

67

ISSN 0256-1840



INTERNATIONAL SOCIETY FOR PHOTOGRAMMETRY AND REMOTE SENSING
SOCIÉTÉ INTERNATIONALE DE PHOTOGRAMMÉTRIE ET DE TÉLÉDÉTECTION
INTERNATIONAL GESELLSCHAFT FÜR PHOTOGRAMMETRIE UND FERNERKUNDUNG

INTERNATIONAL ARCHIVES OF PHOTOGRAMMETRY AND REMOTE SENSING
ARCHIVES INTERNATIONALES DE PHOTOGRAMMÉTRIE ET DE TÉLÉDÉTECTION
INTERNATIONALES ARCHIV DER PHOTOGRAMMETRIE UND FERNERKUNDUNG

Volume		Part	
Volume	XXXII	Tome	6W7
Band		Teil	

PROCEEDINGS OF THE WORKSHOPS

INTERNATIONAL COOPERATION AND TECHNOLOGY TRANSFER

Parma, Italy – February 15 – 19, 1999
Bandung, Indonesia – April 13 – 14, 1999
Cotonou, Benin – December 6 – 10, 1999

Edited by: Luigi Mussio, Bruno Crippa and Gianfranco Forlani
DIIAR - Sez. Rilevamento
Politecnico di Milano

VALIDATION OF AN ANCIENT PERSPECTIVE IN LECCO (ITALY)

PIETRO BROGLIA ^(*) EVA SAVINA MALINVERNI ^(**), LUIGI MUSSIO ^(**)
^(*) Observatory of Brera - Merate
^(**) DIAR - Polytechnic of Milan
e-mail: eva@ipmtf4.topo.polimi.it

Commission VI, Working Group 3

KEYWORDS: cartographic projections, altimetric mapping, panorama, camera lucida, photogrammetry.

ABSTRACT: The authors had the opportunity to collect, analyze and compare different kinds of representation acquired by means ancient and modern technologies. The idea was born out after having found an ancient perspective, realized in the nineteenth century, by means a camera lucida, in the Archive of Brera Observatory - Milan (Italy). To validate the accuracy of the panorama, i.e. the capability of this old technique, to obtain a good altimetric mapping, a modern solution, like a terrestrial photogrammetric survey, was set up and compared.

1. ACTIVITIES AND PURPOSES OF THE ASTRONOMERS OF BRERA OBSERVATORY IN THE NINETEENTH CENTURY

Thanks to their geodetic and cartographic research, in the XVIII century, the astronomers of Brera and the young engineers from the University of Pavia (Italy) could achieve an accurate and realistic survey of the territory. They always used scientific methods and tested new technologies, like the "camera lucida", which is a technique of drawing mountainous landscapes more accurate than the traditional tavoletta pretoriana.

The difficulty to obtain these kind of measurements in a short time and without a big effort, is clearly shown in memories and graphic documentation, collected in books of measurements.

This was the beginning of the modern cartography. In fact the survey of the geodetic base - line Nosate - Somma Lombardo, and the realization of triangular networks of the first and second order of Lombardy belong to this period.

Among the important documents collected in the Archive of Brera Observatory, in Milan (Italy), there were some important drawings, realized during the geodetic campaigns, which provided the altimetric information. This remarks that in that period, a graphic representation of the elevations was required. In order to obtain the best description (survey) of the landscape, the astronomers suggested two solutions for the altimetric problem:

- the realization of an altimetric network, from astronomic, surveying and also barometric measurements;
- the description of hilly landscape with the camera lucida, remarking the importance of surveying the panorama with measurements of azimuth and zenith.

For this reason, in that period ingenious astronomers and surveyors collaborated together with opticians, physicians and mechanics to improve new instruments, like the "camera lucida".

2. THE CAMERA LUCIDA

The "camera lucida", also called "camera chiara", came before the photographic system. It was used to copy a drawing, to sketch a landscape, to draw a portrait, mostly combined with a microscope (Figure 1).

