, characterized by description, authentication, classification - establishes the properties of the object and the evidences related to it. Through this operation some can be answered, like: what is it? Is it genuine? What are its physical characteristics? The second operation evaluates the object according to workmanships, aesthetics, manufacturing decisions and material contextualization. The material contextualization tries to establish relations to similar objects and to contemporary standards of precision. The third operation is the cultural analysis such as the functions and uses (concretes and abstracts) of the object. Regarding to their utility, should be consulted the booklets or communications (letters, magazines) about past uses and its symbolic characteristics. The fourth operation presupposes the diachronic interpretation of the relevance and significance of the object for time and culture.

Nevertheless, it should be noted that the four operations are not isolated from each other. They change one another with the emergence of new facts or when deductions are made. Prown (1982) and Pearce (1994) emphasize that only the first operation is descriptive; the other three include evaluation and judgement, like comparison, sensory and intellectual engagement and emotional response The attribution of relevance, aesthetic qualities and utility are often immersed in their own paradigms, as the historian or curator who employ the operation.

In terms of scientific instruments, scientific paradigms are very important to classify an instrument relevance and utility. Beliefs on the meaning of science vary from period to period. They are useful to describe any instrument as scientific or non-scientific according to the organized body of knowledge – technical aspects and the context - of a given society (Turner 1993; Brenni 2013). Therefore, the biography of a scientific instrument also needs to fit into scientific settings, which include not only the four analytical operations previously mentioned, but also the tacit knowledge to operate the instrument and a diachronic conception of science.

Scientific paradigms are also relevant in the categorization of an instrument in terms of audience as well. As noted by Turner (1993), a scientific instrument can represent three groups of instruments: utilitarian, didactical and internal. However, the boundaries of these three groups are not static. Internal instruments, created by a specific field of study, can become utilitarian or didactical, and vice-versa, in another field of study or at another moment and for different audiences. The target audience from science has changed over the years, going from the specialized knowledge limited to a small number of people in the 17th century to the widespread communication and dissemination of experiments on electromagnetism in the 19th century. Scientific instrument catalogues and instruction manuals are examples of the wide range of scientific instruments made and sold to a diversified audience, representing a source of an object classification and categorization (Heilbron 1993; McConnell 2013).

The small object from the Deutsches Museum

From the previously presented explanation, the object analysis was divided into two parts. The first one includes the description of the explicit evidences of the object, which allowed its identification and initial classification, whereas the second part covers the speculation and deduction of some implicit facts, as well as the comparison to similar instruments based on historical research. The information from both parts constitutes the narrative body.

The evidences

The object to be analyzed (code DMM-2011-1157Z22) was inside a wooden case approximately 20.0 x 8.0 x 4.0 cm (see Fig. 1 and Fig. 2). The object had three stems, each one with nearly 15.0 cm in length and with external diameters 9.0 mm, 7.5 mm and 6.5 mm respectively, as a telescope stick.

Fig. 1 The wood case and the object inside. Source: Deutsches Museum Munich © Takis Lazos.

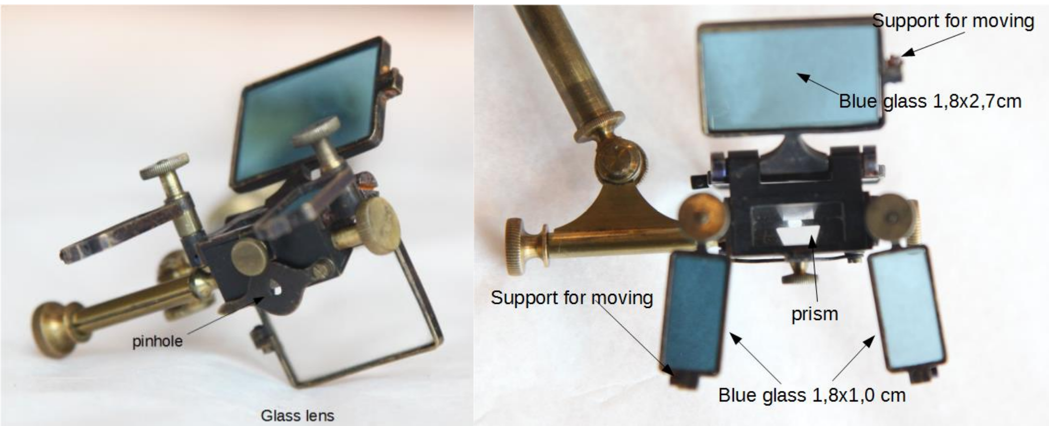
Fig. 2 The first image of the object. Source: Deutsches Museum Munich © Takis Lazos.

