Labyrinth as passive defense system: an analysis of Renaissance treatise of Francesco di Giorgio Martini

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Abstract

The labyrinth enriching Francesco De Marchi's treatise on fortification, which could be interpreted as just a generic and decorative symbol of protection useful to illustrate the contents and aims of the treatise, in reality also refers to a widespread design tradition in the construction of fortresses. This figure embodies an architectural device of opacity and deceiving that can be found in the design of the meandering doors, in the arrangement of the rooms and doors of ravelins and casemates and even in the more general conception of a fortress. Its use as a passive defense system is testified both by buildings in Syria and Spain, and by 15th-century treatises, such as Francesco di Giorgio Martini's, whose *capannato* in particular is here analyzed and redrawn to evaluate the role of labyrinth in the general concept.

Keywords: Labyrinth, Maze, Passive Defense, Circulation Analysis.

1. Introduction

"A labyrinth is a structure compounded to confuse men; its architecture, rich in symmetry, is subordinated to that end. In the palace I imperfectly explored, the architecture lacked any such finality. It abounded in dead-end corridors, high unattainable windows, portentous doors which led to a cell or pit...."

Jorge Luis Borges, *The immortal*

In the introduction of the Second Book to his famous treatise *Della architettura militare*, posthumously published in 1599, the "Bolognese military architect, adventurer, and courtier" (Morgan, 2016: p. 403) Francesco De Marchi (1504-1576) evoked the four labyrinths of antiquity described by Pliny as examples of "*costruzione miracolosa*" e "*ingegnosissima*" (De Marchi, 1599: p. 27). This reference is no occasional. Ciasca (1911) and, more recently, Omodeo (1964) have underlined the existence of at least an edition of his treatise showing also two engravings of labyrinths. One of them shows a complex labyrinth that recalls the plan of a fortress with four square towers and a central circular one (Fig. 1). To get to the center, one has to go through all of peripheral towers.

De Marchi had already provided the Duke of Parma with five designs of vegetal labyrinths for the garden of his Palazzo della Fontana in 1566, when he was in the Lower Countries. This is testified by Smeraldo Smeraldi's plan of Parma of 1592 (Bertini, 2010) – the relationships with the Dutch artistic circles, and in particular Vredeman de Vries' labyrinths (Colonnese, 2018) which is yet to be fully enquired (Morgan, 2016).

Anyway, interpreting De Marchi's figure either as a simple decoration or a symbol of protection useful to illustrate his manifold architectural interests would be rather limited for the labyrinth mainly refers to a widespread design tradition in the construction of fortresses.

2. The opacity of the labyrinth

A common requirement for fortifications architects of different ages and places is to find a way to make two seemingly opposite principles compatible such as opacity and transparency. The architect is asked to imagine a structure able
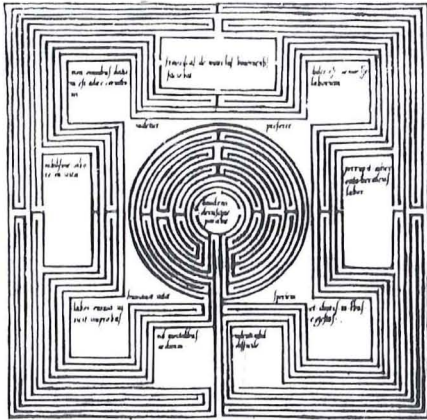
Fig. 1- F. De Marchi, Labyrinth (Omodeo, 1964)

Fig. 2- Sketched plan of Gate Block to Citadel, Aleppo, (Courtesy of G. Michel, 2010)

to provide as much transparency and visibility as possible to those who live inside it, who have to control the surrounding territory; at the same time, the architect is required to present as much opacity and resistance as possible to those who want to dedicate themselves to its conquest - not too different from the perfect fortress imagined and described by Italo Calvino (1967).

The fortress architecture, through the geometry and the arrangement of the part, can constitute not only the infrastructure of the urban defensive system but also a very effective form of passive defense. This includes the provision of either several fortified gates along the ascent path to the *rocca*, as in the Hochosterwitz castle in Austria (Koolhaas et al, 2014: pp. 542-557) or multiple concentric walls, up to the hypertrophic development of the Citadel of Antwerp ironically described by Sebald (2002: pp. 22-25). The design of the entrance gate and interior rooms of the fortress is also part of this subject: in particular the layout of the doors and slots can be inspired to the figure of labyrinth, in order to favor the movement of the defenders and, at the same time, to disadvantage that of the invaders.

