Ricerche e progetti per il territorio, la città e l'architettura
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# Historic preservation and innovative building design for the sustainable rehabilitation of Urban Areas. The case study of Sani-Casaralta Area in Bologna.

## *Conservazione e innovazione per la riqualificazione sostenibile delle aree urbane. Il caso di studio dell'area Sani-Casaralta a Bologna.*

With reference to a specific case study, this paper is an attempt to respond to questions concerning progress toward better understanding of the role of urban unit's mosaic and fringe belt recognition in urban planning and building retrofitting/design.
In particular, the paper describes a reading procedure consisting of data requirements to be used as an "interpretative analysis" of the dismissed military area Sani-Casaralta, in the north sector of the city of Bologna.
By means of specific comparison between local characters and historic evolution, the paper suggests a design procedure based on the use of new technologies as possible interaction between "intentionality" in urban planning and possible evolution of historical urban forms.

*Con riferimento ad un caso di studio specifico, questo contributo rappresenta un tentativo di dare risposta alla complessità del tessuto urbano con particolare riferimento alla riqualificazione del patrimonio edilizio nelle aree periurbane. Il saggio descrive una procedura di lettura finalizzata ad una "analisi interpretativa" della zona militare dismessa Sani-Casaralta, nel settore nord della città di Bologna.*
*Per mezzo di un confronto specifico tra caratteri locali ed evoluzione storica, il saggio suggerisce una procedura di progettazione basata sull'uso delle nuove tecnologie come possibile interazione tra "intenzionalità" nella pianificazione e possibile evoluzione delle forme urbane storiche.*

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Fig. 1. A view of the area case study.

**INTRODUCTION**

Dealing with dismissed and abandoned areas, it is essential to focus on the historic and geographical features which have determined the evolution of urban morphology within the specific context, taking into account that "*the study of urban form covers not only the buildings and other structures that make up the built environment of cities, but also the arrangement of these features in a areal composition most often referred to as the spatial structures of cities. Fundamental to understanding this spatial structure is identifying the processes that create it and the patterns they produce (…). At the (…) local scale, buildings and their associated spaces fall into types that relate to particular socio-cultural forms and functions needed at particular sites, and they generally exhibit great individual variety (…). The value (…) lies in their availability to reveal the broader, historically-derived zones into which urban space has been divided over time still fitting them together as a coherent whole*." (Conzen, 2009)

While the historically consolidated urban textures are structured according to continuity and gradualism of the formative processes, as an opposite, the formation of peri-urban areas consists of intrinsic logic resulting in fragmentary conditions and urban discontinuity: most urban configurations in current expansions show a diffuse, irregular sprawl, with a progressive detachment from the natural, morphological and environmental contexts.

Generally, the more recent expansions in peri-urban contexts, compared to the ones in historic areas, present different features of legibility of urban form, in the specific co-relation with pathways, public and open spaces. The strong co-relation among closed and open spaces has been reported by Osmond (Osmond, 2010), which also refers to previous studies when declaring that *we cannot create a space inside without also making a space outside* (Hillier, 1995).

Thus it's possible to point out a conflict

between the "calibrated" structure of historical villages developed along natural or anthropic boundaries and the complete lackness of relations between recent expansions and natural or historical references. In fact, moving outwards from the city center, generally plots become more fragmented, less tied to fixation lines (Conzen, 2009).
The study of this discontinuity does present deep co-relations to the interpretation of urban landscape as the geographical mosaic of urban units (Whitehand, 2009) and the Conzenian theory of fringe belts formation (Conzen, 1988 and 2004) whose definition, conceptualization, theory, and applied validation on several case studies have been reported by a large set of contributions in Urban Morphology (Conzen, 2009).
In particular, as discussed by Whitehand, "*there is a need for much greater clarity in the methods of characterizing and delimiting (...) (the urban landscape as a kind of mosaic of units) and for wider appreciation of their role in planning*". As Whitehand's study focuses, the recognition of these urban units is very important in its application in planning. The methodological approach towards the knowledge of urban context can also be seen as the typological process of the buildings, at the different scale of the building environment and its correlations among building types, pathways and textures forming the overall urban structure

(Caniggia and Maffei, 1983).
With particular reference to an urban area whose individuality and distinctiveness seem to be referred to as the fringe belt units in form of radial corridors -crossing the concentric belts- (Conzen, 2009), this paper tries to make an effort to engage with the operational problems posed by the production of urban form today, exploiting the concern of correspondence among urban form, building type and open spaces in traditional settlements and new building design.
With reference to the specific case study of a dismissed urban area in the northern part of the city of Bologna, the paper is an attempt to respond to one of the very large set of questions arising from the study of urban morphology. One group of questions concerns progress toward better understanding of the role of *urban units' mosaic and fringe belt recognition in urban planning and building retrofitting or design*.
How best can we interpret and apply fringe belt formation theory in urban planning? How can we change or maintain units' mosaic coherence and fringe belts in urban planning, particularly in relation to green belts?
May the so far recognizable traces of fringe belts even be used as a "design tool" for urban retrofitting? The re-design of mosaic urban units, at a smaller scale of investigation, can be even supported by the study of

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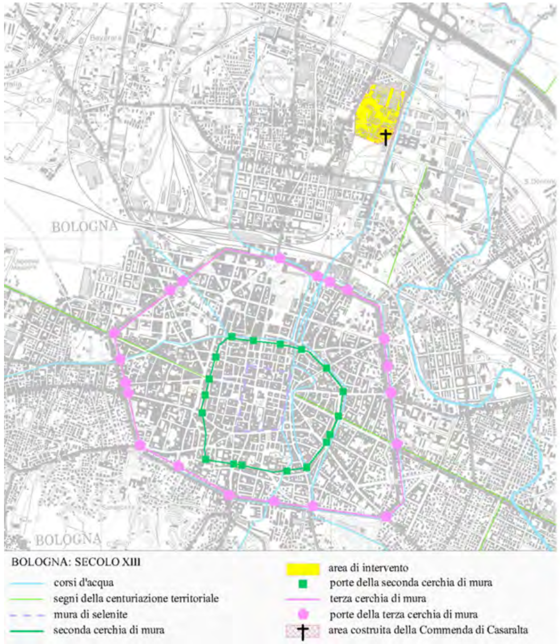


