# Leon Battista Alberti and the Survey of the Walls of Rome

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*Abstract*

*The* Descriptio Urbis Romae *by Leon Battista Alberti represents the result of the first scientific survey of the city of Rome, of which however the author does not provide any data, but only some operational indications. The aim of this contribution is therefore the advancement of knowledge on the Albertian survey project, through the collection of direct clues, coming in particular from the reading of the* Ludi mathematici*, and the analysis of some singularities that can be deduced in the restitution.*
*The study focuses in particular on the survey of the walls of Rome, an element of great importance in the* Descriptio *and which, due to its heterogeneity and territorial extension and the current persistence, is configured as a precious experimental opportunity. The restitution of the walls path, as it emerges from the graphic transcription of the numerical data present in the Alberti text, allows, compared with the current map, to produce new observations, crucial for the subsequent experiments, such as for example divergences of the walls and the coherence of the restitution for individual parts.*
*By means of today's digital simulation tools, designed to retrace a critical selection of the relevant experimental data produced by Alberti with the instruments of the time, and guided precisely by the observation of singularities, the research helps provide valuable clues on the original survey project.*

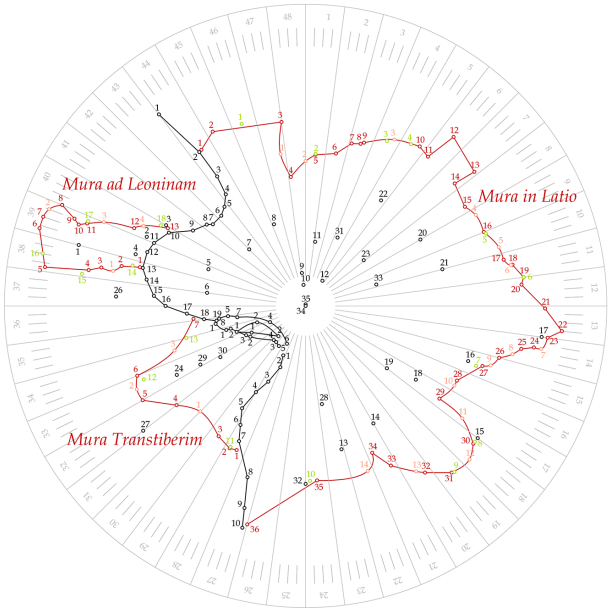
*Keywords:* Descriptio Urbis Romae*, urban survey, representation of the city, cartography, digital simulation.*

## The *Descriptio Urbis Romae* by Leon Battista Alberti

The *Descriptio Urbis Romae* by Leon Battista Alberti [Alberti 2005] is a very important document in the field of urban survey and drawing: testimony of the configuration that Rome had taken towards the middle of the fifteenth century, it is among the first known attempts of topographic representation of the city and, together with what Alberti wrote in the *Ludi mathematici* [Alberti 1973], it defines the progress of knowledge in survey of city at that time. It consists of a short text that explains how to graphically reconstruct the map of the city –synthesized in some essential elements such as walls, doors, river path, Tiberina island limits and significant buildings– starting from the polar coordinates contained in the tables that follow the text itself (fig. 1). A graduated circle, the *horizon*, divided into 48 degrees, each subdivided into four minutes, and a line, the *radius*, split into 50 degrees, which are also subdivided into four minutes, are the only tools –described and illustrated in the codices [1] (fig. 2)– necessary to guide the reader in the execution of this drawing. Despite the drawing of the city is the main subject of the work, it does not appear in any of the codices that have survived, replaced in its entirety by its literal description, the *ekphrasis*: as usual in the period before the introduction of printed reproduction, it was used to protect the identity and fidelity of drawing, being its manual reproduction more susceptible to various mistakes if made by a copyist not necessarily expert on the subject.

*Fig. 1. Graphic restitution of the Descriptio Urbis Romae by Leon Battista Alberti.*




When Leon Battista Alberti arrived in Rome for the first time, in 1432, the city showed signs of medieval decadence: ruined buildings, muddy roads, large areas within the walls uninhabited and used for cultivation and grazing, ruins of ancient buildings reused and surmounted by new buildings [Cantatore 2005; Fiore 2005]. In later years, it began to grow the interest of the curia in the study and enhancement of Roman antiquities in view of the renewal of the city, which was an increasingly important place of pilgrimage to the main buildings symbols of Christianity: Alberti himself, back again in Rome in 1443, began to study ancient and late ancient ruins and early Christian basilicas. It is in this period that he began to dedicate himself to the *Descriptio*, a work with which he implicitly manifested his interest in survey and representation of the city.
However, the *Descriptio* constitutes the conclusion of a far more complex path related to topographic survey, that is explicitly dealt, with a scientific approach, in another work, crucial for understand the genesis of the drawing of Rome evoked in the *Descriptio*: the *Ludi mathematici*. This work, written between 1450 and 1452 with pedagogical purposes, is among the first contributions in history to address issues related to the measurement of space and, as we shall see in particular, to the topographic survey. While in the *Descriptio* there are only the instructions that allow us to reproduce the map of the city by points, in the *Ludi* we find the description of the method and the tools with which Alberti detected these points.