The description of an hypothetical army attacking the entrance block to Aleppo's Citadel (Fig. 2), built under the Kurd Governor Al-Ẓāhir Ghāzī from 1186 to 1216, can clarify this concept:

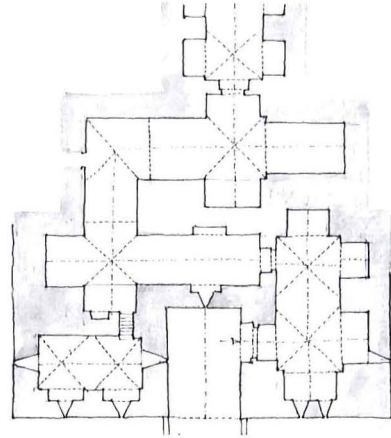"An imagined army would first have to pass through the gate at the head of the bridge and ascend a bridge with large steps, being exposed to arrows from right and left. Reaching the entrance block, the army would have to turn right and attempt to break through the first Gate of the Serpents, while standing under the hot liquids being poured from the machicoulated brattices above. Having succeeded in taking the gate, the attackers would then have to turn left into a large hall … whose single access to the citadel is blocked by another iron door. Breaking through the second door, the soldiers would find themselves in a vast U-shaped hall in which they must once again change their direction three times. At the end of this hall, and on the same axis as the external ramp, stands the third and last defended gate, that of the lions, with its many gates and tunnels" (Tabbaa, 1997: pp. 75-76).

The figure of the labyrinth (Colonnese, 2006) embodies an architectural device of opacity and deceiving that can be found in the design of the meandering doors, in the arrangement of the rooms and doors of ravelins and casemates and even in the more general conception of a fortress. Both the maze and the labyrinth, its archaic and unicursal version, can provide a principle of passive defense able to slow down the enemy's rush, to dissipate his impetus, to expand his route to the core, to disorientate him, to lead him exactly where he did not want to go, "lost, unable to retrace his footsteps, fatally vulnerable and spatially exposed" (Manaugh, 2010), also through the slits opened along it.
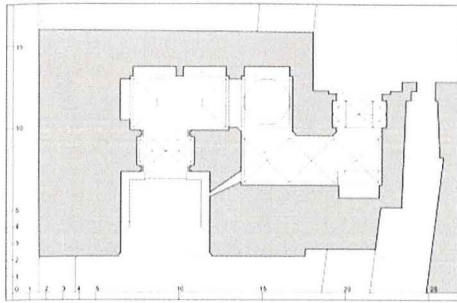
Fig. 3- Plan of Gate of Justice, Alhambra, Granada (F. Colonnese)

Something like this can be experienced in the access gates to the Alhambra of Granada. In particular, the monumental Puerta de la Justicia (Fig. 3) was built in 1348 according to a meandering plan that completely disregards the expectations created by the external façade and the door: once created to disorientate the possible assaulter, today it performs equally effectively a purely aesthetic task, filtering the passage from the lower city and hiding the delights of the Arab citadel until the very end. Anyway, other important traces of the labyrinth as a defensive principle, even beyond the topos of the fortified gate (Hilliges, 2017: pp. 108-110), are also found in the early Renaissance treatises.

3. Giovanni Fontana

In the Early Modern, the labyrinth and the architecture of the fortresses are associated in the texts of the polyhedral Giovanni Fontana, Rector Artistarum of the University of Padua in 1421. "the notion of a mathematical or artificial magic rose from the ancient art of natural magic, embodied in such things as prayers and talismans, to the complex optical, hydraulic and mechanical devices" (Grafton, 2002: p. 7), Fontana was a sort of engineer who, between 1420 and 1440, wrote the *Bellicorum Instrumentorum Liber* (Fontana, 1420-40). Among the many inventions drawn and described in the encrypted manuscript, some are specifically addressed to defense issues, such as "the castle of deception", "the building for an automatic defense", "the unstoppable tower" and "the ingenious prison", according to the