When the three stems were fully extended, including the coupling device, the stem reached approximately 50.0 cm (see Fig. 3).

Fig. 3 The extended DMM-2011-1157Z22. Source: Deutsches Museum Munich © Takis Lazos.

The stems were made of brass, the clamp was made of iron, and the material with a set of prism and lenses at the end of the object was made of black lacquered iron. Two details are important to my analysis: an inscription in the clamp (see Fig. 4) and the set of lenses and prism (see Fig. 5).

Fig. 4 The inscription. *Vincent Chevalier. Ing[r]. Brev[ier]. Quai de l'horloge, 69. Paris.* Source: Deutsches Museum Munich © Ana Paula Bispo da Silva.



(a) (b)

Fig. 5 The set of lens and prism. Source: Deutsches Museum Munich © Takis Lazos.

There were four glass pieces in the lens and prism set: a trapezoidal prism encased within an iron structure with two openings: a rectangular one, from where the light entered the prism; and the other one at the opposite angle, where the light exited the prism. A movable piece on the last opening allowed the viewer to look through the prism (pinhole). The white glass lens had 1.8 x 2.7cm, which had the same size of the blue glass pieces. The complete apparatus was free for moving with accuracy through lateral supports. The prism had a surface area of approximately 2.3cm of length and 1.1 cm width. The material (brass and glasses) showed that it was a mid-nineteenth century instrument. The set of glasses and prism indicated that it was an optical instrument.

The use of colorful glasses filtering the light allowed to determine the construction of that instrument by French or German manufacturers, who already had such knowledge in the 19th century (McConnell 1993).

The knowledge about glasses and light filters improved in the 19th century, and instrument-makers from France and Germany penetrated the market of flint glass previously dominated by England (McConnell 1993). However, the case holding the object was made of a type of wood from a different period. McConnell (1993) states that in the 19th century the optical instrument cases were made of Honduran Mahogamy and they were usually covered by velvet, but that case donated to the Deutsches Museum was made of a lighter-colored wood than Mahogamy, it was not velvet lined nor did it have a special compartment for the lenses of an optical instrument. It had the inscription MELDHAL on it and the initials L.E. had been erased.

The set of glasses and lenses, the telescope shaped, and the instrument possibly dated back to the first half of the 19th century showed that it was an optical instrument used to draw on a table (a coupling device). By contrasting that information with the images of the instruments and with the manufacturer's performance branch, it could be reached the conclusion that it was a Camera Lucida, whose instrument-maker was Vincent Chevalier.

Even though I had come to this conclusion, some questions remain open. From a technical point of view, it was unclear how to use the camera (tacit knowledge) and how it worked (utility or function). Moreover, it was not clear whether the camera was genuine or not, since the case seemed newer than the camera it contained. In addition, it was not clear why the Meldahl family, whose members were from the photographic camera period, had owned such an instrument.

The historical research conducted clarified issues on the utility and function of the camera, besides bringing new elements that helped us achieving a more comprehensive understanding concerning the temporal difference between the instrument and its case. As it can be understood from the following paragraphs, instrument-makers did implement modifications in the original instrument, which led to changes towards some didactical rather than utilitarian functions of the camera and altered its audience.

Comparing similar instruments – the history of Camera Lucida

The Camera Lucida (Fig. 6) was invented by William Hyde Wollaston (1766-1828) in the beginning of the 19th century and patented in 1806, but the name Camera Lucida first appeared in Wollaston's Description in 1807, as an instrument to facilitate drawing objects in perspective[1].

Fig. 6 Camera Lucida in use (Chevalier 1834: book cover).

