Fortezza Vecchia in Livorno

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Abstract From the Middle Ages, the high rocky promontory where Livorno castle stood overlooking a wide expanse of sea was a strategic point for the defence of the entrance to Porto Pisano. Its unique, commanding position between the settlement and the sea was conducive to its development as a favoured site for defence of the area. First the Pisans, and then the Florentines chose this site to direct port activities, and over time erected a series of fortified works which are still embedded within the walls of the Fortezza Vecchia. It was Antonio da Sangallo the Elder who drew up the plans for the fort under the supervision of his brother, Giuliano. It was built between 1519 and 1533 with the aid of an array of expert engineers. The fort is a capacious, enveloping structure with irregular, unusual architectural lines. The original geometric shape, as deduced from treatises, was modified and shaped to account for the nature of the site and pre-existing medieval structures.

Keywords Military architecture · Fortezza Vecchia · Construction techniques · History of architecture · History of construction · Giuliano da Sangallo · Antonio the Elder da Sangallo · Livorno

Introduction

The most fascinating part of Livorno's history is preserved within the walls of the Fortezza Vecchia ('Old Fortress'), which to the eyes of the more observant visitor appears like a great animal, once vital and energetic, and now violated and offered up for dissection (Fig. 1).

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Fig. 1 Fortezza Vecchia, view from the dock. Image: Archivio Fotografico della Soprintendenza di Pisa (AFSPI), n. 143146 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

During its existence, the Fortezza has been modified, patched up and distorted many times to comply with new circumstances, a distinctive feature of the art of fortification, as structures needed to be continually adapted to developments in weapons of attack and defence. The architectural features of the fort are extremely interesting both with regard to the original lines and to those subsequently acquired through time, and “even the way they have been broken and almost crushed on the edge of the sea”.¹

From the Round Tower to the Quadratura dei Pisani

The architectural history of Livorno’s maritime castle in the middle ages goes hand in hand with the development of the Pisan seaport system. Its unique location on a dominant, high, rocky point between the village and the sea, and its singular part in the complex sighting and signalling system devised from the twelfth century for coastal defence, confirms the extreme importance of the area occupied by the fort (Vaccari 2009, pp. 49–52).

By the second half of the twelfth century, Pisa had consolidated its political and trading authority in the Mediterranean, and it was in this context that the *Portus magnalis* or Porto del Magnale (another name for Porto Pisano) was built, *ferè contiguum*, adjacent to the rocky promontory of Livorno castle (Petrarca 1990, pp. 50–51). Between the thirteenth and fourteenth centuries, however, a barrage of attacks from the sea pinpointed all the weaknesses in Pisa’s coastal fortification system.

In 1285, a year after the ruinous defeat in the waters around the Meloria, Ugolino della Gherardesca and Nino Visconti were already considering the expedience of

¹ Archivio Generale della Soprintendenza di Pisa, D29-4.

Fig. 2 View of the round tower, present state. Photo: author

defending Livorno against attacks by Pisa's enemies on Porto Pisano by building a wall around the village.

Although the exact date of construction is still somewhat disputed, it was perhaps following the heavy attack of 1290 that the Pisans built the imposing round tower erroneously known as Matilda's tower² (Figs. 2 and 3), within the castle environs about 30 m from an older tower with a more or less square layout whose walls are approximately 1.50–1.60 m thick. The base of the square tower is marked by several courses of Verrucano green quartzite ashlar masonry.

The walls of the round tower are approximately 2.4 m thick, the masonry is mixed, and in a seventeenth-century drawing is described as *white*, that is, plastered to protect it against the salty environment. If on one hand the use of disparate materials probably betrays a hurried construction, on the other, the use of small pieces of material meant the curved line could be defined without the need for particular manual skill. Inside the circular wall of the tower, a built-in stone spiral staircase leads to the upper floors. The spiral of the stairs embedded in the wall obliges the climber to follow an upward path that coordinates the views and exaggerates circular vision. This type of stairway in stone has the advantage of not being easy to set on fire, unlike wooden scaffolds which burnt down with regularity.

A well-curb and another opening in the wall of the lower floor allowed collected rainwater to be drawn from a deep cistern, where a slit admitted light to the vaulted space (Piancastelli Politi Nencini 1995, p. 27).

² Matilde di Canossa (or Matilde di Toscana) lived from 1046 to 1115, but the exact date of construction of the tower is still somewhat disputed.

Fig. 3 Section of the round tower. Image: Archivio Catalogo della Soprintendenza di Pisa, survey drawing by Architects Giraldi and Milanese. “The drawing belongs to the graphic documentation of the catalogue ICCD n. 09/00061536, property of the Soprintendenza B.A.P.S.A.E. di Pisa”. Reproduced by permission

The circular tower with its staircase built into the solid wall recalls Pisa's famous round campanile, unique for its accessible loggias on each of the six levels. The Pisan architect Deotisalvi (twelfth c.) had already included a similar staircase in the perimeter wall of the Baptistry, even doubling it (Pierotti 1990, pp. 1–8).

The Pisans were accustomed to building towers and campaniles, that is to say, point loads, on their soaking wet, soft and treacherous soil, and they were so skilled at it that when they built campaniles, they had the sensible habit of placing them apart from the churches to give them room to settle. When the Pisan workforce, which had already erected the port towers, were engaged to build the circular tower in Livorno, they found a homogeneous subsoil comprising “a compact bank of clayey sand”, and so the master mason with his sounding apparatus had no problem demonstrating all his expertise (Pierotti 1990, p. 1).

The eye perceives a certain harmony in the shape of this tower, given by the numerical ratios. The diameter of the external circumference is 12 m and that of the internal circumference 7.2 m, that is, a ratio of 5:3. The ratio of the thickness of the walls to the external diameter is 1:5, while that of the thickness to the internal diameter is 1:3 (Table 1).