## For a study of the *Descriptio Urbis Romae*

Although this particular work by Alberti can be considered a significant evolution of knowledge in the scientific representation of the city, and –by extension– even of the data produced by the survey, the studies addressed to it are rare. The National Critical Edition of Jean-Yves Boriaud and Francesco Furlan, published in Florence in 2005 [Alberti 2005], constitutes a precious and indispensable contribution to the philological reconstruction of text and data and to the general framing of the work, and, as usual for this kind of publication, it is devoid of conjectural considerations about the survey operation that necessarily produced this result. On the contrary, the extensive analysis by Luigi Vagnetti, published between the 1960s and the 1970s [Vagnetti 1968; Vagnetti 1974], deals with the issue of restitution in depth –evaluating the discrepancies with respect to 20th century maps– and advances hypotheses on the choice of stations in the survey phase without resorting to experimental tests.
The *Descriptio* tells only how to reproduce the restitution of the city plan, while it does not deal with the method, the instruments and the procedure followed for the related essential survey activities, which are instead explained and illustrated from a theoretical point of view in the *Ludi Mathematici*. Starting from the suggestions collected in Vagnetti's text about the location of the stations and entrusting us to the philological reconstruction of data contained in the National Critical Edition, we started a complex and compelling retrospective investigation of the Albertian work aimed at formulating original considerations on the survey project that led to the definition of the city map. This complex investigation, in continuous evolution, aimed at the collection not only of the indications that Alberti,

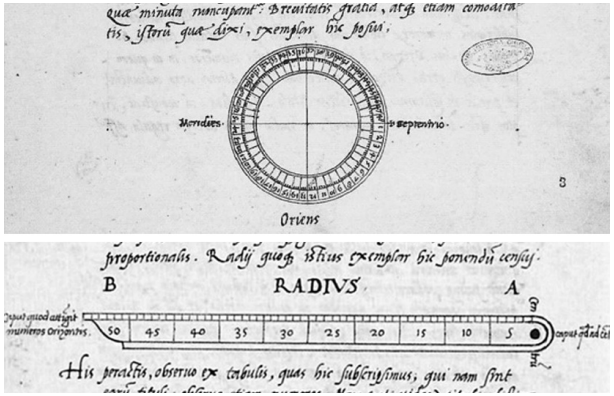



*Fig. 2. Detail from Descriptio, codex Chig. M. VII 149, fol. 3r and 3v, Biblioteca Apostolica Vaticana.*

| *Edifici e monumenti* | *Stato* | *Stazione* | *Mira* |
|---|---|---|---|
| Basilica massima di San Pietro | alterato | | |
| Piramide Tomba di Romolo | - | | |
| Castel Sant'Angelo | originale | ●● | ● |
| Ospedale di S. Spirito (or Chiesa S. Maria in Sassia) | originale | ● | ●● |
| Torre di Parione | - | | |
| Orologio in campo dei Fiori | - | | |
| Rotonda del Pantheon | originale | | ●● |
| Colonna Antonina | alterato | | |
| Casa Di Nerone, nei giardini Colonna | - | | |
| Colonna di Adriano, Colona Traiana | originale | | ●● |
| Fastigio di Costantino (arco di Costantino) | - | | |
| Torre delle Milizie | originale | | ●● |
| Chiesa di San Sabu | originale | ●● | ●● |
| Chiesa di Santa Balbina | originale | | ● |
| Chiesa di San Giovanni a Porta Latina | originale | ●● | ●●● |
| Basilica di San Giovanni in Laterano | alterato | | |
| Chiesa di Santa Croce in Gerusalemme | originale | ● | ●● |
| Chiesa di Santo Stefano Rotondo | originale | | ●●● |
| Chiesa di Santi Giovanni e paolo | originale | ●● | ●● |
| Basilica di Santa Maria Maggiore | alterato | ●● | ●●● |
| Terminale dell'acquedotto (torri dei Capocci) | originale | ●●● | ●● |
| Terme (di Diocleziano) | originale | | ● |
| Chiesa di San Lorenzo in Panisperna | - | | |
| Chiesa di San Pietro in Montorio | originale | ● | ●●● |
| Chiesa di San Giacomo al Gianicolo | - | | |
| Chiesa di San Onofrio sul Colle | originale | ● | ●● |
| Chiesa di San Pancrazio | originale | ●● | ●● |
| Chiesa di Santa Prisca | originale | ● | ●● |
| Chiesa di Santa Maria in Trastevere | originale | ●● | ●● |
| Chiesa di San Crisogono | originale | ●● | ●●● |
| Chiesa di San Vitale | originale | | ● |
| Piramide di Paolo (Cestia) | originale | | ●●● |
| Chiesa di San Pietro in Vincoli | originale | ● | ● |
| Campidoglio | alterato | | |
| Chiesa di Santa Maria in Ara Coeli | originale | | |
| *Porte* | *Stato* | *Stazione* | *Mira* |
| Popolo | alterato | | |
| Pinciana | originale | ● | ● |
| Salaria | demolito | | |
| La donna (Nomentana) | demolito | | |
| San Lorenzo (Tiburtina) | originale | ●● | ● |
| Maggiore | alterato | | |
| Laterano (Asinaria) | originale | ● | ● |
| Latina | originale | ● | ● |
| Appia | originale | ●● | ●● |
| San Paolo | originale | ●● | ●● |
| Portuense | alterato | | |
| San Pancrazio | alterato | | |
| Gianicolense | - | | |
| Santo Spirito al Gianicolo | originale | ● | ● |
| Posteriore sulla Valle (Torriona) | alterato | | |
| Sul Colle (Pertusa) | originale | ● | ● |
| Palatina | - | | |
| Castello | alterato | | |