definitions elaborated by Battisti and Saccaro (1995). Although his treatise *De Laberintis libellus* was lost, two of his labyrinths survived on the sheet 5 of the Codex. The words that accompany them reveal their ancestry from both Pliny and Isidore the Seville's descriptions. Yet the two labyrinths - one circular and one square - (Fig. 4) are extraordinarily innovative for the 15th century.
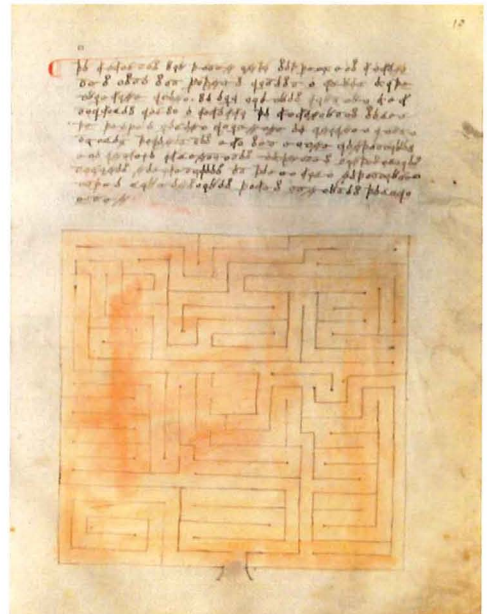

Fig. 4- G. Fontana, Laberinto (Fontana 1420-40)

The former shows an organization of the route that disregards the usual perpendicular axis structuring; the latter, which looks even more chaotic, presents numerous crossings, featuring it as one of the first maze known to scholars, outside the class of the classical one-way labyrinths. These drawings are not to refer to the gardens, as proposed by Hermann Kern (2000: p. 199) but rather to the labyrinth's function as protection and imprisonment. For example, in the circular one the barriers are staggered. This detail, when compared to the iconography Fontana could know, can be assumed as a demonstration that the labyrinth is no longer only a polysemy symbol for its geometry, elegance and symmetry, but rather a scheme adaptable to actual buildings. The square

labyrinth, moreover, highlights the presence of the 24x24 square grid that Fontana used to draw it, indirectly suggesting the possibility of infinite variations starting. They are therefore stratagems and geometrical principles proposed to those who deal with fortifications and prisons in the XVI century.

4. Francesco di Giorgio Martini

Architectural examples of labyrinth application to fortifications properly emerge from Francesco di Giorgio Martini's treatise. The manuscript preserved in Florence (Fiore & Tafuri, 1994: pp. 386-388), which has been extensively enquired by scholars, presents a large number of drawings. They were designed for an illustrated print edition and provide much information on the conceiving and representing architecture at that time. It is interesting to note that, unlike the examples of civil architecture, military architectures are mainly presented with three-dimensional drawings: at least 82 are counted – generally a prefiguration of that *prospettiva soldatesca* (Maggi & Castriotto, 1564, II: p. 43) that is to be largely adopted in following treatises (Scolari, 1984) – compared to only 19 plans. In addition, while the plans of civil and sacred buildings are represented in the form of a diagram, as a simple structural scheme with the walls indicated by a single continuous line interrupted near the doors and windows, the plans of fortresses are true *icnographic* drawings intended as a combination of section and projection on the horizontal plane. For example, by observing the plan in the sheet 55 (Fig. 5) illustrating portions of polygonal fortresses, it is clear that these are no longer diagrams. The relationship between the thickness of walls and the size of rooms is close to reality or at least *verosimile*.