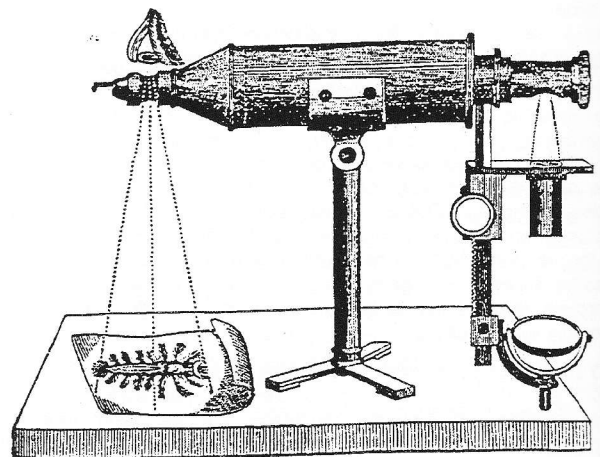


Figure 1. The camera lucida applied to the microscope

The camera lucida was an apparatus consisting of a Wollaston's prism or mirrors, used alone or applied to a vision system (telescope or microscope). It permitted to observe, in the same time, the scene and the paper and to draw a perspective of the scene with a big accuracy and simplicity. In fact the advantage of this instrument was the possibility of obtaining a life - size drawing, without approaching too closely to the object.

In the XIX century, the "camera lucida" was also applied to the telescope. For example, the Graphic Telescope invented by Cornelius Varley (England), consisted essentially of a drawing table and a low - power astronomical telescope with a mirror at each end (Figure 2).

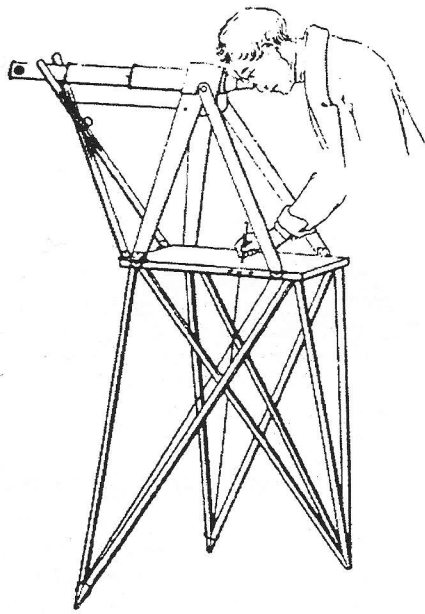


Figure 2. The Graphic Telescope with a drawing table

There is some documentation about other "camere lucide", designed and realized by physicists and opticians in Europe. In particular, in Italy, between 1817 and 1825, Giovanni Battista Amici, a very famous optician of Modena (Italy), realized 273 "camere lucide". One of them, was better than Wollaston's one and had a larger field of view and a good resolution (Figure 3).

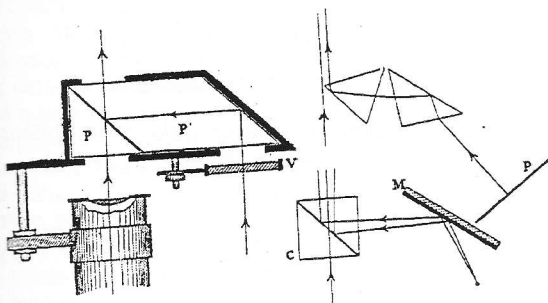


Figure 3. Some optical scheme of the camera lucida

Other optical instruments were realized in Milan by Luigi Consonni and Giuseppe Mozzoni, and in Venice by Giuseppe Selva.

In the XIX century, Giovanni Battista Amici collaborated with Francesco Carlini, the astronomer and director of the Brera Observatory for a long period who took part in many important geodetic and surveying experiences. They developed the model of a "camera lucida" applied to a telescope (Figure 4) and used it to draw some panoramas in North Italy.

Another example is the Teleiconograph of Revoil (French, 1869), which was nothing more than a Wollaston's "camera lucida" applied to a terrestrial telescope and mounted on a stand in the style of a theodolite.

