Geometric Survey and Urban Design: A Project for the Rome of Paul IV (1555–1559)

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The slow development of survey technology—from the first statement of its geometric principles in the mid-fifteenth century to its application in the administration of property and the design of urban spaces—spans an arc of almost two centuries. One of the landmarks of this progress is a drawing in the Uffizi collection, catalogued under the number 4180A (Fig. 1a, b). It is a large drawing, composed of ten joined sheets, and measuring 117 cm by 133 at its widest points. It is a project for a large building complex on an urban site. The constituent elements identify it as a cloister: the cruciform space of a church, an atrium, and an arcaded court. A "rota" and "parlatoio", located between the two latter spaces allow communication between the cloistered religious and lay visitors. This is not an ideal scheme, and it is the survey that makes it specific. The "Piazza del arco di camillo" to the right side and the "piazza di S. Ma(c)uto" at the bottom left, place the project in Rome, on the site occupied today by the late sixteenth-century structures of the Collegio Romano and the seventeenth-century church of Sant'Ignazio. The drawing represents a project for a convent of Franciscan nuns, or Poor Clares, sponsored by the Marchesa Vittoria della Tolfa and was executed in the period 1555–1559, during the pontificate of the marchioness's uncle, Paul IV Caraffa.[1]

Topographic survey is an invention of the Renaissance. Its underlying geometry was described as early as the mid-fifteenth century in a treatise on mathematics by Leon Battista Alberti. In this text, the *Ludi rerum mathematicarum*, Alberti describes a circular instrument for measuring angles in the plane of the horizon and gives instructions for coordinating observations from two station points to fix the position of a distant landmark: that is, for the system of triangulation that is the foundation of geometric mapping (Fig. 2).[2] The mapping of cities required additional techniques. What the cartographer needed to know about the fabric of cities included not

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just the position of things but also their form. In the heavily built up environment of the city the only way to measure form was by the technique that modern survey calls the compass traverse. Raphael described the technique in his report to Leo X, dated 1518–1520, on the project to make a census of the monuments of ancient Rome.[3] It, too, used the circular angle-measuring device known in the sixteenth century as a *bussola*. By combining measurements of orientation and length for every face of a block or section of street it could, in theory, record the internal structure of the city. A sketch plan of the Ponte Sant'Angelo area in Rome from the workshop of Antonio da Sangallo the Younger dated to 1524–5 (UA 1013) records dimensions and

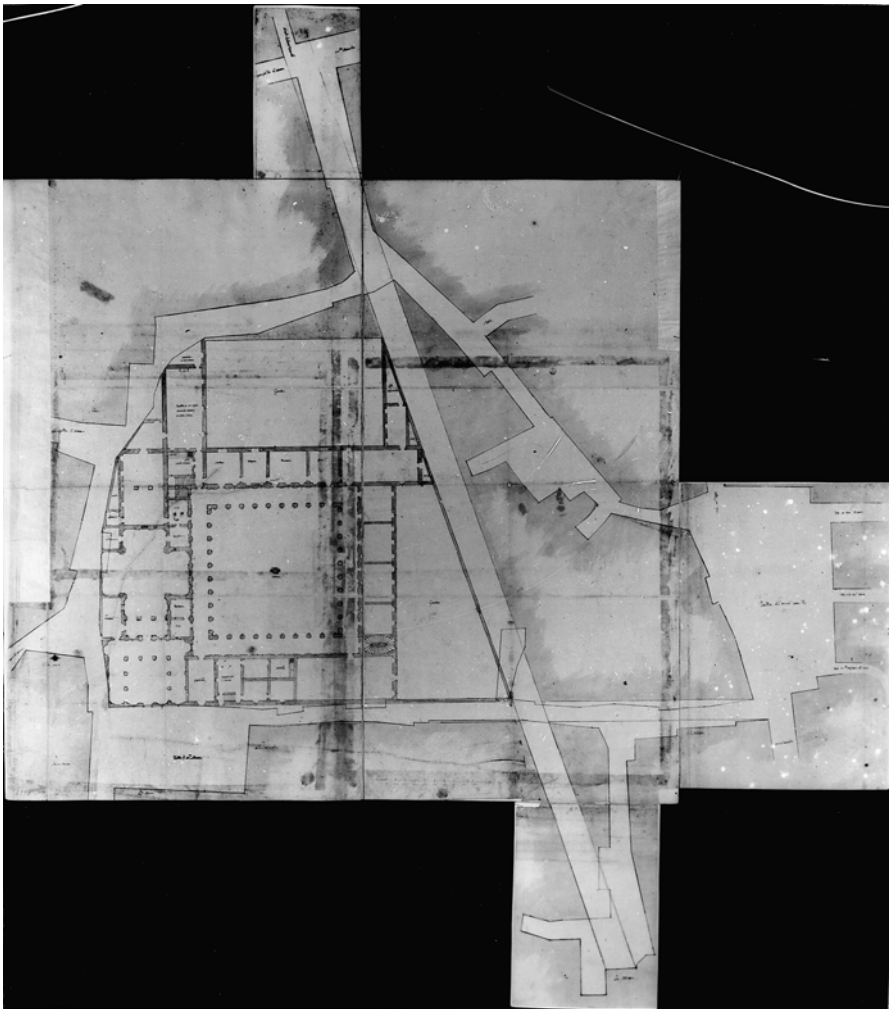

Fig. 1 (**a**) Project for a convent of Poor Clares in Rome, on the site occupied today by the Collegio Romano and Sant' Ignazio 1555–1559, UA 4180 (**b**) Giovanni Battista Nolli, *Nuova Pianta di Roma*, 1748. The area covered by UA 4180

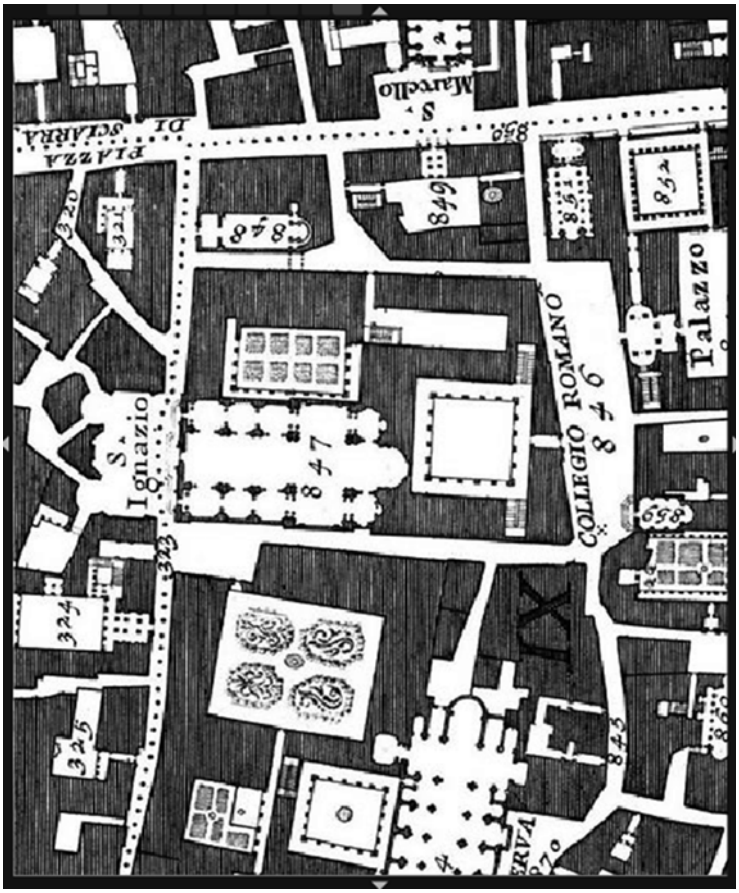

Fig. 1 (continued)

bearings and shows the first stages of this process (Fig. 3a–c).[4] The collection of Sangallo drawings in the Uffizi also preserves a series of working sheets—compass roses—that record observations taken from station points throughout Florence in preparation for the construction by triangulation of a plan of the city (Fig. 4).[5]

All the techniques necessary for mapping the city were in place by the early sixteenth century. Execution, though, lagged far behind theory. In part the problem lay with the instruments, which remained without telescopic sights until the eighteenth century. The compass traverse, in particular, was notoriously inaccurate. The great Ferrarese engineer and cartographer Giovanni Battista Aleotti (1546–1636) testified to the difficulty of this kind of survey:

> Knowledgeable mathematicians (that is map makers) do not hold the bussola to be a reliable instrument. I, honestly, have only rarely, and maybe never, been able to successfully close any plan that I have made using it, and I don't think anyone else does any better. Beyond even the instability of the magnetic compass there are many practical problems (*imperfettioni di mano*) in surveying and drawing the plan of a town or territory.[6]

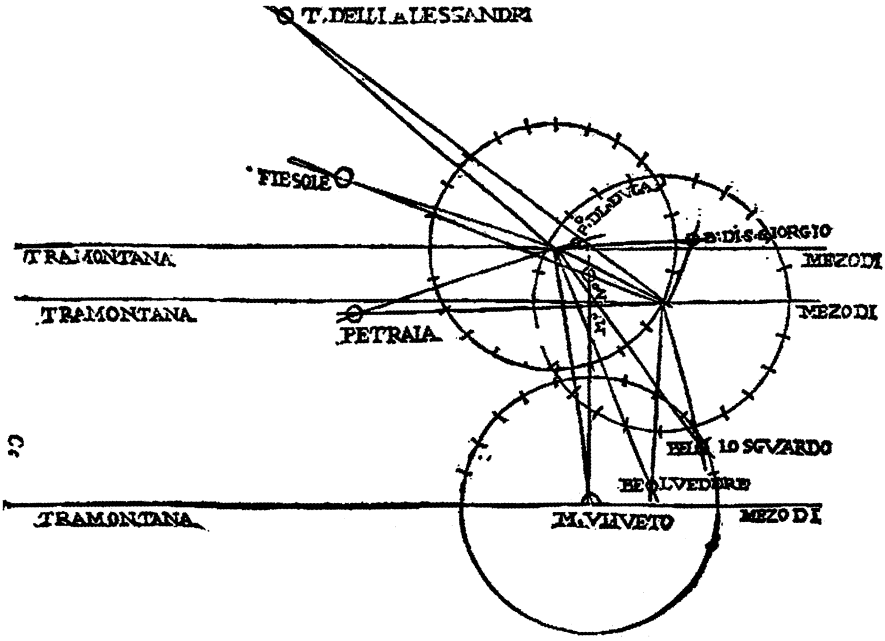

Fig. 2 Triangulation (From Bartoli 1564)