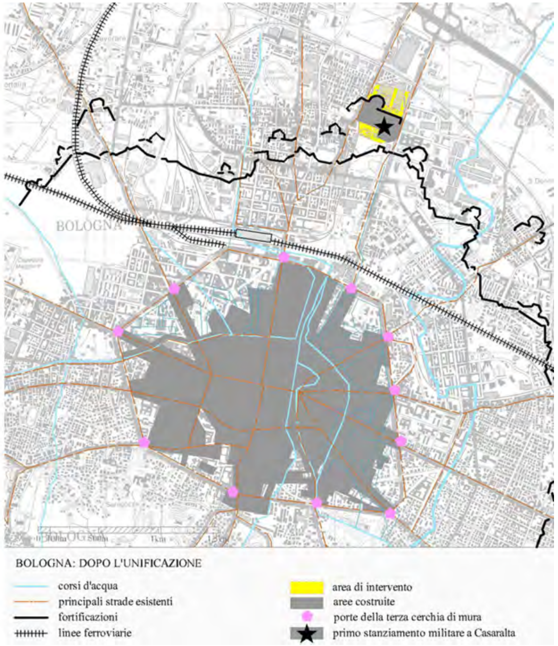


In this page:
Fig. 2. Progressive expansion in the city of Bologna (1700, 1850).
In the next page:
Fig. 3. Planned expansion the north sector of the city (left 1902, right 1940)

urban morphology at the different scales of the built environment?

## A BRIEF HISTORICAL BACKGROUND

With particular reference to the territorial and morphological assets in Emilia-Romagna region, it is possible to point out a correspondence between urban form and the principles determined by the environmental and climatic control requirements, as well as to the rules produced by natural borders, traces and roads directing the historical phases of urban development: the alignments to the centurial grid network in the northern part of Bologna, the correspondence among natural morphology, contour lines and consequential directions in urban development in the hills and mountain historical centers in the south area of the city, the frontage array to main channels and, more generally to the borders derived from natural elements' signs (Gottarelli, 1978; Gresleri and Massaretti, 2001).

As an opposite, most urban configurations in current peri-urban expansions show a diffuse and irregular sprawl, with a progressive detachment from the natural, morphological and environmental contexts. Thus, spatial fragmentation and explosion involve, with different modalities and with increased effects, in the evolution of urban centers with large dimensions. No one city, apart from exceptions to the rules, seems able to escape this evolutionary process.

Figures 2 and 3 show the urban expansion the city of Bologna, limited inside the city boundaries and walls (inner fringe belts) until the end of XIX century; until the first decades of the last century the urban expansions were concentrated in the north sector of the city (Bolognina, inside the red square), in the north-east sector (Libia, red contour). The star indicates the Military area Casaralta-Sani.

With particular reference to the evolutionary

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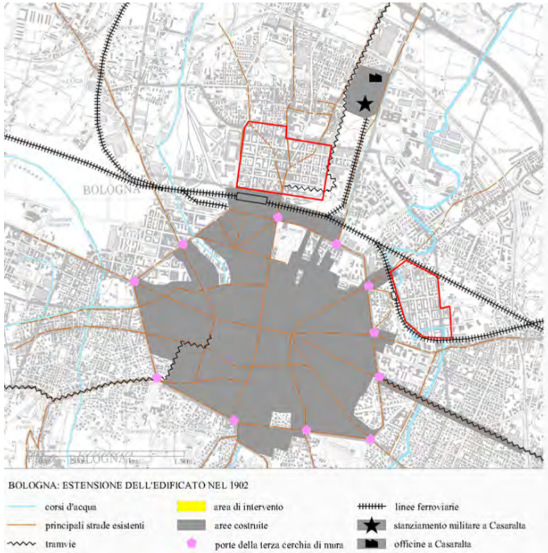
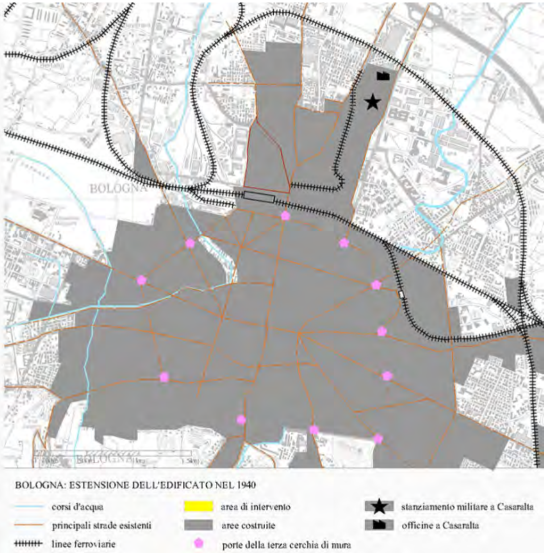
expansion process of Bologna, we can observe a strict correlation among open spaces, natural landscape and urban form quality as a permanent condition in the historical development of the city, until the years of industrial revolution. Until this period, urban development forms are related to the structural concept of the city growing inside limited and controlled boundaries. Inside these limits roadways, squares and open spaces were the structural systems supporting the city and the built up urban environment. The historical urban form is prevailingly legible by the formative and transformative processes of open public spaces, with reference to their quality and level of specific culture. At the end of XVIII century and with a major stress during the XIX century in coincidence with the industrial revolution, the city of Bologna sprawled outside its boundaries, the city walls were demolished, the controlled relation between the city and the countryside was broken. Urban environment was inexorably separated into public and private space: the public bodies managed open areas -main roads, railways and infrastructural technological networks- with reduced extension and even more decreased relation with natural or built up environment.
In contrast with the settlement rules briefly referred to above, the growth processes in most disused urban areas are linked to the intrinsic logic of urban texture, which is essentially produced by the specific nature of the functions of use. These are areas that are unaffected by alignments with road networks or the urban texture of adjacent periurban neighborhoods, as they are proper structures of synchronic formation, extracted from and unconnected with a landscape outside the historic center, an originally wild landscape now occupied by the urban sprawl of the old and the new periphery. In the Bologna urban framework military area are therefore connected to a synchronic collocation spatially distant from the historic center and adjacent to urban expansion.
Thus these places interact temporally with the city which continues to grow within its walls and are situated spatially between the urban expansion of the early decades of the last century and the new periphery. What emerges from these briefly outlined observations is a 'spatio-temporal rupture', making it necessary to seek new modalities and criteria of intervention for an urban rehabilitation capable of reintegrate