The top of the tower was crenelated, at least until 1529, when Ceccotto Tosighi, general commissioner of Pisa, gave the order to remove the merlons: “The merlons

Table 1 Measurements of the circular tower converted into medieval Pisan units

	Measurements in metres	In Pisan feet (0.486 m)	In Pisan cubits (0.5836 m)	In Pisan perches (2,916 m)
External circumference	37.6	77.3	64.4	12.8
Internal circumference	22.6	46.5	38.7	7.7
Internal diameter (lower level)	6.3	12.9	10.7	2.16
External diameter	12	24.6	20.5	4.1
Internal diameter	7.2	14.8	12.3	2.4
Wall thickness	2.4	4.9	4.1	0.8
Height at summit from ground	32.20	66.2	55.1	11
Height at summit floor surface from ground	28.9	59.4	49.5	9.9

Dimensions taken from Archivio Catalogo della Soprintendenza di Pisa, survey drawings by Architects Giraldi and Milanese and by Lucio Walter Parigi

should be removed from the tower keep and a parapet made which I would make as a rampart” (Gaye 1840, II, p. 196).

The top of the tower features a projecting parapet supported by corbels for machicolation-based defence. Powerful chemical bombs were dropped from here, some with an “intolerable stench”, including “decaying fish” or “rotten meat” mixed with linseed water, or macerated eggs or putrid wheat launched against the enemy in glass jars (Martini 1967, pp. 204–209).

The curved perimeter of the tower is marked by a series of arrow slits for the archers, facing mainly westwards and northwards, since the south side was protected by the quadrangular tower. The base segment of the tower widens in successive brick scarcements, and it is said that “in an earlier age, Matilda’s Keep was isolated and supported by a wide, conical base”.

On 2 April 1662, on the “fifty cubit high tower of the old fortress in Livorno port”, members of the Accademia del Cimento (Academy of Experimentation), armed with a *falconetto*,³ iron shot and fine powder, a Galileo geometric and military compass and a two-wire pendulum, carried out a series of experiments on the movement of projectiles by firing them towards the sea. The purpose was to prove whether, as Galileo had claimed, the projectiles took the same time to reach the ground whether fired horizontally or dropped straight down from the same height (Magalotti 1667, pp. 247–248).

Perhaps it was no coincidence that these illustrious men of science chose precisely the Livorno tower to fire *di punto in bianco*, that is, perfectly parallel with the horizon!

We know for a certainty that in 1662 the tower was 50 Florentine cubits high,⁴ half the height of the Pisa campanile, but we cannot verify the effective correspondence of this height, equal to 29.18 m, with the original. I limit myself to pointing out that the present height of the tower, measured from the floor surface

³ A short, slim, small calibre cannon.

⁴ The Pisan and Florentine cubits are both equal to 0.5836 m.

of the summit to the ground is 28.9 m, equal to 49.5 cubits, about 30 cm shorter than in 1662. The reason for this reduction can be attributed to construction from 1855 of new wharfs and loading areas attached to the fort on land reclaimed from the sea.

In the last decades of the fourteenth century, Livorno grew notably in importance as a port due to the silting up of the Stagno lagoon⁵ and the consequent decline of Porto Pisano.

It was in the second half of the fourteenth century that the borders were reinforced through a veritable military defence and attack campaign.

While Pisa fortified its city walls by strengthening the entrances and salient points of the circuit, Puccio di Landuccio, *magister lapidum* (master stonemason) and Francesco del fu Giovanni Giordani, *magister lignaminis et murorum* (master carpenter and mason) arrived in Livorno to build the Rocca Nuova (New Fortress) (Vigo 1913, pp. 14–16), which was built between 1369 and 1379 on the sea at the eastern end of Livorno. Puccio and Francesco encountered a series of setbacks and problems during construction. Indeed, the wooden formwork used for laying the foundations in the sea and all the completed buildings were destroyed by the stormy sea no less than twice. Having to lay the foundations directly in the water, master carpenter and mason Francesco had to build a device able to prevent the mortar being washed away in the first days. Twice poor Francesco, who died while carrying out the work as a result of the inclement weather, lowered the great form bound with ropes and canvas into the water, and twice it was swept away by the raging sea (Vigo 1913, p. 15).

The Rocca Nuova, later called the Quadratura dei Pisani, had the shape of an irregular parallelepiped and incorporated the existing buildings, the quadrangular tower to the south, which is not joined to the walls, and the circular tower at the intersection of the north-east and north-west facades. The eastern facade, oriented towards the village at the subterranean floor level, is of ashlar blocks laid in horizontal courses superimposed and interspaced with irregular rows of bricks, all bound with mortar rich with lumps of white lime. The structure is based directly on the rock, and in the furthest southern corner seems to rest on an existing structure comprising large irregular blocks of stone (Materazzi 1995, p. 51).

About 4.0 m along this side, where the walled-up door is situated, runs a 19.30 m long rectilinear avant-corps set towards north against the circular tower, now visible only at the subterranean level. This wall is built of irregular stone blocks with sporadic brick inserts. At the height of the subterranean floor, is a series of “elongated rectangular slits” (Materazzi 1995, p. 52), that is, loopholes, set at different heights, which due to their position close to ground level are probably connected with the discovery of the greater effectiveness of grazing fire, horizontal and close to the ground.

This technique was widely used for defending the *terre nove* (the new lands built by the Florentines between the end of the thirteenth century and the first half of the fourteenth century) and in fortified outposts, such as Ripoli castle, which were part of the broader system of protection of the *contado* (countryside) implemented by

⁵ “Laguna di Stagno” (Pond’s lagoon) was located just to the north of the Porto Pisano.

Pisa's rulers in the mid-fourteenth century (Leverotti 1989, pp. 243–262). Livorno was one of the main cornerstones of this system.

Around the middle of the fourteenth century, along with grazing defence, systems for machicolation-based defence were enhanced, and a system of corbels built with progressively jutting rows of bricks was added to the crenelated walls of the Rocca Nuova, which were vertical and without a steeply sloping foot (scarp). It is probable that in Livorno, as with Ripoli castle, corbels were arranged on both sides of the wall to balance and reduce the strain on the walls produced by the load (Bevilacqua 2011a, pp. 78–83).

It was precisely in this period that the use of early firearms, that is, “bombards”, began to spread. At least in the early days, they were quite ridiculous contraptions. They were cast in a number of pieces, and for this reason often exploded. Their projectiles, first in stone and only later in metal, were obviously not explosive and caused very limited damage.