By "closing a plan" Aleotti referred to the successful outcome of a compass traverse, when the endpoint of a series of observations around a closed perimeter coincided with the spot where the survey began. The great Leonardo da Vinci himself was one of those who failed. When Nando de Toni constructed a plan of the walls of Cesena from the survey data recorded in Leonardo's notebooks, he discovered that the artist had made enough errors that the last segment of wall did not meet the first.[7]

The great number of observations required to complete the survey of even a small section of the city made the failure of the compass traverse there almost inevitable. Antonio da Sangallo's survey of four short blocks in the Banchi (Fig. 3) required approximately 80 measurements of distance and bearing to record the course of the streets and the contour of the building fronts that define them. The labor involved in capturing this level of detail goes a long way toward explaining the rarity of drawings of this kind. It is not surprising, then, that Leonardo Bufalini's pioneering plan of Rome of 1551 (Fig. 5a, b), despite seven years of work, does not attempt a precise account of the course of the city's streets. Bufalini gave purchasers of his plan a new, comprehensive view of the city that included the first published survey of the Aurelian wall and, thus, the first realistic representation of the shape of the city. The plan seems to be based on at least two different systems of survey: a triangulation of major monuments and a compass traverse of the wall. The two were not integrated and the forms generated by them on the plan cannot be reconciled. Most streets may not have been surveyed at all but their courses laid down by eye between the points fixed by the two survey systems.[8]

Because of its limited precision and inadequate level of detail and because of its woodcut format and 14 poorly coordinated sheets, Bufalini's *Roma* was not a useful instrument for urban planning. Uffizi 4180A gives a better account of Renaissance survey. It also preserves considerable information about how maps were produced in the mid-sixteenth century. The drawing consists of two discrete parts: the project for the convent and the plan of the building site. The architectural project is a

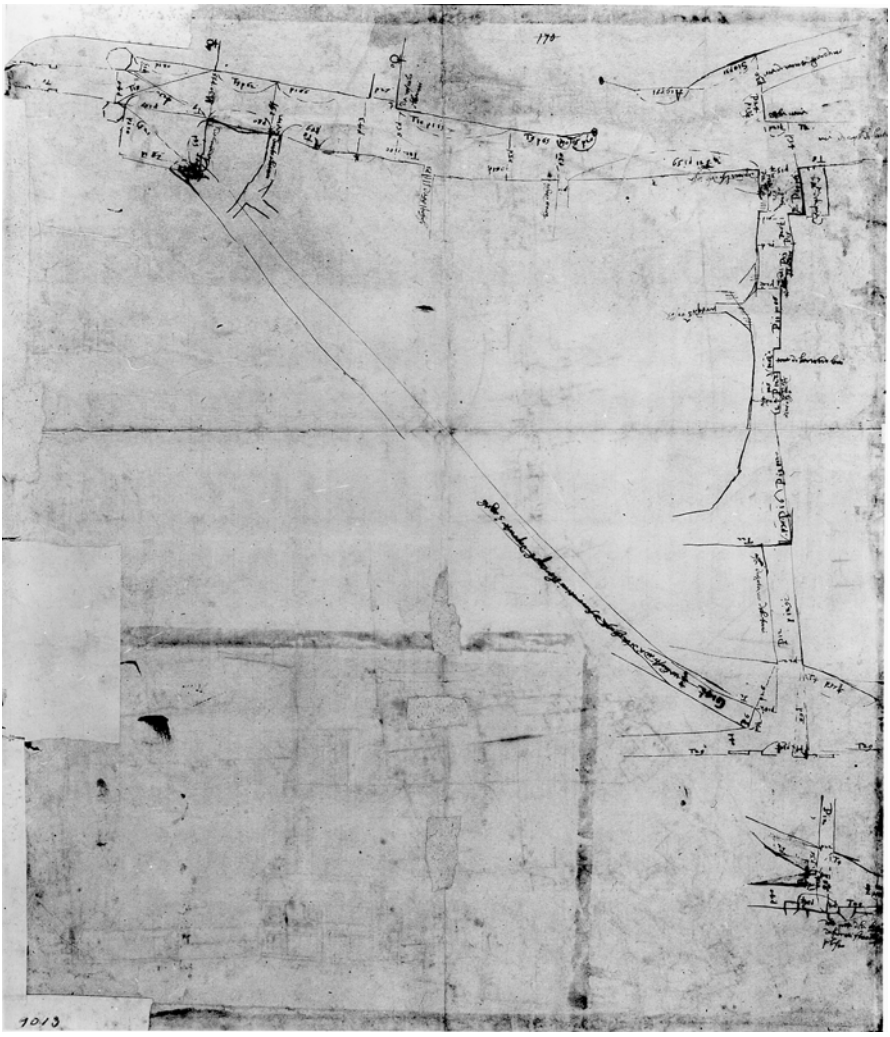

Fig. 3 (**a**) Workshop of Antonio da Sangallo, the younger. Sketch plan of the area of the Banchi, at Ponte Sant'Angelo, Rome, 1524–5 (UA 1013) (**b**) UA 1013, detail (**c**) Area of the Banchi in the view of Rome of Antonio Tempesta, 1593

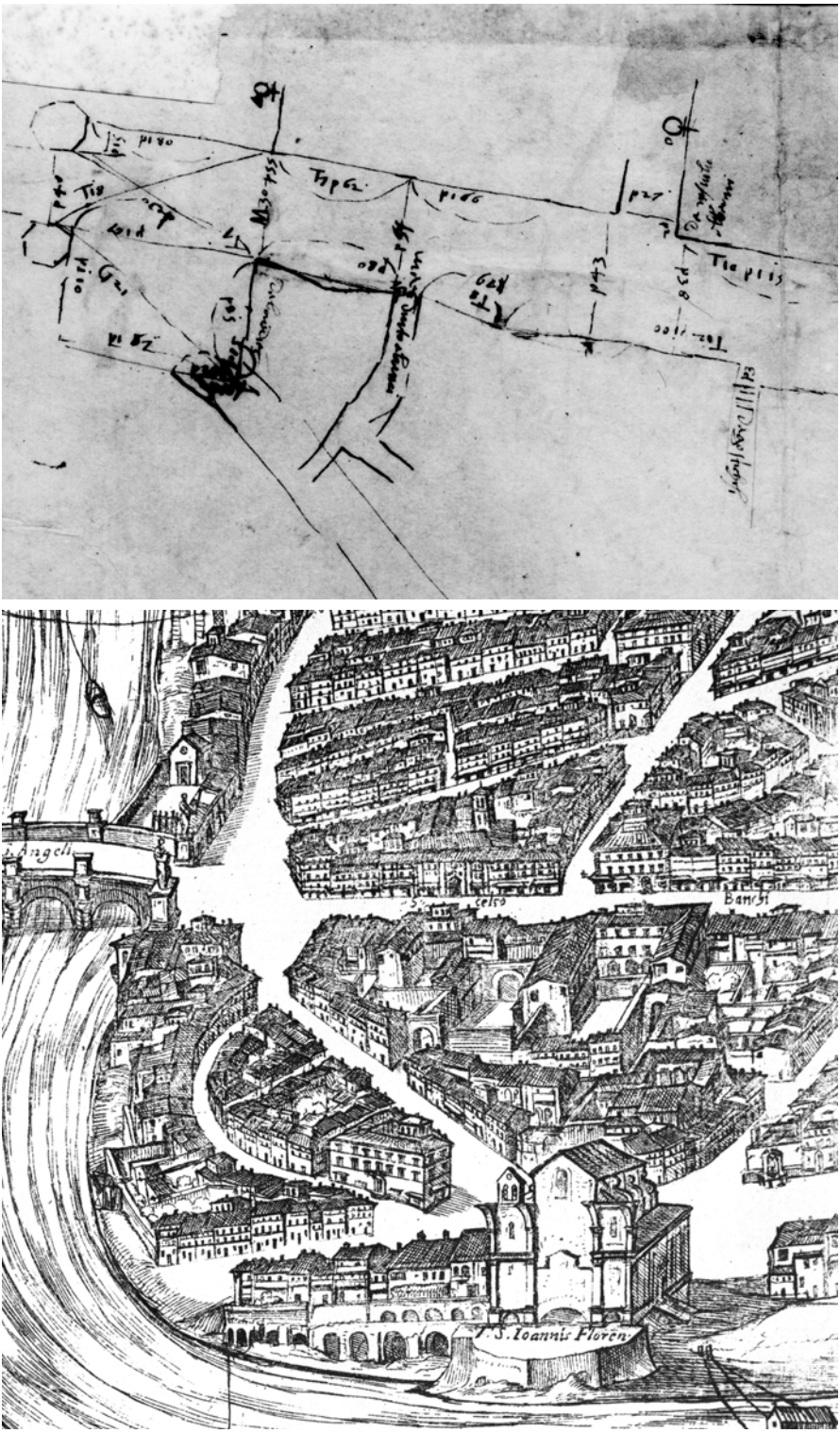

Fig. 3 (continued)

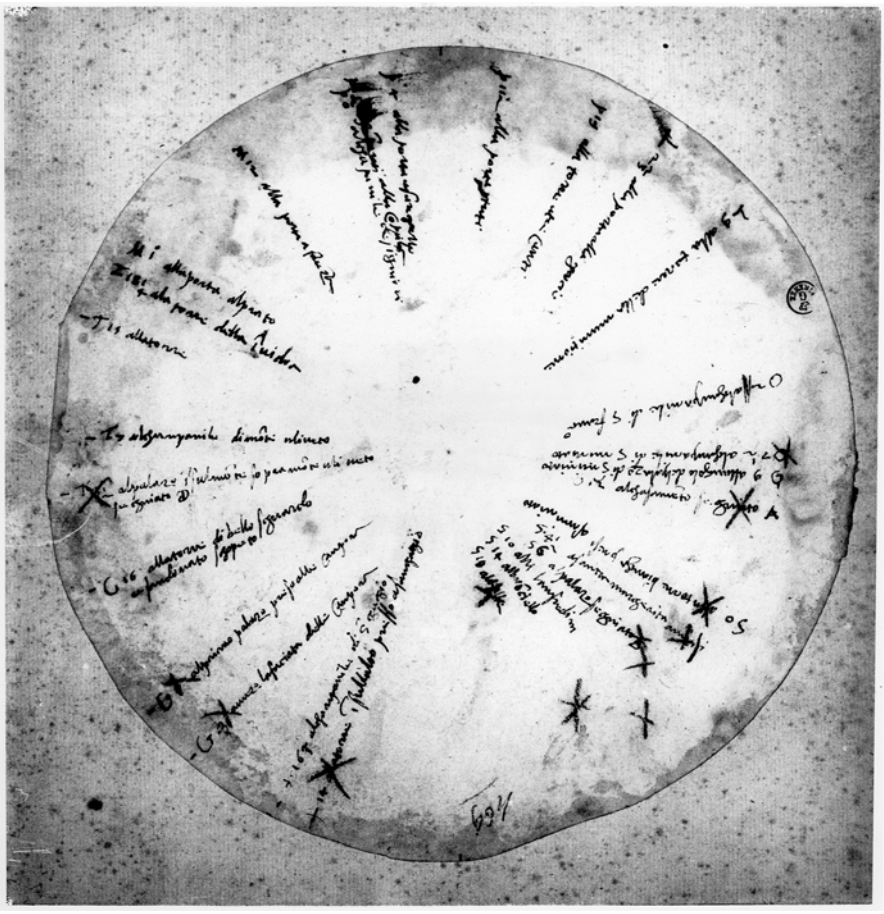

Fig. 4 Workshop of Antonio da Sangallo the Younger, Notes from one station point for a survey of Florence, UA 773

finished work, developed elsewhere and transcribed here line for line. This part of UA 4180 shows no revisions or construction lines and the level of presentation is high. Walls have been reinforced with a light wash and the function of the rooms inscribed. The survey of the site is also handsomely drawn, the wash, applied here with a broad brush, blocking out the built up area beside the streets. This is a drawing meant for presentation outside the workshop, probably to the clients of the project. The survey, however, unlike the project, is not redrawn after an earlier draft. At this stage in the history of urban mapping, the process of transforming survey data into a plan took place on the finished drawing itself. A couple of details speak for this conclusion.