The Wollaston's Camera had a quadrangular prism and circular glasses: a convex lens (*ik* in Fig. 7) and a blue glass for brightness control (*lm* in Fig. 7). This optical set provided double reflections and a parallax adjustment. Thus, the observer could see the pencil at the same position of the object, no matter his chosen viewing angle in relation to it (through a pinhole). The Camera Lucida of Wollaston had some advantages (especially regarding mobility) over the Camera Obscura, which was already known at the time, allowing users to take the camera to the field to landscape sketching (Wollaston 1807: 5).

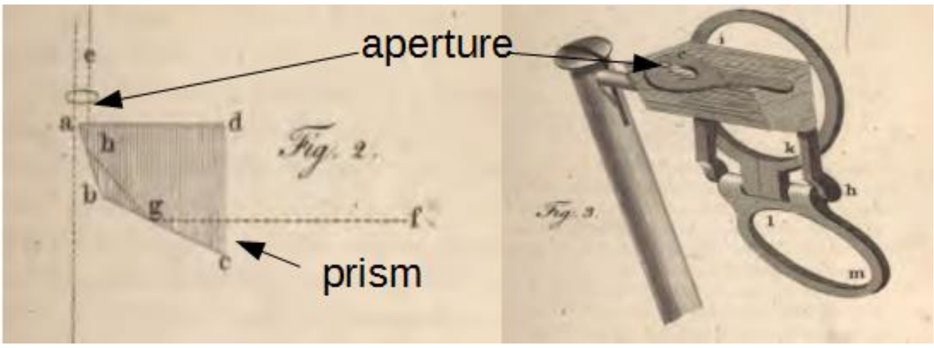


Fig. 7 Wollaston's Camera Lucida (Wollaston 1807: 5).

In his instrument description, Wollaston indicated James Newmann (1790-1830), at 24 Soho Square, London, as the main seller of his Camera Lucida. Newmann was famous for selling every requisite for drawing and painting, supplying the British painters. This may reflect that the main applicability of the camera at the time of its invention was related to art. It seems that Newmann and the other Camera Lucida instrument-makers made no significant changes in the object until 1819.

The Italian astronomer, microscopist, botanist and well-known instrument-maker Giovanni Battista Amici (1786-1863) announced in the Italian city of Modena some improvements to the Wollaston's Camera in 1819, four years after he had known it, related to the internal reflections. Wollaston's Camera failed to small eye movements

[1] A picture of Wollaston's Camera Lucida can be seen in Fiorentini (2006:10), from Whipple Museum.

when the virtual image onto paper was lost from the observer. Trying to solve this problem, Amici designed five different sets of prisms, mirrors and crystals until he could get a new Camera Lucida. By using mirrors and crystals, Amici modified the light path into the prism, widening the viewing angle and correcting the parallaxes in the angles (see Fig. 8). One of those sets could be easily adapted to microscopes and terrestrial telescopes, changing the Camera Lucida use and attracting the microscopists' attention (Hammond & Austin 1987).