Accounts of use of the new weapons in Tuscany are increasingly frequent during the second half of the fourteenth century, but the only case of a real provision of the still rudimentary canon observed in this period, apart from the Santa Maria in Castello stronghold, is precisely in the Quadratura dei Pisani (Fig. 4) (Severini 2008, pp. 85–96; Bevilacqua 2011a, pp. 82–83).

The corbel-supported parapet of the Rocca Nuova was equipped with brick arched lintel-framed circular loopholes for hand cannon. These loopholes, inserted in the jutting parapet as machicolations, were also present on the top of the round tower. This feature is revealed in a number of old photographs, but various restoration works have disguised and hidden them. In some cases, the circular openings have been blocked up and in others, vulgarised and turned into paltry dripstones.

Fig. 4 Quadratura dei Pisani, detail of the eastern facade. Image: AFSPi n. 52921 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

The Advent of Firearms

Up to the middle ages, weapons, siege and defence systems had remained more or less the same. With the advent of firearms, fortifications very quickly became obsolete and had to be rebuilt, sometimes without ever having been subject to any attack. At the beginning of the fifteenth century, Livorno came under the protection of the King of France, or more exactly, of his lieutenant, Jean Le Meingre, Sire of Boucicault and Governor of Genoa, who sold the city to the Genoese in 1407. In this period, the new rulers strengthened the pre-existing medieval fortifications. They opened three embrasures at water level in the Quadratura dei Pisani directed towards the north, west and south respectively (Piancastelli Politi Nencini 1980, p. 46). Then “an embrasure above that facing sirocco (southeast), a double-order one towards the village and the embrasure on the west side of the square tower” were opened (Piancastelli Politi Nencini 1995, p. 34).

However, the real art of war developed in Tuscany, a somewhat quarrelsome, turbulent region, in the second half of the fifteenth century, when artillery replaced the cavalry. Starting with the destruction of Fiesole, the “mother” city in 1125, Florence conducted an often ruthless policy of conquest and violent submission of the other Tuscan cities for almost 500 years. In 1421 it bought Livorno, the long-desired access to the sea, for 100,000 gold florins, while Pisa, already bought in 1405, strenuously opposed Florentine rule. Florence implemented its plan to strengthen the port infrastructures thus: at Porto Pisano, by now subject to Livorno, it preserved the Pisan towers and built an octagonal marble tower-fort known as del Marzocco, a prism of purest marble in typical Alberti style⁶ (Trotta 2005, pp. 43–65; Morolli 2006, p. 251); completed restoration of the dock; built a new marble jetty; repaired the crumbling port walls around the Rocca Nuova and Vecchia; and began excavation of the seabed of the dock.

During the second half of the fifteenth century, new ideological impulses stirred the governing authorities, who had to plan the construction of fortresses able to hold out against cannon fire and to provide for cannon able to destroy such fortresses. It was Francesco di Giorgio Martini who, in his treatise *Architettura civile e militare*, advocated an ideology based on the *iustitia* guaranteed by widespread possession of cannon (Pierotti 1995, p. 64). Francesco Guicciardini tells of the terror sown when Charles VIII invaded Italy in 1494 with lighter and slightly more efficient weapons than those in use (Guicciardini 1971, pp. 1464–1466). The Florentine government took up the intriguing and perennial challenge with systems of attack and defence, and pursued the Aristotelian concept whereby “just as assailants are concerned with finding the means to prevail, so also those who defend themselves have found some and must find and devise others” (Aristotle 1957, p. 1331a). So for the well-being and preservation of the states, it was necessary to design new forms, new architecture to replace that of the past, ingenious though it was, and with which to constrain *tanta violenza*, such violence. In Francesco di Giorgio Martini’s treatise,

⁶ Giampaolo Trotta has recently claimed that work is by Alberti: “It is credible, therefore, even if to date there is no documentary proof, that Alberti was chosen for the important global project (new, Florentine marble Piraeus) through Giovanni Rucellai” (Trotta 2005, p. 60).

the cannon becomes a terrifying, uncontrollable instrument against which it is difficult to defend. The only solution was to build extremely thick walls, with the outer faces of the wall in brick and the intervening space filled with rubble, but not even this would be enough. Starting from the sixteenth century, after Francesco di Giorgio, we have a flood of treatises proposing new defence systems. Within half a century or less, the same strongholds built to Francesco di Giorgio's plans would become inadequate.

The new architecture of fortification, however, had a fundamental feature: "the relationship between its component parts is comparable to that of the parts of a geometric system. For this reason, any variation affects the whole, as in the geometric *continuum* of the perspective" (Fara 1993, p. 11).

Brunelleschi's discovery of the principles of linear perspective and the reproducibility of objects in a drawing corresponded with the designability of objects through drawing. The schematic diagram became a transferable, multipliable, propagandisable structure. Euclidean geometry helped our artists achieve this result as it is the height of abstraction and so allows for the greatest possible schematisation (Pierotti 1995, pp. 12–15). The design of the walls was the subject of interminable debate. It was necessary to limit the length to reduce the number of defenders to be deployed and the possibilities for attacking them, but at the same time, account had to be taken of ballistics, that is, the possible paths of a projectile launched by a piece of artillery (Severini 1994, pp. 49–133).

This gave rise to the so-called bastioned front, conceived according to formal rules and geometric ratios and refined on the basis of the calibre and range of the artillery in use. A curtain wall connects to a monumental bastion which essentially must allow cannon to be placed in such a way as to eliminate blind spots and offer only an oblique and not frontal exposure to attacking fire, deviating its direction and dampening the dynamic force.

Giuliano and Antonio the Elder da Sangallo and the Design of the Fortezza Vecchia

At a time when the art of war was undergoing rapid transition, it was decided to begin fortification of Livorno, a strategic part⁷ of the Florentine state. But in 1498 Livorno castle was still lacking defences. In 1500, during one of the assemblies consisting of expressly convened representatives of the Florentine judiciary and eminent citizens, at which the Priors solicited opinions on the most important questions concerning the Republic's domestic and foreign policy, Jacopo Tealdi reminded them to provide for the fortification of Livorno and proposed sending an expert "equal to Sangallo".⁸ In 1501 the main concern was still that of fortifying the town because imminent occupation by Pisa was feared.⁹ On 3 June 1502 the *Balia*

⁷ "Livorno, right eye of our state" (Frattarelli Fischer 1995, p. 177).

