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PORTA PALATINA HISTORIC SURVEY DRAWINGS: DIGITAL REPLICAS AND COMPARISON WITH UPDATED DIGITAL ACQUISITION

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KEY WORDS: Survey, Porta Palatina, Turin, Andrea Palladio, Digital Acquisition

ABSTRACT:

The proposed research aims at a comparison of the main historical surveys conducted on the Porta Palatina by different authors, with the data of a current digital survey. Through a work of redrawing and superimposition of information deducted from historical drawings, the analysis will highlight the consistency, discrepancies and inconsistencies of these drawings compared to the current state of the artefact. Therefore, the instrumental survey, necessary for the subsequent stages of graphical analysis, was carried out using photogrammetric techniques and Metashape software.
The drawings taken into consideration for this work are those by Sangallo (1494-1497 ca.), by Palladio (1566 ca.), by Promis (1869) and by D'Andrade (1883): they constitute a very interesting documentary heritage, although heterogeneous, in which qualitative drawings (Sangallo), scaled drawings (D'Andrade), measured drawings (in vicentine's feet for Palladio, in meters for Promis) alternate.

1. PORTA PALATINA OVER THE CENTURIES

The Porta Palatina (Principalis Sinistra) is the only city gate that remains almost intact of the fortified walls, realized for Julia Augusta Taurinorum (the ancient Turin) in the 1st century AD. The four main city gates were very similar in shape and size: they were with a cavedium, developed around a central courtyard surrounded by high walls. Regarding the other gates, the Porta Decumana, very similar to the Porta Palatina, was incorporated over the centuries in the construction of the Acaia castle, which later became Palazzo Madama (Mercando, 2003; Ratto, 2015).

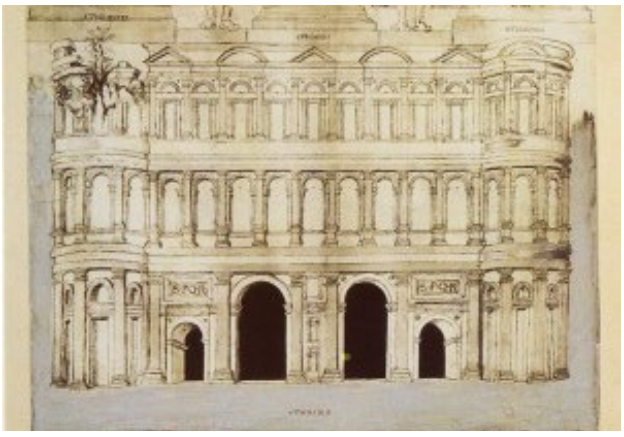

Figure 1. Giuliano da Sangallo. Survey of Porta Marmorea, 1494-1497. © Biblioteca Apostolica Vaticana.

The Porta Praetoria (or Segusina), is visible in mid-fifteenth century maps, then definitely demolished, after some reconstructions, in 1585. Little is known about the Porta Principalis Dextera (or Marmorea) except that it was destroyed around 1660 (Mercando, 2003): a Giuliano da Sangallo's drawing, for a long time referred to it, according to recent studies, "portrayed, instead, reinterpreting with some freedom, one of the other gates still intact at that time, probably the Porta Palatina" (Ratto, 2015).

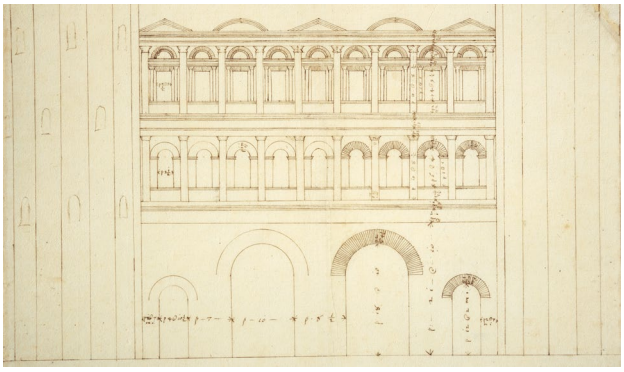

Figure 2. Andrea Palladio. RIBA31826, 1566. © RIBA Collections.