BOLOGNA: ESTENSIONE DELL'EDIFICATO NEL 1902



BOLOGNA: ESTENSIONE DELL'EDIFICATO NEL 1940 areas called upon for the first time by the present evolutionary processes, to form a part of the city.

**THE SEARCH FOR A STRUCTURING URBAN NETWORK FOR THE ACCESSIBILITY AND FRUITION**

Because of the quantity and quality of the problems connected with the intrinsic typicalness of the buildings, the conditions of criticalness of the surrounding infrastructural context, the potential margins of unexpressed residual natural landscape and the high degree of transformability, the Casaralta-Sani Area sums up and concentrates the significance and the criticalness of a city. Therefore the required analysis must be multi-scalar and multi-purpose in approach.

A congruent planning outcome must take into account to what extent a settlement may be transformed without losing its original environmental identity; thus, the first step is to seek the identity in such heterogeneous, complex and articulated urban contexts. This task appears to be difficult in reaching, as the growth processes in most disused urban areas are linked to the intrinsic logic of urban texture, which is essentially produced by the specific nature of the functions of use.

Assumed that project of transformation cannot translate into self-determined architectural emergences or be conceived to assert its diversity as a rule of conduct, on the other side, operations of transformation must also be ruled out as they are dictated by principles of historicist conservation, employing *repertoria* and materials ready for potential re-use, often in a distorted way.

In a time of profound changes in the growth model of cities, we are witnessing a shift from a phase of urban expansion to a phase of transformation and rehabilitation. Renewed attention to urban quality entails new reflections, all of which are apparently aimed at calling into question the effectiveness of traditional planning which seems inadequate to govern the physical and architectural outcomes of urban transformations. Most design guides and planning regulatory norms seem to focus on issues or matters of design detail and materials and seem unaware of the way that the deeper structuring levels –street layout or plot formation- affect settlements form. (McGlynn and Samuel, 2000).

As pointed out above, the most substantial differences between peri-urban or fringe-belt urban areas and historic urban settlements mostly regard the identification, determination and integration between built-up landscape and open spaces in the particular definition and construction of spatial urban relations: collective spaces, squares, streets, green areas. Therefore the processes of transformation aimed at interventions of urban rehabilitation first and foremost must be based on the search for and identification of the signs of urban texture, and of scarcely identifiable alignments, with the purpose of re-connecting the paths, the existing fruition systems of access in surrounding areas and the traces of urban formation lines partly or completely lost, if ever they existed. The recovery of 'signs' should be seen as a test, a preventive design exploration of the hypotheses of new open spaces and the layout of urban texture which originate from the alignment with the existing systems of road networks in the surrounding areas towards the area of rehabilitation, as well as from the eventual recovery of historic pathways.

**POST-WAR TRANSFORMATIONS AND BUILDING TYPES IN HISTORIC URBAN TEXTURES**

However, the project of urban architecture is not limited to interventions on 'empty spaces': the aim is to attempt to retrace the growth process of the building systems by means of a 'vectorial' design process (Tombazis, 1995) where, starting from the rules of alignment and continuity with the signs of urban texture (pathways, roads, canals, level lines), hypotheses may be formed congruent with the definition of a new network of urban flows capable of catalyzing the functions and activities of new urban build-

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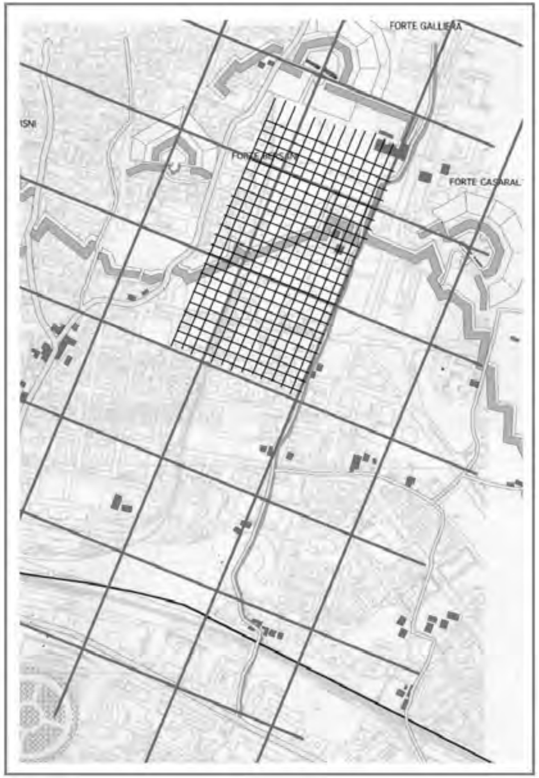


Fig. 4. The chart highlights the correspondence between the centurial grid and the plan of the ancient extra-urban fortifications drawn from historical maps (Forte Casaralta, Galliera, Forte Spisni).