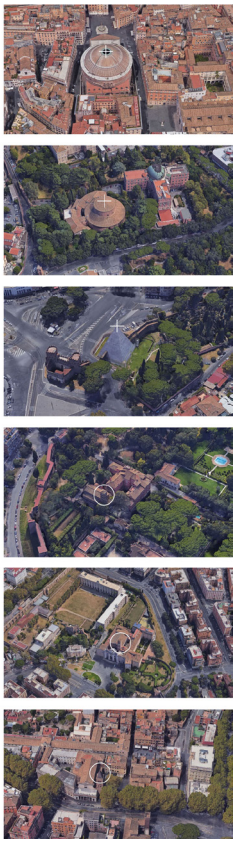



*Fig. 3. Evaluation of buildings, monuments and gates considered in the Descriptio in relation to their possible role as targets (1-3) or stations (4-6).*

more or less consciously, has left us, but also of those that originate from direct –through current experience and digital simulations– and indirect observation of the city – by means of its representations over the centuries.
A first chapter of this research concerned first of all, as in Vagnetti, the direct restitution of the map evoked in the *Descriptio*, in order to express some initial considerations on the placement of buildings and monuments considered by Alberti, through an automatic restitution process and digital simulations of uncertainty. This first phase allowed us to observe how the instrumental error –both in the measurement of the angles and in the orientation– is not sufficient to justify the deformations of the plan [Valenti, Romor 2016].
Furthermore, from a critical observation of the shape of the buildings, necessary to comprehend on which architectural element Alberti has focused attention in the measure phase, it is clearly evident that some of them constitute perfect targets, others can be ideal stations. In fact, the presence of some buildings among the others and their geographical position appear crucial for the survey, giving us important clues on the procedural nature of the survey itself.
In particular, we considered the buildings that were present at the time of Alberti, in the form we know them today, discarding those that no longer exist or whose identification is doubtful (fig. 3a). These buildings and monuments were subjected to a qualitative analysis to evaluate their capability to fulfill the role of stations and/or targets. Individual emerging elements, unique, unambiguous and relevant, have been considered good targets; towers or structures having high terraces, from which we can enjoy a full view of the surrounding panorama, have been considered as possible places for stations. Bell towers, excellent targets, have been considered less suitable for the placement of the stations, for two reasons: the difficulty of placing the instrumentation in the reduced space available; the limited possibility of sighting to the outside through the small openings that normally characterized this kind of structures.
The studies conducted so far on the *Descriptio* hypothesize that Alberti has established two or, most probably,

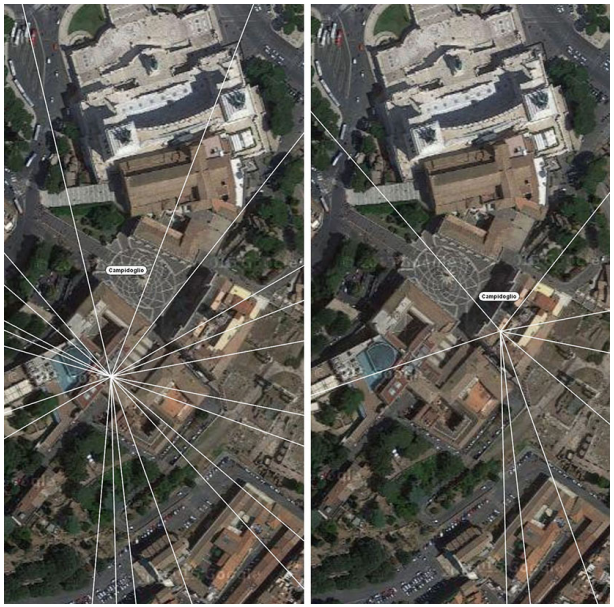



*Fig. 4. Two solutions for identifying the station on the Capitol hill via a backward intersection.*