In a publication only a decade old when UA 4180 was drafted, the mathematician Nicolo Tartaglia characterized the process of map-making as one of transferring data from the site to the sheet. Translation was to be as direct as possible, extending to the use of the same instrument for both survey and drafting. North is the constant reference and the magnetic compass fixes it both in the field and on the drafting

table. The plan was to be drawn by laying the "*bossolo*" (Tartaglia's spelling of *bussola*) on the drawing surface, aligning it with north using the magnetic compass, and rotating the sighting arm to the bearing recorded in the field for the first side of the figure. A stylus line impressed in the paper recorded the bearing of the sighting arm, and perforations in the paper mark the center of the instrument and the terminal point of the length, measured to scale, of that first side. These steps are repeated around all faces of the figure and only when they were complete was ink applied between terminal points to make the figure visible.[9]

In a process like this there are signs that identify the sheets on which data became image: needle holes, stylus lines that extend beyond inked ones, and, of course, corrections. UA 4180 has all of these. Most are visible only with a magnifying lens but

Fig. 5 (**a**) Leonardo Bufalini, Map of Rome, 1560 (original 1551) and (**b**) detail

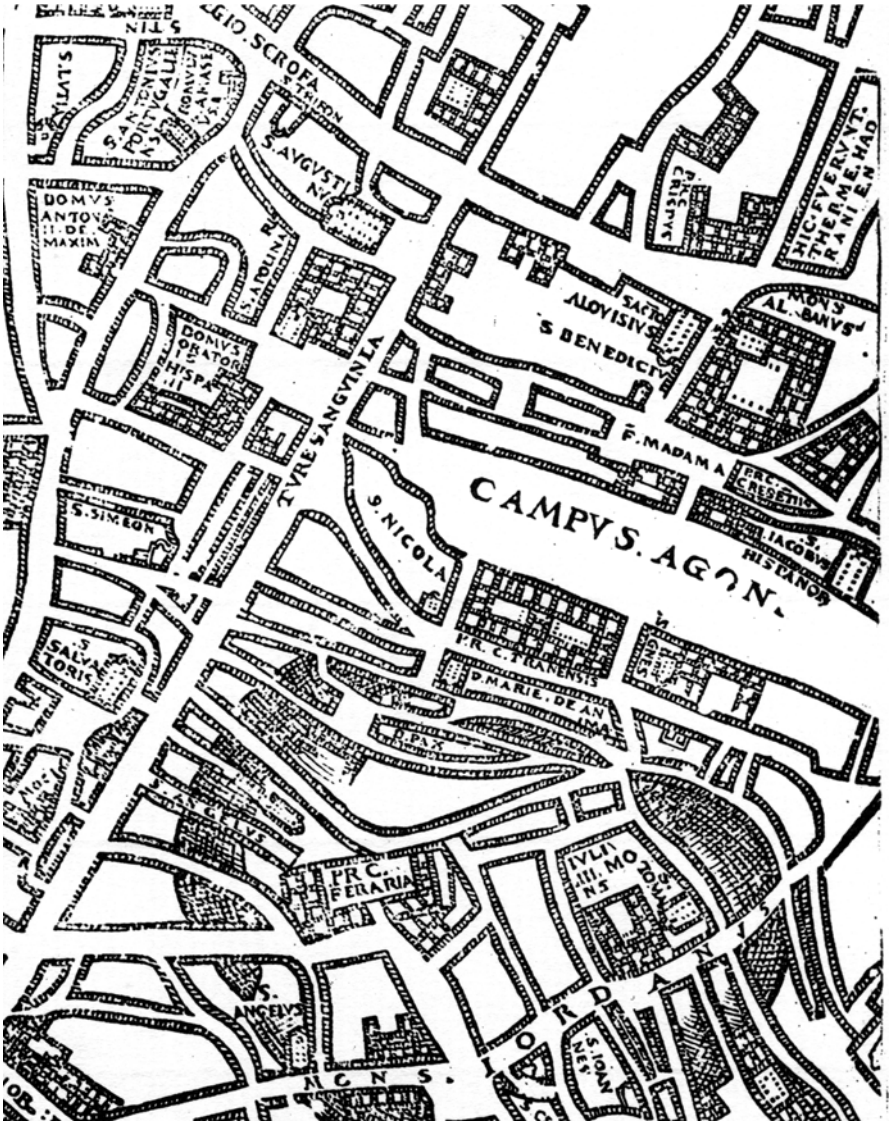

Fig. 5 (continued)

one correction is large enough to see in the photograph of the drawing as a whole (Figs. 6a, b and 7a–c). A long erased line running down the left side and across the bottom of the sheet represents a first attempt to construct the block plan. The executed plan is different from the erased one in a number of ways. In the first place, it is laid on the sheet differently, rotated with respect to the earlier image by about 5°. This adjustment served to coordinate the street facades on the north and west sides of the convent block with the left and bottom edges of the sheet, establishing a

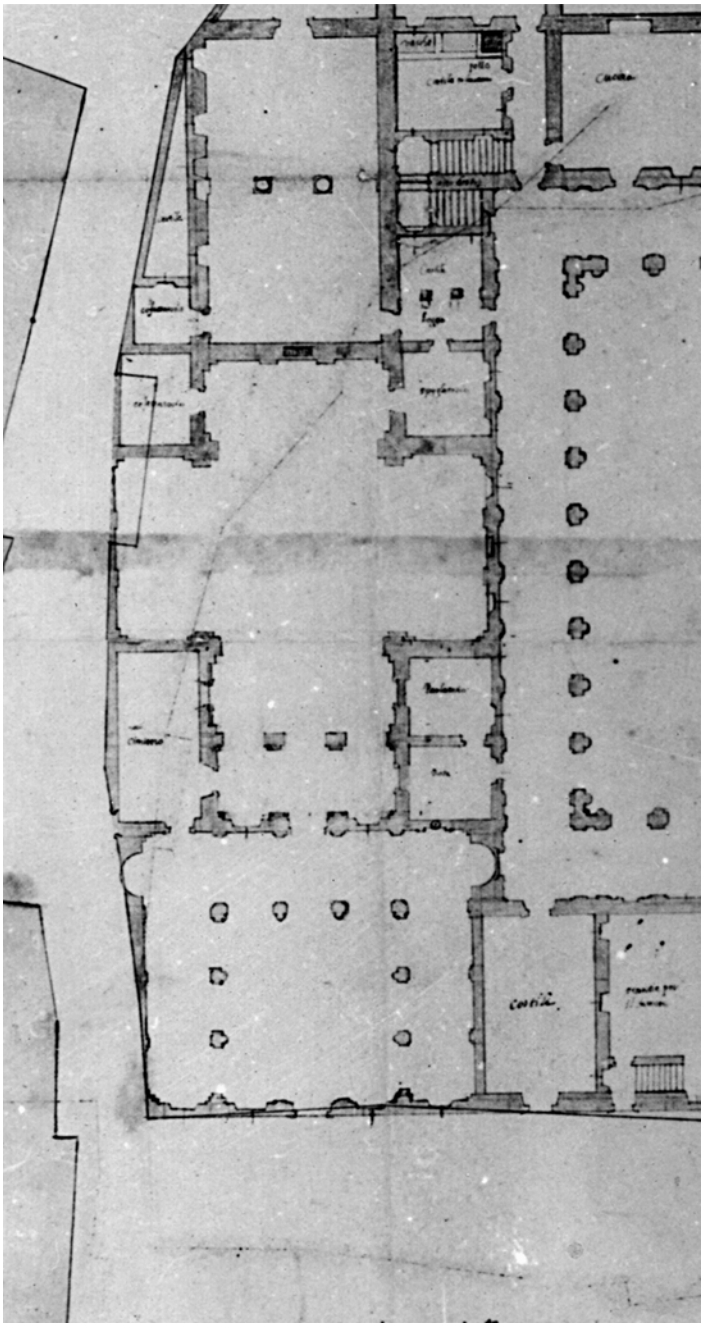

Fig. 6 (**a**, **b**) Details from UA 4180 (1555–1559), showing the failed first effort to construct the image from the survey

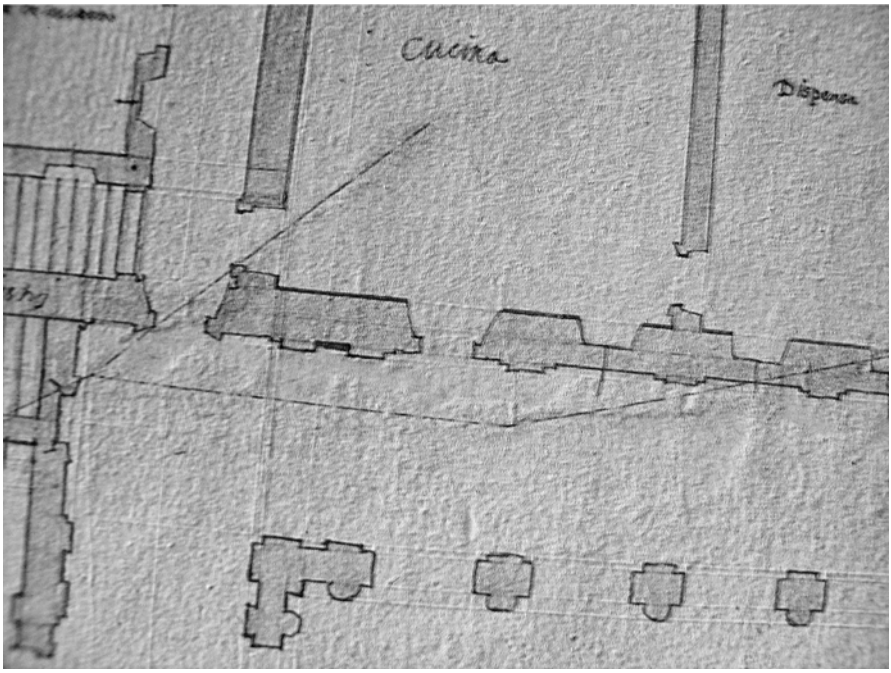

Fig. 6 (continued)

stable compositional base for the mapped image as a whole. The second attempt to lay out the plan also involved moving the building site about 15 cm higher on the page, which further solidified the image by making room for the entire Piazza di San Macuto. But the most fundamental change is the simplest one. The redrawn plan is 50 % larger than the draftsman's first effort.[10] The change in scale meant that the plan had to be constructed anew from the survey data.

