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Publication date:
2015

Permanent link:
https://doi.org/10.3929/ethz-a-010577882

Circulation Patterns and the Transformation of a Historic Hospital in the Time Perspective of OB

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ABSTRACT. Hospitals are complex buildings that are never finished. They undergo continuous transformations throughout their lifetime. In this scenario the design of the flows and pathways (people and logistics) within the hospital is of great importance in the performance of built environments concerning accessibility to care and efficiency in the delivery of care. The network of flows is in turn linked to needs conditioned by technological developments and health requirements.

Given the concept of base building and fit-out systems tested in the INO project, this paper aims to address the notion of 'open building' in healthcare buildings studying the relationship between the network of flows and, base building systems.

This topic has been developed analysing the empirical case study of Santa Maria Nuova Hospital, which, since the year of its foundation (1288), has never stopped being a hospital. It has undergone several renovation projects over the past six centuries and is now undergoing the final redevelopment process.

The paper focuses on certain aspects: What building modifications were necessary to accomplish a change of use in the hospital over time? How circulation patterns evolve throughout the time? Which spatial elements of the original structure allowed for modifications to the architecture and for the circulation to evolve from ring and linear patterns to an integrated network?

Through a description of five plans of the hospital we highlight how the spatial elements (cloister and nave) and changes in technical, social, political, and medical practices influenced these patterns.

Thanks to this historical analysis the paper contributes to detect the OB matrix not just as physical invariant but also as pattern of occupation of space (intelligibility) supported by cloister and nave presence.

KEYWORDS: hospitals, circulation pattern, support, transformation, intelligibility

1 Circulation patterns over time

Santa Maria Nuova hospital is one of the most important hospitals in Florence. It was built in the historic centre of Florence and can be proud of a long development history, starting from its foundation (1288) up until today. Below, we will recount the history of the Santa Maria Nuova building through a description of the principal transformations the hospital underwent over time in an attempt to interpret the major causes underlying this process of change: hospital set-up, the evolution of medical procedures, political causes or natural events. This description will be summarized in five plans where some diagrams show the circulation patterns and represent their evolution over time.

1.1 1288-1500 The foundation

Santa Maria Nuova hospital was founded in 1288 by one of the most important merchants in Florence, Folco Portinari. It was built, in response to the population growth, to take care of the poor and the sick and to give them spiritual support. It was constructed at the limit of the last wall surrounding the city. In this way patients could benefit from the healthy environment and the inhabitants of Florence were not bothered by the bad smells coming from the hospital (Lucarella 1986). The hospital was situated on the north side of a square in an area close to the Church of Sant'Egidio and a small convent next to it. The original structure of the hospital was

a nave, and it was probably built in the same place where the future men's ward would be located (Pampaloni 1961) (Fig. 1).

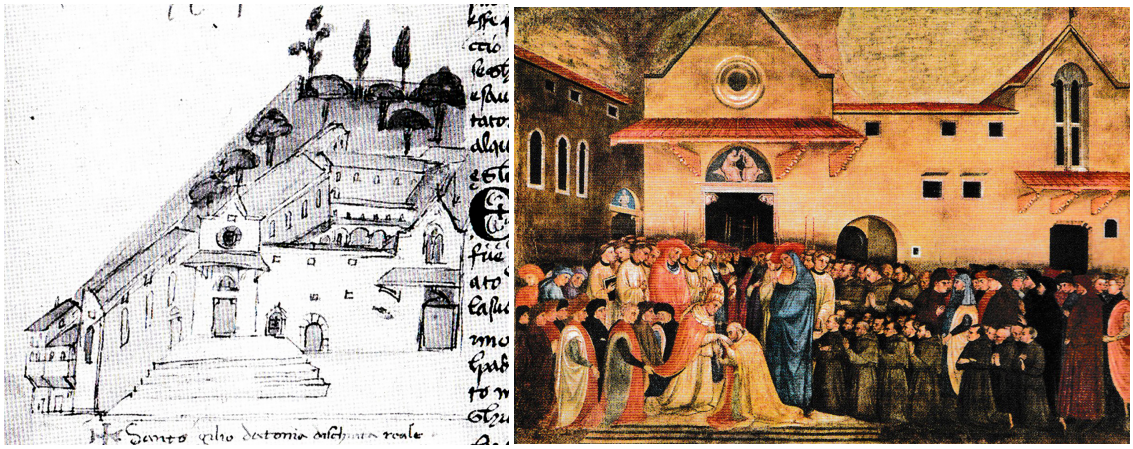


Fig. 1. The original core of the hospital in the 1400. On the left: Drawing of Codice dei Rustici. On the right: Fresco of Bicci di Lorenzo

Due to the growing number of people in need, the hospital very quickly became too small to take care of all the people. Thanks to donations from private citizens of Florence and the Portinari family, very soon the small convent was acquired (1296) and it was possible to build a new men's ward – the first part of the cross shape – , a cemetery, a sewer and a furnace (1315). Not long after, the new hospital ward was enlarged by another perpendicular block that represented the right wing of the cross shape (1341). Finally, at the end of the 1300s the Samaritana cloister and a new dormitory were built (1395).

The women's hospital was built in 1348 on the other side of the square, in a nave on the western side of the Oblate convent (Fig. 2). The name "Oblate" means the nuns that take care of patients. In the subsequent years the hospital, thanks to donations and inheritance, started a business activity that led the hospital to acquire a vast amount of real estate in Florence (Diana 2005). At the end of the 1300s there were 62 beds in the men's hospital and 58 beds in the women's hospital (moreover one bed accommodated three to four people).