The drawing reveals that Martini intended not only to provide constructive information about the building but also to remark some peculiar features of a fortress plan. In opposition to the envisioning canon, the oblique-line hatch is not used to fill the sectioned parts with but rather the connections between the single rooms, the true focus of this drawing. Excluding the walkways, which are represented as stairs connecting rooms
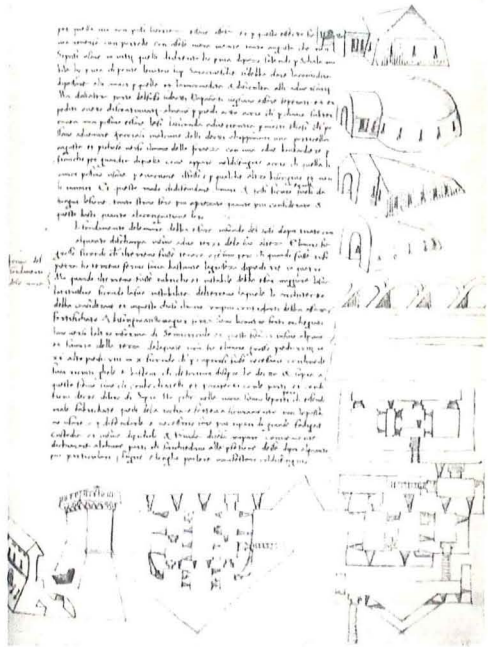

Fig. 5- F.di Giorgio Martini, sheet 55 from *Trattato* (Martini, 1967)

at different heights, Martini used hatch to highlight either the doors, to which corresponds a sort of T-shaped symbol; or the arrow-slits, to which corresponds a V-shaped symbol. The doors always open in the direction of the widest part of the T, that is on the side of the defenders. The slits are designed to be used by the widest part of the V, allowing the defenders sometimes to enter the small niche to better point crossbows or guns towards the enemy. In some cases, the slots of the loopholes are not simple pyramid-shaped trunks with a rectangular base but they are enlarged and deformed in order to provide the defenders a greater mobility.

4.1 The *capannato* or *casamatta*

The idea of labyrinth is not mentioned directly but it emerges clearly in Book V, Chapter 10, where Francesco di Giorgio Martini (1967: p. 439) introduced, among the forms of reduced and economic fortifications, the so-called *capannato*. The *capannato* or *casamatta* is a sort of low bomb-proof construction with strategically located guns, which had to be
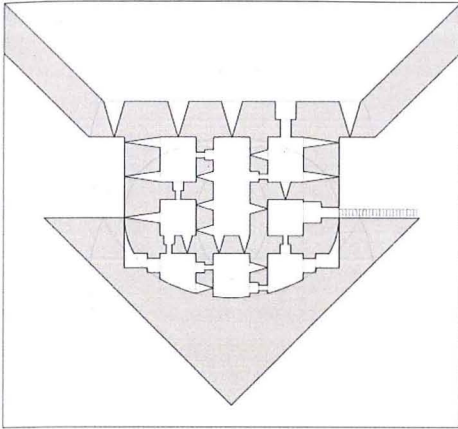
Fig. 6- Redrawing of plan from sheet 55 (F. Colonnese)

Fig. 7- Nine steps of attackers' way into the *capannato* from sheet 55 (F. Colonnese)

placed at the corners of the fortress and connected to it with underground passageways. After stating the general principle that "si debba dare la comodità di passare alli amici e l'incomodità e difficultà alli inemici" (Martini, 1967: p. 440), he describes the eight principles that the construction of a door is expected to follow:

"Prima, dico adunque si debbano fare le porti in quella parte della fortezza che manco può essere da bombarde offesa, e con questo abbi più libera e sicura uscita e entrata per quelli dentro che si può; secondo , che innanzi ad essa sia un rivellino, nel modo dichiarato; terzo, che la porta non sia semplice, cioè che sieno più entrate e più porti, secondo la possibilità *di chi edifica*, prima che alla principale ed ultima intrata della fortezza si pervenga; quarto, che nissuna porta sia incontro all'altra; quinto, che la prima entrata non sia mai perfaccia volta verso la campagna, ma per fianco; sesto, che ogni porta abbia le offese e difese per fianco, più che è possibile; settimo, che l'entrata della porta sia sempre sepulta e bassa, sicché andando a quella sempre si scenda, et uscendo si sagli; ottavo, che la porta sia bassa e stretta, salva la debita proporzione, acciocchè manco sia offesa di fuori, e di minore guardia e *così* di maggior fortezza *sia*" (Martini, 1967: p. 441).