ings, in re-proposing the growth model of historic cities.
The analysis of the relation between building components and types, and the system of open spaces in historically consolidated urban areas points up the possibility of 'reading' the rules of building texture in a phenomenological perspective (C. Norberg-Schulz, 1996), seeking a system of relations and correspondences which make the historic building resources an expression of urban identity. It is therefore necessary to consider the possibility of orientating architectural practice towards the intentional recovery of the laws of spontaneous urban texture also by virtue of a greater environmental awareness. Its applicability should be evaluated also in those cases where it is necessary to give urban identity to a city that does not exist, because it has never existed or because it was destroyed, or because it has undergone traumas in urban relations, thus requiring a high level of transformation. In addition, this search tends towards a further confirmation of the formal urban texture of architectural facades, no longer linked solely to a logic of internal functionality, but to perceptual rules, to built-up space viewed in a relationship of mutual generation with internal space.
With the intent of contributing to the definition of the concept of the environmental performance, (Caniggia and Maffei, 1885), this paper uses the reported case study as a test area with a high capacity for transformation, whose re-generation can be prevailingly address to solve the need for physical and environmental re-connection with the surrounding urban contexts and textures. The analyses carried out aim to demonstrate that it is necessary to re-appropriate the legibility of the relationships between natural space and built-up space, at different scales, in order to re-construct the system of relations and to provide a design solution congruent with the context.
Despite the pressure deriving from the new needs of an industrial society, the urban culture of the 19th century until the middle of the last century succeeded in formulating consistent proposals of growth, using urban courtyards schemes which provided a solid compaction of the residential plan in the urban form. In the development of the Bolognina quarter, one of the first expansions of the city of Bologna, urban courtyard housing, designed for self-inclusive community living, takes on a defined urban connotation despite the absence of a road hierarchy and of functional relations between roads and public spaces.
The urban texture and the building form, in the relation with urban open space, still differs greatly from the episodic disorder of more recent expansions characterized by a morphological variety resulting from the

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Fig.5. Urban Courtyard Housing in Bolognina Quarter.

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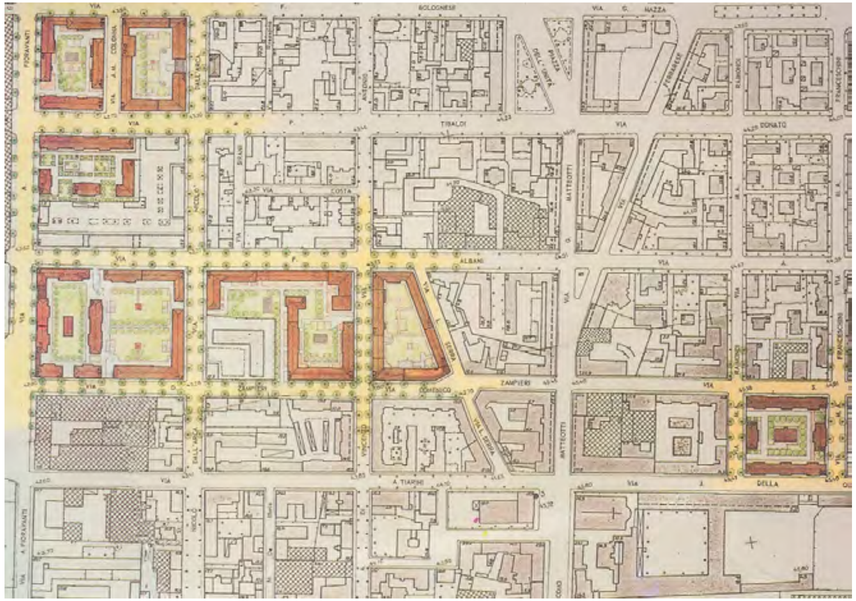
trivialization of the local building tradition.
The analysis of the building system in the North sector of Bologna (Bolognina) shows a heterogeneous range of building types which, in a virtual direction approaching the area of rehabilitation –from the features of the historic buildings and of the courtyard social housing of 19th century towards the disused areas of the Sani-Casalta Area- constitute an extremely varied and complex building repertory.
While the most recent urban plots (northern areas) present more disarticulated forms, the area of the first urban expansion, as detailed in the following figures, still presents urban building blocks with a clear distinction between public, collective and private functions. As reported by other similar case studies from Whitehand (2009), in comparison with the old town pattern, the plots are squatter and regular.
While the first planned building blocks present squatter and regular forms, with prevailing alignments along the main roads (1910-1930), during the following years (1935-1960) it can be observed a progressive detachment of the building scheme from the urban court scheme (see the left and right schemes in Figure 7, compared to the central ones of the same figure).
Thus this period seems to act as a clear dividing line in the different modality of identification, determination and integration be-

On the right:
Fig. 6. Urban Courtyard Housing in Bolognina Quarter. A detailed plan. Source: AA.VV., *Le nuove corti*, IACP, Bologna, Ed. Grafiche Zanini, 1990.
At the bottom:
Fig. 7. Different Residential Building Types in the Urban Courtyard Housing, first expansions in Bolognina Quarter. Source: AA.VV. *Le nuove corti*, IACP, Bologna, Ed. Grafiche Zanini, 1990.



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tween urban built-up forms and open spaces in the peri-urban area of Bolognina Area.