In this period the hospital had two wards (men's and women's hospital); services areas, built around the courtyards, where artisans and clergymen worked; and public and common spaces such as the church. In the hospital there was also a "spezieria" (pharmacy and laboratory), a kitchen, a storage room, a caretaker's house and some dormitories on the first floor for the hospital staff and clergymen.

The expansion of hospitals at the end of 1300 all over Europe was characterized by some common traits: a loggia (not present in Santa Maria Nuova); a main entrance from a large square; a cloister, behind the façade; and separated wards between men and women (Henderson 1997).

During the 1400s the church was enlarged; the Medicherie and Ossa cloisters and the other areas around the church were built (1418-22); the longitudinal section of the cross-shape was extended on the north side and a new wing, similar to the one on the right, was built on the left (1479) (Fig.2). At the end of the 1400s the hospital had a symmetrical and balanced cross-shape, which was to be an example and an architectural model for all the hospitals built during the Renaissance (Fig.3). The cross-shaped wards were wide open spaces that facilitated circulation, aligning the beds against the walls. At the head of the cross shape, or at the interception of the two perpendicular limbs, there was usually a chapel or an altar.

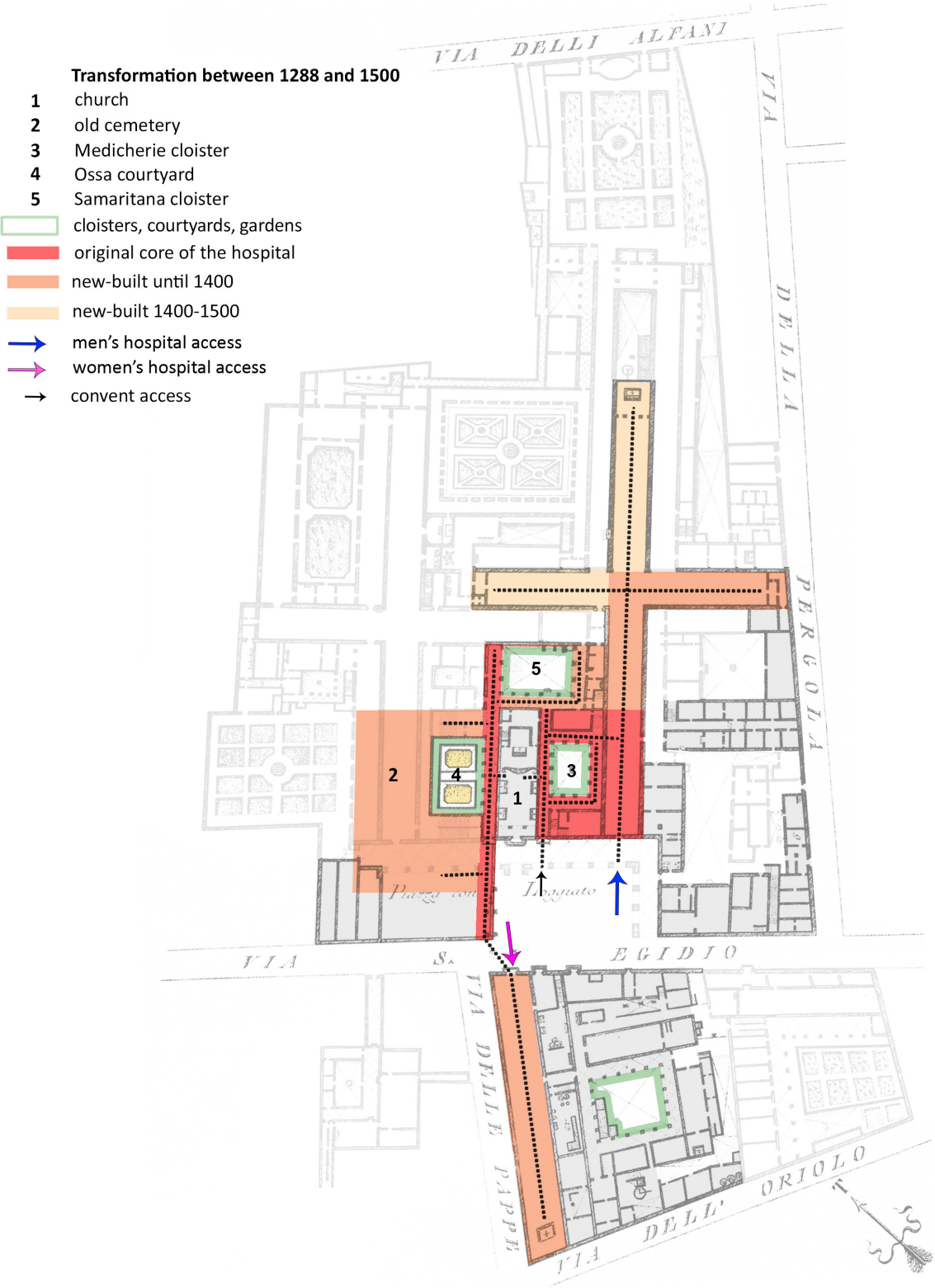


Fig. 2. Recreation of the hospital foundation and the development phases between 1288 and 1500. The old cemetery (number 2) is approximately represented because of lack of documents.