The drawing below the text (Fig. 6) confirms the principle expressed in words. The doors are not aligned along an axis but shifted and arranged on the neighboring sides of the rooms. They are
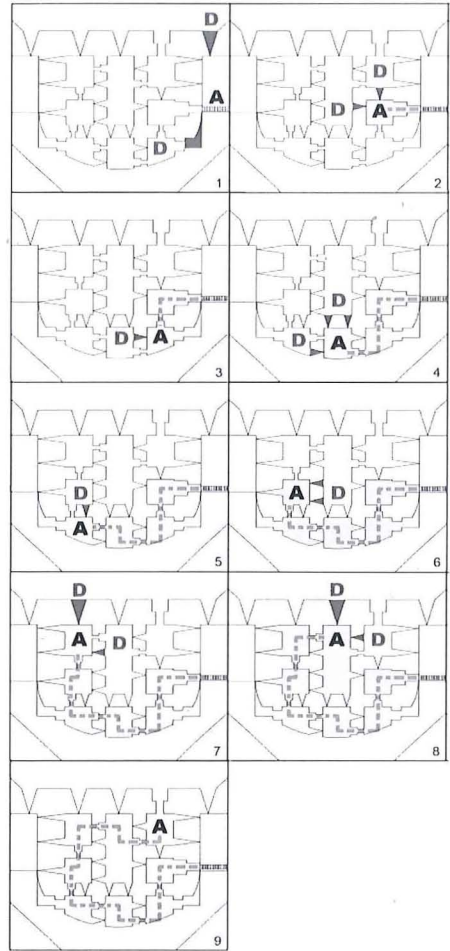
thus designed to force the attackers both to separate from their comrades and to continuously change their direction, increasing their confusion. Meanwhile the defenders always occupy the rooms ahead of them, in order to block the door from the side of the hinges and to exploit the loopholes systematically oriented towards the room where the attackers are.

Just before the door is knocked down, the defenders move back into the next room and wait for the attackers to come in, ready to hit them through the loopholes as soon as they enter. The arrangement of the doors and the orientation of slits thus identifies the obligatory sequence that awaits the aggressors (Fig. 7).
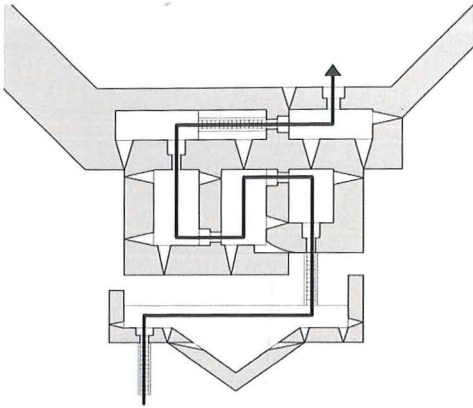
Fig. 8- Redrawing of plan from sheet 55 with the internal route in black (F. Colonnese)

Martini's aim is to oppose opacity and closures to the gaze and impetus of the assailants. For example, in the plan reconstructed in fig. 8, they are forced to go through 6 rooms, 7 doors, changing direction 8 times and being targeted by darts through 9 different loopholes. The three wooden ramps or stairs can also contribute to keep the destination hidden.

The labyrinthine principle is not applied only to the *capannato* but also to other typologies of defensive system. Occasionally, some rooms are excluded from the route and designed exclusively to house the defenders, like in the diagram in the sheet 55; in other cases, like in the fortress in the sheet 74, Martini (1967, plate 285) increases the length and complexity of the corridors by designing them as a zigzagging line that increases the number of edges and ravines useful to surprise the assailants. More often, attackers are required to cross all the rooms, like a real one-way labyrinth.

The fortress in the verso of sheet 63 (Martini, 1967, plate 264), envisioned by a rare combination of plan and perspective at human eye's height, shows a doubly symmetrical cross setting. An axis is concluded by two mighty triangular bastions while the other is composed of two low linear bodies concluded with minor bastions. The internal disposition confirms such a Janus-faced organization, with the rooms ordered in two labyrinthine sequences that,