**GREEN BELT GRIDS AS RADIAL FRINGE BELT CORRIDORS STRUCTURING THE URBAN RE-CONNECTION**

The analysis of the building form must be associated with the study of existing open areas, with particular reference to fringe belt areas and green belts.
The need for housing quality aimed at a greater balance between nature and built-up areas: a new use of open spaces and of the natural elements that, from their current role as residual and separate entities in fringe belt formations, should become elements structuring human settlements.
To date, most of the interventions aimed at improving living conditions in cities result in timid attempts of central areas' transformation in pedestrian urban places and functional re-management of parking areas, or the creation of green areas and urban spaces for leisure activities. These interventions all share a common limit in that they are episodes, islands, sporadic and sectorial urban fragments." Despite the importance attributed to empty spaces in theory, in practice there has been a growing tendency to consider such places as urban remains, whether they are situated in urban or extra-urban territory." (Gibello, 2005)
The use of external spaces therefore can also be associated with their potential value as ecologically regenerated places. This represents an acceptable ecological solution contributing not simply to the reduction of the thermal loads of the building's envelope, but to the improvement of micro-climatic conditions of densely built urban centers with reduced natural environment.
We do not need more studies to demonstrate that plants have a strong effect on climate: trees and green spaces can help cooling our cities and save energy (Santamouris, 2007). Trees are able to provide solar protection to individual houses during the summer period while evaporative transpiration from trees can reduce urban temperatures (Buttstädt et al., 2010). Trees also help mitigate the greenhouse effect, filter pollutants, mask noise, prevent erosion and calm their human observers.
As reported in numerous citations in literature, results of computer simulations aimed at studying the combined effect of shading and evaporative transpiration of vegetation on the energy use of several typical one-storey buildings have showed that by adding one tree per house, the cooling energy savings varied from 12 to 24%, while adding three trees per house can reduce the cooling load between 17 to 57 percent (Ferrante, 1997; Ferrante et al, 1998, 1999; Fioretti et al, 2011). According to this study, the direct effects of shading account for only 10 to 35% of the total cooling energy savings. The remaining savings result from temperatures lowered by evaporation and transpiration (Ferrante and Mihalakakou, 2001).
Furthermore, the role of green areas as potential ecological networks in urban environment may be of crucial importance: ecological networks, which have already been widely adopted in the environmental and naturalistic field as a means of supporting the physical reconnection of natural episodes, may take on a decisive importance in urban settings as well (Cities Alliance, 2007). Thus, the search for a correspondence between the traces of a lost urban texture, present road networks and ecological networks may be an urban tool for the accessibility and relation of urban greenways. If these greenways are transferred to the scale of systems of the urban texture, they may function as a catalyst in urban fruition. This is particularly important considering the general basic structure of current fringe-belt urban formation producing "neighborhoods with streets that do not connect, (that) (...) neglect (...) the importance of plot patterns, (...), the illegibility of street patterns and circuitous and often unsafe pedestrian routes" (McGlynn and Samuel, 2000).
In the case in question an analysis of potential ecological pathways at a larger scale has been developed to re-connect urban

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textures with existing surrounding areas.
As shown in Figure 8, a main pedestrian route can be found by the recovery of the disused railway ex-ferrarese (north-north-east and south-south west) as an ecological pathway (also coinciding with a main axis of the centurial grid, as previously shown in Figure 4).

## A "SUSTAINABLE NETWORK" IN THE URBAN REHABILITATION OF THE AREA SANI-CASARALTA

As these briefly outlined observations have highlighted, the buildings' setting may be defined as parts of a symbiotic relation with open spaces of the urban texture, thus we need to observe the different components of urban morphology according to a transversal design approach in a scalar, interdisciplinary and historical sense.
For an adequate contextual reference, it is necessary for the functional, physical and environmental parameters to be congruent and integrated with structural invariants and evolutionary factors characterizing the historical development of building processes.
A design methodology orientated towards the congruence of interventions is strictly bound to the concept of sustainability intended as an integration of typological, morphological and natural components. The analyses aimed at reading the historical traces and signs produced by the evolutionary process have determined, in the different phases of interpretation, subsequent hypotheses of re-connection and re-meshing of building volumes.
The main re-connection from physical and ecological point of view has been hypothesized in the recovery of residual and or potential natural areas mainly coinciding with the band of the disused railway, which is, in fact, a radial fringe belt corridor with the structuring role of urban re-connection and green pathway in the rehabilitation of the urban area.
The layout is therefore defined by the struc-

Fig. 8. The study of residual natural areas in the north sector of Bologna shows the area Sani as the Polar Component of a potential ecological axis along the radial fringe belt corridor represented by the dismissed railway Bologna-Ferrara (green dashed line, s-sw and n-ne oriented). On the right of this corridor, the Commercial Fiera District; on the left, the Residential Area of Bolognina.

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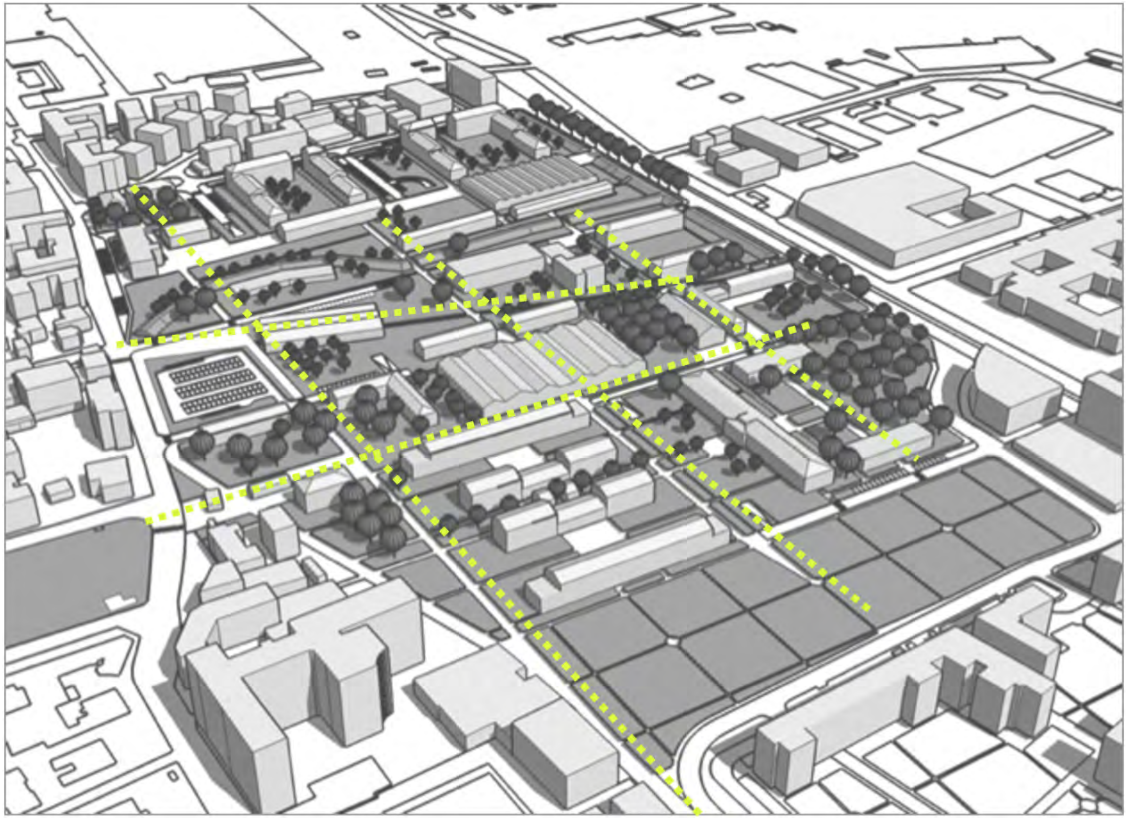

