

COMPARISON BETWEEN A CAMERA LUCIDA PANORAMA AND A PHOTOGRAMMETRIC SURVEY

PIETRO BROGLIA ^(*), EVA SAVINA MALINVERNI ^(**), LUIGI MUSSIO ^(**)

^(*) Observatory of Brera - Merate

^(**) DIIAR - 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 of ancient and modern technologies. The idea was born out after having found an ancient perspective, realized in the nineteenth century, by means of 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 terrestrial photogrammetric survey was set up and compared.

THE CONTRIBUTE OF THE ASTRONOMERS OF BRERA OBSERVATORY TO THE CARTOGRAPHIC REPRESENTATION

This paper resumes, develops and completes a recent research about the use of camera lucida to draw panoramas (Broglia et al., 1999).

Thanks to the geodetic and cartographic research, in the XVIII century, of the astronomers of Brera Observatory - Milan (Italy) and the young engineers of the Pavia University (Italy), many documents were collected which testify their capability to realize 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 "tavoleta pretoriana" (Hammond et al., 1987).

A lot of important documents collected in the Archive of Brera Observatory, give evidence the great work, between the XVIII and XIX century, of famous astronomers and geodesists, like Boscovic, De Cesaris, Reggio, Oriani and Carlini (Carlini, 1862). Their researches were very important; in fact during their campaigns of measurements the altimetric information was provided to complete the cartographic representation and some other important objects of geodetic knowledge (latitude and longitude) (Monti et al., 1980).

Among these personalities, the figure of Ruggero Giuseppe Boscovic is recalled for his Dalmatian origin (he was born in 1711 in Ragusa and died in 1787 in Milan). He was a Jesuit, Professor of Mathematics in the University of Pavia and of Astronomy in Brera. He became Director of Brera Observatory at its foundation. Furthermore he contributed at the progress of the knowledge of the form of the earth, trying to realize the trigonometric measurements from the France to the

Adriatic Sea and the mountains of Istria and realizing the geodetic network of the first order in the Papa State. He opened the new age in the history of the Italian Cartography. In fact, after a period in France (from the 1773), he returned in Italy (in the 1779), to collaborate with the astronomers of Brera about different cartographic problems. Boscovic obtained important results, developed theory and applied methods and instruments sometimes for the first time used.

Regarding it, in the same period some ingenious astronomers and surveyors collaborated together with opticians, physicians and mechanicians to improve new instruments and to obtain surveys more accurate than the traditional ones. In less time, important contributions were achieved, like the "camera lucida", which can be considered the precursor of the photographic systems (Amici, 1819, 1823). Indeed Francesco Carlini, another astronomer and director of Brera Observatory, 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 (Carlini, 1841).

Some panoramas were collected in the Archive of Brera and among these, in the papers of Carlini, the panorama of the hilly landscape of Lecco (Italy) was recently found. 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 1). 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 cannot be a simple sketch made by free hand. The purpose of the previous research was to investigate and to pursue studies and hypothesis regarding the author and the localization of the point(s) of view, from which the panorama was (were) obtained.

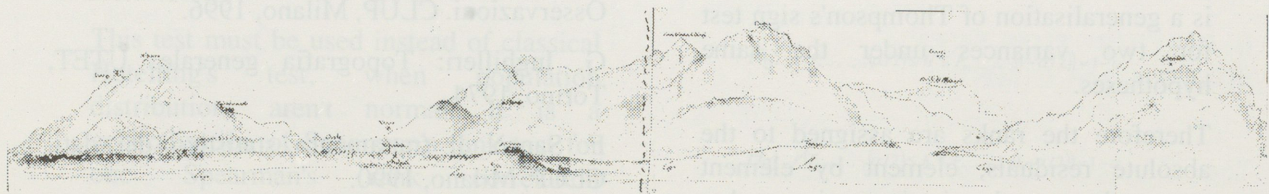


Figure 1. Panorama of the mountains from Lecco (Italy)

SOME CONSIDERATIONS ABOUT THE ANCIENT PANORAMA OF LECCO (ITALY)

Some particular elements of the drawing, regarding the knowledge of the area surveyed, are important to identify the author. Furthermore analyzing the notes written on the panorama of Lecco and taking into account some other coincidences (Broglia et al., 1999), the authors arrived at the conclusion that the architect Giuseppe Bovara was the author. He realized the panorama from 1804 to 1816 and it was found in the Carlini's documents, because there was a big friendships between the astronomer and Bovara.

