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Land Use, Mobility and Environment

Urban sprawl processes characterize the landscape of the areas surrounding cities. These landscapes show different features according to the geographical area that cities belong to, though some common factors can be identified: land consumption, indifference to the peculiarities of the context, homogeneity of activities and building typologies, mobility needs exasperatedly delegated to private cars.

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MOBILITY AND COMPETITIVENESS

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3 (2012)

Published by

Laboratorio Territorio Mobilità e Ambiente - TeMALab
Dipartimento di Pianificazione e Scienza del Territorio
Università degli Studi di Napoli Federico II

Published on line with OJS Open Journal System by Centro di Ateneo per le
Biblioteche of University of Naples Federico II on the servers of Centro di Ateneo
per i Sistemi Informativi of University of Naples Federico II

Direttore responsabile: Rocco Papa
print ISSN 1970-9889
on line ISSN 1970-9870
Registrazione: Cancelleria del Tribunale di Napoli, n° 6, 29/01/2008

Editorials correspondence, including books for review, should be sent to

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TeMA

Journal of
Land Use, Mobility and Environment

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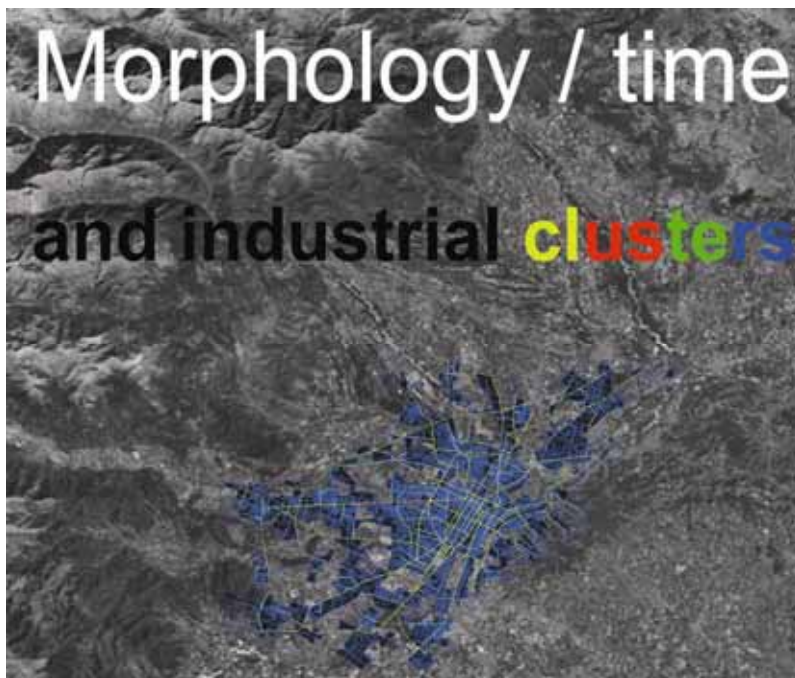
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THE CLUSTERING EFFECT OF INDUSTRIAL SITES:

TURNING MORPHOLOGY INTO GUIDELINES FOR FUTURE
DEVELOPMENTS WITHIN THE TURIN METROPOLITAN AREA

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ABSTRACT

As urban societies seek to redefine themselves following the decline of manufacturing, they are left with physical and social transformations supported by successive stages of industrial growth and shrinking. At the same time, new paradigms are developed in urban planning to address the challenge of cities that are declining and cities whose population is rapidly rising. As such, these attempts raise the need to understand the impact of the street network on how cities thrive or shrink, additionally to social, cultural and economic changes. This paper uses space syntax methodology and a comprehensive mapping of industrial distribution to analyse the evolution of Turin (capital of car manufacturing in Italy) and its relationship to industry from 1920 to the present.

The paper focuses on the morphological clustering of industrial sites and how alternative concepts for planning development may be generated. The analysis showed that industry began within the urban core along the primary routes of global-scale movement. However, as a new era of economic production took place at the end of the 20th century, the street network and industry followed a different spatial logic. Industrial activities spread along the periphery in island clusters in close proximity to global arteries of movement. Turin's centre, on the other hand retained a backbone of integrated streets that enabled its reinforcement when industry relocated. The analysis of their historic development shows that new concepts should be informed by quantitative analysis of the evolution of the urban street network and its effects on economic activity, such that the configurational logic described may provide the basis for future guideline policies.