Another drawing edited by Andrea Palladio probably depicts Porta Palatina, but the note of reference was made by Kemball (Zorzi, 1958).
Referring to the transformations of the Porta Palatina over the centuries, it is known that in 1724 the gate was used to establish the Carceri Vicariali; in 1864, the restoration of the monument was formally assigned to Carlo Promis (Promis, 1869). The project included the construction of a new school building leaning against the inside facade of the gate, completed in 1875. A new restoration was carried out by Alfredo D'Andrade (D'Andrade, 1899) with the excavation that highlighted the

[*] This paper is the result of the research on Porta Palatina carried out together by the authors. The authors wrote together paragraphs 1 and 7, M. Vitali wrote paragraph 2,3,6, E. C. Giovannini paragraph 4,5.

square bases of the towers and part of the ancient pavement, the demolition of the Promis building and the reparation of the towers (1903-1915). The works were interrupted with the outbreak of the First World War, to resume only in 1935, when a new project for the Archaeological Zone was promoted by the Municipality and finished in 1938.
The gate, which fortunately was untouched by the bombings, was the subject of new restorations since 1946 and the entire archaeological area was reconsidered from those years with numerous resettlement projects (for brevity we will not treat this period): the definitive configuration of the Archaeological Park was achieved some years ago, with the project by Aimaro Isola, Giovanni Durbiano and Luca Reinerio (2003) (Baietto, 2015).

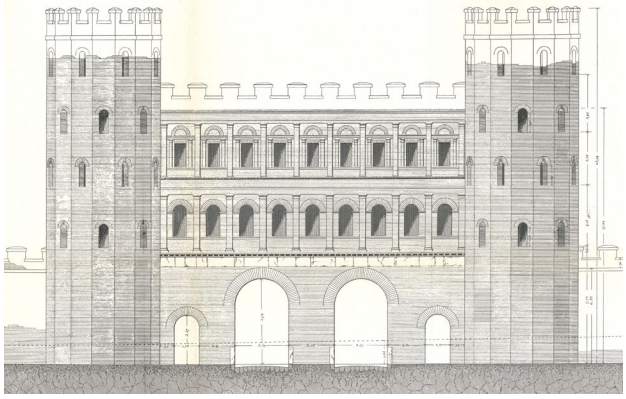

Figure 3. Carlo Promis. Survey of Porta Palatina, 1869.

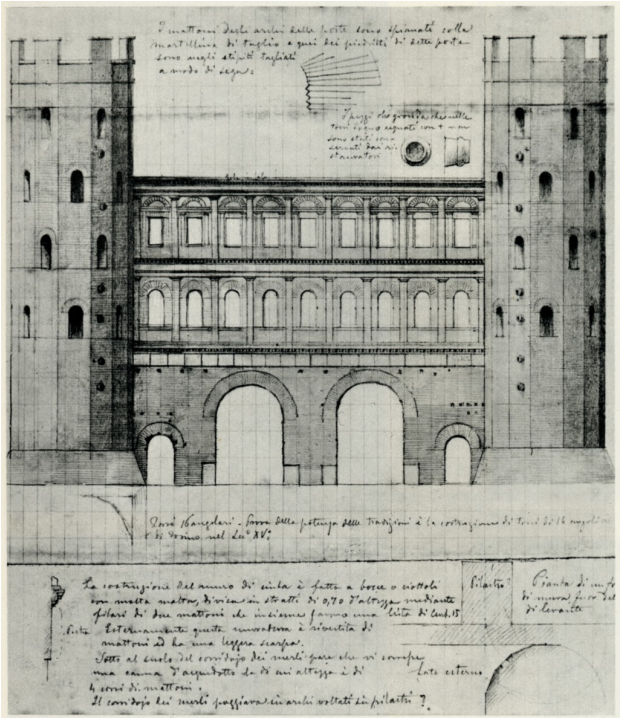

Figure 4. Alfredo d’Andrade, Survey of the gate, 1883. © Fondazione Torino Musei, Fondo d'Andrade.