The differences between these two versions of the plan illustrate something fundamental about the condition of survey imagery at the middle of the sixteenth century. The difficulties of sizing the image and positioning it on the page show that the draftsman did not know the shape of the blocks before beginning the drawing. There existed no map of the city that he could consult, nor had he transformed his own survey data into a plan before beginning work on UA 4180. For an image intended as a formal presentation drawing, the inability to envision the shape of the project created significant difficulties. The redrafting of the plan shows the author of UA 4180 coming to terms with the surprises inherent in the sixteenth century mapping process.

As both the product of an on-site survey and formal presentation of a design project, UA 4180 has a complex character very different from what we have come to expect from the more rationalized design process of modern practice. The place where the drawing's two natures collide is on the northern and western perimeter of the convent, where the regular forms of church and cloister meet the circumstantial

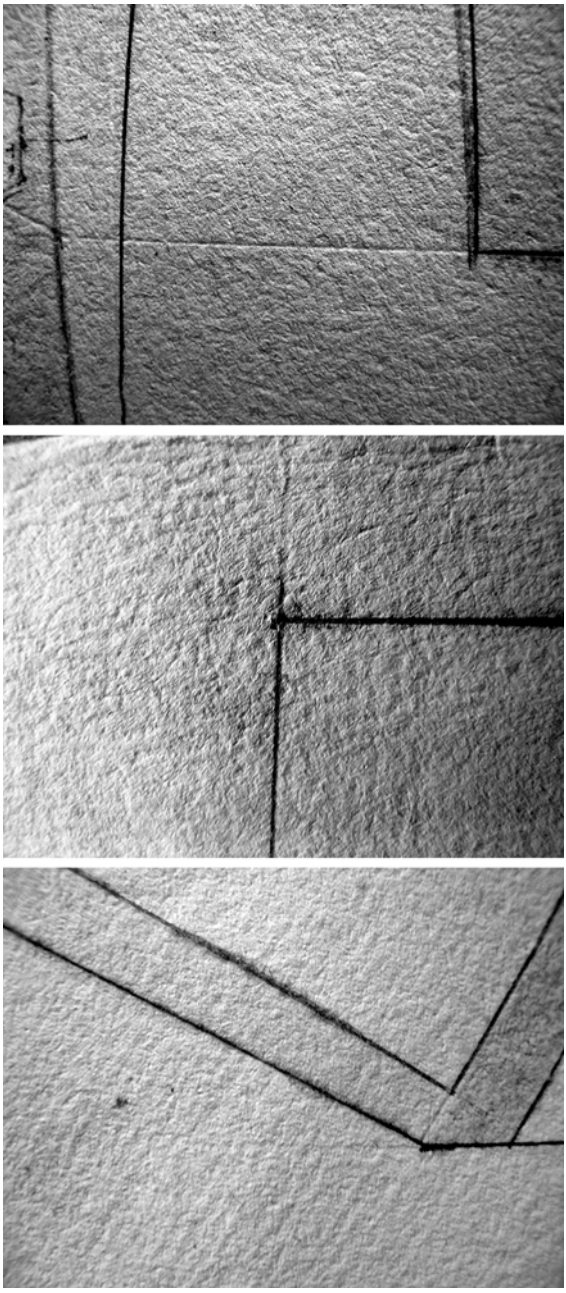

Fig. 7 (**a**–**c**) Details from UA 4180, showing the pinholes and stylus lines used for the construction of the image

shapes of the city. Here, the drawing presents two separate, superimposed plans (Fig. 8a–c). One, with the wall thickness washed in pink, represents the convent project. The other—drafted with a single, un-reinforced line—records the limits of

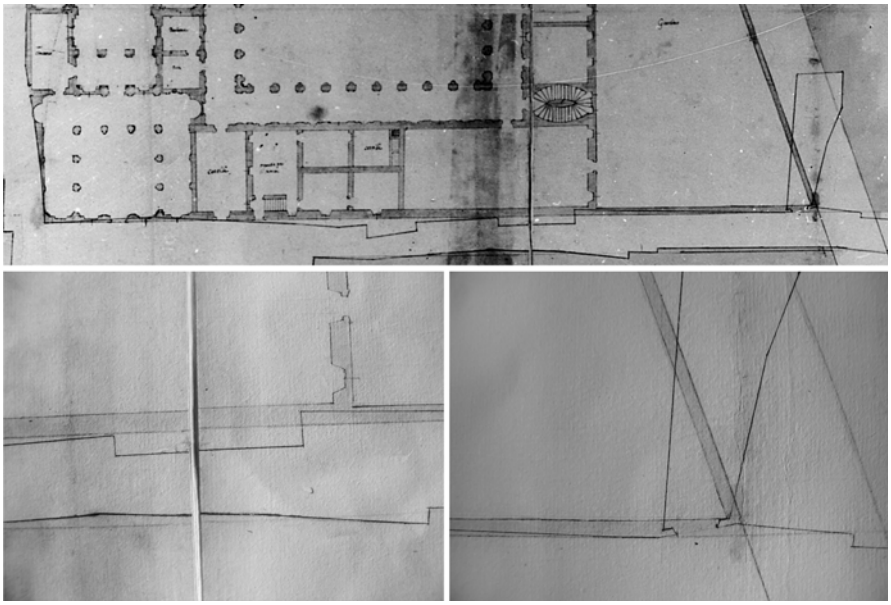

Fig. 8 (**a**–**c**) Details from UA 4180, showing the existing building lines and the proposed street front of the new project

the existing structures. It is easy to imagine that in an early moment, the plan constructed on UA 4180 consisted only of this line drawing, which was then copied onto a separate sheet where the convent project was worked out. Only when a final design had been established would the internal articulation of the convent have been added to the master sheet. One of the results of this process is the small failure of the convent project to fit the available space. One sees this best at the left of the drawing where the walls of the atrium, church and service rooms have been thinned beyond serviceability to remain within the line defined by the existing property (Fig. 9). In places like this, it is evident that the walls defining the convent were drawn over those outlining the block.

Planning with UA 4180

In modern practice, the plan constructed on UA 4180 would have served to generate two kinds of information important for the design process. In the first place, it would reveal the shape of the property and give a scaled representation of its size. In the second, it would fix the position of the elements of the project in relation to the existing urban fabric. In this latter respect, the most important features of the design were the endpoints of the proposed street that was to define the southern boundary of the convent, the streets and square to the right of the sheet. To accomplish these goals the surveyor had to execute the most difficult of all the operations of his discipline.

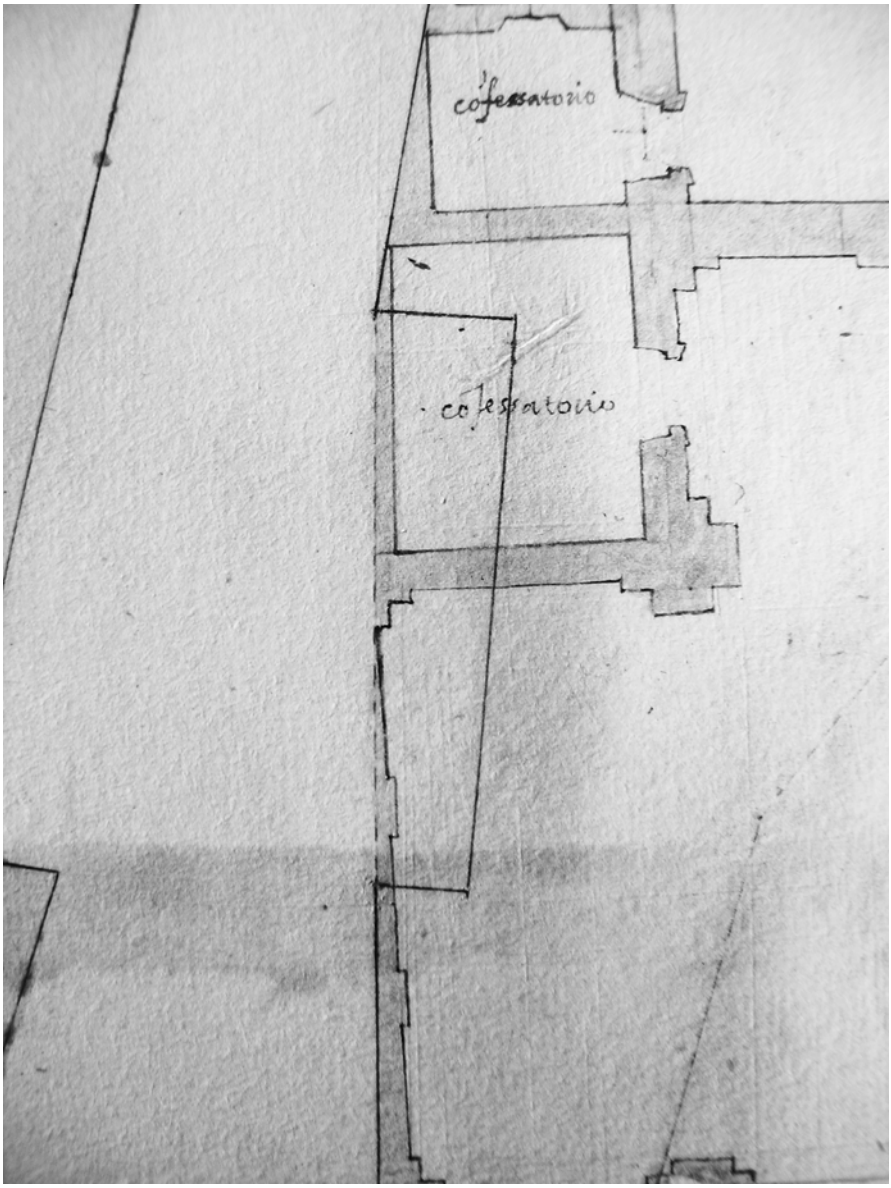

Fig. 9 UA 4180, Detail of the church's left transept and confessionals showing the wall thinned to fit the architectural project within the mapped space of the city block