⁸ "In his name and that of the second bench he recommended providing for Livorno and Cascina, and recommended sending one equal to San Gallo" (Frattarelli Fischer 1995, p. 177).

⁹ "The Pisans are anxious to go and take possession of it" (Frattarelli Fischer 1995, p. 177).

of Florence sent a letter, dictated by Niccolò Machiavelli, to Girolamo Pilli, commissar of Livorno, which spoke of the arrival of the engineer Luca del Caprina in this place and of his rapid departure (Gaye 1840, II, p. 54). It is probable that the expert “equal to Sangallo”, warmly recommended by the most authoritative citizens of Florence, was precisely Luca del Caprina from Settignano, who a year later, in 1503, took over from Giuliano da Sangallo (1445–1516) in work on the Verruca fortress and who stayed in Livorno for such a short time that he was not even paid.

Thus the Florentine republic, shaken by rebellion and by the long, ruinous war with Pisa, also provided for the defence of Livorno with the supply of munitions and experts. Between 1502 and 1504 we find master armourer di Giovanni in Livorno with the job of making projectiles, and among the armourers there was also the Norman Hermit, Auni, with a considerable salary of six gold florins a month (Canestrini 1857, XXVIII).

However, the entire Pisa affair absorbed all the Florentine government’s resources and energy, and the Sangallo brothers, Leonardo da Vinci and Luca del Caprina took part as expert military engineers in the service of the state (Borsi 1985, p. 369). But in 1505 Livorno once more found itself in a state of turmoil and chaos, and the stronghold was in very bad condition, neglected and left to itself (Canestrini 1857, pp. 185–186). Pierantonio Carnesecchi was sent to Livorno in great haste to organise repair of the defences. Antonio da Sangallo (1455–1534), who was not at all familiar with the place, arrived a year later, on 20 March 1506. He noted that the models studied in Florence bore absolutely no resemblance to that observed directly on the ground,¹⁰ and so he took 3 days to re-measure everything and make a new drawing. However, it is unthinkable, as Amelio Fara emphasises, that in 1506 Antonio worked independently from his brother Giuliano (Fara 1995, p. 133). Antonio’s design for the Livorno citadel, which to date has not been recovered, was almost certainly also revised by Giuliano. On the other hand, because of the extremely complementary nature of their works, it is difficult to distinguish the individual works of the two architects, even if Giuliano seems to have been the pre-eminent personality.

In 1502 Giuliano was in Arezzo planning the citadel, on which construction began in 1503, but Antonio intervened in the building on 13 June 1505. In 1503 Giuliano was occupied in construction work for the Verruca fortress bastion facing towards Pisa, was then replaced by Luca del Caprina, and in 1504 we find Antonio there. In the same year, the latter was also employed at Castrocaro (Fara 1993, pp. 30–31).

The Florentine wish to build “a useful, honourable work” (Frattarelli Fischer 1995, p. 177) in Livorno in accordance with Antonio da Sangallo the Elder’s plan was not entirely successful. Work on the citadel re-started in 1519 and was completed in 1533 under the rule of Duke Alessandro de’ Medici. Vasari tells us that after the death of Giuliano, Antonio was sent to draw up plans for the Livorno fort, but the project was never fully completed.¹¹ However, Vasari’s information is

¹⁰ “The models he had seen there did not correspond to what he had seen on the site”, (Frattarelli Fischer 1995, p. 180).

¹¹ Vasari says that after the death of Giuliano “having to build the fort in Livorno, Antonio was sent by Cardinal de’ Medici to draw the plans; which he did, even if it was not then entirely executed, nor in the way Antonio had drawn it” (Vasari 1550, IV, p. 288).

faulty and incomplete, since Antonio had already been to Livorno in 1506 and on that occasion had made a drawing “of quality” which he then presented to the Florentine magistrates (Gaye 1840, II, p. 81). In 1519 then, work on the project began again, supported, writes Vasari, by Cardinal Giulio de’ Medici, even if it was not entirely executed according to the plan. Perhaps Vasari refers to the fact that the original rectangular structure with four bastions was not built.

The Livorno citadel is a work stylistically similar to that of Pisa, where Antonio began work in 1509, but in August management of the site was taken over by Giuliano, who drew up the final plans. It is probable, therefore, that as early as 1506 in Livorno, the Sangallo brothers developed and perfected the new idea of a concave retired flank which Giuliano had experimented with in Arezzo some years earlier and which, a few years later, he adapted and built in Pisa. It seems relevant, therefore, that on 4 April 1511, while Giuliano was in Pisa with his brother to oversee work on the citadel and the new fortalice at Porta San Marco, he was sent with all haste to Livorno to repair damage to the port walls caused by the stormy sea (Gaye 1840, II, p. 121).

A succession of different engineers, technicians and experts oversaw the various stages of construction in Livorno. From 1519 these included Antonio Marchisse, Nicolao di Pietrasanta and Baccio Biagio, and from 1526 (the year in which Medici rule was overturned and replaced with an aristocratic republic), Jacopo da Poggibonsi, Goro, Amadio d’Alberto, Giovanni Francesco da Sangallo and Michelangelo. However, from the archives consulted to date, it does not appear that Antonio came back to Livorno.

The original design included a fourth buttress with the vertex jutting out toward the sea in a northeasterly direction. Three monumental bastions were built, but construction of the fourth buttress was decided against because of lack of funds, the unstable political situation, the hygiene and sanitary conditions, and above all because it was not necessary. The *Quadratura dei Pisani*, overlooking the wide expanse of sea to the west/north-west, and with its circular tower converted to a keep, observatory and command post, became the fourth bastion. Furthermore, the side that should have been occupied by the never-built bastion was guarded by the imposing towers of Porto Pisano, which shared lines of sight with the fort’s keep. After all, enemy fleets were not yet able to transport siege weapons, which would also have been difficult to aim at the shore. The fort had everything it needed for defence against attack from the sea, and another bastion would only have increased costs without any defensive benefit.