In order to find the point(s) of view, some tops of mountains and some places were recognized in the panorama and compared, using a mathematical analysis, with the measurements made on the Regional Technical Map of Lombardy. The two sets of measurements were compared using a least squares linear regression between azimuth angles and linear distances; analogous considerations were made for the elevation angles, referred at the surface of the sea and compared to the vertical distances measured on the panorama.

The correct localization of some points on the panorama depends on the selection of the point station. The point of view, considering the whole panorama, was firstly placed in Lecco, near Belvedere Street, in proximity of the lake. Successively observing the residuals of this first analysis and their systematic behavior, the analysis was refined considering the two parts of the drawing separately. Thus two different points of view, which minimized the mathematical solution, were found.

The first point of view, using only the first twenty points of the section of the panorama with the Mont. Barro, was situated in the cross-roads between Turati and Belvedere Streets, at the altitude of about 220 m. on the sea level. It is important to refer these considerations at the period, in which the panorama was realized; therefore the historical map, realized by IGM in the 1888, was used. In this map, the main street of Lecco ran parallel at the Turati Street

and there were not houses among these streets and the lake. So the visibility in this area toward the lake, in the XIX century, was very large, this made possible the presence of a point station to draw a panorama.

The second solution, referred to the second section of the panorama with the Mont. St. Martino, obtained using sixteen points, showed the point of view localized in the center of gravity of a triangle. Its vertices were located: at the Church of S. Nicolò (rebuild in the 1830 by the architect Bovara, in more steps, with the bell-tower finished in the 1904, on a Visconteo keep), at the Canonica of the XVII century and at the house of Bovara (now Municipal Library) (Daccò et al., 1988). Also this part of the town of Lecco, in the XIX century, permitted a good view of the lake and of the mountains around it.

COMPARISON WITH A MODERN TERRESTRIAL PHOTOGRAMMETRIC SURVEY

To validate the accuracy of the ancient panorama, i.e. the capability of this old technique, to obtain a good altimetric mapping, a modern terrestrial photogrammetric survey was set up and compared. In January 1999, a photogrammetric survey was organized using a metric camera WILD P31, lens 100 mm, taking 6 images from the bell - tower terrace of the St. Nicolò, the main church in Lecco. The black and white images were digitized by DTP scanner with low-resolution and then they were mosaiced in a photogrammetric panorama by means of commercial software (Figure 2).

To realize the comparison between the photogrammetric panorama and the ancient one, in the set of points (listed below), only twenty eight points were identified and measured (Table 1). In fact, the correct identification of the other nine points (shown in bold in the same list) were not possible, on the photogrammetric panorama, for the scarcity of either characteristics, or good and identifiable elements, moreover for the presence of some occlusions (Figure 3).



Figure 2. Modern terrestrial photogrammetric survey from Lecco (Italy)

Point number	Name on the Map	Altitude on the sea level (m)
1	Barro	889
2		657
3	Regina	817
4	Regina	814.7
5		448.2
6	Barro	922
7	Barro	850
8	Barro	830
9		800
10		585.8
11	Zucco in Boffalora	405.4

13	Valmadrera	240
14	Malgrate	220
15	Corno Birone	1116.2
17	Cornizzolo	1240
18	Rocca	272
19	Cima Rai	1215
20	Prasanto	1244.8
21	Parè	200
22	Canzo	1366
23	Cimone	1177.3
24	Cimone	1259
25	Cimone	1190
26	Cimone	1180.5
27	Cimone	1122.5