KEYWORDS:

urban morphology, configuration analyses, industrial development, econometric analyses

FOREWORD

The article is based on studies of Laq-TIP (High Quality Lab – Territorial integrated project) in collaboration with formative experiences of the MSc in Advanced Architectural Studies, UCL. Basic concepts of Space Syntax theory are applied in order to develop new morphological rules for future industrial developments in the Metropolitan Area of Turin (AMT). Although Space Syntax analysis is not extensively and technically explained, the paper draws on the results displayed through graphic and visual analyses. The main configurational properties are highlighted and the location of industrial sites are initially questioned in this light. A series of correlations between the development morphology of industrial sites and the syntactic measure of choice¹ were proposed and some general properties about clusters presented. The last part of the article asserts that though traditional strategies of regeneration took place in Turin's city centre, key questions are left open regarding the distribution of present and past island clusters in the city's periphery areas.

1 INTRODUCTION

Cities and regions grow, shrink or collapse and accordingly sustain significant changes to the economic, social and environmental conditions. Over the last 30 years most mechanisms and internal systems have been investigated and published, but the forecasting or monitoring methods still lack effective policies. In the next 20 years, the City of Turin is facing strategic choices for a regional context broader than their administrative boundaries. Turin has published books and made attempt to forecast, describe and share future scenarios. The complex role of city space needs to be fostered with a new methodology with the aim of raising the awareness of local authorities whose actions are connected not only with their administrative boundaries but overreaching also in time.

The transformation of society in the last few decades has in a substantial way changed regional economic, social and physical structures. In particular, investments in transport infrastructures aim at urban regeneration and regional integration. In the last year, LAQ-tip has studied how various places are reproduced and transformed in the metropolitan area of Turin (AMT). The studies focused on the effects on local physical environments and social activities, and the interdependency between these two aspects, in relation to the development of the AMT. The data gathered includes interviews, document studies, statistical analyses and geographical information. The basic aim is to develop tools The Research Centre uses as predictive and monitoring methods for informing public authorities about the influence of spatial choices on the logic of urban structure.

Since 2000, much analysis of urban and territorial forms has paid great attention to the relations of configuration and land uses in the urban grid. There have been many different experiments with configuration analyses as an interpretative tool for the existing urban socio-economic and environmental city structure. A number of socio-economic, environmental and transportation data regarding the AMT has been collected and geo-referenced, and a consistent number of indicators becoming quality factors for guiding urban transformations.

Such data was assessed to provide insight on:

- the unforeseen effects of the masterplan and transformation of the city structure;
- the location of activities according to their likely public success and use;

¹ It is a syntactic measure applied to global and local conditions, measuring the movement "flow" through a space. A space has a strong choice value when many of the shortest paths, connecting all spaces to all spaces of a system, passes through it.

- movement patterns and flows in cities as shaped by the street network;
- the evolution of the local centres and sub-centres that makes cities liveable;
- how patterns of security and insecurity are affected by spatial design;
- how spatial segregation and social disadvantage are related in cities;
- how buildings can create more interactive organisational cultures;
- how existing cities, urban areas and buildings are linked in the configuration of the urban grid, and simulate the likely effect of new interventions.

These studies of Turin's city fabric are mainly driven by Space Syntax theory, a scientific-based methodology and analytic tool used to transform urban qualities such as movement, urban growth, activities and transportation growth from an undervalued resource into a tangible manageable asset for making local public authorities aware of socio-economic and environmental impacts. The following section will summarise three basic concepts of this theory: the theory of 'natural movement', 'centrality' and the 'movement economy'.