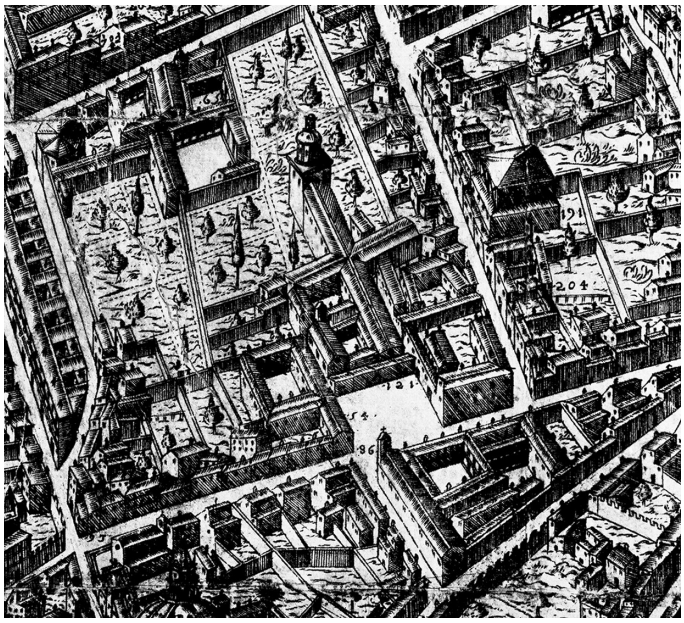


Fig. 3. Drawing of Florence in 1585 with the cross-shape hospital near the Church

1.2 1500-1700 Era of the grand duchy and great expansion

Between the 1400s and the 1500s the role of the hospital changed. At first, the hospital had a social service role (taking care of the poor and the sick). In the Renaissance it specialized in healthcare, becoming one of the most important centres of medical research in Europe for anatomical-pathological research and surgery training. After several plague epidemics "healthcare" became fundamental in political policy: for the first time public and individual healthcare and hygiene was brought to the fore (Mazzi, 2004). It is also important to consider that the principal reason to go to hospital was poverty, as the hospital for the poor meant survival. In the 16th century the hospital accommodated more than 1000 patients. As a consequence the needs and requirements changed and the hospital was not big enough.

During the Grand Duchy of Francesco De' Medici some of the most important transformations to develop in the 1600s were initiated: an underground passage was built to link the women's hospital to the men's hospital; Bernardo Buontalenti completed the north ward of the cross shape by building the Sacramento Chapel (1575); the first part of Buontalenti's loggia was built (1619) overlooking the square to provide access to the church and the men's hospital (Fig.4). This last construction was very important as the loggia gave a new face to the complex, representing an interesting signal of urban renewal. This celebrative image started the complete renovation of the hospital through a series of transformations involving outpatient care, medical staff training and scientific research.

With the expansion of the men's hospital the cross shape was transformed: three parallel wards were built on the north side of the hospital to gain space and to distinguish patients according to their different pathologies. Finally, this expansion offered the possibility of installing single iron beds, and the three-four person beds, which were the main cause of high mortality in the hospital, were disposed of.

The construction of the new women's hospital (1660) can be considered the most important expansion during this period, offering single beds for female patients too. It was built in a cruciform shape, similar to the men's hospital. The old cemetery was demolished and a new one was built between the two longitudinal wings of the two hospitals. The construction of the new women's wards offered the possibility of redesigning the square: the left part of the Buontalenti loggia was built and some buildings to the left of the complex were demolished.

To provide the offices, library and accommodations on the first floor with a suitable entrance, large staircases were built on the north side of the Ossa cloister. This obstructed the passage between the Ossa cloister and the Samaritana cloister. To recreate a connection the refectory was reduced and a new passageway was built to link the Medicherie and Samaritana cloisters.