Fig. 9. Plan-volumetric configuration in the Urban Area Casaralta-Sani in relation to urban grids (green dashed lines). On the right of this grid, the Fiera District; on the left the residential area of Bolognina.

turing role of the pathways and green open spaces. From the layout and volumetric plan aimed at reconnecting the whole urban system, the planning singles out some key elements to be developed at further scales of investigation and design.

## EXISTING BUILDINGS AS AVAILABLE RESOURCES: ADAPTABILITY TO TRANSFORMATION AND INNOVATIVE BUILDING SOLUTIONS

The idea of urban expansion by unit addition, which then forms units of a superior urban unit, as in the case of historic building types, may be reinterpreted as a way of rendering visible the parts within the successive and superior levels of hierarchical order. The analysis of building resources, the assessment of spatial capacity, the structural frames as well as the state of conservation of the buildings have allowed the identification of disused buildings suited for transformation. The intersection of the intrinsic potential of the building system with criticalness and values at the urban scale of the physical and environmental system has permitted the identification of the buildings to be reconverted to new functional uses.
Also at the architectural scale, the design process has followed the hypothesis of 'subtraction and addition' aimed at the recovery of the structural grids in the existing buildings. An environmental recovery can

therefore be implemented in new functional uses compatible with the spatial features and with the existing structural system.
The legibility of use functionality referred to the different housing units is made possible by the correspondence of the structural grids with the vertical partition of the units, while the different envelope solutions produce individuality and variety. The technological innovation therefore focused on the formal and technical texture of building facades, identifying active and passive technological systems aimed at specific thermal requirements and energy-saving performance of the buildings.
Over the last decades, energy oriented innovations in building technology have emerged in many areas of the building construction sector. This interest is furthermore evident when considering the growing number of "Green Buildings" and the subsequent media attention they attract (Brown and Vergragt, 2008).
Many studies on low carbon, passive houses and zero energy buildings have been developed in recent years (Aelenei et al, 2011; Ferrante and Cascella, 2011; Golcalves, 2010; GDI, 2008; Grove-Smith, 2010; GTZ, 2006; Hernandez and Kenny, 2010; Heinze and Voss, 2009; IEA, 2008; JRC, 2008; Kapsalaki et al, 2011; Marsh, 2002; Marszhal et al, 2011; Sartori et al, 1998). Among the latest are the experiences aiming at setting to zero the carbon emission of a whole City. A Pilot City Plan study to set to Zero the Carbon Emissions in the existing cities has been developed in the framework of Copenhagen Climate Plan (City of Copenhagen, 2009). Large interest in "Green Buildings" and Zero Energy Buildings (ZEB) recent European and National Directives on Energy Performance of Buildings, easy accessible Best Available Techniques (BATs), all seem to point to further exploitation of BAT and better penetration of ZEB into building construction practices.
In the frame of the legislative plane, recently the European Parliament (European Parliament, Directive of the European Parliament and of the Council on the Energy Performance of Buildings, Directive 2010/31/EU), amending the previous 2002 Energy Performance of Buildings Directive, has approved a recast of the same Directive, proposing that all new buildings built after 31 December 2018 will have to produce as much energy as they consume on-site. Other countries, such as the UK, have already established comparable targets for all new housing which will see 'net-zero' achieved by 2016.
As briefly reported above, nowadays, on the energy side, energy-saving technologies have been successfully developed, energy-efficient building designs have been experienced and extensively publicised; we now possess the technical knowledge to design and construct zero-energy buildings and no carbon city as well. "More-over, extensive monitoring of local, national, and international building stocks means we know more than ever before about the precise potential for improved energy performance" (Guy, 2006). In parallel, the observed growing interest in "green buildings" results in "highly visible" and attractive contemporary "monuments", often located in the framework of superimposed, universal and incremental master-plans and "radical urban surgery" (Charlseworth, 2006), whose real impact on current behaviour and smaller building practices is still negligible (Brown, Vergragt, 2008).
Today we need to shift this energy-efficient technical knowledge from new developments and newly conceived buildings to existing buildings, since they represent the biggest challenge both in carbon terms –because of the large amount of existing stock- and for its social, potential impact on the sustainable recovery of urban sites. In parallel, we need to turn unsightly, unattractive, unsafe and abandoned sites in attractive and pleasant urban areas, in which to live, to gather, to move. Thus, we do need to face urban morphology taking into deep consideration the effectiveness of energy saving and/or generation in its application on urban building (re-)design (EU Report, 2010).
The acceptance of these large set of con-