The weight of medieval tradition played a considerable role in the drawing up of the plans for Livorno. Furthermore, construction of the fort hinged on both economic and defensive needs, so it was logical to repair and modernise the old existing structures and use them. The layout of the Livorno fort was not geometrically regular because of the massive medieval structures it incorporated, its particular position completely surrounded by the sea, and its significant relationship with the urban context.

The fort was built following demolition of a crowded group of houses, the captain’s house, the church of St. Giulia and a stretch of medieval wall, a part of which was swallowed up in the earthworks north of the citadel. An entire piece of

Fig. 5 Fortezza Vecchia, plan of the upper level: A. Rocca Nuova, later called Quadratura dei Pisani, the perimeter incorporates the quadrangular tower **a** and the circular tower **b**, 1, Ampolletta middle bastion. 2, Cavaniglia or Canaviglia west bastion. 3, Capitana north bastion. Image: author, after (Piancastelli Politi Nencini 1995, p. 79)

land disappeared to create the moat and the esplanade, a large area free of obstructions to provide clear lines of fire. As early as 1519 “the foundations were dug” for the Livorno walls, building was begun on the middle bastion, called the captain’s house (later called ‘Ampolletta’), and the long curtain walls were raised to the east on the land side and to the south on the dock side. At the far end of this latter curtain, work began in 1520 on construction of the new seaward bastion, called the ‘catena’ or chain, later called Cavaniglia, and later still Caviniglia, and as the foundations had to be laid directly in the water, wooden formwork was made, not without difficulty. Posts were planted at the far end of the land side curtain wall to raise the landward bastion, called ‘towards Stagno’, and now ‘la Capitana’ (Figs. 5 and 6). In 1523 the essential lines of the two curtain walls and three bastions were completed, and the perimeter appeared similar to that of today. In the same year, work began on excavating the moat (Piancastelli Politi Nencini 1995, pp. 47–53).

Fortezza Vecchia: Dimension and Building Technique Choices

A detailed reading of the Livorno stronghold, known as Fortezza Vecchia, highlights the typicality and the anomalies of its architectural features, and allows a

Fig. 6 Fortezza Vecchia, plan of the subterranean level: 1, Ampolletta bastion, hemispherical dome. 2, Cavaniglia bastion, trapezoidal room. 3, Capitana bastion, dome. 4, central platform, cistern. *a*, south gallery. *b*, north gallery. *c*, entrance. Image: author, after (Piancastelli Politi Nencini 1995, p. 79)

series of relations between dimension choices, urban context and morphology of the site to be established.

In Livorno we find the now fully developed and informed execution of an orillon bastion with concave retired flanks, a single order of loopholes in the casemate and a well-structured system of vents for airing the rooms (Severini 1970, p. 61).

The salient points of the modern bastion are “the lines of fire coming perpendicularly from all the other flanks and the curtain walls” which gave “reciprocal protection to the bastions, and crossfire at the focal point in front of the curtain walls” (Cadorna 1882, pp. 9–10). Nevertheless, the faces, flanks and curtain walls of the three Livorno bastions are not proportioned in accordance with established models; their irregular layout is rather an adaptation to the site. Their shape is not symmetrical with the bisector of the angle of the walls which the bastion was built to defend. The Fortezza Vecchia is not, therefore, completely included in the envelope of defensive flanking lines, as a land-based citadel would be (Fara 1995, p. 132). The Ampolletta, the middle, southeasterly bastion, has an exaggeratedly acute salient angle and the line of defence that starts from the flank of the norther bastion, la Capitana, does not trace its north face. The line of grazing fire of this latter front does not fall perpendicularly on the flank of the opposite bastion, but in proximity of the entranceway adjacent to the retired flank of the Ampolletta. Access to the fort from the walled land was only possible by crossing the 70 cubit

wide moat in a boat pulled with a rope.¹² The anchoring stone is still visible on the Ampolletta bastion orillon. In this stretch the loopholes ensured flanking of the landward curtain, but not reciprocal defence of the fronts. However, such protection “per flank” is sufficient for a construction situated on the sea. Indeed, the artillery of a potential aggressor would only have been able to converge from that side (Fara 1993, p. 31).

On the other hand, the layout of the Capitana bastion with its lengthened fronts, ensures flanking fire. The catena, or Canaviglia, bastion had always presented problems of stability due to the difficulty of laying foundations in the sea and the consequent precariousness of walls above. The layout of the south front is not rectilinear and the wall includes a number of repairs and toothings, testimony to a series of structural interventions. The anomalous perimeter of this face increases the blind spots and does not permit a system of complete flanking.

Next to this, the niche which housed the winch for winding the chain situated at the entrance to the 35 cubit wide harbour is still visible. The contour of the Canaviglia bastion is very wide; the throat, where at least in theory the flanks should intersect with the curtain walls, instead contains the facades of both the quadrangular medieval tower and the contiguous corner of the Quadratura (Fig. 7).

The west flank is connected to the corner of the Quadratura dei Pisani, which functions as the seaward curtain, by a short stretch of wall 16 cubits long. In this section we can observe the inspired grafting of an unusual trapezoidal room, covered by a ribbed vault with an octagonal central ventilation oculus (Fig. 8), that links the concave retired flank with the square tower and the medieval stronghold.

This room, together with the variety of shapes of the interior rooms, represents a text of great interest, in which we can recognize the Sangallo brothers’ research into ancient spatial concepts filtered and mediated by Brunelleschi’s inventions. As with the Pisa citadel, it seems that also in Livorno the need to forgo any ornamentation acted as a stimulus to experiment with a repertory of varied geometric shapes (Severini 1970, p. 58).

The Livorno case is stimulating since once the ideal geometric shape, as deduced from the treatises, was transferred to the site, it was modified and moulded to conform to two local restrictions, the nature of the site and the existing medieval constructions.

Since the site where the fort stands did not allow for rigorous application of geometric matrices, the reference model available to Antonio da Sangallo was incompatible with the nature of the site and he redesigned the defensive perimeter with shapes that complied with its morphology.

In Livorno, the length of the curtain walls in relation to the dimension of the bastions is considerably increased, and is not related to the Sangallo brothers’ prototypes such as Nettuno, Sansepolcro or Pisa, where the curtain walls are approximately 30/35 m long.