28	Fornaci	200
29	Forcella	1324
30	Castel di Leves	959
31	Punta W	200
32	Tremezzo	1699.4
33	Abbadia	200

34	Crocione	1641.5
35	Coltignone	1270
36	Coltignone	962
37	Coltignone	1046

Table 1 - Set of points identified on the panorama

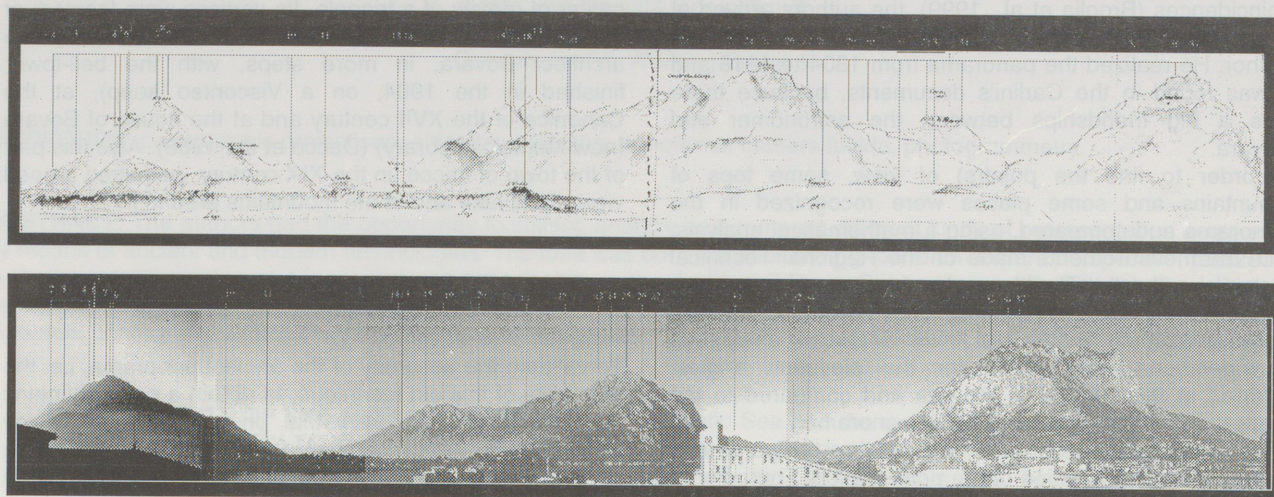


Figure 3. Identification of the same set of points on the two panoramas

For this comparison, the measurements performed on the ancient panorama on the horizontal and vertical axis, firstly used to localize the points of view, were newly used together with the same type of measurements, done on the photogrammetric panorama (Figure 4).

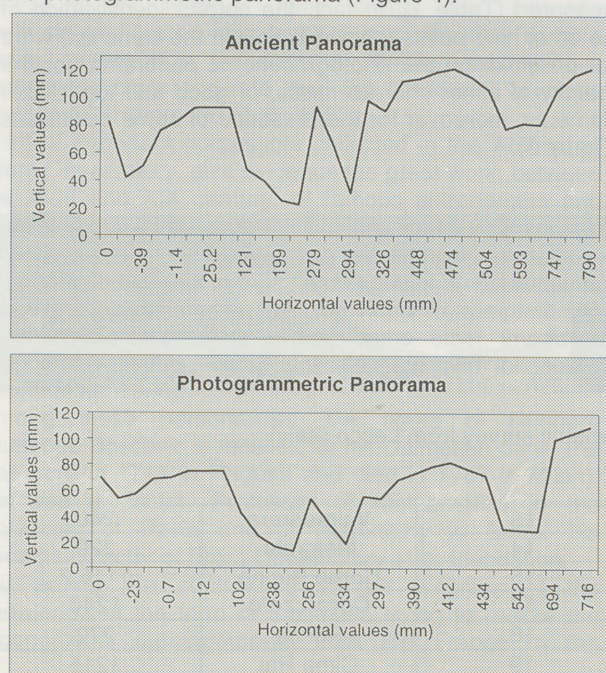


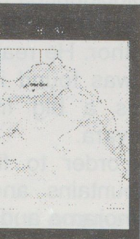
Figure 4 - Measurements performed on the ancient and photogrammetric panoramas

The differences, among these measurements, have not pointed out a simple systematic behavior. However they show very high values, related the points localized in the second section of the panorama (Table 2).