This is not a plan that could be made by the elegant and relatively accurate methods of triangulation. Only a compass traverse could measure the shape of the streets and blocks at the convent site, and this, as we have seen, was a process notoriously prone to error. The common solution to the open circuit of an imperfect traverse, one

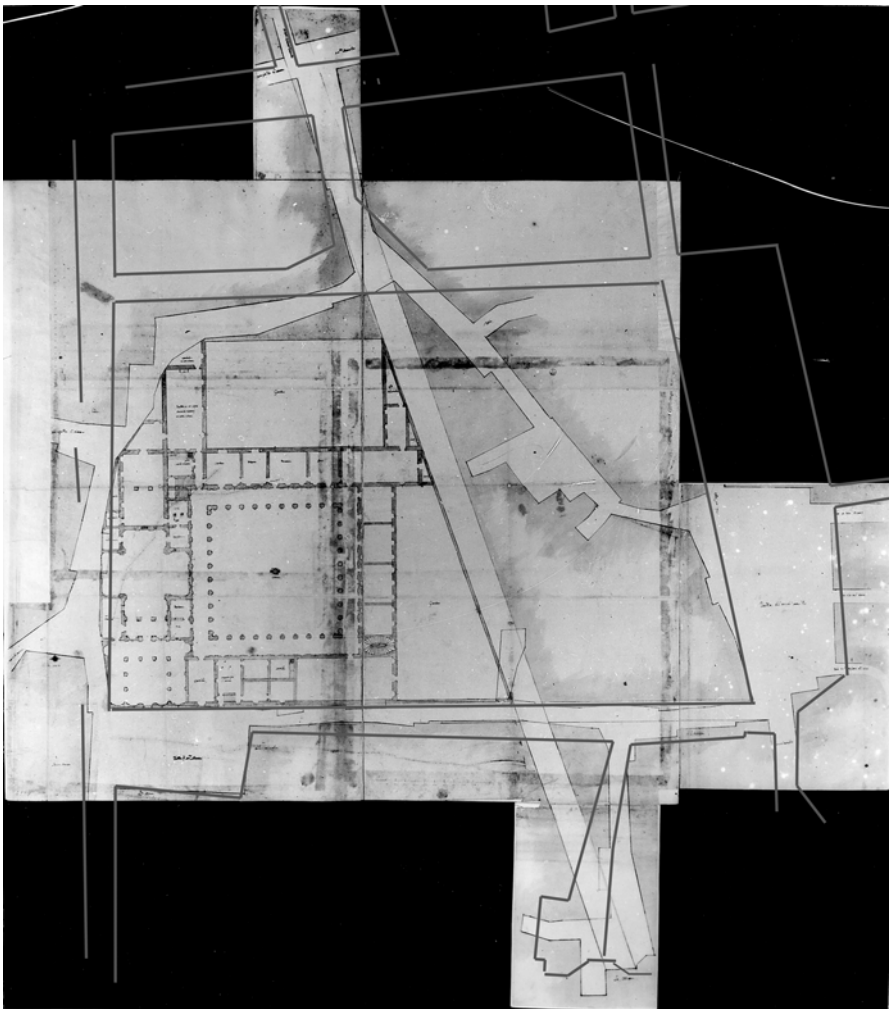

Fig. 10 UA 4180, overlaid with the outline of the Nolli plan, 1748. The scale of the two images has been equalized and the outline positioned on the basis of the Via di Sant'Ignazio frontage (the street in front of the proposed church). North is to the left of the figure

supposes, was to "adjust" angles and segment lengths. The draftsman of UA 4180 did something like this on the right side of his sheet. This is the side least related to either the convent or the new street and therefore the side least likely to have been the starting point for the construction of the plan. It is here that the draftsman would have discovered his problem, and a series of erasures suggest that it was also here that he made the changes that resolved the plan. This adjustment had little effect on the shape of the area to be rebuilt for the convent but at the overall scale, that of the street project, the distortions make an important difference.[11]

By superposing UA 4180 onto the representation of the Collegio Romano area in Giambattista Nolli's 1748 plan of Rome, we get some measure of the accuracy of the sixteenth century survey (Fig. 10). Figure 10 aligns the Via di Sant'Ignazio front of the Collegio Romano represented by Nolli with the *filo*, or building line, proposed in UA 4180 on the west side of the central block. When the scales of the two plans are equalized the comparison reveals the differences. One is the compression of the UA 4180 plan on the east-west axis, from the top to the bottom of the plan. This is most easily read in the position of the Corso. Running right-left on the small flap attached to the top of the plan, it lies closer to the Via di Sant'Ignazio in UA 4180 than it does in Nolli's *Ichnografia*. More important as a measure of the value of UA 4180 for the planning process, is the bearing of the new street. Although the eastern end of the street aligns with its position on the Nolli map, the western end is significantly displaced. Instead of leading to the door in the northern arm of the transept of the Minerva, it intersects the church to the south of the apse. If buildings had been cleared from the transept door following the orientation indicated in the drawing, the street would not have intersected the existing road on the east side of the site, the "Strada a Monte Cavallo" leading to the Quirinal.

It would not have been possible to build directly from UA 4180, nor can this have been the purpose of the drawing. Had it been, a compass rose to plot the orientation of the new street would have been a minimum requirement. To build the street, direct visual observation would have been essential. Surveyors on the roofs of buildings at the ends of the street and at intervals in between would probably have been necessary to direct a somewhat approximate demolition of structures. The only way that the project represented in drawings like UA 4180 could be realized on the ground was through the presence of the architect or a knowledgeable collaborator at the site. The information of this drawing, like contemporary drawings prepared for projects purely architectural in nature, was approximate—essential but not sufficient.[12]

UA 4180 is unusually expansive as an architectural drawing in that it presents a broad physical context for the convent project. It is also a rare document of the use of survey for urban design. As a project of civil architecture, it is comparable to the sketch plan of the Banchi area in Rome (Fig. 3), which seems to have been related to a project to improve the street system at the Ponte San Angelo and the sight lines to the church of San Giovanni dei Fiorentini.[13] A more fully developed design—also by Antonio da Sangallo the Younger's workshop—for the expansion and fortification of the feudal residence of Pratica in the Pontine marshes is more typical of the kind of project for which surveys were produced (Fig. 11).[14] The geometric nature of fortifications based on canon and interdependent bastions made drawings and models essential to military design. Tartaglia speaks of them as if their production were a matter of course.[15] In contrast, the area inside the city walls was less frequently mapped, and design there lagged in its use of survey.[16]

Surveys of urban design sites become more common in the second half of the century, as patrons began to see their utility in the planning process. A painting of

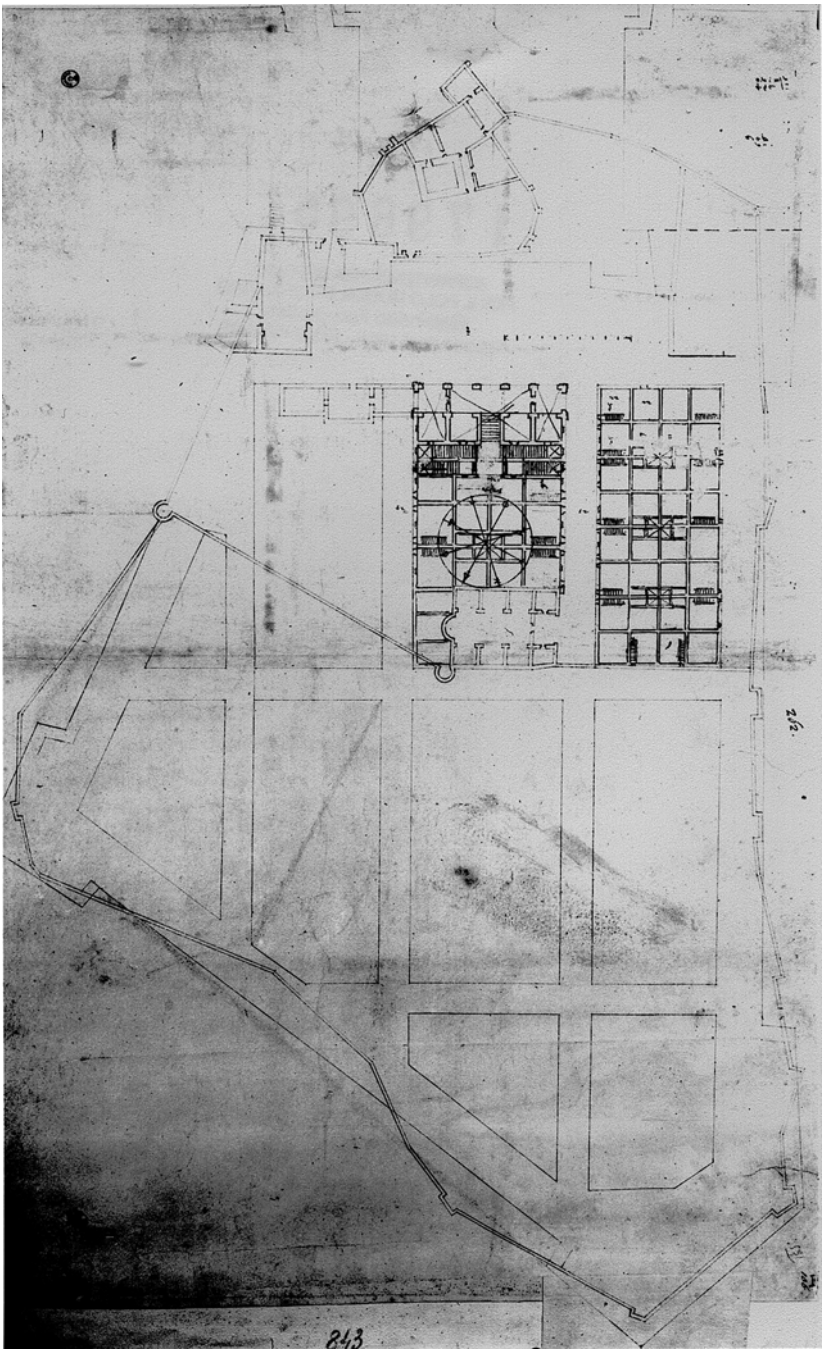

Fig. 11 UA 483, Workshop of Antonio da Sangallo, the Younger. Project for the reconstruction of the town of Pratica (after 1539)