¹² “A boat with a hawser that crossed the fort moat”, Bernardino Pagni da Pescia, sent to inspect the forts of the Florentine state, visited the Fortezza Vecchia on 30 August 1543 (Romby 2005, pp. 100–101).

Fig. 7 Cavaniglia bastion, view from the keep, the Quadratura dei Pisani in the foreground, 1950. Image: AFSPI, n. 52901 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

Fig. 8 Cavaniglia bastion, trapezoidal room, covered by a ribbed vault with octagonal central oculus. Image: AFSPI, n. 89656 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

It was towards the mid-fifteenth century, following the increase and unification of calibres, that curtain length tended to become standardised. According to Maggi, the optimal length was 250–300 cubits (Severini 1970, p. 56).

The increased relative distance between the bastions and the increased length of the curtain wall in Livorno, already marked out in 1523, albeit tied to rules set on the basis of the artillery calibre and range, was strictly connected with the particular conformation of the area. The detailed plan drawn up by Giovan Battista Belluzzi shortly before 1547 is useful for verifying some dimensional solutions (Lamberini

Fig. 9 Cavaniglia bastion, detail of base in blocks of Panchina Livornese stone. Image: AFSPi, n. 102838 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

2007, I p. 171). The east curtain is 125 cubits long (about 73 m) while that to the south, along the dock and with front firing cannon-ports, is 132 cubits (77 m), both being in relation to the portion of land fronting them and with the harbour opposite. Then again, the fort relates directly to the surrounding area, particularly to the dock, which measures 242 cubits (about 141 m) and, as can be seen, the perimeter along the side facing the harbour, defined by the sum of the length of the face of the Ampolletta bastion, the curtain wall and the face of the Canaviglia bastion, is also equal to 242 cubits.

The curtain walls, consisting of two-brick thick cavity walls filled with lime and brick rubble mixed with fragments of tufa, were erected on a base of wide, rough-hewn blocks of stone called Panchina Livornese, protruding at least 0.5 cubits (Fig. 9).

A torus moulding in half-round stone (Fig. 10), the only decorative licence admitted to please the eye, accented below by a row of bricks laid edge on, marks the intersection of the sloping surface of the scarp with the start of the vertical parapet.

Alberti went as far as saying that the elegance of mouldings and facings were not suitable for the walls of fortifications (Fara 1993, p. 16), and Belluzzi, while underlining the uselessness of decoration for military architecture, presented numerous types of base and moulding (Lamberini 2007, II, p. 291). The elegant torus mouldings of the Pisa citadel delayed construction and completion of the work, but Giuliano would not forgo his expressive methods (Severini 1970, p. 53; Bevilacqua 2011b, pp. 120–123). In Livorno, however, any decorative superstructure was eliminated, and every element was subordinate to its purely defensive function. The original elevation ratios of Sangallo's citadel have been completely altered by successive super-elevations. The detachment of a section of masonry revealed a rounded upper parapet dating back to the early stages of construction, but

Fig. 10 Detail of half-round stone torus accented below by a row of bricks laid edge on. Image: AFSPI, n. 90797 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

Livorno's rounded brick-clad capstone was not embellished with a sharply jutting sandstone torus moulding as happened in Pisa.

According to the traditions of good practice, the ratio between the height of the parapet and the scarp was 1:2 or 1:3. In Livorno this precept was disregarded with a ratio of 1:4. According to Captain Castriotto, the height of a bastion wall should be 24 ft. from the base to the moulding¹³ and 8 ft. from the latter to the top, in a ratio of one to three.¹⁴ Giovan Battista Belluzzi also reiterates that the height of the scarp should be 14 cubits, while that of the parapet should be from 4 to 5 cubits.¹⁵

In Livorno, the scarp wall is about 10.5 cubits high, so the height of the original parapet, now concealed, was 2.5 cubits, resulting in a fairly low curtain and differing from the theoretical criteria that govern composition ratios.

The inclination of the scarp also appears excessive and contravenes the formal and metric rules that usually dictate an incline of one foot for every five cubits.¹⁶ However, Belluzzi explains that instead of the usual one-fifth per cubit inclination,¹⁷ some prefer a greater inclination and others even none at all.¹⁸ This would explain

¹³ Venetian foot equal to 0.348 m.

¹⁴ "Height from the bottom of the moat to the moulding 24 and 8 ft. from the moulding to the top" (Maggi 1583, I, p. 27r).

¹⁵ "Height of the main exterior curtain wall to the moulding 14 cubits"; "height of the exterior parapet above the moulding to the top 4 cubits in five" (Lamberini 2007, II, p. 290).

¹⁶ "The ordinary scarp given to walls is one foot for every five cubits of height, and this up to the cordon" (Maggi 1583, II, p. 38v).

¹⁷ The measurement equals 117 mm.

¹⁸ "With regard to scarp walls, there are many who want even more scarp than a fifth per cubit, and others want none at all" (Belluzzi 1598: 53v; Lamberini 2007, II, p. 347).

Fig. 11 Ampolletta bastion, detail of retired flank. In the foreground, the anchor stone for the rope for crossing the moat and the stone shelf inserted in the orillon scarp. Image: AFSPi, n. 89672 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

an unusual and completely anomalous expedient included in the interior scarps of the Livorno fort orillons. These are so convex and protruding that to give a wider slewing range to the embrasure set in the retired flank at water level, the inclination of the flank scarp had to be corrected and made less acute by means of a stone shelf inserted in the scarp (Fig. 11).

The brick scarp wall is interrupted by stone inserts set alternately edge on and flat to create a sequence of vertical courses, which also appear on the Pisa citadel, and which in Livorno can even be found on the parapet, although their arrangement is chaotic and discontinuous as a result of heavy-handed interference. This construction method is a modern version of the *opus africanum* (Fig. 12), a Phoenician technique later adopted by the Romans, formed of pillars of alternating vertical and horizontal blocks of stone, filled in with smaller blocks in between. The use of this technique has a number of advantages, a faster building time and better structural behaviour (Sparacio 1999, p. 190).

The resistant pillars bear the vertical load, while the bricks between absorb the transversal strain.