three stations to make his survey [Vagnetti 1968; 1974]. The main goals we wanted to achieve at this stage were the identification of the station in the Campidoglio and the position of the secondary measurement stations. We proceeded along two different paths to identify possible solutions.
To locate the position of the most likely station on the Campidoglio, we proceeded with a resection. Firstly we identified the real coordinates of the points (IGM map), corresponding to the surveyed buildings that have an unequivocal target. Subsequently we defined a significant set of lines, having origin in an auxiliary and approximate center on the Campidoglio and passing through the identified points. Then we found the solution of the system that better approaches to the angular values measured by Alberti, by moving only the approximate central station, located on the Campidoglio.
The solution of the system, applied to the full set of the useful targets, identified the main station to the orographic point that, even today, we may consider the highest point of the hill (fig. 4a). We have also generated a different solution using a reasoned selection of the targets, so to eliminate those that introduced an excessive angular compensation. This solution identified a point placed near west side of the Palazzo Senatorio (fig. 4b).
This first phase allowed us to observe how the instrumental error –both in the measurement of the angles and in the orientation– is not sufficient to justify the deformations of the plan. In continuity with this first investigation, with this study we have set ourselves the goal of providing new answers to questions still open on the survey project carried out by Alberti, focusing attention on the walls, the first element to be cited in the introduction to the *Descriptio* and in the tables that show the lists of coordinates that define the interpolation points.

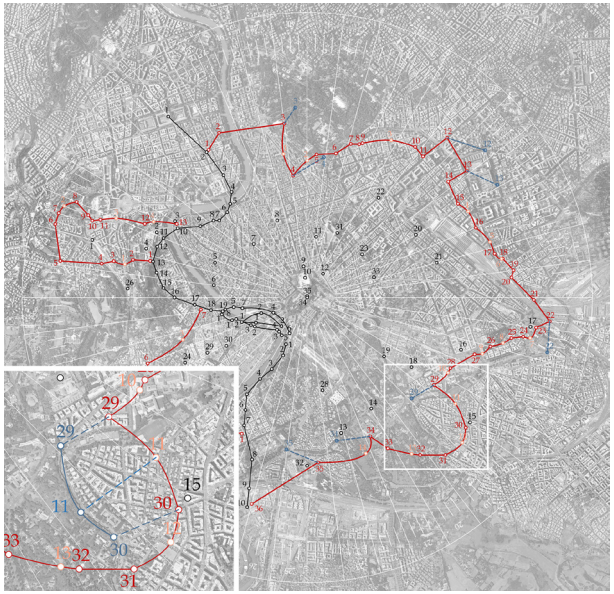
## The city of Rome and the representation of its walls

To understand the originality of the Albertian contribution to Roman cartography history, before moving on to the next phase of analysis, it is better to make a brief investigation on the medieval representations of the city [Frutaz 1962], in which the walls appear as strong and preponderant signs, harbingers of allegorical meanings –as in the case of ancient Rome in the shape of a lion– or symbolic – considering the circular shape given to the walls in drawings contemporary to the *Descriptio* (fig. 5). In the maps designed by Paolo di Limburg and his brothers (fig. 5a) and by Taddeo di Bartolo (fig. 5b), the path of the walls appears circular and continuous, as well as, partially, in the drawings by Pietro del Massaio (fig. 5c) and Alessandro Strozzi (fig. 5d), where however the discontinuities between the wall sectors in correspondence of the river are respected. In all cases, even in other representations, the authors always tend to give a clear representation of the walls construction type, highlighting the tower and curtain system.
The drawing of the walls that derive from Alberti's instructions therefore appears to be opposed to this type of representation: a limited set of points that describes with geometrical rigor the layout of the walls in plan and does not linger on other types of information.
Reading again the aims expressed by Alberti and giving a value at the order in which they are listed, it is

*Fig. 5. Maps of Rome by Paolo di Limburg and brothers (a), Taddeo di Bartolo (b), Pietro del Massaio (c) and Alessandro Strozzi (d).*

evident the predominance of the geographical objective on the merely informational one: first, he considers the boundaries (the city walls); then, the river, the most emergent geographical element that complete the path of the walls; the roads, the entrances to the city and, only later, the main buildings and monuments; finally, the delimitation of the hills and of the inhabited areas.
The order in which the elements to detect are mentioned reveals a scientific approach oriented to survey the geographic and urban features of the place, from general to particular, from the boundaries (walls and rivers) to, finally, the monuments. The manifest intention of Alberti to proceed rigorously to the identification of the path of the walls, putting it as the primary objective and devising a system to differentiate the survey and the representation of vertices and curves, suggests that some of the buildings identified in the survey may have been selected for their strategic position in relation to the measure of the points selected on the walls, rather than for their importance and relevance in the city map.