Fig. 12 The Foundation of Cosmopolis, Sala di Cosimo I, Palazzo Vecchio, Florence (1557)

1557 on the ceiling of the Sala di Cosimo I in the Palazzo Vecchio in Florence makes an explicit claim about their use (Fig. 12). The image by the painter and architect Giorgio Vasari celebrates the foundation in 1548 of Cosmopolis (Portoferraio on the island of Elba). Cosimo, surrounded by his advisors, looks at the site from some indeterminate vantage. In his hand, he holds a plan of the project, while before and, symbolically, below him lies the city itself. It, too, is represented in plan.[17] Vasari's painting makes the purpose of such plans explicit: they allow the patron to visualize the city as a whole, as though hovering over it like a demigod. A more literal statement of purpose appears in the dedicatory text of a survey plan of Parma executed between 1589 and 1592 and given a new dedication in 1601. With the plan, "You, Duke Ranuccio, can see the proportions and relationships of the streets to one another and of any street to the body (of the city) as a whole, and if you want to bring the city to its full dignity you will clearly see the places that need to be improved."[18]

With few exceptions, sixteenth-century plans that represent the whole city—like Bufalini's *Roma*—give a schematic and generalized picture of their subject. In that regard, the Cosmopolis plan of Vasari's painting is probably not dissimilar from real working drawings. A plan for the enlargement of the village of Guastalla of 1553 provides an example of this kind of image (Fig. 13). The town, located on the Po

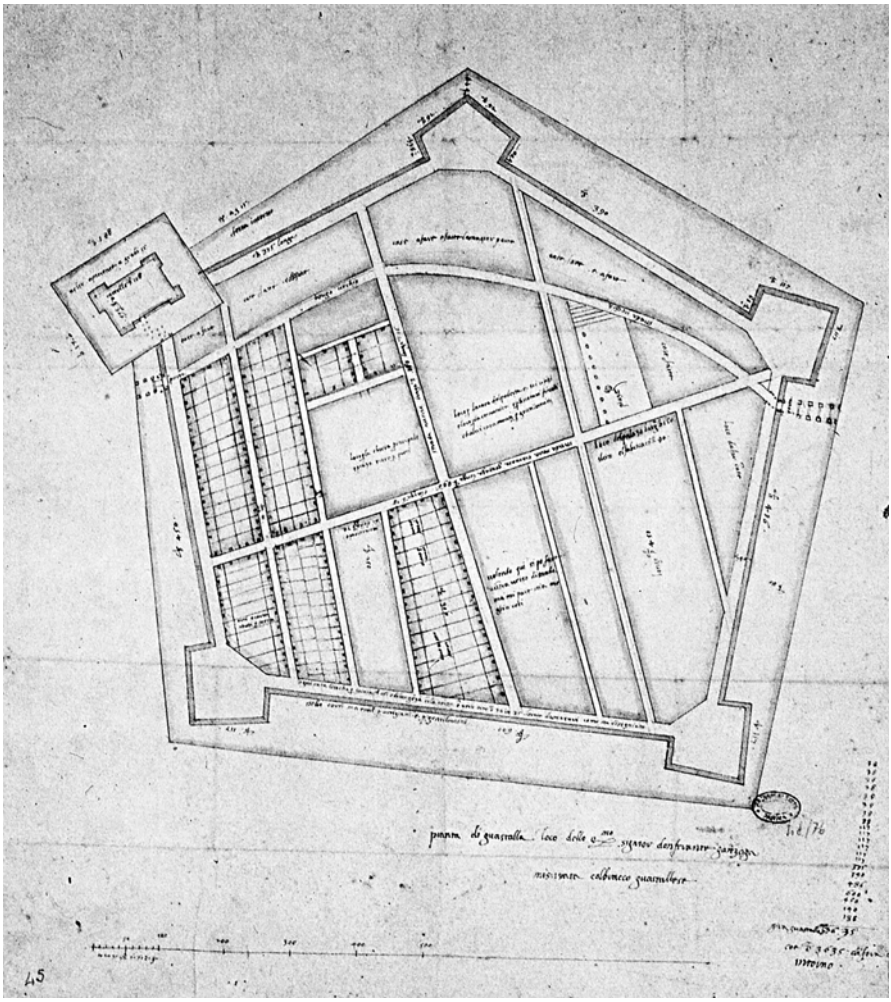

Fig. 13 Domenico Giunti, plan of Guastalla, 1553 (Archivio di Stato di Parma, Raccolta mappa e disegni, volume 48, plan 76)

between Mantua and Parma, was being transformed into a feudal residence by Ferrante Gonzaga, then governor of Milan for Charles V. The drawing is by Domenico Giunti, Ferrante's architect.[19] It is a survey of the defensive perimeter then in the course of construction and also includes a necessarily less concrete and only partially drawn project to develop the area within the new walls. In comparison to UA 4180, the schematic character of the plan is striking. Geometric survey is limited. Inscriptions give bearings for the western curtains at the top of the sheet but for no others. The street plan is defined by dimensions alone. The town as built follows this project in part, but the drawing can only be considered an outline

of the scheme. It gives a general picture of the arrangement of blocks, but the orientation of streets and the angles of intersections are significantly different in the town itself. While there is no question that this plan responds to the idiosyncrasies of the Guastalla site, its rough accuracy and limited detail give it an appearance similar to the images that illustrate ideal towns in the literature of military architecture.

UA 4180 is much more precise. It records plan details of individual house fronts and takes as its subject a block and street system of a complexity that no Italian city plan of the sixteenth century had yet addressed. While it was not a blueprint to be executed without further creative intervention, it did establish terms for the consideration of the architectural and urban design project that would not have been possible before the invention of survey. At the practical level, it identified the property to be dedicated to the convent and to the proposed street and marked out the areas of demolition. At the conceptual level, the level of formal design, it offered an outline of the area available to the architect for design, something that the verbal description of sites that we know from medieval practice could not do.[20] Without survey, information about shape would only have been known after demolition had cleared the ground. The drawing also allowed the designer to understand the relationship between the convent and street projects and, at the largest scale, to know the relationship between them and the rest of the city.

UA 4180 was also the means by which the architectural and urban planning idea was represented to a public outside the design workshop. What it might have communicated to that audience is embodied, first of all, in the medium. The translation of the three dimensional city into a two dimensional diagram would still, at this date, have preserved an element of wonder. At the same time, the mathematically based image claimed an objectivity that removed its content from the realm of rhetoric. Spectacular and matter of fact, the survey had very special virtues as an advocate for the project. As it turns out, the drawing is not an entirely honest witness to the situation. In the first place, the drawing presents information about the availability of land. It illustrates an entire city block, washed by a unifying grey-green tint, implying a resource that was not, in fact, in the hands of either the Marchesa or the Pope. A contemporaneous plan for the same site gives what is probably a more accurate picture of the Marchesa's property. Inscribed with the date 1557 and identified as the "Pianta del palazzo di Paolo 4o", it illustrates the area of the houses at San Macuto that the Marchesa proposed to convert into the convent of Poor Clares (Fig. 14).[21] The property mapped there represents less than half of the site covered by the UA 4180 project. It was not until 1581 that the land between the houses of the Marchesa and the Piazza del arco di Camigliano (now the piazza of the Collegio Romano) was acquired from private owners, and then by Pope Gregory XIII for the Collegio Romano, the successor to the convent of Poor Clares as the recipient of the Marchesa's pious charity.[22]

UA 4180 also makes an assertion about the centrality of the site. The project is the central focus of the drawing, of course, but the identification of connections to the Pantheon, to San Marco, to the Minerva, and to Monte Cavallo suggest a similar relation to the city as a whole. Finally, and most importantly, the drawing claims that the convent and street were natural improvements to the site. The blank space

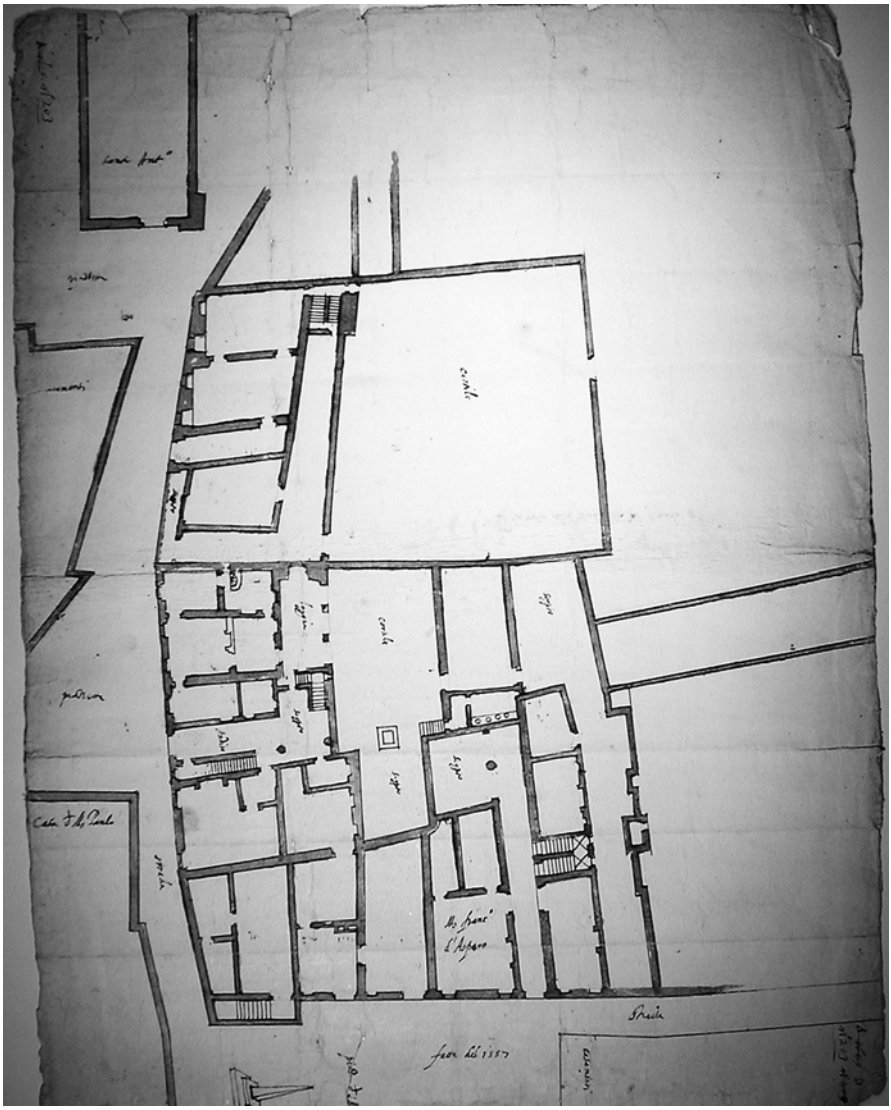

Fig. 14 "Pianta del palazzo di paolo 4o," partially showing the area covered in UA 4180, 1557 (Accademia di San Luca, Fondo Mascarino 2360, plan 1)

of the Piazza di San Macuto gets an architectural focus and the new street (thanks to the slight distortion of the survey) is shown as an organic continuation of the existing road from the Quirinal. For all its technical accomplishment, the plan's rhetorical sophistication also stands out.