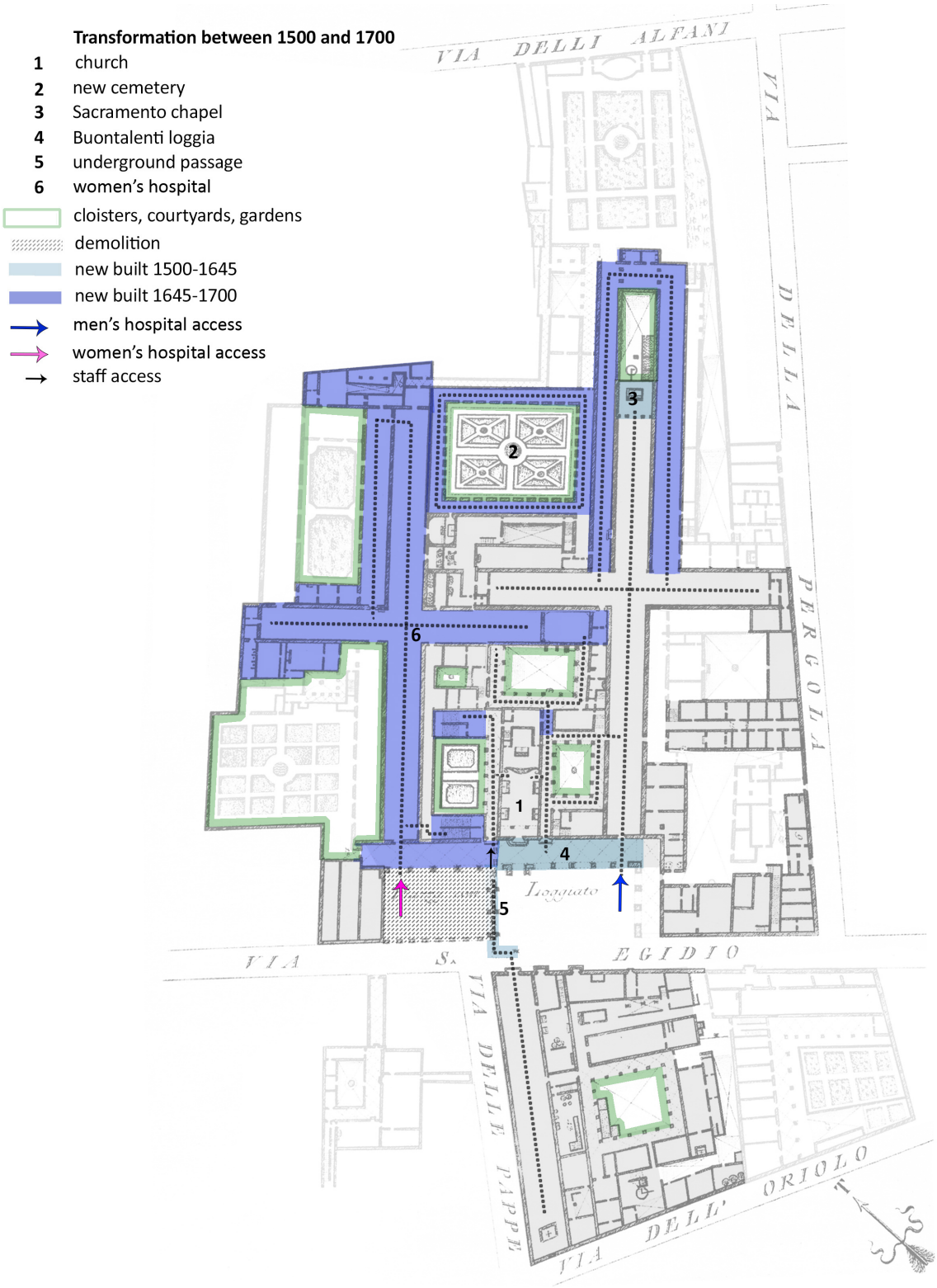


Fig. 4. Expansion of the Santa Maria Nuova Hospital between 1500 and 1700

At the beginning of the 1700s the hospital had a well-defined structure: a loggia, which represented a filter between the public square and the healthcare spaces; two large cross-shaped wards (men's hospital and women's hospital), which were not directly connected; cloisters and courtyards; and numerous spaces for support services built around the other areas of the complex.

1.3 1700-1900: Transformation towards "modernity"

1.3.1 From 1700 to 1870

The hospital realized that the mere internal reorganization of its equipment was not enough, but rather the spaces had to be extended to make them more suitable for patients with different diseases. At the turn of the nineteenth century (1800s) a series of expansions, additions and intricate paths were constructed that are still preserved in the hospital today. Even in earlier times there was specialized differentiation in how the sick were grouped, but from this time on the various diseases were defined in more detail and therefore required special environments (Diana, 2012).

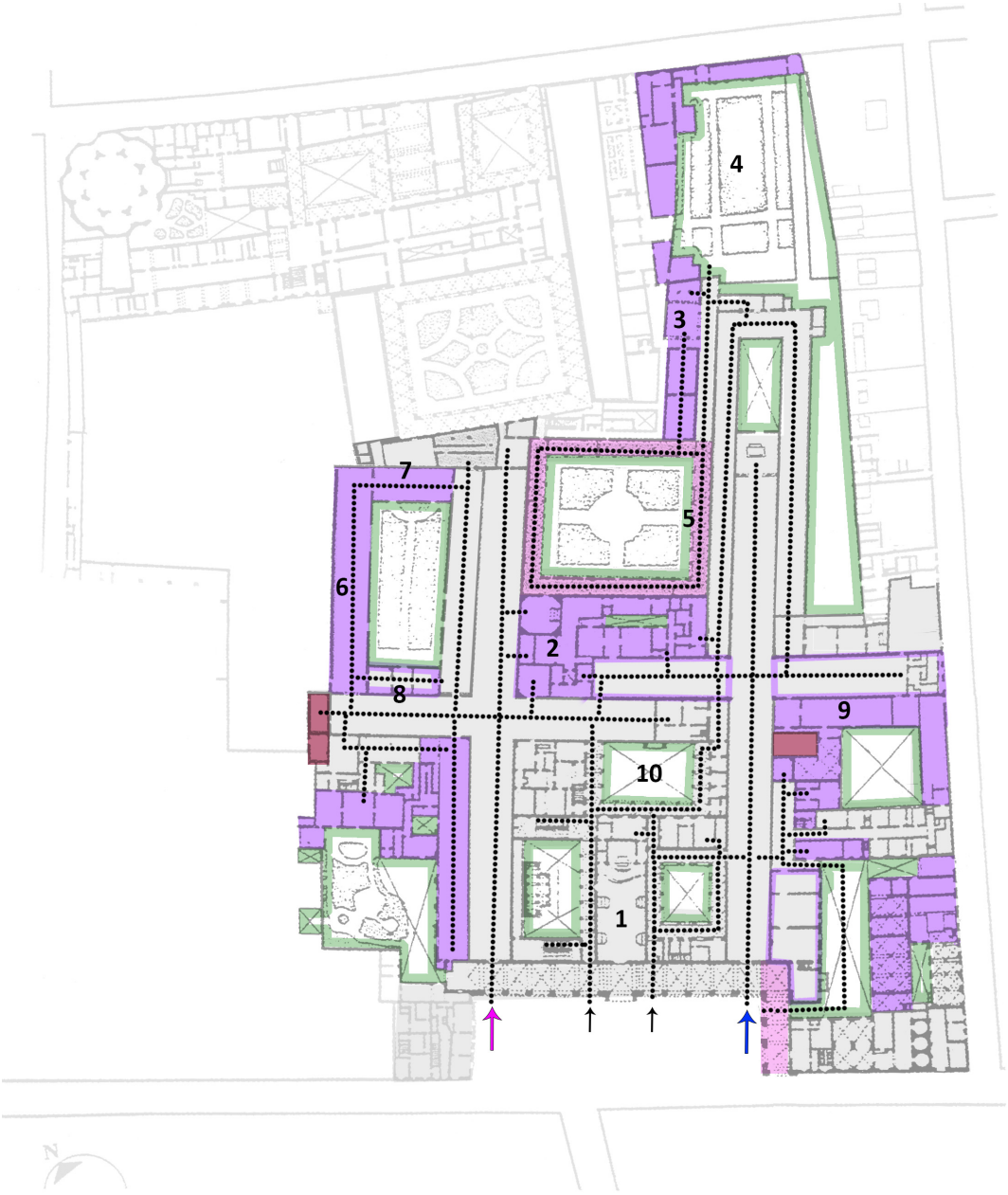
A significant extension concerned the closure of the loggia of the cemetery which became a ward for ophthalmic and contagious female patients. Then both the men's and women's surgical sections were established: the Angeli ward (with an operating room) and the Rotone ward in the female area were built from scratch; surgical examination rooms for women were also created, which mirrored the Rotone ward. The men's hospital was instead expanded in height with the construction of a ward on the first floor and the quadrilateral surgery.