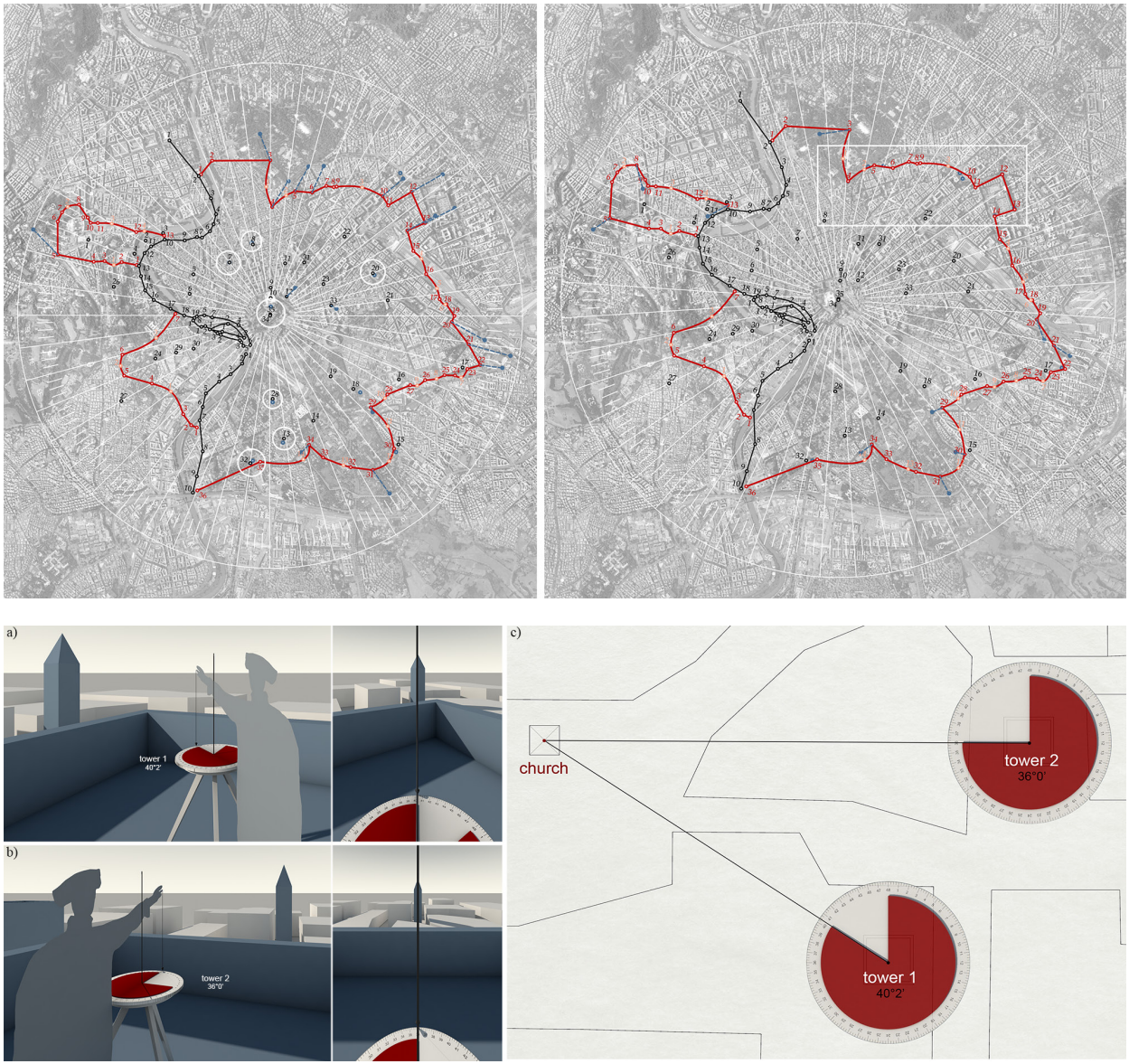
*Fig. 6. Overlap between the drawing that emerges from the Descriptio and the Rome photomap.*



So, let's see what the data provided by Alberti consist of. He considers three portions of walls (fig. 1): *in Latio*, coinciding with the vast eastern sector of the Aurelian walls, *Transtiberim*, the old Aurelian walls of Trastevere, and *ad Leoninam*, the fifteenth-century Vatican wall. Each sector is discretized through a given number of points, which refer to two elements of the walls: the first, the *anguli*, are attributed to vertices in which the walls change direction; the others, called *auges*, define points of greater projection/protuberance/protrusion of portions of walls that Alberti perceives as curves, even if we know that the layout/plan of the walls consists of a broken line. Then there are other points that belong to the route of the walls: they are listed elsewhere as doors or monuments (as in the case of the Pyramid of Cestius), that for now we do not consider. The walls so called *in Latio* are the most interesting from the point of view of comparative analysis, since almost completely preserved; in fact, *transtiberim* walls have almost completely disappeared in favor of the new Gianicolo's walls and the walls *ad Leoninam* have been incorporated into the successive structures and replaced in their function by the bastions of Sangallo. Moreover, the text does not consider the portions of walls along the river now absorbed by the banks, although still present at the time of Alberti, as shown by many maps coeve and immediately successive. Once the tracing of the walls in the three sectors has been carried out, and a first comparison is made with the current map, it is possible to make a series of observations, which will serve as an objective basis for the subsequent experiments. First of all we can see how, by aligning the drawing with the current photoplan according to the main buildings, the path of the walls does not coincide with the image of the walls on the map. Moreover, we can frequently record an inversion of the concavities/convexities of the walls where Alberti places the *auges* (fig. 6): this also happens for a building –the church of San Giovanni a Porta Latina– which, unlike reality, is located outside the walls in Alberti's drawing. This clue, in addition to highlighting critical aspects of the survey, can be useful to determine the degree of awareness that Alberti had of the urban space of Rome. Finally, if it is true that it is not possible to find an overlapping solution that simultaneously satisfies all the coincidence conditions relating to buildings and walls, it is possible to see how this happens for individual and more or less extensive portions of points (fig. 7).