The project described on UA 4180 had a mixed fortune. The convent of Poor Clares was very short lived. For the few years that the nuns were in residence at San

Fig. 15 Early project drawing for the Collegio Romano, Rome (Archivium Romanum Societatis Iesu, Armadio 5). The street at the bottom of the sheet (the west side of the site) is the Via di San Ignazio

Macuto, they occupied quarters adapted from earlier structures. No part of the convent project described in the Uffizi drawings was built. The Marchesa della Tolfa did lay the foundations for a new church—later inherited by the Jesuits—but these occupied a different and less grand position on the convent site than had been imagined in the drawing.[23] The street fared much better. Though not complete in all its parts, the section within the convent block was built as planned. It disappeared under the construction for the Collegio Romano in the late sixteenth century but the earliest drawings for that project include it as one of the boundaries of the site, and plan-views of the city from the 1570s (Mario Cartaro 1576, DuPérac-Lafréry 1577) illustrate it as part if the street system of the area (Fig. 15).[24]

The use of survey did not transform the kind of project that was proposed in UA 4180. The new street connects two terminal points in much the same way that the Via Giulia or the Via Lungara, Julius II's streets through the properties just east and west of the Tiber, had done at the beginning of the century. Plans of the generation of UA 4180 were, nevertheless, pioneers. They taught an audience of designers, building patrons, and civic administrators the value of survey both in design practice and as a tool of representation. Such plans allowed projects to be represented in much more concrete terms than had been possible when verbal description was the only way of communicating information about a design idea. If the imprecision of early survey limited its value for the definition of form, the

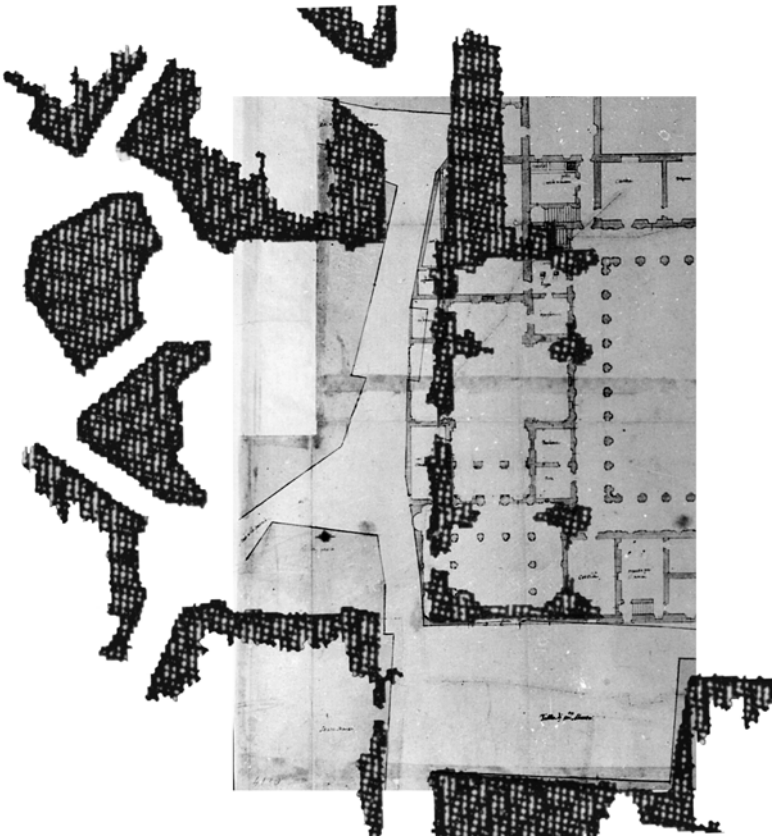

Fig. 16 UA 4180, Detail overlaid with Filippo Raguzzini's Piazza Sant'Ignazio (1727–1736) from Nolli 1748

uniquely abstract vantage on urban space that it offered ultimately opened up unimagined possibilities.

Urban design in the sixteenth century continued to be dominated by orthogonal spaces and straight streets, but a century later, in projects by Bernini, Borromini, and Pietro da Cortona, the topography revealed by survey and displayed in plan would inspire projects that transformed the accidents of the city's street system into coherent formal designs. There is no more spectacular example of this type of Roman urban design than the piazza built on the northwest corner of the Marchesa della Tolfa's site 170 years after the drafting of UA 4180. The circular spaces and triangular buildings of the Piazza Sant'Ignazio that Filippo Raguzzini built for the Jesuits of the Collegio Romano (1727–1736) demonstrate more dramatically than any other Roman square the formal control that drawing and survey introduced to urban design (Fig. 16).[25]

Notes

1. UA 4180 is attributed to Bartolomeo de'Rocchi. See Popp (1937). On the UA4180 site, see Rinaldo (1914); Bösel and Karner (1986–2007, vol. 1, 180–211, especially 180–182); Benedetti (1992); Palmerio and Villetti (1987); Villoslada (1954, 61–67, 93–98, 133–36); Valone (1994); and Lucas (1990, 164–165). On Paul IV more generally, see von Pastor (1901–1953, vol. 14, 56–434).
2. Alberti (1960–1973, vol. 3, 135–173). Also see Vagnetti (1968) and Stroffolino (1999).
3. See Bruschi et al. (1978, 459–484) and Thoenes (1986).
4. Günther (1984, 234–239).
5. Frommel and Adams (1994–2000, vol. 1, 128–30), where the drawings (UA 771r and v, 772r, 773r, 774r) are tentatively dated to 1526.
6. From a manuscript prepared in final form in the early 1630s, and published as Aleotti (2000, 539 (154r)). For the dating, see Rossi (1998, 164).
7. De Toni (1974, 137 and Figure 41).
8. Ehrle (1911). Also see Friedman and Schlapobersky (2005) and Maier (2007).
9. Tartaglia (1606 [1546], 129–131).
10. The upper left, or northeast, corner of the drawing contains two scales. Both measure 100 units. The one closest to the edge of the paper, corresponding to the first attempt to lay out the plan, measures 8.6 cm, the other 12.9 cm. This relationship is consistent for all measurable dimensions of the two plans. There is also a 100 unit scale at the base of the drawing that measures 12.9 cm. Another drawing in the Uffizi collection, UA1900, offers a reduced project for the Marchese della Tolfa site. The convent is smaller and the drawing presents only the property directly affected by the architectural project, with no urban context and no reference to the new street proposed in UA4180. That plan is drawn at the scale of 15.4 cm to 100 palmi, that is, 19 % larger than the plan of UA4180. It presents a simplified version of the site and includes some details not registered in UA 4180 (e.g. a door between the first and second projection on the western face of the property). There are enough discrepancies between that plan and the one registered on UA4180 to conclude that they were constructed separately. Both, however, were made on site.
11. The erasures modify the south face of the convent block, the face that defines one side of the present-day Piazza del Collegio Romano. They are visible at both the top and bottom of that face, a few centimeters to the left of the line that makes the final definition of this side of the block. It is probable that the corner of the block on the western street, the present day via di Sant' Ignazio, had been established early in the projection of the plan. This was an important point in the project and one whose relationship to the area of the convent, and especially to the door of the church, was relatively easy to measure. The faces of the south side of the block, generated in a series that began in the east at the end of a long compass traverse, apparently landed on a point too far to the north and had to be corrected.

12. The drawings for architectural projects of the period had a similar relationship to execution. Those that survive are mostly detail sketches and the plans that we know are often quite different from what was built. Nothing like a full set of working drawings ever existed. See Ackerman (1954). Nor were the architectural projects of Phillip II of Spain, spread across widely scattered sites and centrally controlled by the king himself, recorded in more than a bare minimum of drawings. For the lists of drawings sent to building sites, see Wilkinson-Zerner (1993, 46–62, esp. 58–59). In these cases, as in Renaissance Rome, we must assume that verbal instruction supplemented the drawings.
13. See note 4, above.
14. UA 843 r, dated after 1539. See Frommel and Adams (1994–2000, vol. 1, 151–152). The drawing is inscribed on the verso: "Pratica di me[sser] luca di maximo".
15. Tartaglia (1606 [1546], 69r). For Tartaglia, design, not materials, is the essence of military architecture and design is produced and shared through drawing: "Lo ingegno del huomo, nel fortificare una citta (secondo mio parere) si conosce per la forma, e non per la materia." He tells his interlocutor that he could improve the defenses of Turin in six different ways. To explain them, he states, "a me saria necessario (a volere a sofficientia ben dechiarire, e con ragione dimostrare di cadauno di quelle particularmente sua valuta) a designare varie e diverse piante" (70v). One of the qualities of a good defense is to ensure that the enemy is never closer to the curtain he intends to attack than from a bastion from which he can be attacked. This is a geometric issue and Tartaglia promises to show his interlocutor how it is done with a drawing: "faro figuralmente vedere" (71r). His interlocutor says he will show that he has understood the lesson by making "una pianta designata de mia mano" (71v).
16. The war offices of Italian states collected towns plans of both friend and foe. Concerned exclusively with fortifications, they generally leave the area inside the walls blank. See van den Heuvel (1991, 53–61), citing Biblioteca Nazionale Turin, Ms. q. II. 57 (old signature Serie Atlas C N 5 [Bc. Atl Sala XV]). Also see Lamberini (1988) and Warmoes et al. (2003).
17. See Battaglini (1978, 89–91) and Fara (1997, 3–24). In a letter of 19 June 1549, Cosimo's architect Giovanni Camerini speaks of two plans for the layout of the city's streets and defenses that he has sent to the duke. Fara identifies a drawing of 1553 as reflecting one of those plans (Fara (1997, Figure 33)). It is substantially the same as the plan that Vasari places in Cosimo's hand in the Palazzo Vecchio painting.
18. "…potrà vedre le proportioni e le corrispondetie che hanno tutte le strade et borghi fra loro et ciascuna a tutto il corpo di quella et volendola ridurre al suo vero decoro, chiaramente conoscerà i luoghi che rimuovere si dovrebbono per ridurrla a perfetione…" Adorni (1980, 34). Also see, Uluhogian (1983).
19. The plan measures 372 mm by 428. It is preserved in Raccolta mappe e disegni, volume 48, plan 76 (previous catalogued as volume 70), Archivio di Stato di Parma. Also see Soldini (1992–3) and Storchi (1999).