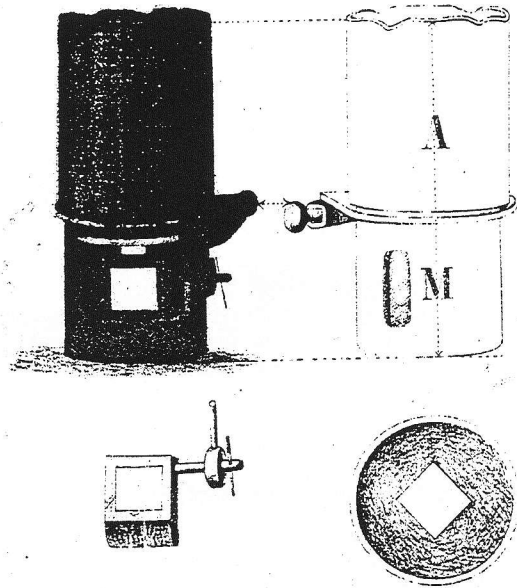


Figure 4. Amici's camera lucida realized for Carlini

3. THE PANORAMAS

Francesco Carlini was a very poliedrich man and gave a big contribute at the geodesy and cartography. He tested the technique of "camera lucida" to survey hilly landscapes. In 1817, Carlini had the opportunity to study Keller's panorama of the mountains surrounding the Duomo of Milan; this panorama was obtained only by means of a telescope. Carlini validated the accuracy of this drawing, comparing the position in the panorama of some points with the position obtained from azimuth and zenith measurements. He found a standard deviation of one degree between the two sets of measurements, confirming that Keller had drawn his panorama, using angles approximately measured on a Topographic Map. Being an astronomer, Carlini studied the real possibility to realize panoramas and some years later did experiments with the telescopic "camera lucida", thanks to the progress in this field. In one of his documents, Carlini showed the possibility of obtaining more perfect panoramas with the system of Daguerre, using its capability to acquire objects of dim light, like mountains, observed from a long distance.

Therefore the "camera lucida" can be considered the precursor of the photographic system.

For sure, during the geodetic campaigns in 1821 -1822, Carlini drew the panorama of Mont. Rosa from the Observatory of Turin (Italy), using Amici's "camera lucida" applied to a small telescope. A copy of this panorama (Figure 5) was found in the Archive of Brera; it was collected in "Der Mont. - Rosa Eine topographische and naturhistorische Skizze" book, edited in 1824 by Ludwig Freiherrn von Weide in Vienna.



Monte Rosa visto da Torino

Figure 5. Panorama of the Mont. Rosa drawn by Carlini from the observatory of Turin (Italy), by the camera lucida

Some others panoramas were collected in the Archive of Brera, but in some cases the information regarding the technique used was not found.

Another drawing showing mountains was contained in the book of measurements of the astronomer Oriani. It was realized in 1820 and represented the Mont. Orfano, observed from Solferino, in the South of Garda Lake (Italy) (Figure 6). The drawing was made from the top of Solferino hill, from which the view was enough wide, during the campaign of the geodetic survey of the medium parallel arc, as far as the Adriatic Sea; probably the "camera lucida" was used.

During the surveying for the Second Topographic Map of Lombardy, Carlini drew another panorama. It consisted of a strip of tissue paper, 90 cm large and 10 cm wide, representing the mountain profile as observed from Mont. Orfano (BS) (Figure 7). Notes on it confirm that the author is Carlini.

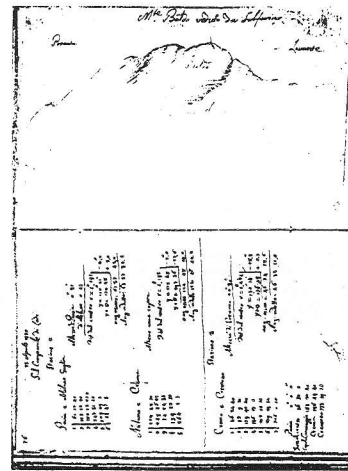


Figure 6. Panorama of the Mont. Baldo from Solferino (Brescia - Italy)



Figure 7. Carlini's panorama observed from the Mont. Orfano (Brescia - Italy)

4. THE PANORAMA FROM LECCO

The panorama of the hilly landscape of Lecco (Italy), recently found in papers collected by Carlini, belongs to this period. It covers an arc of 180 degrees, from Mont. Barro to Mont. St. Martino. It is a strip of two papers, 95

cm large and 15 cm wide, sewn one to other (Figure 8). This panorama is very interesting, because it shows every details of the landscape with accuracy and regular proportions, as it was made in scale. For these reasons and for its style it can not be a simple sketch made by free hand.



Figure 8. Panorama of the mountains from Lecco (Italy)

The purpose of this research was to investigate and to pursue studies and hypothesis regarding some questions about this panorama. For example, the point(s) of view of the panorama were localized with a lot of difficulties. The hypothesis that this panorama was obtained from successive surveys on the area is uncertain, because signs of any principal or secondary geodetic stations in Lecco were not found.

Moreover the panorama points are out of the ability and the artistic taste of the author (the shades were obtained by the watercolor) and besides his knowledge of the area. These elements are important to identify the author. In fact references to this panorama were found in a lot of papers of Carlini written during the period of the Second Topographic Map of Lombardy, but the notes on the drawing don't seem to belong to him.