2. MAIN RESEARCH FOCUS

The proposed research aims at a comparison of the main historical surveys conducted on the Porta Palatina by different authors, with the data of a current digital survey. Through a work of redrawing and superimposition of information deducted from historical drawings, the analysis will highlight the consistency, discrepancies and inconsistencies of these drawings compared to the current state of the artefact. Therefore, the instrumental survey, necessary for the subsequent stages of graphical analysis, was carried out using photogrammetric techniques and Metashape software.
The drawings taken into consideration for this work are those by Sangallo (1494-1497 ca.), by Palladio (1566 ca.), by Promis (1869) and by D'Andrade (1883): they constitute a very interesting documentary heritage, although heterogeneous, in which qualitative drawings (Sangallo), scaled drawings (D'Andrade), measured drawings (in vicentine’s feet for Palladio, in meters for Promis) alternate.
Palladio survey drawing, which until now, was not considered in the documentary heritage corpus of drawings related to the city gate of Turin. The drawing, encoded as RIBA31826 and conserved at Royal Institute of British Architects (RIBA) shows a roman gate similar to Porta Palatina, but even if it is certain that the author of the drawing is Palladio, the measures and notes were made later, probably by his son Orazio. As Zorzi says Palladio visited Prince Emanuele Filiberto in 1566 and made a survey of some Ancient Monuments of Piedmont.
The drawing made by Carlo Promis in 1869 represents the gate facade framed by two towers. In this case, Promis added measurements not only for the gate but also for the walls that surrounded the monument. In particular, Promis investigated also the evolution of the urban plan of the city starting from the original castrum.
The first part of the work was carried on first, by the analysis of drawings. This comparison was made possible by digitally representing the bi-dimensional CAD drawing of the surveys of both authors that involved the transcription and conversion of measurements from Palladio vicentine’s foot to the International System of Units.
The comparison of both digital replicas of the historic survey drawings enlights a discrepancy in the proportions and position of architectural elements that compose the facade of the gate.
The comparison of these digital replicas of historical drawings with data and drawings of the current survey are intended to clarify, on the one hand, as have occurred some changes over time, such as those concerning the level of the roadbed, the other are oriented to verify that the gate represented in the historical drawings (which lacks an unequivocal caption) is the Porta Palatina, which from a composition /quality point of view could be confused with one of the other three coeval city gates.

3. DIGITAL ACQUISITION AND SURVEY DRAWING

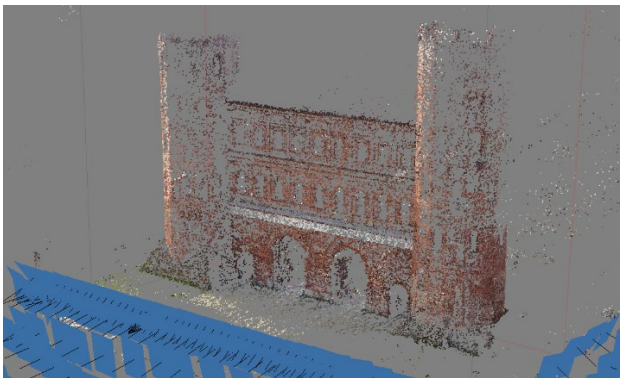

Figure 5. Alignment of photographic shots and creation of the dense cloud with Metashape.

Starting from the information presented here, the research project has focused on the SfM survey in order to provide the necessary representations for the subsequent stages of graphical

analysis and comparison with the historical survey drawing. For this stage of the work, a photographic survey was carried out to make a photo-modelling with Metashape® software. According to established practices in this operational field, an appropriate number of mid-size frames (106) were shot, and a dense cloud was created, which, cleaned and settled, shows about 2,850,000 points. The associated mesh model, constructed with 6,000,000 faces, was subsequently oriented and scaled into space and textured for the realization of orthophotos (Fig. 6) and in scale drawings (Fig. 7).

Figure 6. Orthomosaic of the north elevation of the Porta Palatina produced starting from the texturized model

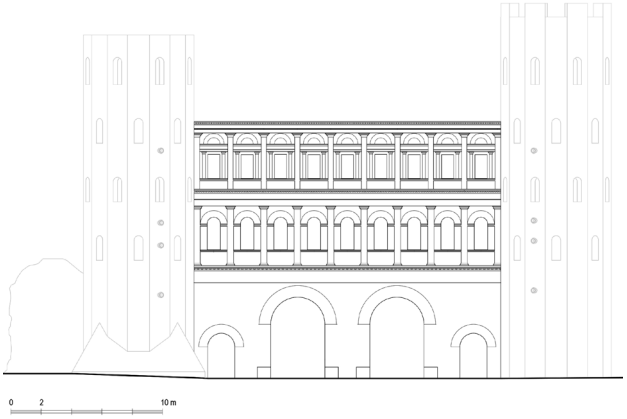

Figure 7. In scale drawing of the north elevation of the Porta Palatina © M. Vitali