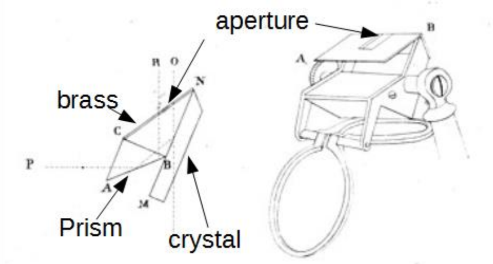
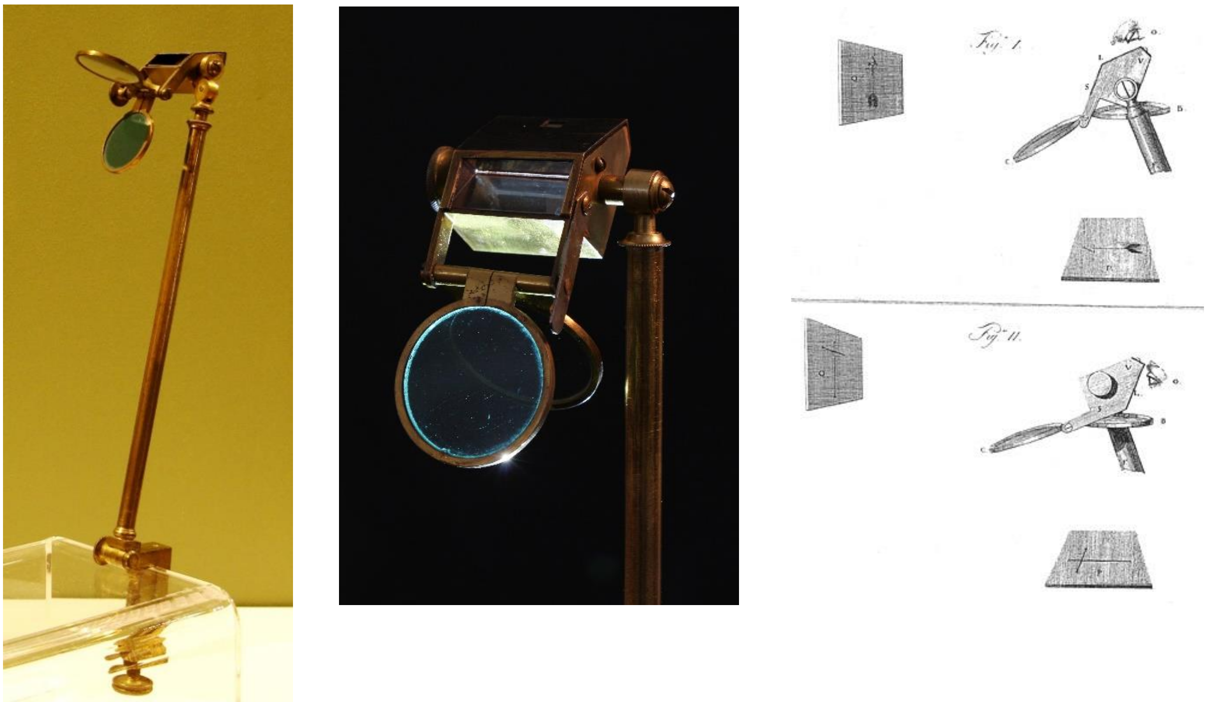


Fig. 8 Amici's camera Lucida (Amici 1819: 35).

The Amici's Camera (see Fig. 9) was presented to the French Academy of Sciences and to the Italian instrument-makers in 1820. In 1825, the new model was published in the section of the Edinburgh Journal of Science entitled "History of Mechanical Inventions and Processes in the Useful Arts" (Brewster 1825: 157). The instrument still used two glasses: the lens and a colored glass. The main change was inside the optical set, which now included a triangular prism and a crystal. That presented no change to the camera's results: its images had the same quality of Wollaston's and less skilled drawers would notice no difference.



(a) (b) (c)

Fig. 9 Amici's Camera Lucida. (a) The apparatus fixed. Source: Modena's Observatory © Alberto Meschiari. (b) Details from the optical set. Source: Modena's Observatory © Alberto Meschiari. (c) Two possibilities to look through the camera (Amici 1819: 35).

According to Amici (1819), his improvements facilitated drawing significantly as it could be made anywhere, and that resource was important for travelers who reproduced landscapes from moving ships. There is no consensus as to whether the Amici's Camera had a large audience. Hammond & Austin (1987) underline that it was not reproduced in large scale due to its complexity. Nevertheless, as noted by Fiorentini (2004), because the use of Amici's Camera was effective, it increased among other instrument-makers. On this issue, the literature reports that the camera was reproduced by M. Lerebours of Place du Pont-Neuf, in France (Hammond & Austin 1987). Another French instrument-maker, Chevalier, who had also known Amici's Camera, started to produce it after implementing some changes.

Although Vincent first published his inventions in 1834, including the Camera Lucida and its instruction manual (Fig. 10), it had already been part of his catalogue since 1827 (Chevalier 1827). The basic set of prism and lens of his camera was similar to Amici's: a triangular prism and a crystal to avoid the parallax. Vincent emphasized that the best camera results depended on: i) the instrument position regarding the table on which it was fixed; ii) the correct use of lenses and colored glasses; and iii) the proper lighting between the drawing paper and the object.