*Fig. 7. Local overlap of single parts of the drawing of the Descriptio to the map of the city.*

*Fig. 8. Digital simulation of the use of horizon.*



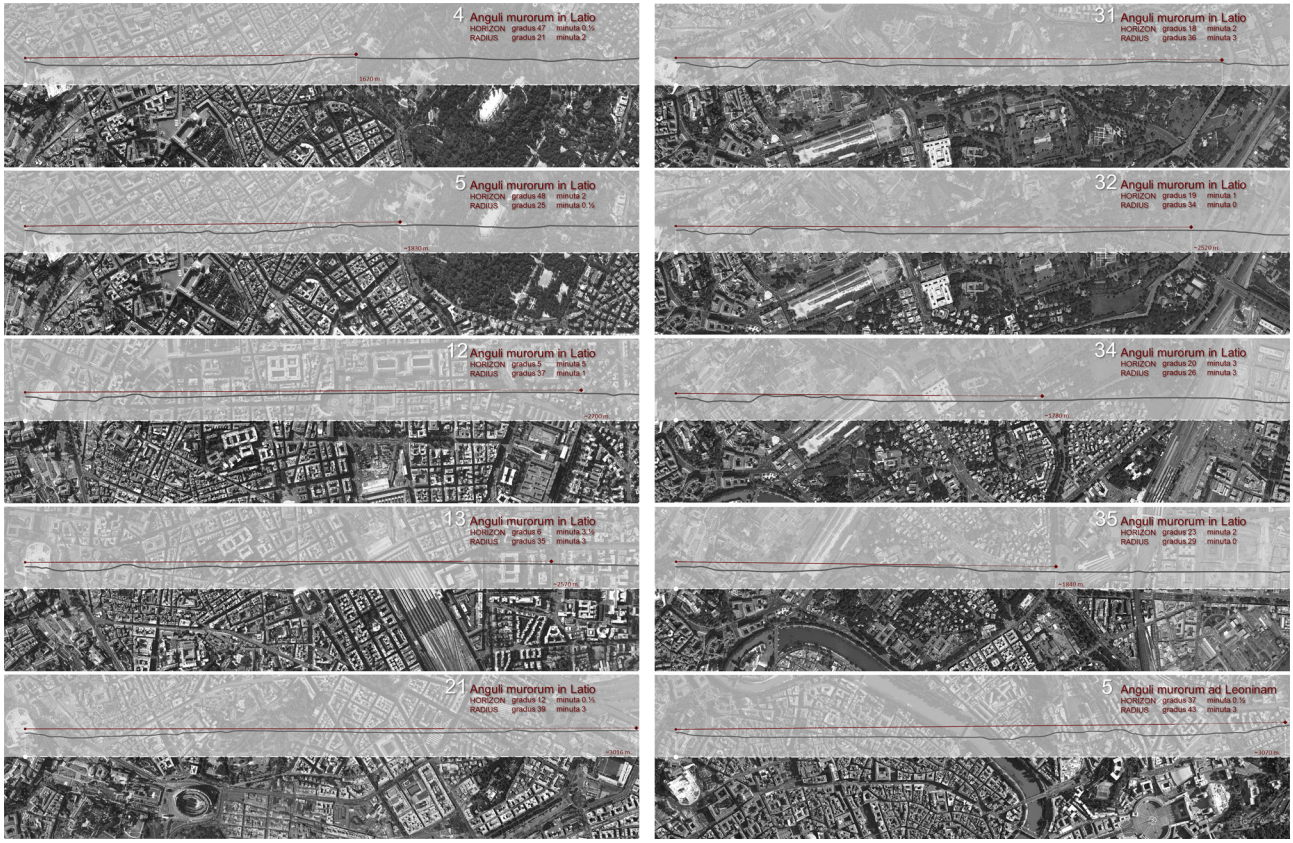



*Fig. 9. Sections of the ground conducted for a station point located on the Capitol hill and some significant monuments, in order to verify their actual visibility from that station.*

## Understanding *Descriptio*: experiments

Considering these data and results only, since we do not have documents that clearly record the operative phases of the Albertian survey, we have collected useful clues to formulate hypotheses on the relative project.
To begin with, it is Alberti himself who provides explicit, though not exhaustive, clues. For survey operations, he uses a *horizon*, a graduated circle completely identical to that used in the *Descriptio* for reproducing the city plan, but larger (the diameter measures one arm); positioned the instrument in a first station, we can read on it the angle value of each targeted point thanks to a plumb line, held in hand by the operator, that aligns the eye, the center of the disc and the target (fig. 8a). Collected the angular values of the entities visible from the first station, we pass to the next, taking care to re-orient the horizon in the direction taken in the first station [2]: also in this case, we proceed to measure the angles of the same entities (fig. 8b). For each point to be detected it is necessary to note the value of the angle from two different stations, there-

fore the number of total stations will vary depending on location and visibility of the targets with respect to the stations themselves. Then, we move to the phase of restitution. We arbitrarily represent on a sheet the position of the first two stations, considering that the distance between them determines the scale of the drawing; thanks to *horizontes* of reduced dimensions placed in correspondence of the points that represent the stations, we determine by intersection the plan position of the various surveyed points (fig. 8c). Alberti says that the first point to drawn on the sheet, center of the reduced horizon with which we reported the angles of the measurements taken from the first station, coincides precisely with it and therefore, in our case, with the Capitoline Hill. Afterwards, he provides a method for measuring large distances between two points by exploiting proportionality with limited and known distances, directly measurable.