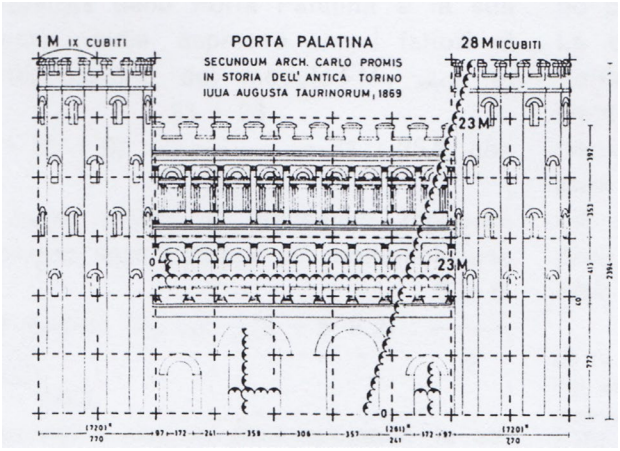

Figure 8. Graphic analysis by Kurent, excerpt (Kurent 1965)

A previous investigation focused on the graphic analysis and the representation of the north elevation based on the units of measure and the construction modules used for the architectural composition. In this regard, the work was closely related to previous research developed by Kurent (Kurent, 1965) (Fig. 8) on the survey drawings made by Promis (Promis, 1869).
The module used by Kurent for his graphic analysis refers to the particular type of brick used to make the gate, the Lydica, with standard measures of 44.39 cm (cubitus) x 29.57 cm (pes) x 7.47 (palmus): "the common measure for the dimensions mentioned is 1 palmus; the ratio of brick dimensions is 6: 4: 1. "(Kurent 1965, p.39). In an attempt to re-study the modularity concerning the updating of the survey’s measurements, it would seem sensible to use modules based on feet (fig. 9).

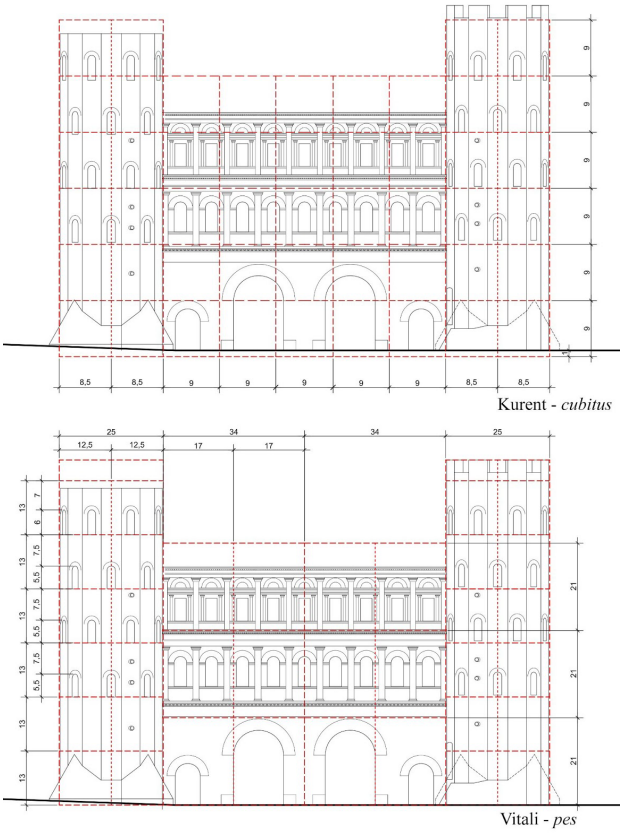

Figure 9. Graphical analysis, with a comparison – on the current survey – between the modular scheme set on cubits (Kurent) and the one set on feet © M. Vitali

4. ANALYSIS OF DRAWINGS

The analysis of the drawings has the purpose of verifying what kind of information can be extracted from them. This information can then be used for comparative purposes to verify whether the drawings produced over time refer to Porta Palatina or not.
Specifically, G. B. da Sangallo and A. Palladio have stylistic similarities, particularly in the presence of alternating tympanums crowning the upper order.
The information on the drawings can be broken down into thematic levels (Giovannini 2017) such as:
Level of Elements (LoE) which breaks down the object of study into its main semantic components. It consists of identifying the main architectural elements. This type of analysis is useful for example in the case of three-dimensional modelling. The use of BIM software provides for the analysis of the LoE that will serve as the basis for the modelling of custom families that reflect their semantic characteristics.