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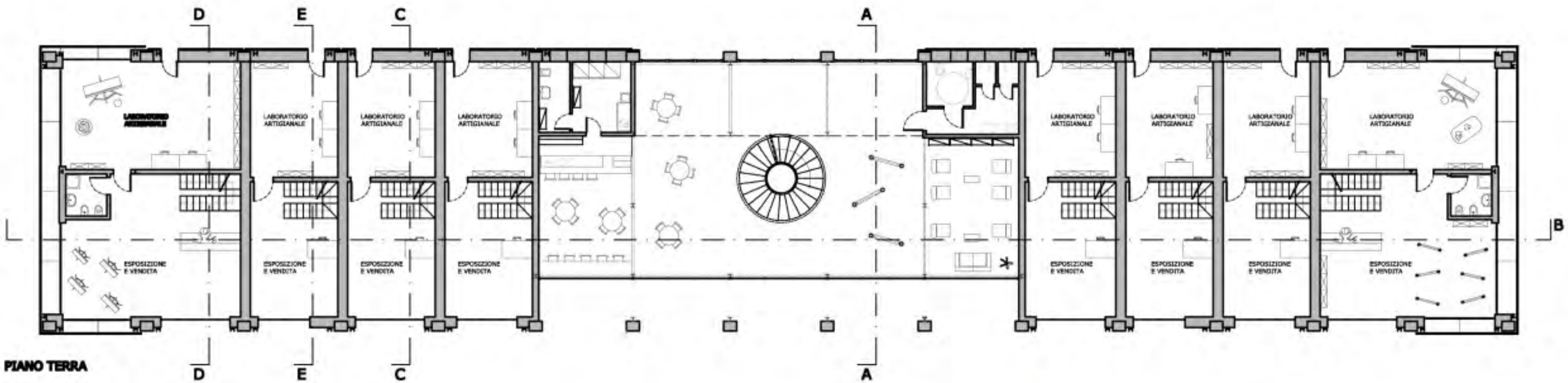


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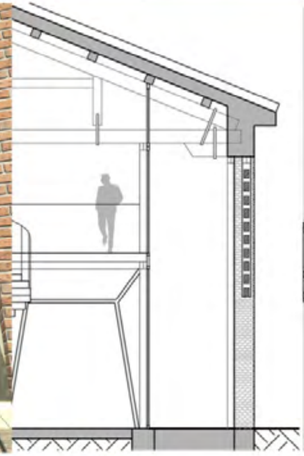
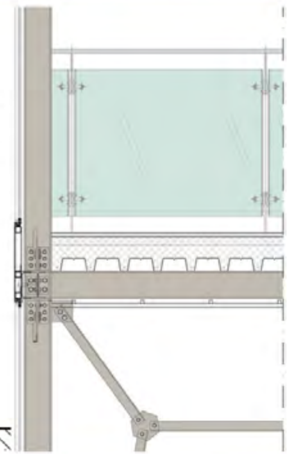

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Fig. 10. Building retrofitting and photovoltaic system integration in the building facades. North façade (top) ground floor (middle) South façade (below).
Fig. 11. Different views of the same building.
In this page:
Fig.12. The Design of a new office building. A view of the building (top) and a longitudinal section (below) where is reported, qualitatively, the thermal performance of the building in the different seasons (winter on the left, summer on the right). Photovoltaic panels are located on the rooftop of the building.

straints in the Sani-Casaralta area (fringe-belt recovery and exploitation via the green network structure, legibility of functional uses as improvement of urban identity, energy saving measures) can become an opportunity. In fact, the study of the residential courtyards in the historic Bolognina areas could have suggested to re-use this building type in the redevelopment and infilling of open areas among existing buildings in Casaralta-Sani area; but this idea has been discarded to respect and preserve the area as a "polar component" of the green fringe belt entering into the city core, through the "ecological axis" along the dismissed railway Bologna-Ferrara. The number of build-

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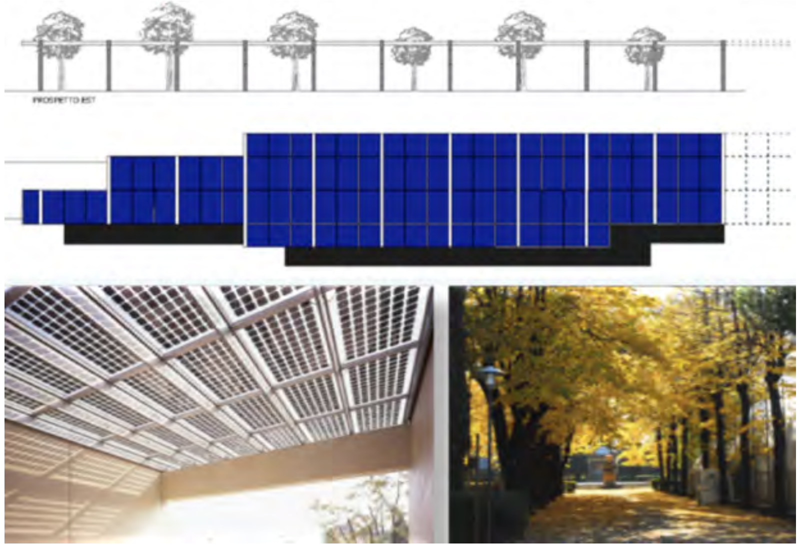


Fig. 13. Possible integration of photovoltaic systems along the shelters in the main pedestrian routes of the open public spaces in the CASARALTA-SANI Area.