We then collected implicit clues: the nature and consistency of the deformations that emerge in the discrete representation of the walls –a more articulated element than the simple group of buildings and monuments indicated by single disconnected points– constitute further useful information for the formulation of hypotheses on the survey project.
Considering then the practical problems related to the survey, we can obtain valuable clues about the visibility of the mentioned subjects in relation to the places that could allow a panoramic viewing of the city. Here is therefore the importance of the visual experience, present and past: the first can be conducted today either by direct observation or by digital simulations able to derive significant sections of the urban territory (fig. 9 a, b); the second can be pursued through views of the fifteenth and early sixteenth centuries, which depict a still not too dissimilar Rome from the city surveyed by Alberti (fig. 10).

*Fig. 10. Panoramas of Rome by Martino Van Heemskerk from Monte Caprino (Capitolin hill), 1534 (a, b). Panoramas of Rome by Antonio Van Den Wyngaerde from the Baths of Constantine, 1550 (c), and from Monte Mario, 1550 (d).*

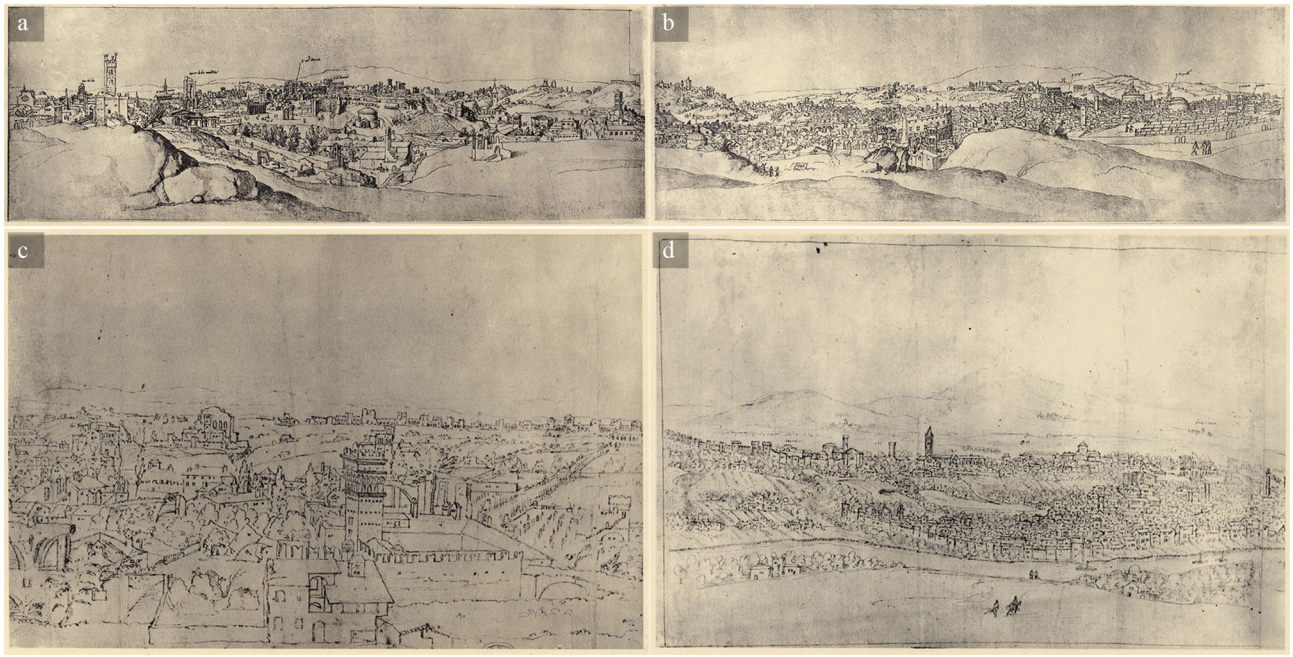
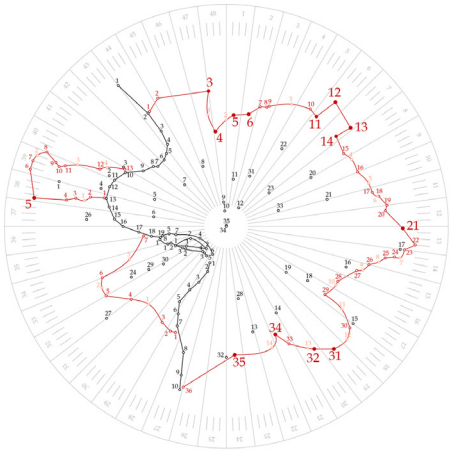