Level of Measures (LoM) analyzes all dimensional information. For more efficient comparative analysis, the Transcript of Measurements (ToM), a table that analyzes dimensional information, can also be useful. When using BIM software combined with VPL Visual Programming Language, ToM data can be used directly for generating architectural forms. VPL algorithms communicate very efficiently with spreadsheets and allow parametric modelling algorithms to generate complex shapes based on the numerical data in them.
Level of Accuracy (LoA) to be understood in a different way than the metric accuracy investigated in the geomatic field, refers to the potential accuracy of the single resource analyzed. In this case, the LoA value is the result of interpolation between morphological and dimensional information. This level of analysis is useful in the virtual reconstruction process where decision making raises questions about the level of uncertainty in the reconstruction and the data underlying those reconstructions.

Author	dimensional information	morphological information
G.B da Sangallo		●
A. Palladio	●	●
C. Promis	●	●
A. d'Andrade		●

Table 1. dimensional and morphological information from different drawings.

5. TRANSCRIPT OF MEASUREMENTS

The first passage was to transcript all information in a table that clearly describes the content of all drawings with their specific unit.

Author	Unit	to cm
G.B da Sangallo	Roman's foot	29,7
A. Palladio	Vicentine's foot	35,7
C. Promis	International System of Units	-
A. d'Andrade	International System of Units	-

Table 2. unit used in analyzed drawings.

As illustrated in the Table 1, Sangallo and d'Andrade drawings are not useful for dimensional analysis.
Then a first comparison was done between the Palladio drawing and the Promis one. Then Promis was compared with the data of digital acquisition to verify the accuracy of his survey.
Regarding the Drawing of Andrea Palladio, encoded as RIBA 31826 is similar to other drawings belonging to the Palladian Corpus and conserved at the RIBA.
The gate is represented as a central body with two main fornices and two lateral passages and it is framed by two towers that have a different type of representation: the towers are sketched while the gate has measurements annotated.
The gate is composed of three main levels. After the ground level dedicated to fornices Palladio draw the marble fascia that separates the first level from the others that consist of a superimposed order of windows framed by intercolumniation.
Palladio also annotated the main architectural elements indicating their measures.
Within his corpus of drawings, Palladio indicates feet with a p but there are also sub-dimensional units of the foot, such as the ounce indicated with a snail and the minutes indicated with a lowercase letter m. According to Palladio the vicentine's foot is divided into 12 ounces each composed of 4 minutes.
Palladio measurements refer to diverse elements of the superimposed orders. The area of the pedestal, the base, column and capital of the order and then the architrave. The windows are framed by intercolumnio and are built with an aedicular form. The window of the first order has the form of a rectangle surmounted by a half-circle. In the second order, the window is squared and reduced in the eight.
To facilitate the transcript of measurements and the comparison of measures, the annotated dimensions were encoded and represented in a legend (Fig.10).