A vertical straight line carved into the stones marks each pillar, and some stones carry a horizontal straight line perpendicular to it. The carved lines acted as checks and guides in the different stages of construction of the brick parapet. So Giuliano in Pisa and later Antonio in Livorno used an ancient technique, perhaps seen by Giuliano in Rome or observed during his visit to Naples, that did not lead to sliding or separation.

Fig. 12 Detail of wall building technique, modern version of the *opus africanum*, detail along the east curtain Image: AFSPI, n. 90060 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

Of particular interest are certain interior rooms of the bastions which feature the herringbone brick pattern, as in the Pisa citadel, confirmation of Brunelleschi's influence on the Sangallo building methods. It is significant that this technique is recorded by Antonio in a paper where he sketched an example of a herringbone spiral vault, and included a short note.¹⁹ The herringbone technique allows vaults to be raised without the enormous expense of wooden scaffolding and giving constructive continuity to the walls (Ragghianti 1977, p. 230).

During reinforcement work on the Capitana, the north bastion, discovery was made of the extrados of the gunpowder magazine's 6.6 m diameter hemispherical dome with central oculus, which revealed the particular system of arranging bricks in a series of alternating diagonal courses. This herringbone technique is not recognisable in the intrados of the dome, which is completely plastered, while the extrados has been reinforced and refilled with earth, and is no longer visible in its present state (Fig. 13).²⁰

In the Ampolletta, the middle bastion, a circular central cavity opens up with niches on the sides and alternate minor cavities. The space, about 8.5 m in diameter, is covered with a hemispherical dome with central oculus, which acts as a ventilation outlet, set at the height of the planking level. Collapse of part of the plaster has revealed the use of the innovative herringbone pattern that we also find in the central compartment of the sixteenth century cistern situated in the central platform, and which we can see in the ribbed vault of the trapezoidal room of the seaward bastion (Fig. 14).

The use of such technique, particularly by the Sangallo brothers on small and medium-sized circular areas, became standard in Florence starting with

¹⁹ "Round vaults in mezzane (bricks) that they build without scaffolding in Florence", Gabinetto Disegni e Stampe degli Uffizi, drawing by Antonio da Sangallo the Elder, 900A.

²⁰ Excavation of the upper platform and discovery of the extrados were photographically documented, the photographs are held by the Soprintendenza di Pisa.

Fig. 13 Capitana bastion, extrados of the dome built with the herringbone technique. Image: AFSPI, n. 133145, n. 133143 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

Brunelleschi's buildings, and spread throughout Tuscany in the Pisa and Arezzo fortifications, and in one of the small Renaissance bastions on the Firenzuola walls (Gurrieri 2011, p. 39).

Livorno's Fortezza Vecchia fits fully into the dynamics of this diffusion, and shows a singular, varied range of examples of self-supporting herringbone vaults and domes.

Concluding Note

The Fortezza Vecchia is a veritable architectural palimpsest, comparable to a parchment where a variety of stories and languages, very often not concordant with each other, can be read. Between 1559 and 1565, Cosimo I de' Medici built a palace for himself, set against and included in the perimeter wall of the Quadratura dei Pisani, where a number of buildings opened onto a central courtyard. Cosimo's palace was connected via an elevated gallery to another building, built on the platform of the seaward bastion, which local tradition erroneously links with the name of Francesco I.²¹

Since the second half of the nineteenth century, the fort has no longer been reinstated as such, and has been used for the most disparate and incongruous

²¹ Recent research places the date of construction after 1627 (Baldini 2012, pp. 183–213).

Fig. 14 Ampolletta bastion, intrados of the hemispherical dome raised with the herringbone technique. Image: AFSPI, n. 89669 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

Fig. 15 Fortezza Vecchia, view after bombing, 1944. Image: AFSPI, n. 120 under authorization of the MIBAC/Soprintendenza di Pisa, register number 15245 of 21 November 2013. Reproduced by permission

purposes—council housing, prison, heavy mineral oil storage and goods warehouse—and suffered long periods of abandonment and total neglect (Piancastelli Politi Nencini [1995](#), p. 78).

The lovely jetty, already eroded by time and neglect, was bombed during World War II (Fig. 15), and then during the post-war reconstruction years was heavily-handedly and indiscriminately demolished.

In June 1946, the Provincial Institute for Reconstruction Works ordered the demolition and removal of 9237.6 cubic metres of rubble from the buildings and the inner courtyards of the Fortezza Vecchia, with transport to authorised dumps.²²

In 1948, Piero Sanpaolesi, head of Pisa's Department for Monuments and Galleries, began "research and survey works to identify the original structures from the superimposed structures", and between 1950 and 1952, once the building complex had been freed of the "useless superstructures", began the necessary, ill-considered and complete "demolition of the precarious walls to isolate the old Fortezza Pisana".²³

Despite the disparate use, destruction, demolition, abandonment and neglect, the Fortezza Vecchia has become a symbol of Livorno, even if mutilated and reduced to a ruin, but perhaps precisely because of this, a more effective witness to a past that no longer exists.