There were also some changes to the services: the creation of two bathrooms (the first breakthrough that testifies to the growing attention to hygiene) and the centralization of the kitchens in the area straddling the two cross-shaped wards (Fig. 5). The bathrooms were equipped with a supply of hot water and stone basins where patients could wash, instead of a tub that was passed from bed to bed and gradually refilled.

This period witnessed an economic crisis, an increase in hospitalization due to epidemics, and large-scale admissions of French and Austrian soldiers due to the presence of Napoleon in Italy. Cuts were made to the management: there was less food and it was of poor quality, sheet changes were reduced, the washing of wool mattresses was prohibited, and staff numbers were reduced (Diana 2012).

At the beginning of the nineteenth century the hospital started to be considered old. In Florence there were big plans for that area and the urban fabric, and the hospital had too many problems: it was a place of contamination, which gave off a stench, there was a constant coming and going of carts carrying the sick or dead, and the poor filled the portico asking for help. The idea of removing patients from ordinary life arose and the sick were considered outcasts by the new bourgeois society.

The Samaritana cloister acted as a connection for circulation between the two crosses which were not directly linked. Some services were centralized for men and women and were located in the area close to the cloister. The two cruciform wards still served as axes of movement between the various areas of the hospital (the only access to the pharmacy was from the men's ward), as well as fulfilling their hospitalization function (Fig. 5).



Transformation between 1700 and 1870

1	church
2	services (kitchen and restroom)
3	surgery School and student services
4	Stufa garden
5	ophtalmic and infections wards
6	Angeli ward
7	Rotone ward
8	women's surgery examination
9	men's surgery (first floor)
10	Samaritana cloister

cloisters, courtyards, gardens
new built 1700-1870
refurbishment/rehabilitation
men's hospital access
women's hospital access
staff access

Fig. 5. Modifications in the settlement between 1700 and 1870

1.3.2 From 1870 to 1900

From 1860 the debate within the hospital concerned the lack of adequate spaces for the School, the educational needs that led to the creation of specialist environments with respect to the general ward, and the need to improve the hygiene conditions (many patients died because they fell ill in the hospital), also driven by the emergence of a new category of hospitalized patients from the upper-middle class who had more requirements and more financial clout.

Due to a lack of space and the need for new healthier and specialized environments the dermatology, ophthalmology, and paediatric specializations were decentralized in the other Florentine hospitals and some fundamental changes were carried out within the hospital, which changed its image. In 1880 there were 1200 beds (Diana 2012, 171).

In 1867 the convent of Santa Maria degli Angeli was transferred to the hospital and the School was gradually expanded into that area. In 1881, a new pavilion for men was built (Fig. 6). In 1888 the new examination rooms, which served both inpatients and outpatients, were opened and occupied a part of the old men's ward at the front of the square. This change was prompted by the high demand for consultations in town – or as we would say today the number of outpatients increased. In the same period the Angeli pavilion and the Central pavilion were also renovated (Fig. 6).

The position of the examination rooms in the men's ward led to the hospital's main entrance being moved to the female ward. This shift, which had been planned as part of a unified design for a hospital with comb-shaped pavilions, along with the demolition of the north ward of the women's cross and the construction of two new pavilions (longitudinal and transversal), caused a radical change in the internal paths. The transversal pavilion was to be the first part of the east-west link which, joining up with the wards of the men's cross, would unite all the pavilions, but it was never completed. The reconstruction of the remaining longitudinal pavilion was also given up and the hospital thus acquired the form of an inverted U with a large garden in the middle for those entering from the female ward.

The hospital with comb-shaped pavilions was never built (the exact reasons why are not known); perhaps the management did not like it, but it was a cultural problem and not due to a lack of funds. Perhaps they were tired of making rushed compromises in the sense that three of the five pavilions had to be adapted from existing ones and it would have been a sloppy improvement. Moreover they feared undermining the established image of a city block and upsetting the balance with the nearby bank, theatre, and neighbouring streets. The new project would change the whole block and access routes, so it was decided to build just two new pavilions (Diana 2012).

The new pavilions were raised and had large windows, small windows at the top for ventilation, side entrances and were divided into two wards, each equipped with bathrooms and services. By the late 1880s the hospital had five pavilions including three new ones and new gardens.

In the 1890s the great void left by the demolition of the women's cross and the non-realization of the east-west pavilion link led to the redistribution of the functions and a reorganization of the paths that united them, in particular: the east-west connection, the south-north connection from the entrance, and the links between the cloisters. In this period the corridor spatial element appeared, i.e. a place for the exclusive passage from one destination to another (Koolhaas, 2104). Moreover the need arrived in hospitals, also thanks to the influence of Florence Nightingale, to separate the circulation spaces from the patient treatment areas.

This gave rise to a real change in the circulation patterns within the hospital: it became a network of corridors. To create these connections doors were opened, stairs were demolished and rebuilt, and covered walkways crossing the courtyards were constructed.