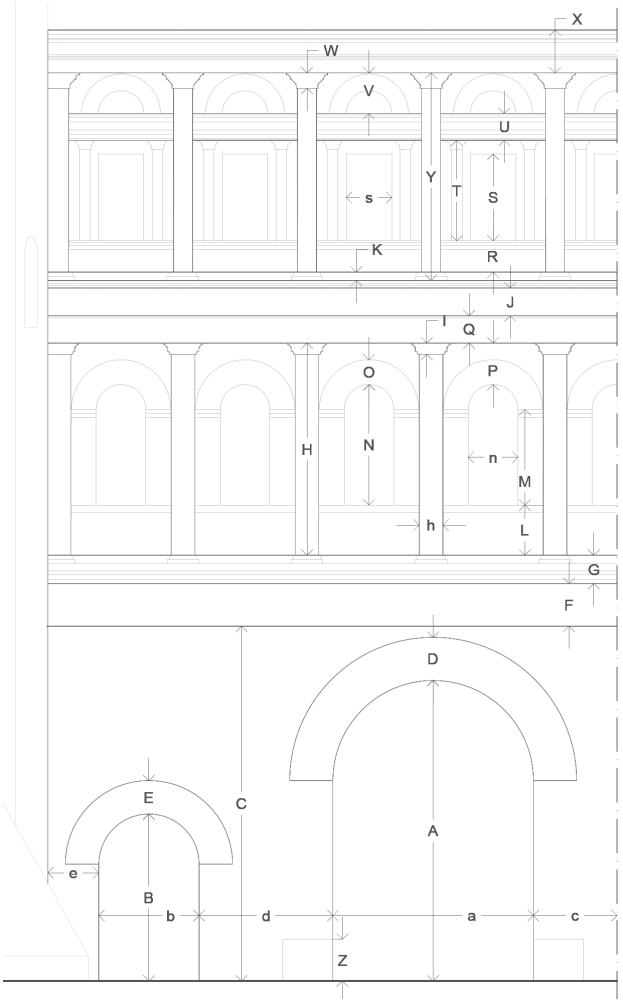

Figure 10. Legend of encoded measures © E. C. Giovannini

The dimensions found on RIBA 31826 were indexed, using alphabetic characters. In the case of dimensions for horizontal distance, lower case letters were used, while for vertical ones, upper case letters were used.
At the same time, we tried to use the same letter when we referred to the same architectural element.
Starting from the drawing of Andrea Palladio, the transcript of Measures has the aim to verify the accuracy of dimensions with respect to the one made by Carlo Promis in his survey drawings. (Fig.3 and Fig. 12).
Since Promis had transcribed all the dimensions, based not only on the survey but also in coherence with the brick used to build the gate.
The disparity of granularity in the type of metric information present on the two drawings examined is evident.
Contrary to other Palladian drawings, Palladio does not add the details of the mouldings in this architectural representation.

Moreover, since it is a frontal view, his stylistic choice is not to burden the drawing by indicating unmeasured elements.
Then, to allow for an effective comparison between indicated dimensions by both authors, the ToM provides fields for transcribing A. Palladio's measurements in Piedi vicentini and converting them according to the current International System of Units.
The measures present in the drawing have been put in correspondence with the respective takes and transcribed analysing the Promis. Some of the partial dimensions of Promis were subsequently summed or recalculated based on the dimensional element corresponding to the measurements indicated in Palladio.

dimension letters	A.Palladio				C. Promis	
	piedi	once	minuti	conv. Cm	provenance of measures	cm
A	18	10		672		574
a	10			357		359
B	12	2	1	435		337
b	4	10	2	174		172
C	21	10		779		
c	8	6		303		306
D	2	4	2	85		
d	7			250		241
E	1	7	3	59		
e	2	7	1	93		97
F	2	1		74		73
G	1	8		60	28+14+21	63
H	10	8	2	382	214+42+42 +15+63	376
h	1	3	1	45		44
I		7	2	22	42/6*3	21
J	1	3		45		42
K		6		18		21
L	2	3	2	82	15+63	78
M	5	1		181		170
N	6	4		226		214
n	2	6		89		44
O	1		11	44		42
P	2	1		74	42+42/6*5	77
Q	1	3		45		42
R	2	2		77	56+21	77
S	4	9	2	171		155
s	2	3	2	82	40*2	80
T	5	5		193	155+21	176
U	1	3		45	14+21+14	49
V	1	10		65	42+26+18	86
W		10		30	18+26	44
X	2	3	2	82	28+18+55	
Y	10	8	2	382	56+7+155+21+14 +21+14+42+26+1	374

Figure 11. Transcript of measurements and comparison between A. Palladio and C. Promis representations.
© E. C. Giovannini

As shown in Fig.11 the most of elements in Palladio drawing corresponds in eight and with the architectural elements dimensions in the C. Promis drawings regarding the superimposed orders.
The ground level of C. Promis representation has not relevant dimensions to be compared with the Palladio ones.