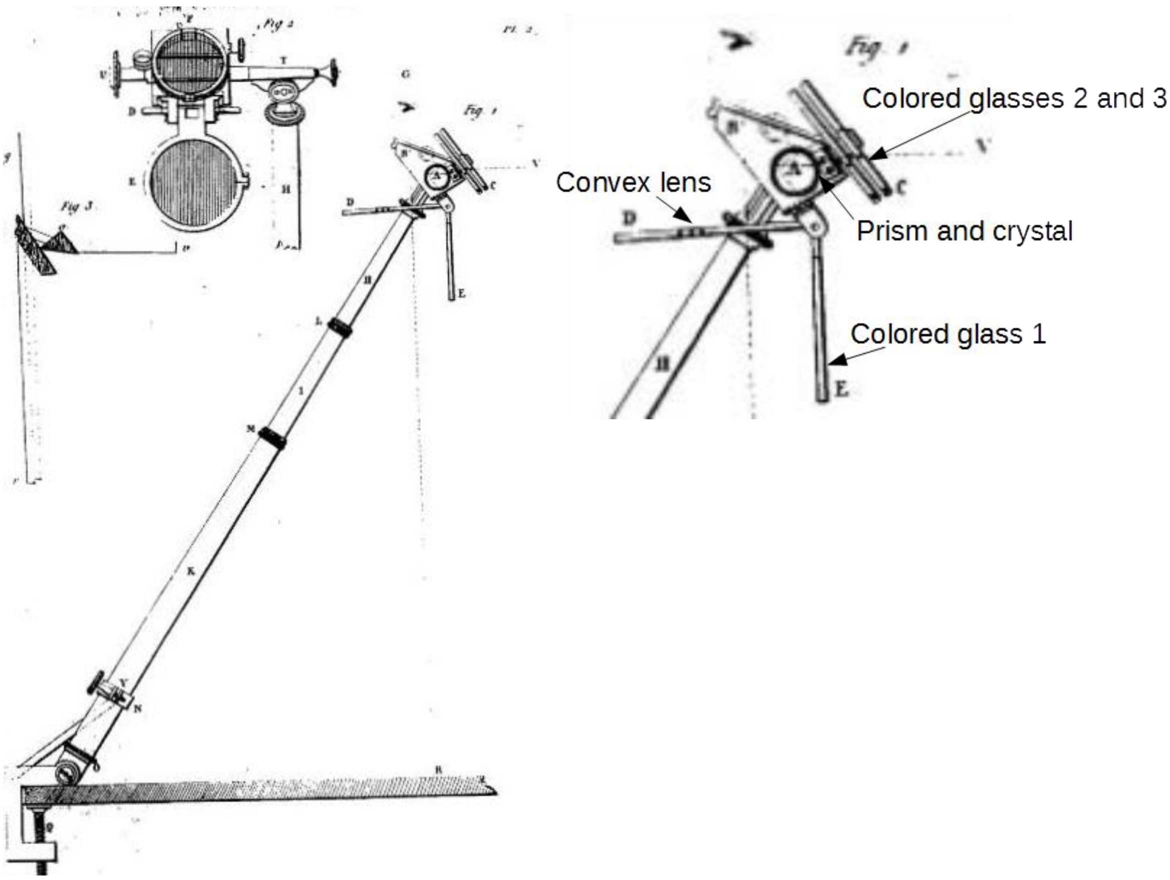


Fig. 10 Vincent Chevalier's Camera Lucida (Chevalier 1834: 16).

The condition (i) implies in the virtual image size. If the distance between the object and the camera was equal to the distance between the instrument and the paper, then the lenses were not necessary because the dimensions of the object on the paper were the same as the real image. On the other hand, if the distance between the object and the camera was greater than the distance between the camera and the paper – as in a landscape reproduction –, then the convex lens (Fig. 10) was necessary to enlarge the image on the paper (Chevalier 1834: 7-10). The convex lens and the colored glass 1 were circular, as we can see in Figure 10. Vincent implemented a change by adding two-colored glasses (glasses 2 and 3, of unknown size and shape) that were related to the (ii) and (iii) conditions.