Point number	DX (mm)	DZ (mm)
1	0	12.5
2	-22.6	-11.4
3	-15.7	-6.3
4	-5.9	7.2
6	-0.7	13
7	12	17.8
8	13.2	18
9	15	17.9
10	19	5.1
11	12	14.7
13	-38.7	9
14	-30.8	9.2
15	23.2	39.7
16	29.7	30.8
18	-40.4	12
19	32.4	42.7
20	28.5	36.7
22	48	44.2
23	58.3	40.7
24	59.4	40.1
25	62	39.8
26	66.9	39
27	69.6	34.1
30	53.2	46.9
32	50.7	52.1
34	65.5	52
35	52.5	5.9
36	69.6	11.9
37	73.7	11.9

Table 2 - Differences between the ancient panorama and the photogrammetric one

1641.5
1270
962
1046
panorama



DZ (mm)
12.5
-11.4
-6.3
7.2
13
17.8
18
17.9
5.1
14.7
9
9.2
39.7
30.8
12
42.7
36.7
44.2
40.7
40.1
39.8
39
34.1
46.9
52.1
52
5.9
11.9
11.9

panorama and

01
11

Therefore a best fitting by means of a spline interpolation, in two components (x, z), was realized. Firstly, using the values of differences and the measurements made on the ancient panorama, the result of the interpolation was very good, with a $\sigma_0 = 3.15$ mm, for the horizontal component, and a $\sigma_0 = 1.84$ mm, for the vertical component. Then using the same values of differences and the measurements made on the photogrammetric panorama, another good result was obtained, with a $\sigma_0 = 3.48$ mm, for the horizontal component, and a $\sigma_0 = 1.61$ mm, for the vertical component. The residuals of these interpolations are shown in the Table 3.

Point number	Ancient panorama		Photogr. panorama	
	X residuals (mm)	Z residuals (mm)	X residuals (mm)	Z residuals (mm)
1	0.435	-0.272	-0.034	-1.332
2	0.767	1.601	1.007	0.610
3	-1.142	-2.301	-1.538	-0.717
4	0.475	1.085	1.399	2.649
6	-0.209	0.112	-0.131	-1.950
7	-0.712	0.438	-2.153	0.354
8	0.180	-0.265	0.214	-0.001
9	0.174	-0.532	1.280	0.408
10	0.889	1.637	-0.128	-0.073
11	-1.541	-2.194	0.163	0.164
13	6.489	1.528	4.297	0.421
14	-5.793	-0.535	-3.995	-0.567
15	-1.002	0.721	-0.873	0.525
18	0.255	-0.570	0.172	-0.025
19	1.274	-2.075	1.477	-1.284
20	-0.606	1.936	-1.890	1.214
22	1.115	-0.836	4.278	-1.270
23	-1.824	0.041	-5.735	0.749
24	-1.191	0.854	-0.969	1.118
25	1.275	0.428	3.171	-0.179
26	1.688	-1.630	1.343	-1.883
27	-1.381	0.909	-1.645	1.134
30	0.843	-0.175	0.641	-0.098
32	-0.718	0.110	-0.900	0.124
34	0.133	0.011	0.567	-0.076
35	0.321	-0.057	0.001	-0.001
36	-0.752	0.130	-0.001	0.001
37	0.487	-0.085	-0.006	-0.001

Table 3 - Residuals between the ancient panorama and the photogrammetric one

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.
- Broglia, P., Malinverni, E. S., Mussio, L., 1999. *Validation*

of an ancient perspective in Lecco (Italy). Int. Archives of Photogrammetry and Remote Sensing, vol. XXXII, part. 6W7.

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.

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

Monti, C., Mussio, L., 1980. *L'attività geodetico 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.