6. CONSIDERATIONS ABOUT C. PROMIS DRAWINGS

Promis dedicates to the Porta Palatina a chapter of the *'Storia dell'antica Torino Julia Augusta Taurinorim'* (Promis 1869) entitled *'Le porte e specialmente la Porta Palatina'* (The gates and especially the Porta Palatina), in which he describes the historical events that affected the four main city gates, dedicating ample space to the Porta Palatina and to the drawings, surveys and studies that followed one another over the centuries.
One of the drawings on which the author dwells is that of Giuliano da Sangallo, according to Promis referred to the Porta Palatina, as reported in the introduction and suggested by many more recent authors.
According to Promis, «This design would be very accurate, whenever it did not please to San Gallo, as well as his contemporaries, to embellish this and other buildings, applying at whim shafts, cornices, frontispieces; making marble pilasters, which there are brick and placing them where they were never. The towers are circular and with decoration continued by that of the body in the middle, but the four passages are all open; on the supreme cornice there is a little attic, but the too much freedom used elsewhere prevents me from paying attention to it. I traced it from the original as the first drawing of our antiquities...» (Promis 1869, 200).
The boards that accompany the descriptive text are composed of three elaborates:
- Board I presents the plan of Roman Turin and the details of a strip of the north façade of the gate, at a scale of 1/40 properly dimensioned.
- Board II contains the *'Pianta della porta Romana, o Palatina al 1/125'* (Plan of the Porta Romana, or Palatina at 1/125), in which the horizontal dimensions of the interturrio are reported.
- Board III 'FRONTE A NORD E VERSO LA CAMPAGNA DELLA PORTA ROMANA O PALATINA' (North elevation and towards the farmland of the Roman or Palatine gate), which shows the north elevation of the door with the height of the towers.
The analysis of the boards and the comparison of the Promis measurements with the actual survey measurements provides a lot of information: from a first comparison, we can notice in Board II a good correspondence on the horizontal measurements, with a difference of about 3-5 cm. Only one measurement by Promis, the one between the two doors to the right of the axis of symmetry of the facade, shows an anomalous value, with a difference of 20 cm: this value, unlike the others indicated, does not follow the rules of symmetry of the facade and suggests an error of transcription from the drawings to the printed board.
A comparison for the height measurements relative to the interturrio must instead be conducted starting from the superimposition of the elevation of Board III and the current survey drawing, mediated by the measurements reported in Board I, in the drawing 'Parti della Porta Romana all'1/40'(Parts of the Roman Gate at 1/40), which, however, concern only the two upper levels occupied by the regular layout of the windows.