According to the proportion of light between the object and the paper, three possible effects could be noticed: the drawer could neither see his/her hand nor the pencil on the paper; the object could disappear; or the object could be well delineated. To control lightness, it was necessary either to move the table towards the lighter parts of the object or to move the colored glasses 2 and 3 vertically towards the prism to reduce the object brightness. The overlap between the convex lens and the colored glass 1 allowed the drawer both to control the proportion of lightness between the object and the paper and simultaneously to see the virtual image and the pencil. According Chevalier:

> Different colored glasses, adapted to the improved Camera Lucida, allow to freely modify the light coming from the object or paper, as well as to see, with the same distinction, the image of the pencil used to trace the lines [….] And, if it is necessary, for the same drawing, the colored glasses can alternately be moved towards the object or the paper if not all the parts of the object are equally illuminated. (Chevalier,1834: 8 - our translation)

Vincent's Camera, with the aid of two different color glasses, had created something different from the previous model. Actually, his camera had the same optical device as Amici's from an external point of view; however, in terms of quality, it produced different results. The two-colored glasses that he had added worked as filters, leaving the images well delineated and allowing the viewer to identify shadows and details. As a result, the landscapes could have a different color for each drawer. From the detailed instructions given by Vincent, it is possible to conclude that the use of the camera was not obvious. Therefore, if the user did not know how to adjust the camera and the glasses, it would not be possible to see the image.

Charles Chevalier also made some modifications to Vincent’s Camera (Chevalier 1838: 10-15), but it cannot be said that he created something new for he only made an exchange by replacing the circular lenses for the rectangular ones (Fig. 11). Maybe this explains why the camera exhibited in the Museum (Fig. 12) kept Vincent Chevalier’s signature, in spite of being similar to Charles Chevalier’s. On the other hand, similar cameras can be found in scientific catalogues with Charles Chevalier’s signature, thus indicating him as its creator.

In 1836, Basil Hall (1788-1844), a British naval officer who commanded many explorations and scientific and diplomatic missions, wrote a letter to Charles praising Vincent’s Camera (Chevalier 1838: 40). In the letter, he emphasized that the camera filters had allowed him to easily draw many of the landscapes he had seen. The new device had made the drawing of objects in perspective easier and it had also controlled the aspects related to colors and brightness.

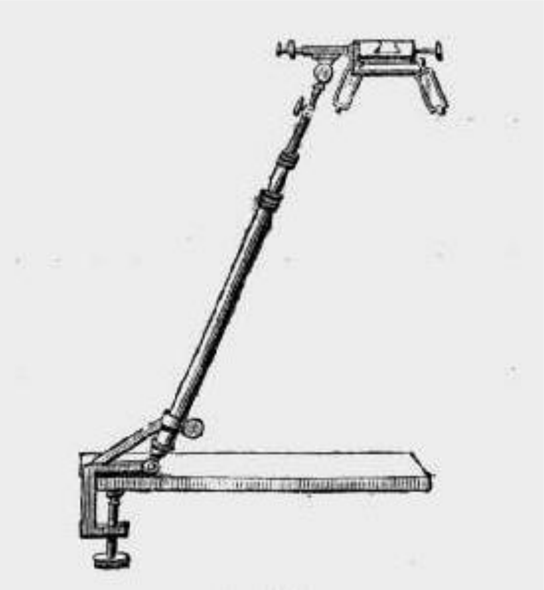


Fig. 11 Charles Chevalier's camera on sale by Arthur Chevalier (catalogue) in 1860 (Chevalier 1860: 35).

Fig. 12 Museum's camera with Vincent Chevalier's signature. Source: Deutsches Museum Munich © Takis Lazos.

As Vincent Chevalier had registered no patent on the new device he had created, Charles and Arthur, after his death, sold it as Charles Chevalier's Camera. In Arthur's catalogue from 1860, it shows: "Wollaston's Camera Lucida improved by Charles Chevalier," although that camera is completely different from the first one, invented by Wollaston.

Probably, like Amici and Vincent Chevalier, other instrument-makers also made modifications in Wollaston's Camera Lucida. Indeed, new materials and techniques must have been created in the period between the first Camera Lucida and Arthur's Catalogue (1860). Moreover, there were other manufacturers meeting local specification needs in London, the United States, France, Italy, etc. Depending on the country and the buyers' intention, subtle or considerable modifications must have been made (McConnell 2013; Brenni, 2013). Figure 13 presents the Camera Lucida models from 1820 to 1930, i.e., after Chevalier's modifications.