In order to identify the author of this panorama, many documents of other important surveyors of that period were analyzed. In the books of geodetic measurements between 1803 and 1807, the name of the young engineering Giuseppe Bovara was many times repeated. His diary, recently found, confirms both his presence during the geodetic campaigns and his hard work made with the astronomers of Brera. In 1810, Bovara specialized in architecture in Rome. He also drew a Map of the Naples Gulf, showing his strong interest in the cartographic representation. After leaving Rome, he lived and worked in Lecco and in its neighborhood. Bovara was also a big friend of Carlini during all his life.

Analyzing the panorama of Lecco, it seems clear that the notes have been written by Bovara, instead of by Carlini, and other coincidences (described later in the paper) confirm that Bovara was the author.

Anyway there are some other questions to answer to, so the ancient drawing has been analyzed and compared to the modern photogrammetric survey.

5. PRELIMINARY ANALISYS

In order to find the point(s) of view, some tops of mountains and some places were recognized in the panorama and compared with the measurements made on the Topographic Map. The points were recognized using different kind of maps at different scales: the Map of Touring (scale 1:200.000), the Regional Technical Map of Lombardy (scale 1:10.000), the Thematic Map of Lecco District (scale 1:50.000) and, for the historical buildings in the city, the first Map of Italy (scale 1:100.000) realized by IGM in the 1888.

In order to make a mathematical analysis, a reference system on the Regional Technical Map of Lombardy was assumed. The origin was placed in the intersection of the cartographic grid at the coordinates 5.078.000 m (North), 1.531.000 m (East) of the sheet B4d4 Lecco (x grows towards West and y grows towards North). This reference system was used for the measurements made on the

maps; on the contrary, the measurements on the panorama, were referred to the first top of the Mont. Barro, positioned in the left part of the panorama.

The two measurements were compared using a least square linear regression between azimuth angles and linear distances: $d = k + s\theta$, where d represents the horizontal distance measured on the panorama in mm and θ the cartographic azimuth. Analogous considerations were made for the elevation angles α . The reference system for the elevation angles was the surface of the sea. As before, the measurements of the elevation angles from the map were compared to the vertical distances h measured on the panorama, according to the least square linear regression: $h = k + s\alpha$.

Changing the point of view, the residuals for 36 points, estimated using these relations, were obviously variable. In fact the correct localization of the some points on the panorama depended on the selection of the point station. The point of view placed in Lecco (near Belvedere Street) provided the least standard deviation. The optimal solution showed the point of view coordinates, in the local reference system: $x = 911$ m, $y = 550$ m., $z = 230$ m, the panorama scales for the azimuth angles: $k = 12.1$ mm, $s = 271$ mm, the panorama scales for the elevation angles: $k = 40.5$ mm, $s = 226.7$ mm, and a standard deviation of 17.1 mm.

Notice that no points were rejected, because a robust down - weighting procedure for outlier identification was set up. Furthermore the preliminary information, concerning the elevation of the lake (and of the candidate point(s) of view), was introduced in the system with a very small weight.

Observing the residuals, they had a systematic behavior. In fact the drawing was made on two papers and every paper seemed to have its own point station. Therefore analyzing separately the two parts of the drawing, two different points of view, which minimized the mathematical solution, were found.

The first solution, obtained for the section with the Mont. Barro, using only 20 points, showed the point of view coordinates, in the local reference system: $x = 860$ m, $y = 696$ m., $z = 216$ m, the panorama scales for the azimuth angles: $k = 9.5$ mm, $s = 274.0$ mm, the panorama scales for the elevation angles: $k = 15.9$ mm, $s = 275.4$ mm, and a standard deviation of 8.4 mm. The second solution, related to the section with the Mont. S. Martino, obtained with 16 points, showed the point of view coordinates, in the local reference system: $x = 716$ m, $y = 184$ m., $z = 210$ m, the panorama scales for the azimuth angles: $k = 21.5$ mm, $s = 342.7$ mm, the panorama scales for the elevation angles: $k = 54.6$ mm, $s = 197.3$ mm, and the same standard deviation, because the solution is unique.

After this analysis, the great reduction of the standard deviation confirmed that the panorama was likely realized from two points of view in Lecco.

6. THE PHOTOGRAMMETRIC SURVEY

In January 1999, a photogrammetric survey was organized to confirm and validate the results obtained and to identify the correct points of view of the ancient drawing. Using a metric camera WILD P31, lens 100 mm, 6 images were taken from the bell - tower terrace of the S. Nicolò main church in Lecco. Once it was upon an ancient tower, property of Bovara since 1800; there are news that recall the possibility of the participation to the realization of this drawing by Bovara himself.

The black and white images were digitized by DTP scanner with low-resolution and then they were mosaiced in a photogrammetric panorama (Figure 9).