References

- Aristotle, 1957. *Politica*. W. D. Ross, ed. Oxford: Oxford University Press.
- Baldini, Nicoletta. 2012. Per la storia della Fortezza vecchia di Livorno. La palazzina di Francesco I de' Medici in documenti d'archivio fra il XVII ed il XIX secolo. *Nuovi Studi Livornesi* XIX: 183–213.
- Bevilacqua, Marco Giorgio. 2011a. Le mura urbane di Pisa dal XII al XIV secolo. pp. 51–90 in *Le mura di Pisa. Fortificazioni, ammodernamenti e modificazioni dal XII al XIX secolo*, M.G. Bevilacqua, C. Salotti. Pisa: Edizioni ETS.
- Bevilacqua, Marco Giorgio. 2011b. Pisa nel XVI secolo. Le prime fortificazioni a "la moderna". pp. 119–179 in *Le mura di Pisa. Fortificazioni, ammodernamenti e modificazioni dal XII al XIX secolo*, M.G. Bevilacqua, C. Salotti. Pisa: Edizioni ETS.
- Borsi, Stefano. 1985. *Giuliano da Sangallo I disegni di architettura e dell' antico*. Roma: Officina Edizioni.
- Canestrini, Giuseppe. 1857. *Scritti inediti di Niccolò Machiavelli riguardanti la storia e la milizia (1499–1512)*. Florence: Barbèra, Bianchi.
- Cadorna, Raffaele. 1882. *Il Castello di Brolio, studio architettonico-militare*. Torino: Tipografia Vincenzo Bona.
- Fara, Amelio. 1993. *La città da guerra nell'Europa moderna*. Torino: Einaudi.
- Fara, Amelio. 1995. L'architettura militare di Giuliano e Antonio il Vecchio da Sangallo. pp. 126–133 in *La Fortezza Vecchia. Difesa e simbolo della città di Livorno*, G. Piancastelli Politi, ed. Milano: Cassa di Risparmi di Livorno.
- Frattarelli Fischer, Lucia. 1995. Documenti per la storia della Fortezza Vecchia di Livorno. pp. 177–188 in *La Fortezza Vecchia. Difesa e simbolo della città di Livorno*, G. Piancastelli Politi, ed. Milano: Cassa di Risparmi di Livorno.
- Gaye, Giovanni. 1840. Carteggio inedito d'artisti dei secoli XIV–XV–XVI. Tomo II, 1500–1557. Firenze: presso Giuseppe Molini.
- Guicciardini, Francesco. 1971. *Storia d'Italia*. S. Seidel Menchi, ed. Torino: Einaudi.
- Gurrieri, Francesco. 2011. Una cupoletta a "spina-pesce" nel cantiere brunelleschiano di Santa Maria Del Fiore. *Critica d'Arte* 47–48: 30–42.

²² Archivio Generale della Soprintendenza di Pisa, D29-3.

²³ Archivio Generale della Soprintendenza di Pisa, D29-1.

- Lamberini, Daniela. 2007. *Il Sanmarino. Giovan Battista Belluzzi architetto militare e trattatista del Cinquecento*. I–II. Firenze: Leo S. Olschki.
- Leverotti, Franco. 1989. Trasformazioni insediative nel Pisano alla fine del Trecento. *Archeologia medievale* 16: 243–262.
- Magalotti, Lorenzo. 1667. *Saggi di Naturali Esperienze fatte nell'Accademia del Cimento*. Firenze: Giuseppe Cocchini all'Insegna della Stella.
- Maggi, Girolamo. and Castriotto, Iacomo. 1583. *Della fortificatione delle città*. Venezia: Camillo Borgominiero.
- Martini, Francesco di Giorgio. 1967. *Trattati di architettura ingegneria e arte militare*. C. Maltese, ed. Milano: Il Polifilo.
- Materazzi, Silvia. 1995–1996. *I materiali ceramici rinvenuti nella Fortezza Vecchia di Livorno*. M. G. Marzi (tutor). Tesi di Specializzazione in Archeologia: Università degli Studi di Firenze.
- Morolli, Gabriele. 2006. Il ritorno della magnificenza antica. pp. 245–253 in *L'uomo del Rinascimento. Leon Battista Alberti e le arti a Firenze tra ragione e bellezza*, C. Acidini, G. Morolli, eds. Firenze: Mandragora.
- Petrarca, Francesco. 1990. *Itinerario in Terra Santa*. F. Lo Monaco, ed. Bergamo: Lubrina.
- Piancastelli Politi Nencini, Giovanna. 1980. La Fortezza Vecchia. pp.43–58 in *Livorno e Pisa: due città e un territorio nella politica dei Medici. Livorno Progetto e storia di una città tra il 1500 e il 1600*. Pisa: Nistri Lischi e Pacini Editori.
- Piancastelli Politi Nencini, Giovanna. 1995. La Fortezza Vecchia: dalla storia al restauro. pp. 15–124 in *La Fortezza Vecchia. Difesa e simbolo della città di Livorno*, G. Piancastelli Politi, ed. Milano: Cassa di Risparmio di Livorno.
- Pierotti, Piero. 1990. *Una torre da non salvare. Storia di 16 commissioni, 147 commissari, 150 anni di progetti per la torre di Pisa*. Pisa: Pacini Editore.
- Pierotti, Piero. 1995. *Prima di Machiavelli: Filarete e Francesco di Giorgio consiglieri del principe*. Pisa: Pacini Editore.
- Severini, Giancarlo. 1970. *Architetture militari di Giuliano da Sangallo*. Pisa: V. Lischi.
- Severini, Giancarlo. 1994. *Progetto e disegno nei trattati di architettura militare del '500*. Pisa: Pacini Editore.
- Severini, Giancarlo. 2008. Fortificazioni pisane alla fine del Trecento. *Laboratorio Universitario Volterrano Quaderno XI*: 85–96.
- Ragghianti, Carlo Ludovico. 1977. *Filippo Brunelleschi: un uomo un universo*. Firenze: Vallecchi.
- Romby, Giuseppina Carla. 2005. Dentro la Fortezza. “Artiglierie, monizioni, vettovaglie e soldati” nelle fortezze di Cosimo I dei Medici. pp. 95–110 in *L'architettura degli Ingegneri. Fortificazioni in Italia tra '500 e '600*, A. Marino, ed. Roma: Gangemi Editore.
- Sparacio, Renato. 1999. *La scienza e i tempi del costruire*. Torino: UTET.
- Trotta, Giampaolo. 2005. *L'antico Porto Pisano e la Torre del Marzocco a Livorno*. Livorno: Autorità Portuale.
- Vaccari, Olimpia. 2009. Livorno, Un castello marittimo della repubblica pisana. pp. 47–81 in *Castelli e fortificazioni della Repubblica Pisana*, M.L. Ceccarelli Lemut, M. Dringoli, eds. Ospedaletto (Pisa): Pacini Editore.
- Vasari, Giorgio. 1550. *Le vite de' più eccellenti architetti, pittori, et scultori italiani, da Cimabue insino a' tempi nostri*. Firenze: Lorenzo Torrentino.
- Vigo, Pietro. 1913. Le difficoltà nella costruzione della “Quadratura dei Pisani” a Livorno. *Bullettino Storico d'Arte e di Storia I*: 12–16.

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