20. This represented a considerable improvement over the uncertainty about boundaries that reigned in the era of purely verbal description. When land was cleared for the Piazza Maggiore in Bologna at the beginning of the thirteenth century, not all of the properties within the perimeter of the project were identified before demolition began. A second set of purchases was necessary to gain control of the site and to regularize its perimeter. See Bocchi (1995–1998, vol. 2, 11–16, esp. 16). For late medieval urban design systems see Friedman (2009).
21. Fondo Mascarino 2363, plan 1, Accademia nazionale di San Luca, Archivio storico. The drawing measures 58 by 44 cm. It carries the inscription, presumably of a later date: "Casa del Colegio de Gesuiti alla Guglia di S. Mauto". See Marconi et al. ([1974], 16).
22. The land was expropriated by Gregory with a *Motu Proprio* of 13 July 1581. Cerchiai (2003, 63).
23. Bösel and Karner (1986–2007, vol. 1, 181).
24. The Collegio Romano drawings are held in Armadio 5, Archivium Romanum Societatis Iesu, Rome. They have been published in Lucas (1990, 164–65, cat. no. 96). For the Rome plans, see Frutaz (1962), Plate 244 for the relevant detail of the Cartaro plan, Plate 250 for the detail of the DuPérac-Lafréry plan.
25. The surviving eighteenth century plan of the piazza was produced in 1731 for the *Maestri di Strade*, the agency in charge of the physical city, as one of a series of plans of public spaces. Disegni e piante, c. 80, no. 240, Archivio di Stato di Roma It is illustrated in Habel (1981, Figure 16). Also see Connors (1989, 279–294).

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Accademia di San Luca: Fig. 14
Archivium Romanum Societatis Iesu, Rome: Fig. 15

References

Ackerman, James. 1954. Architectural practice in the Italian Renaissance. *Journal of the Society of Architectural Historians* 13(3): 3–41.

Adorni, Bruno. 1980. Iconographia della città di Parma (1589–1592). In *'Io Smeralda Smeraldi ingegnero et perito della congragatione dei cavi del Parmigianino.' Territorio, città, offizio nel Ducato di Parma 1582–1634*, ed. Carlo Quintelli and Luca Monica. Parma: Grafiche STEP.

Alberti, Leon Battista. 1960–1973. *Opere Volgari*, ed. Cecil Grayson. Bari: Laterza.
Aleotti, Giovanni Battista. 2000. *Della scienza et dell'arte del ben regolare le acque*. Modena: Panini.
Bartoli, Cosimo. 1564. *Del modo di misurare le distantie, le superficie, i corpi, le piante, le prouincie, le prospettiue, & tutte le altre cose terrene, che possono occorrere a gli huomini, secondo le vere regole d'Euclide, & de gli altri più lodati scrittori*. Venice: F. Franceschi.
Battaglini, G.M. 1978. *Cosmopolis: Portoferraio medicea, storia urbana 1548–1737*. Rome: Multigrafica.
Benedetti, Sandro. 1992. La prima architettura gesuita a Roma: Note sulle chiese dell'Annunziata e sul Collegio Romano. In *L'architettura della Compagnia di Gesù in Italia, XVI-XVIII secolo: atti del convegno, Milano, 24–27 ottobre 1990*, ed. L. Patetta and S. Della Torre, 57–68. Genova: Marietti.
Bocchi, Francesca (ed.). 1995–1998. *Bologna*. Bologna: Grafis.
Bösel, Richard, and Herbert Karner. 1986–2007. *Jesuitenarchitektur in Italien 1540–1773*. Vienna: Österreichische Akademie der Wissenschaft.
Bruschi, Arnaldo, et al. (eds.). 1978. *Scritti rinascimentali di architettura*. Milan: Il Polifilo.
Cerchiai, Claudia (ed.). 2003. *Il Collegio Romano dalle origini al Ministero per i beni e le attività culturali*. Rome: Istituto Poligrafico e Zecca dello Stato, Libreria dello Stato.
Connors, Joseph. 1989. Alliance and enmity in Roman Baroque urbanism. *Römisches Jahrbuch der Bibliotheca Hertziana* 25: 207–294.
De Toni, Nando. 1974. I rilievi cartografici di Leonardo per Cesena ed Urbino contenuti nel manoscritto "L" dell'Istituto di Francia. In *Leonardo da Vinci: Letture vinciane I–XII (1960–1972)*, ed. Paolo Galluzzi, 133–148. Florence: Giunti-Barbèra.
Ehrle, Francesco. 1911. *Roma al tempo di Giulio III: La pianta di Roma di Leonardo Bufalini del 1551*. Rome: Danesi.
Fara, Amelio. 1997. *Portoferraio: architettura e urbanistica 1548–1877*. Turin: Edizione della Fondazione Giovanni Agnelli.
Friedman, David. 2009. Urban design without drawing. In *Arnolfo's Moment: Acts of an international conference*, Florence, Villa I Tatti, May 26–27, 2005, ed. David Friedman, Julian Gardner, and Margaret Haines, 125–146. Florence: Leo S. Olschki.
Friedman, David, and Paul Schlapobersky. 2005. Leonardo Bufallini's orthogonal *Roma* (1551). *Thresholds* 28: 10–16.
Frommel, Christoph L., and Nicholas Adams (eds.). 1994–2000. *The architectural drawings of Antonio da Sangallo the Younger and his circle*. New York/Cambridge, MA/London: Architectural History Foundation/MIT Press.
Frutaz, Amato Pietro (ed.). 1962. *Le piante di Roma*. Rome: Istituto di studi romani.
Günther, Hubertus. 1984. Das Trivium vor Ponte S. Angelo: Ein Beitrag zur Urbanistik der Renaissance in Rom. *Römisches Jahrbuch für Kunstgeschichte* 21: 164–251.
Habel, Dorothy. 1981. Piazza S. Ignazio, Rome in the 17th and 18th centuries. *Architectura* 11(1): 31–65.
Lamberini, Daniela. 1988. Funzione di disegni e rilievi delle fortificazione nel Cinquecento. In *L'architettura militare veneta del Cinquecento*, ed. Sergio Polano, 48–61. Milan: Electa.
Lucas, Thomas (ed.). 1990. *Saint, site, and sacred strategy: Ignatius, Rome and Jesuit urbanism: Catalogue of the exhibition: Biblioteca Apostolica Vaticana*. Città del Vaticano: Biblioteca apostolica vaticana.
Maier, Jessica. 2007. Mapping past and present: Leonardo Bufalini's plan of Rome (1551). *Imago Mundi* 59(1): 1–23.
Marconi, Paolo, Angela Cipriani, and Enrico Valeriani (eds.). 1974. *I disegni di architettura dell'Archivio storico dell'Accademia di San Luca*. Roma: De Luca.
Palmerio, Giancarlo, and Gabriella Villetti. 1987. L'isolato del convento di S. Maria sopra Minerva in Roma alla fine del Cinquecento. *Architettura storia e documenti* 1–2: 5–33.
Popp, A.E. 1937. Unbeachtete projekte Michelangelos. *Münchener Jahrbuch der Bildenden Kunst*: 12: 439–443.
Rinaldo, Ernesto S.I. 1914. La signora Vittoria della Tolfa marchesa della Valle e la donazione fatta al Collegio Romano. In *La fondazione del Collegio Romano. Memorie storiche*, 61–67. Arezzo: Cooperativa Tipografica.

Rossi, Massimo. 1998. La cartografia aleottiana. In *Giambattista Aleotti e gli ingegneri del rinascimento*, ed. Alessandra Fiocca, 161–187. Florence: Leo S. Olschki.
Soldini, N. 1992–3. La costruzione di Guastalla. *Annali di architettura* 4–5: 57–87.
Storchi, Stefano. 1999. *Guastalla: La costruzione di una città*. Reggio Emilia: Diabasis.
Stroffolino, Daniela. 1999. *La città misurata. tecniche e strumenti di rilevamento nei trattati a stampa del Cinquecento*. Rome: Salerno editrice.
Tartaglia, Nicolò. 1606 [1546]. *Quesiti et inventioni diverse*. Venice: segno del Lione.
Thoenes, Christof. 1986. La 'lettera' a Leone X. In *Raffaello a Roma. Il convegno del 1983*, 373–381. Rome: Edizione del Elefante.
Uluhogian, F. Miani. 1983. *Le immagini di una città: Parma (secoli XV-XIX). Dalla figurazione simbolica alla rappresentazione topografico*. Parma: La Nazionale.
Vagnetti, Luigi. 1968. La *Descriptio urbis romae* di Leon Battista Alberti. *Quaderno dell'istituto di elementi di relievo dei monumenti di Genova* 1: 25–78.
Valone, Caroline. 1994. Piety and patronage: Women and the early Jesuits. In *Creative women in medieval and early modern Italy*, ed. Ann Matter and John Coakley, 157–184. Philadelphia: University of Pennsylvania Press.
van den Heuvel, Charles. 1991. *'Papiere Bolwercken': De introductie van de Itliaanse stede- en vestingbouw in de Nederlanden (1540–1609) en het gebruik van tekeningen*. Alphen aan den Rijn: Canaletto.
Villoslada, R. Garcia. 1954. *Storia del Collegio Romano dal suo inizio (1551) alla soppressione della Compagnia di Gesù (1773)*. Rome: Apud aedes Universitatis Gregorianae.
von Pastor, Ludwig. 1901–1953. *The history of the Popes: From the close of the middle ages*. London: Kegan Paul, Trench, Trübner.
Warmoes, Isabelle, Emilie d'Orgeix, and Charles van den Heuvel (eds.). 2003. *Atlas militaires manuscrits européens XVIe-XVIIIe siècles: Forme, contenu, contexte de réalisation et vocations: Actes des 4es journées d'étude du Musée des plans-reliefs, Paris, Hôtel de Croisilles, 18–19 avril 2002*. Paris: Musée des Plans-Reliefs.
Wilkinson-Zerner, Catherine. 1993. *Juan de Herrera: Architect to Phillip II of Spain*. New Haven: Yale University Press.