| | ENERGY DEMAND [kWh] | [mq] | [mq] | ENERGY SUPPLY BY RES [kWh] | DIFFERENCE [kWh] |
|---|---|---|---|---|---|
| 1 | 74300,0 | 450,0 | 584,0 | 96000,0 | 21700,0 |
| 1bis | 74300,0 | 450,0 | 584,0 | 96000,0 | 21700,0 |
| 2 | 41700,0 | 247,0 | 178,0 | 30000,0 | -11700,0 |
| 2bis | 41700,0 | 247,0 | 178,0 | 30000,0 | -11700,0 |
| 3 | 97350,0 | 590,0 | - | - | -97350,0 |
| 4 | 163174,0 | 987,0 | 204,0 | 35000,0 | -128140,0 |
| 5 | 42635,0 | 253,0 | 172,5 | 29000,0 | -13635,0 |
| 6 | 44765,0 | 265,0 | 544,0 | 90000,0 | 45000,0 |
| 7 | 86086,0 | 521,0 | - | - | -86086,0 |
| 8 | 52000,0 | 308,0 | 526,0 | 87000,0 | 35000,0 |
| 9 | 18300,0 | 108,4 | 172,4 | 29000,0 | 10700,0 |
| | 736˙000 | | | 522˙000 | -214˙000 |
| PV System in open areas | | | 501,6 | 74500,0 | 74500,0 |
| PV on Pathways | | | 3650,0 | 600000,0 | 600000,0 |
| | | | | | 460˙000 kWh |

Tab.1. The table summarizes the total energy demand calculated for each building unit, and thus for the whole urban area. It can be observed that the integrated use of photovoltaic systems in the buildings -Energy supply by Renewable Energy Sources (RES)- is balanced by the photovoltaic shelters in the open urban areas. Thus the total Energy Demand for heating and cooling requirements (736.000 kWh/y) is overcame by the total Energy Supply (982.000 kWh/y).

ings have been mantained and no expansion have been hypothesised; futhermore the “open vision” of existing buildings (considered as built forms of landscape resources) floating as islands of a built memory within the open green areas has been preserved and enhanced by the extension of permeable and green open spaces.

At the scale of building technology design, buildings’ facades have been transformed and developed as a long array of different modules where the housing units are conceived according to different repertory solutions, giving shape to new forms of urban identity. The integration of and correspondence between envelope systems, structural grids and technological components for energy micro-generation give the architectural envelopes the role of climatic control, respecting the existing building constraints in case of building retrofitting, and the urban grid as a whole when designing new buildings.

A specific calculation to verify the feasibility of proposed solutions have been furthermore developed. The overall energy consumption of the urban retrofitting has been calculated. The results show that it’s possible to achieve a Zero Energy Balance and a Zero CO2 Emission Urban Re-Development (See Table 1).

A similar urban area, built-up by conventional buildings, with no use of renewable

sources, would have alternatively released in the ambient 305˙000 kg/year of $CO_2$.
Underlying these examples is a hypothesis of development applied to new urban spaces in which the urban form process is respected without using mimetic architectural reproduction or a priori, self-determined solutions; these examples are an attempt to elaborate a synthesis among typological experimentation, technological innovation and environmental congruence.
The design solutions for the Casaralta area involve a composite whole of new urban buildings which, through the recovery of existing structures, direct the innovative potential of materials and technologies towards energy control as well as new forms of integration and experimentation recalling historical typological settlements.
Architecture thus seems to provide an opportunity to re-connect and re-mesh "lost boundaries" so as to catalyze public fruition by exploiting the links with the existing resources. In this perspective it is therefore possible to establish a relation of correspondence among form, structure and function, re-interpreting and enhancing the existing building stock, seen as an environmental resource in the integrality of its components. In particular, the application of innovative systems at a technological scale, when its insertion is compatible with the context of existing building structure, allows an overall estimation of energy balances, thus introducing, in practice, the valid principle of environmentally compatible technological innovation.

## CLOSING REMARKS

The examples reported above represent a counter-tendency with respect to most cases of urban transformation usually characterized by massive demolition and re-construction. In Italy, in particular, the attempt to furnish concrete solutions for the rehabilitation of industrial or disused areas often results in transformations where the "horror vacui" leads to solutions unwarranted by actual demand, thus producing unsatisfactory, self-referential outcomes ranging from "tabula rasa" to often-episodic integral conservation. In this perspective, the case study of industrial and military disused areas in the north sector of Bologna may represent a further step towards the concept of "compatibility of urban transformation".
The aim of this study is to verify how the urban forms identification, the recognition of fringe belt and the exploitation of historic and natural components of urban places, may translate into innovative proposals where open urban spaces and pedestrian flows are integrated into the built-up environment within a recognizable identity system. In the search for a reasonable co-habitation between innovation and tradition it is therefore evident that technological innovation can find elements of generation in a critical reading of the features of urban places and of the existing environmental resources.
The final aim of the study is the search for an operational reading containing, in its structure, the information instrumental to the subsequent design hypothesis, even at a meta-design stage.
In this perspective it is extremely important to observe the main existing systems (physico-environmental, typological and technical) on which hypotheses may be formulated through a hierarchically-ordered reflection, from the general to the particular, at the different scales of the built-up environment. The search for a definition of the concept of environmental performance in urban transformation (Caniggia and Maffei, 1883) implies a re-thinking of the global performance seen in its entirety, and therefore difficult to define; a subdivision into sectors, if useful for analytical purposes, necessarily requires a comparison with the interacting whole of the different components, of the system into the system, and of the different systems reciprocally interconnected.
There is therefore a "global performance" given by the capacity of interaction among the various and specific performances; these sectorial and interacting entities even when considered separately, are always linked to their environmental, social, and spatiotem-

poral context. Thus the concept of a global performance seems to be derived by the integration of different performance factors.
It can be thus assumed that a global performance cannot be achieved by extending the range of the possible design solutions or procedures.
On the contrary, a sustainable design solution taking into deep consideration the study of urban form, its different modality of identifications, in a multi-scalar and multi-disciplinary approach, seems to be prevailingly produced by the "intersection areas" of the different reading levels in urban morphology.

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