unlike what would seem at first glance, are not connected to each other. This stratagem was expected to assure that, although one of the defending bodies had fallen, the attackers would end their run in a *cul-de-sac* and would not penetrate the other body, which could have kept on its defensive work. The same precaution rules the diagonal-symmetrical fortress in the sheet 71 (Martini, 1967, plate 280), in which the interlocking of the two labyrinthine systems developed on a regular grid is even more ambiguous (Fig. 9).
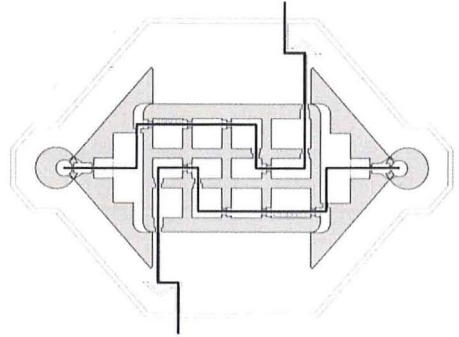

Fig. 9- Redrawing of plan from sheet 71 with the internal routes in black (F. Colonnese)

5. Considerations

The presence of labyrinthine schemes in the 16th fortresses either built or designed on treatises is largely yet to be enquired. Francesco di Giorgio Martini's works and designs directly influenced both Leonardo da Vinci (Di Bernardino, 2017), who had the opportunity to study his treatise and whose manuscripts show several schemes of meandering fortifications – even with the same graphic marks – and the compatriot Baldassarre Peruzzi, who configured the entry system with *angiporto* for the Rocca Sinibalda as a meander, as evidenced by the plan in the recto of sheet 555 at the Uffizi (Ongaretto, 1988).

Martini surely contributed to give the fortress design process a sort of mathematical framework. This is particular evident in the arrangement of both rooms and walls according to grid. Through a simplification of "the rules of the game", Martini indirectly demonstrates that the core plan of a complex fortress could be

conceived as a sort of ideal chessboard on a reticulated sheet. The plan of the *capannato* is thus organized into a network of quadrangular rooms linked together by two types of perceptive and spatial one-directional operators: the slits and two doors – one entrance and one exit – that are expected to be not aligned on the same axis. In general terms, it refers also to the problem of the tessellation of the plane with single (*monomini*) or combined squares (*domini*). In practical terms, the route produces a trajectory that, not surprisingly, can recall the space-filling curve that Giuseppe Peano conceived in the 1890 for covering of a square and, in particular, the graphic iterations built by David Hilbert (1891) to illustrate how it works (Fig. 10).
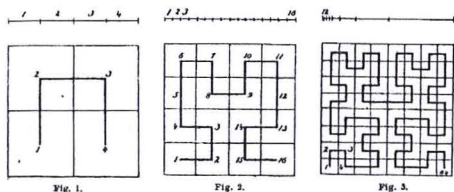

Fig. 10- D. Hilbert's diagrams illustrating Peano's Curve (Hilbert, 1891)

The idea of labyrinth could have contributed to this result. In particular, the Middle-Age floor labyrinths existing in many European churches had been designed on square grids and quite the same was happening with the vegetal labyrinths in the XV and XVI century gardens, as also testified by the surviving labyrinths designed by Fontana. Thus, between the end of the 15th and the beginning of the 16th century, in a transitional period marked by the search for technical solutions that would guarantee an adaptation of the defenses to the new conditions of the war (Marconi, 1988: p. 28), the labyrinthine system of rooms was still considered as a valid passive defense principle and was declined according to mathematical parameters common to the design of church and garden labyrinths. Girolamo Castriotto and Giacomo Fusto Maggi (1568), authors of one of the most famous 16th century treatises, still indicated the geometric complexification as a self-protection solution for fortified cities. Besides heavy walls, inner citadels, or armed bastions, they proposed an "indirect" or "soft fortification" (Lewis & Lambert, 1992) through the use of a complex street plan, with "indirect streets and narrow walkways … as agents of spatial disorientation, leading an invader everywhere but where they actually wanted to go" (Manaugh, 2010).

In conclusion, the labyrinth drawn by Francesco De Marchi seems to constitute both a sort of revealing clue and an allegorical seal of an idea that since the Middle Ages had inspired also the designing of structures and spatial devices of passive defense but that at the end of the 16th is likely to have exhausted its agency: obliterated by the new centrality of the ramparts and the complex geometries of the "alla moderna" fortifications, the labyrinth kept on influencing ludic, decorative and symbolic applications.

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