At this point the process of modernization within the hospital stopped.

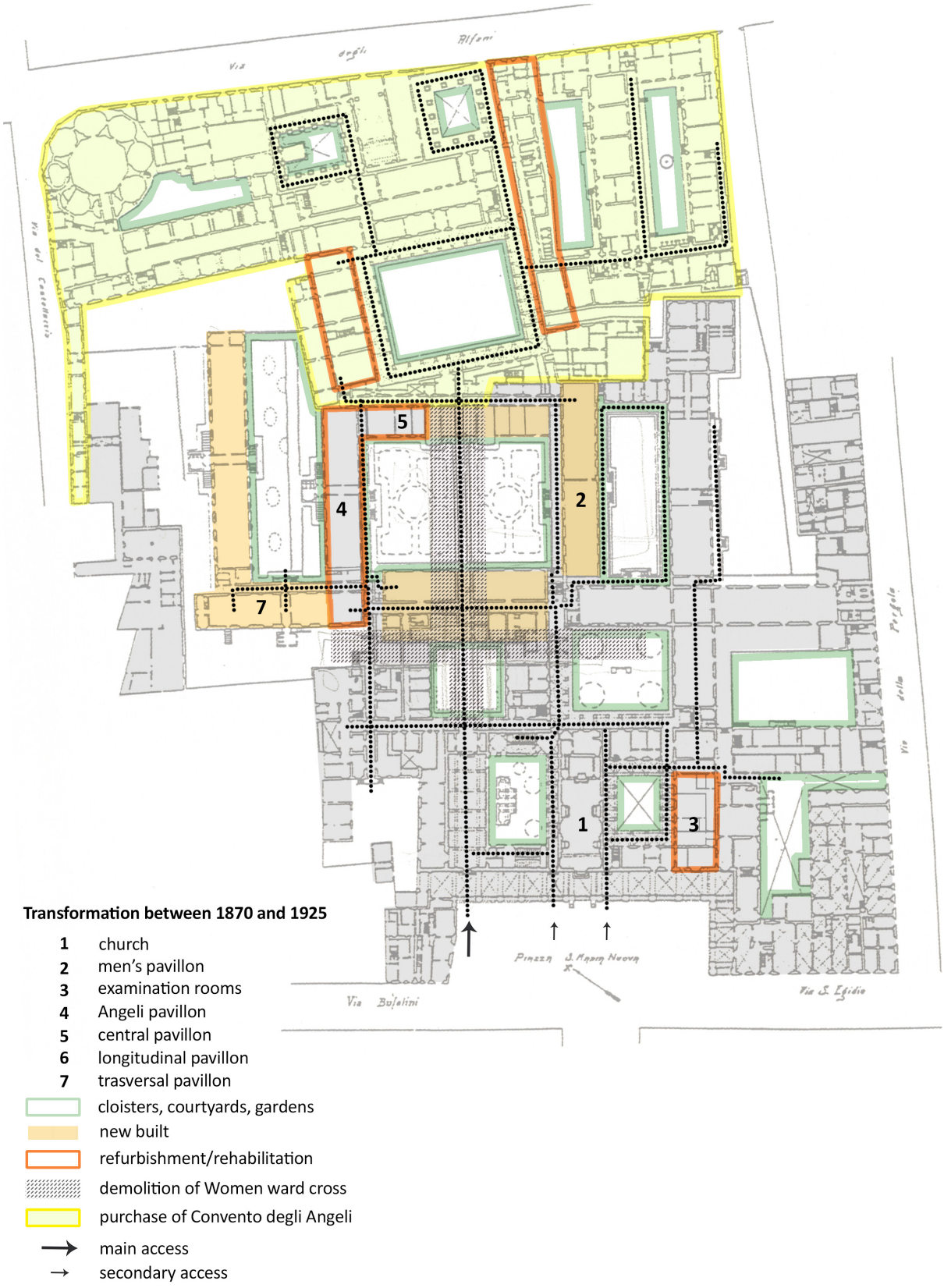


Fig. 6. Changes between 1870 and 1900 in Santa Maria Nuova Hospital (Florence, IT)

1.4 1900-2010: The current unified project

In 1900 the new laundry area, heating system and toilets were installed.

A smallpox epidemic broke out in Santa Maria Nuova and its development in the city confirmed the idea of the isolation and not only the separation of the sick; there was an increase in hospitalization and a lack of space inside the hospital; and there was an increasingly strong need for a new office to carry out research for the Institute of higher learning. These factors led to the practical consideration of the creation of a new hospital out of town (the current Hospital of Careggi), whose construction began in 1914.

Santa Maria Nuova continues to perform the role of a hospital, but its size is greatly reduced: part of the hospital was sold to the adjoining Bank (1933) and the convent of Santa Maria degli Angeli was transferred to the University of Florence.

In the Seventies and Eighties there were strong developments in the field of health technologies. Their inclusion within the hospital resulted in many changes, but the most significant change of the century was when the rectangular wards were divided up into corridors and smaller rooms.

In 1988 a new financial law passed by the Italian Government provided funding for hospitals and the Local Health Authority decided to intervene in a significant way at Santa Maria Nuova which could not otherwise continue its medical activities due to the underdeveloped installation and structural conditions.

Later the funds deriving from art. 20 of Law 448/1998 allowed for the approval, in 2000, of the new redevelopment project and subsequent variations, still in progress, which is the only major project ever carried out involving the entire structure in a unified manner after that of 1800.

The guiding principles of the project are renewed interest in the historic hospital and the desire to program the intervention actions on the structure according to a single plan that takes into account the health needs (enhancing the functions of the emergency department, outpatient services, and the day hospital), the latest technological developments and the more social nature that characterizes the entire hospital.