*Fig. 11. Selection and evaluation of the points of the walls that are still present and recognizable and can therefore be taken into consideration for subsequent experiments.*

*Fig. 12. Two of the main maps taken into consideration for the historical analysis of the fiducial points selected on the walls: maps of Rome by Leonardo Bufalini, 1551 (a), and by Mario Cartaro, 1576 (b).*



| Anguli | G | V | R |
|---|---|---|---|
| *Latio* | | | |
| 3 | 2 | 0 | 1 |
| 4 | 3 | 3 | 3 |
| 5 | 1 | 3 | 1 |
| 6 | 3 | 3 | 3 |
| 11 | 3 | 3 | 3 |
| 12 | 2 | 3 | 1 |
| 13 | 3 | 3 | 3 |
| 14 | 3 | 3 | 2 |
| 21 | 3 | 3 | 3 |
| 29 | 2 | 3 | 1 |
| 31 | 2 | 3 | 2 |
| 32 | 3 | 3 | 2 |
| 33 | 3 | 3 | 2 |
| 34 | 3 | 3 | 3 |
| 35 | 3 | 3 | 3 |
| *Leoninam* | | | |
| 5 | 3 | 3 | 3 |


Data and clues we have collected, even if significant, produce a too labile and undetermined investigation structure in order to formulate hypotheses about the survey project. Before beginning the subsequent critical analyzes, it was therefore necessary to set some axioms, based on the previous studies and the most accredited considerations. First of all, let's say that one of the stations (the first) coincides with the Capitoline Hill. Furthermore, to reduce the possibility of choice of stations, suppose that the surveyed points have all been detected from inside the walls.

Referring to the walls, we first looked for the correspondence between the surveyed points and the portions of walls currently visible and substantially identical to those present at the time of the *Descriptio*, in order to conduct subsequent investigations on a limited and reliable number of points. The research has produced a selection of points that have been evaluated, with varying degrees of reliability, in relation to their recognition in the survey phase and to our ability to identify the point on the walls today (fig. 11). The issue of recognizing points is very complex: if it is easy and immediate to identify a point in the plan on the theoretical level, instead falling into the practice of the surveyer and colliding with the physicality of the walls we wonder if that particular point refers to the internal or external side of the walls, which implies the assumption of stations not necessarily internal to the boundary. Each point has been subjected to the scrutiny of historical analysis, in order to evaluate its existence and consistency at the time of Alberti and nowadays. We therefore considered a series of maps and panoramic views –collected during the research– catalogued as direct sources, if they represent the city contemporary to themselves (fig. 12), or indirect sources, in the case of successive interpretations of ancient or medieval Rome. The restoration documents [Mancini 2001] also allowed us to evaluate the alterations of the walls over time and assess their relevance.

Given the data described and the preliminary observations, we therefore produced a series of considerations using a specially developed software that allowed to simulate different configurations of survey starting from the identified fiducial points and assuming pairs of possible stations in relation to the deformations that the map presents. The quality and quantity of deformations emerged with respect to the

current photo plan allowed to distinguish two categories of errors: instrumental/systematic, detected with the tools offered by new technologies, and material/operational, identified through philological reconstruction. The first ones derive from the reduced tolerance of the low-tech instruments used by Alberti and from the inaccuracies of orientation, reading and restitution, the others from critical aspects of the survey project. Let's focus now on this last aspect. The fact that the drawing of the city (as already noted for the buildings) overlaps the current map only for single portions leads us to believe that the Albertian map is actually a combination of more surveys, distinguished not only by type of elements detected (walls, buildings, river), but also within a single category, as it happens for the walls. The hypothesis of the multiplicity of surveys is also corroborated by the total lack of data relating to the survey of heights and inhabited center, promised by Alberti himself in the introduction to the *Descriptio*.

## *Descriptio Urbis Romae*: the research continues

The observations and considerations that have emerged so far therefore lay the foundation for future investigations aimed not only at applying the same digital simulations to the remaining categories of surveyed elements (gates, river course and Tiber island), but also at testing new hypotheses on the survey project, starting from different assumptions, such as the possibility that Alberti used the towers of the walls as stations for his survey of the city.

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### Notes

[1] There are six known codices of the *Descriptio Urbis Romae*: Chicago, Newberry Library, ms. 102, end of XV century; Oxford, Bodleian Library, ms. Can. Misc. 172, 1487; Venezia, Biblioteca Marciana, cod. It. XI, 67, second half of XV century; Roma, Biblioteca Apostolica Vaticana, ms. Chig. M.VII.149, half of XVI century; Roma, Biblioteca Apostolica Vaticana, ms. Barb. Lat. 6525, XVII century; Milano, Biblioteca Ambrosiana, ms. O 80 sup., XVI century.

[2] As explained by Alberti, to properly orient the second station it is essential that it be surveyed from the first and that we note the relative angle on the *horizon*; later, we have to place the instrument in the next station and orient it by rotating the *horizon*, so that the opposite angle value of the first be toward the previous station.

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