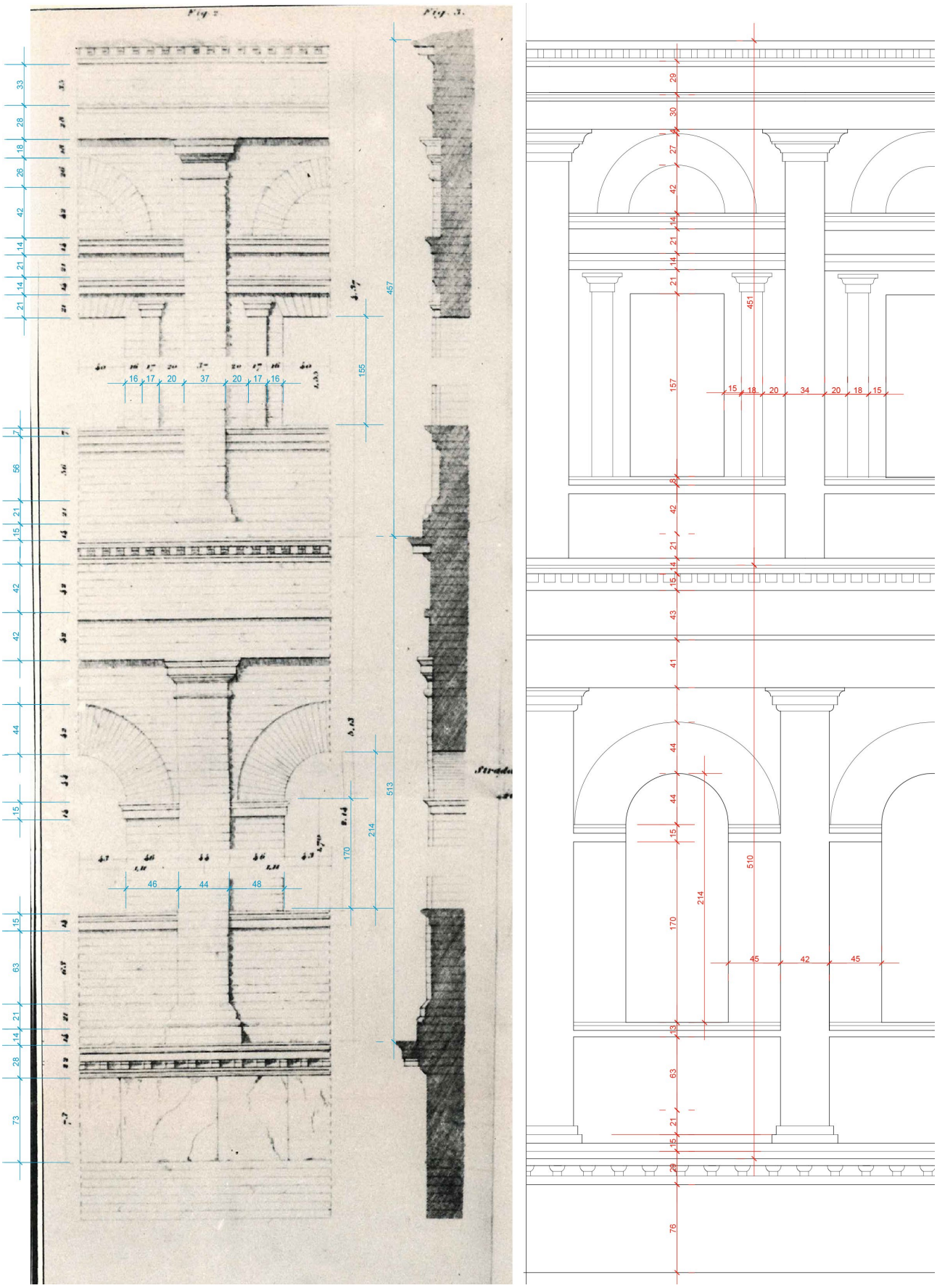

Figure 12. Comparison between the elevations shown in the historical survey of Promis and the elevations deduced from the current survey. On the left: the detailed drawings of Promis (shown in Board I), in which the dimensions, difficult to read on the original, are rewritten in light-blue; on the right: excerpt of the survey elevation with the indication of the real dimension of the same elements measured by Promis. © M. Vitali

The superimposition of the two drawings is quite difficult because, strangely enough, the drawing by Promis presents great inaccuracies in the measures that define the distance between the keys of the fornices and the position of the stone band, with a gap of about 30-35 cm. The upper part of the elevation, on the other hand, overlaps with a certain precision (with a maximum error of 5 cm), which is lost above the windows of the last order, where some horizontal bands seem to be missing, which produces a shortening of the pilaster-strips in the area above the windows, with a gap again significant, which is around 25 cm (Fig. 13).

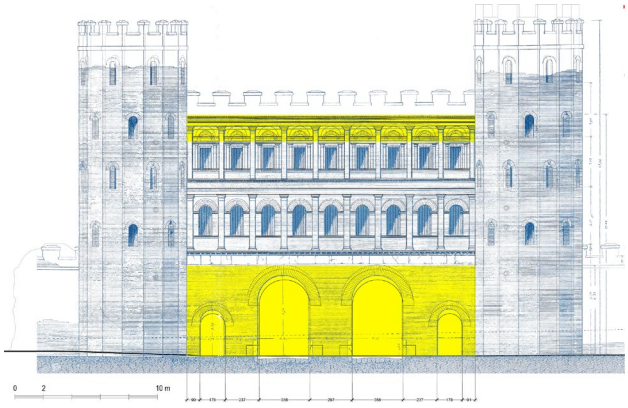

Figure 13. Superimposition of the actual survey (in black) on the elevation drawn by Promis (in light blue). In yellow are highlighted the parts where there is a lack of correspondence between the drawings © M. Vitali

The detail drawings contained in Board I show, as mentioned above, the vertical heights above the stone band: the heights of the elements that characterize the structural, functional and decorative levels of the façade - both in the vertical and horizontal scanning - are extremely precise, with differences of around 1-2 centimetres. The only wrong measure is the one defining the distance between the reinforcing arch of the masonry above the windows of the second order and the notched band immediately above (Fig 12).

7. CONCLUSIONS

The analysis of the results achieved allows, on the Promis drawings taken into consideration, to formulate hypotheses, quite reliable, on the nature of the drawings. Having evaluated the differences in terms of rigour and precision between the drawing of the complete elevation (which presents numerous gross inaccuracies and a lower level of precision) and the detail drawing (much more precise in general terms, and almost free of errors) it can be hypothesized that the first drawing (Board III) was dedicated to the qualitative reading of the artefact and of the transformations undergone over time (in fact, the vertical dimensions refer exclusively to the two lateral towers), while the second (Board I), constituted a true and proper survey, in which, moreover, the measurements suggest a close relationship between dimensions and construction module (the thickness of a brick).
The analysis of the results achieved by the ToM allows to state that the A. Palladio drawing is probably representing Porta Palatina. Further investigation can be done in the future regarding the ground level height that is, until nowadays the main research question mark available to determine if the drawing represent the Porta Palatina gate or one of others gate of the city wall.

Imagining the future developments of the research, it is easy to foresee how the analysis of the drawings will be propaedeutic to the creation of a complex three-dimensional information model within which the sources analysed, the relative derived models, two-dimensional and three-dimensional, will be able to coexist and create a knowledge space system able to contain and relate the representations of Porta Palatina, understood as an artefact that records over the centuries countless transformations, or as an element of the urban scene, also in constant transformation.

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