The elements that have guided the redevelopment project are aimed at retrofitting the fifteenth-century system to regulation standard, functional reorganization in homogeneous areas, the separation of internal routes, the development of the emergency department which was lacking a surgical unit and of the outpatient activities which took place in unintegrated areas, and solutions to improve the deterioration of the structural and installed systems.

The hospital is divided into three major functional areas: the emergency area incorporating the emergency department, intensive care, emergency radiology, the day surgery, and operating rooms; the outpatient area and services including the reception area, blood test centre, dialysis services, and pharmacy on the ground floor; the ward areas on the upper floors. Linking the two emergency and outpatient areas is the most public area with the entrance to the museum and the bar.

Comparing the plan from 1902 to that of the present day we can see the main changes in the architectural and distribution layout. The main entrance to the hospital for outpatients and visitors was brought back to old men's ward, while what remained of the old female ward became the entrance to the emergency department. On the east side of the square there is another entrance for outpatients visiting the blood test centre.

These different accesses – emergency, museum, visitors/outpatients – also guide the internal distribution along the longitudinal and vertical axes (Fig. 7). The emergency entrance from the square (in red) provides instant access to the emergency area, and consequently the more intensive care areas.

The visitor entrances (in blu) are located in the south of the square and are divided into a reception entrance for patients and visitors and the entrance to the blood test centre near the analysis laboratory. The paths for users and visitors, thanks to the construction of the third side of the Samaritana cloister, allow easy access to the diagnostic radiology area, the examination area, and the vertical connection to the inpatient areas on the upper floors. Another distinction is made for the logistics routes (in green) which use accesses located in Via della Pergola and arise from the basement occupying the spaces behind the hospital complex. Then there is the access to the museum, located in the centre of the porch, with a path that leads around the Church of Sant'Egidio and the Ossa cloister then continuing up to the floor above.

Three new blocks for the vertical connections (one for emergency and two for the visitors and staff) were then

constructed without sacrificing anything of the original structure. They have largely solved the problem of differentiating the flows and thus allowing a more coherent distribution of the functional areas on the upper floors (Fig. 7).

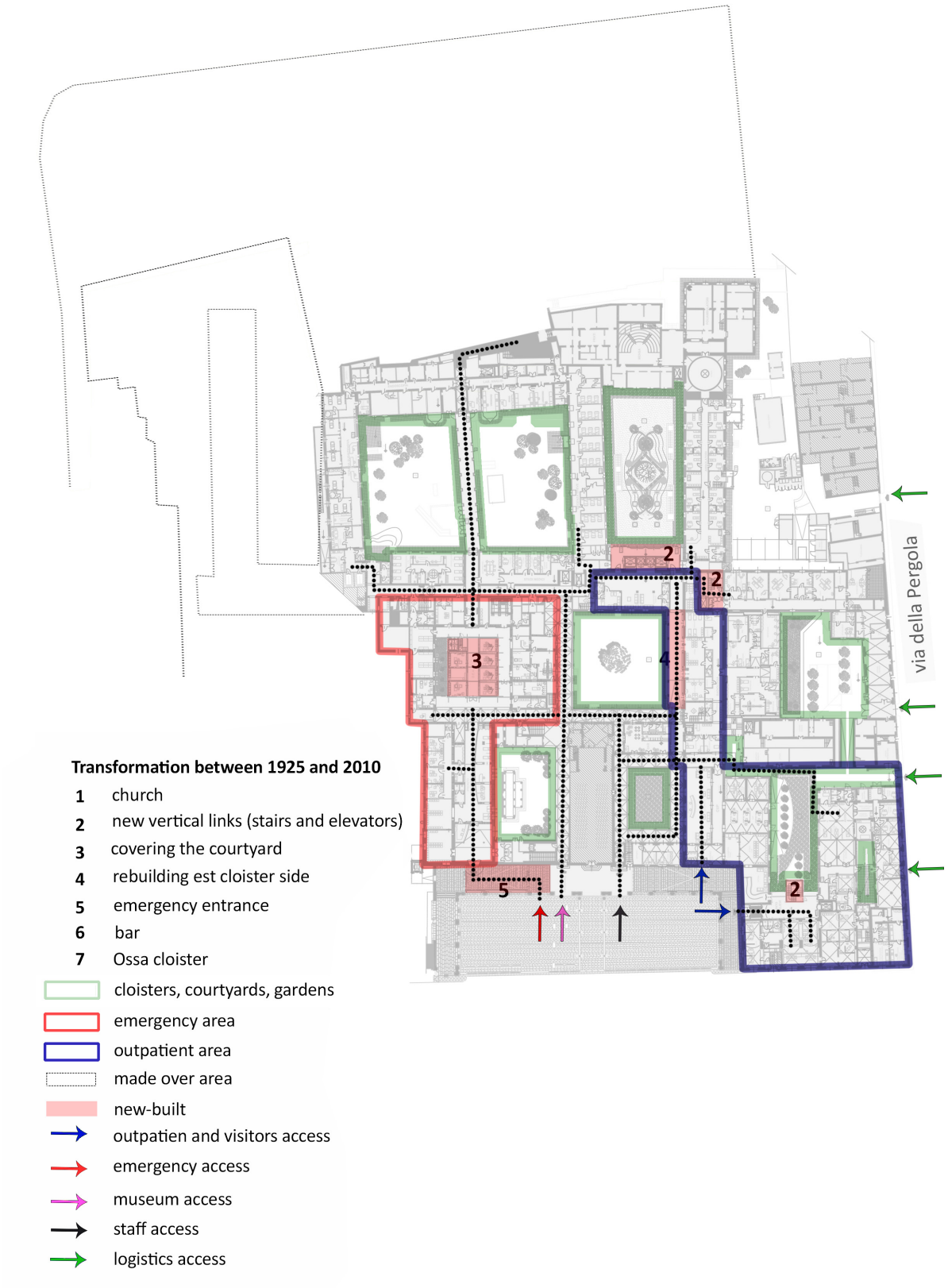


Fig. 7. Changes from 1900 to the present-day rehabilitation project of Santa Maria Nuova Hospital (Florence, IT)