Using this representation, the same criterion of analysis was applied identifying 23 tie points between the photogrammetric panorama and the ancient one. The correct identification is validated by the small standard deviation calculated. Let recall that, in this case, the point station is known.

The hypothesis that Bovara were the author is also confirmed by some particular elements of the drawing, like the correct position of the Valmadrera church; it must be probably added later by Bovara, from his house in Lecco. Moreover Bovara himself built the church in Valmadrera in the 1810-1816; this new sets a limit for the data of the end the panorama work, while the data of its beginning is fixed in the period 1804 - 1807. In this period Bovara was collaborating with the astronomers of Brera, before moving to Rome.

The panorama was found in Carlini's documents, thanks to the big friendship between the astronomer and Bovara.

The research of information about ancient and modern technologies to acquire a correct altimetric representation of the territory, is very important and still in progress.

REFERENCES

Amici, G. B., 1819. *Sopra le camere lucide*. Opuscoli Scientifici, Vol. 3, pagg. 25-35, Bologna.

Amici, G. B., 1823. *Sur la chambre claire*. Annales de Chimie et de Physique. XXII, pagg. 137-55.

Carlini, F., 1827. *Notizie di diverse carte topografiche della Lombardia e dei paesi limitrofi*. Biblioteca Italiana, Vol. 46, pagg. 41-61, Milano.

Carlini, F., 1841. *Su ciò che ancora mancherebbe ad una compiuta descrizione geografica del nostro paese*.

Giornale dell'I. R. Lombardo, Vol. III, pagg. 145-162, Milano.

Carlini, F., 1862. *Ricordo degli studi topografici eseguiti in Lombardia*. Effemeridi astronomiche di Milano per l'anno 1863, Appendice, pagg. 3-26, Milano.

Daccò, G., Cattaneo, B., 1988. *Memorie di un architetto - Autobiografia e Catalogo della Raccolta di Giuseppe Bovara*. Lecco.

Ferrari da Passano C., Monti C., Mussio L., 1977. *La meridiana solare del Duomo di Milano, verifica e ripristino nell'anno 1976*. Veneranda Fabbrica del Duomo di Milano, Milano.

Gabba, L., 1928. *La Carta della Lombardia a cura degli astronomi di Brera*. Contributi della Regia Specola di Brera, n. 15, Milano.

Govi, G., 1889. *Intorno ad una nuova camera lucida*. Atti Accademia dei Lincei, Vol. 5, pagg. 3-6, Roma.

Hammond, J. H., Austin, J., 1987. *The camera lucida in Art and Science*. Adam Hilger, Bristol.

Monti, C., Mussio, L., 1980. *L'attività geodetica astronomica, topografica, cartografica degli astronomi di Brera dal 1772 al 1860 studiata attraverso gli Atti Ufficiali dell'Osservatorio*. Memorie dell'Istituto Lombardo, vol. XXVII, Memoria 5, Milano.

Mori, A., 1903. *Cenni storici sui lavori geodetici e topografici e sulle principali produzioni cartografiche eseguite in Italia*. Istituto Geografico Militare, Firenze.

Mozzoni G., A., 1827. *Descrizione ed uso di una nuova camera lucida*. Giusti, pagg. 32, Milano.

Zantedeschi, F., 1862. *Intorno ad un piano di meteorologia ed alla applicazione della camera lucida al cannocchiale per ottenere dei panorami di Monti in grande scala e della maggiore esattezza*. Atti dell'Istituto Veneto, Serie III, Tomo VIII, pagg. 120-125.

Zantedeschi, F., 1870. *Della camera lucida di Wollaston*. Atti dell'Istituto Veneto, Serie III, Tomo XV, pagg. 1065-1067.

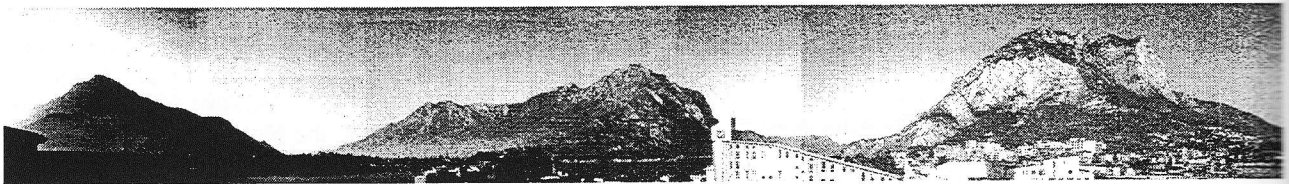


Figure 9. Modern photogrammetric survey from Lecco (Italy)