Fig. 13 Pablo Garcia's personal collection of Camera Lucidas. Source: Shapiro Center for Research and Collaboration © Pablo Garcia/NeoLucida

A possible narrative

After 1860, the use of the Camera Lucida began to decline. Scientists were more enthusiastic about its adaption to microscopes and telescopes (Fiorentini 2006), for which there was no need of filter use. The sold models were once again used according to their original purpose, that is, to facilitate the delineation of objects in perspective, like in Wollaston's Camera. Hence, only some amateur painters and drawers continued to use the Camera Lucida for sketching (Hammond & Austin 1987). Few objects are listed in the scientific instrument catalogues and most of them referring to Wollaston's Camera[2].

In the end of the 19th century, scientific knowledge was restricted to Academies and Universities. Optical instruments were necessary, only in a very restricted and specialized environment. By going through processes of evolution and transformations, they gradually acquired precision. The instrument-makers understood that transition and focused on the microscope and telescope production and sales and on their improvement to meet the needs of a specific audience of non-amateur scientists (Brenni 2013).

On the other hand, society as a whole was changing its conceptions of nature. The photographic camera could capture images better than drawings. For this mass-audience, the focus shifted to large scale photographic camera manufacturing (Hammond & Austin 1987).

Ferdinand Meldahl (1827-1908), a Danish architect and art enthusiast, became a professor at the Royal Danish Academy of Fine Arts in 1863 (SchiØdte 2003). Despite being a prominent person at the time, he received no mention of his work in the natural sciences. Chevalier's Camera Lucida in that period was still present in catalogues (general instruments catalogues); however, its use had become restricted to painters and drawers. I raise the hypothesis that Ferdinand either bought or gained the secondhand instrument, stored it in a personal case and used it to for his architectural drawings and/or teaching. Probably, one of his daughters inherited the camera and used it to develop her artistic skills, as drawing was one of the skills desired for "well educated" women in the 19th century. Chevalier's Camera Lucida remained in the family until 2011, when it was donated to the Deutsches Museum.

Another possible narrative could be elaborated according to the objective of the instrument analysis. For the history of art, it could expand the discussion that draws a parallel between the real image and the image of objects from optical instruments (Do they represent nature?) (Fiorentini 2004). From an educational perspective, it could be expanded the discussion about the physical phenomenon related to optical instruments and how the new scientific discoveries have changed the camera use. The narrative about Ferdinand Meldahl and his family could work as a background information to the development of science, highlighting the discussion on issues of human values and gender controversies.

Final remarks

The first Camera Lucida was produced based on the basic laws of refraction and reflection. As it reached specialized instrument-makers, improvements were made in order to expand its functions and accuracy. Object improvements were gradually made as a result of the discovery and use of better quality materials, such as glasses and

[2] Some catalogues consulted: Pike (1845; 1856); South Kensington Museum Catalogue (1877), Deleuil et son fils (1848), etc.

prisms. Both camera and material improvements happened due to the expansion of scientific knowledge, among other reasons.

It is noteworthy mentioning that some improvements have leverage increased demand for specialized skills to use the camera and instruction manuals with more detailed descriptions on the object. A new audience began to show interest in the object, leading to modifications in its function and utility. Instrument-makers have played a key role in implementing modifications to the instruments they developed and from the design and because of the wide dissemination of their new instruments/objects around the world through their catalogues.

The Camera Lucida, invented by a scientist, started as an object to improve sketches and paintings. Gradually, in later years, it started being adapted to microscopes and helped scientists to reproduce images. When the photographic machine was invented, the Camera Lucida became a domestic and didactical instrument.

In brief, conducting an analysis of the scientific instrument here presented, using the assumptions of the material culture approach, allowed me to contextualize it. By comparing the different models of Camera Lucida, it was possible to perceive that instruments are in constant change in terms of materials, tacit knowledge, function and utility. Individuals – scientists, instrument-makers and audience – involved in the design, production, sales and use of the scientific instrument addressed in this essay played a fundamental role in this modification process.

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