2 Discussion

The study of the evolution of a historical hospital can in our view provide interesting contributions to the theory of Open Building allowing the identification of the matrix that connotes a complex settlement and «makes it possible [...] to support any complex of occupation or any pattern of movement» (Hillier 2007, 245). Our research group has devoted years to this type of observation of complex buildings such as hospitals, which undergo constant evolution throughout historical periods that witness the evolution of functions, healthcare technologies, building technologies and the role of the social structure within them and in the city. The research finds a basis in different approaches to architecture: from studies on architectural composition and building types, studies of spatial configuration, the approaches of the open building theory in terms of spaces and construction techniques, to those of the spaces syntax theory on the concept of topology and spatial occupation.

Architecture is an art of «inaccurate precision» that can solve «functional needs ... only in an environment that leaves many levels of generality» (Purini 2000, 81). And «generic function refers not to the different activities that people carry out in buildings or the different functional programmes that buildings of different kinds accommodate, but to aspects of human occupancy of buildings that are prior to any of these: that to occupy space means to be aware of the relationships of space to others, that to occupy a building means to move about in it, and to move about in a building depends on being able to retain an intelligible picture of it». (Hillier 2007, 223). In the Open Building perspective, "inaccurate precision" and "generic function" can be interpreted as the "support" that characterizes the keys of the "intelligibility" of a spatial configuration. These keys make possible the spatial configuration to accommodate all the uses that are compatible with the size of the space, the structure that gives them material form, and the topological relationships.

The study of SMN hospital in Florence reveals how this property has been supported throughout its evolution by the presence of the cloisters and the relationship between them and the closed volumes mediated by the porches. The cloisters have been the key to the internal intelligibility of the generic function that has made it possible to adapt to the evolution of the functional programs of care and healthcare technology. The cloisters have been the key to external intelligibility in interelations with the city, mediated by the entrances and the Buontalenti loggia on the square. The cloisters and large linear blocks with the wall structure covered by trusses (the naves of the historic wards) are the spatial, structural and typological matrix – the “support” – which has enabled us to confirm the intelligible unity of the complex settlement over time. In its interior the circulations patterns have been modified to become increasingly complex and differentiated according to specific functional needs (Fig. 8).

From the outset two patterns interacted within the hospital complex: circulation around the cloisters and circulation inside departments, at first undifferentiated in the cross-shape wards and then differentiated in the corridors. It was the evolution of the cloisters within the almost urban, and therefore generic, building fabric of the hospital complex that slowly over the centuries transformed the pattern of the paths from the ring and linear circulation combination to an integrated network in which it is still the cloisters that support intelligibility marking how the hospital community occupies the space and its relationship with the city (Fig. 9).

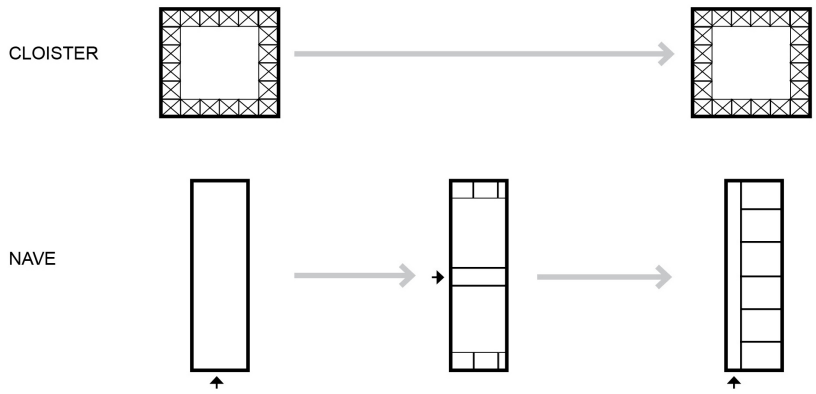


Fig. 8. Spatial elements over the time

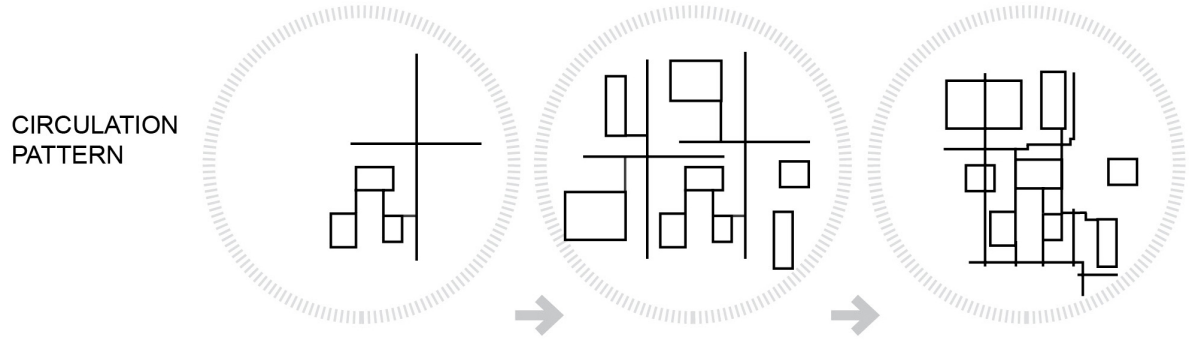


Fig. 9. Circulation patterns over the time

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