1.1 BACKGROUND CONCEPTS

Space Syntax was developed to understand space as an aspect of social life (Hillier 2007). A scientific methodology was developed in order to uncover the underlying structure pertaining to (city) space by way of its configuration. The rules of language are based on syntax as the sequence and connection between words that give meaning to our sentences. Spatial configuration (Space syntax) is the meaningful sequences and links in an urban grid, it is examined by way of the axial map. The axial map represents the linear nature of urban open space. The urban environment is reduced to an axial map that is a matrix of the 'fewest and longest lines' representing potential patterns of movement (Hillier 1996). According to Hillier, it is this patterning of movement that over time gives shape to an emerging urban environment called a city. The relationship between the urban grid and movement is referred to as the theory of 'Natural Movement' (Hillier 1996) and suggests that all things being equal, movement flows are systematically influenced by the spatial configuration of the street network. Thus, the urban grid plays a crucial role in movement, rather than other factors such as attractors or magnets (i.e. land use functions which influences the proportion of pedestrian movement within a system). This is because the urban grid has a pattern of integration which has the potential to draw different types of movement, generating more movement in some places compared to others. Integration is a configurational property measuring a line's 'depth' or 'shallowness' within the system, such that deeper lines or spaces result in more segregated integration values, which have the by-product of reducing the potential for movement and thus co-presence.

Moreover, if the grid has an impact on movement, this in turn will have an effect on the distribution of functional land use. The theory of the 'Movement Economy' (Hillier 1996) suggests that areas naturally attracting high levels of movement will attract movement-dependent land uses, such as retail. According to Hillier, such areas will have higher densities of development than other areas, and because of this will then attract more land use activities which will benefit from close proximity to those already there. Referred to as the 'multiplier effect' (Hillier 1996), this process generates many aspects associated with city life often taken as a given such as:

- diversity generated by a mixture of land use;
- co-presence of people intermingling as they participate in different activities;
- the vibrancy of well utilized spaces attracting more uses and more people.

Further to this, the movement economy contributes to the formation and location of core areas. 'Live centrality' or the element of centrality that is led by markets, retail, entertainment, along with other activities that benefit from movement, emerges as a spatially led process that changes over time (Hillier 1999). In 'Centrality as a Process' (Hillier 1999), Hillier explains how the process is dependent on both configuration and function, driven by the social and economic life of urban societies: as settlements grow, land uses are located according to the movement economy. Based on the study of several English town centres, core areas will emerge as linear segments of a most integrated line, which then, gradually become more convex and compact due to a process of grid intensification, in particular, where local grid conditions follow a 'two-step' grid pattern. As settlements grow, the pattern of integration changes, shifting the centrality outwards. With linear growth moving away from the centre, local sub-centres emerge along radial routes, with even smaller scale sub-centres developing away from the main radials. Significantly, the process works at a global and local level; globally, the process seeks those locations with respect to the settlement as a whole; locally, it is the local grid conditions that give rise to the centre.

2 SCENARIOS FOR THE *URBANIZED LANDSCAPE*

The complexity of mixed use cities requires a more accurate way of describing the configurational patterns that impact functional land use distribution. One of the basic questions is how to build new development scenarios for industrial spaces? How do these areas counteract or influence their configurational properties? Hillier describes the process of the 'deformed wheel' (Hillier *et al* 1993) that whilst governed by varying socio economic factors pertaining to different cultures, remains evident in all cities, such that the fundamental city form is a network of linked centres and sub-centres, at all scales of growth. It is also a dual process (Hillier 1996) between a foreground network of public space, shaped by micro-economic factors, and a large background network of residential space, shaped by cultural factors. Thus it is in the public realm – those movement-rich and integrated areas where people come together that the private realm divides.

The town planner and scholar Sieverts makes a claim towards redefining the European city in its contemporary state. He defines this as '*urbanised landscape*' or '*landscaped city*' – '*the built up area between the historic city centre and open countryside, between the place as a living space and the non-places of movement*' (Sieverts 2003). In this space, he proposes that rather than reinforcing the traditional assumptions about the two – romanticised historic centre and destructive suburban sprawl, this '*interpenetration of open space and built form, with open space as the binding element*' offers new creative potential (Sieverts 2003). Only by redefining this relationship is it possible to address the realities of the contemporary city in their totality, opening the possibility of a new model of order, which according to Sieverts, is more akin to the 'pluralistic and democratic society' of contemporary times, rather than the old model of a centralized city.

How is it possible to build scenarios for the (intermediate) non-place of movement? While syntactic analysis has provided the core theoretical framework for studying the configurational qualities of industrial sites, Sievert's view is considered when confronted with the results of the city 'as it is' and the proposition of the city 'as it could be'. An urbanized landscape can be reinvented through 'meaningful' open space.

3 OVERALL SYNTACTIC ANALYSIS

The spatial configuration of the city of Turin was examined over three periods, representing key phases of industrial development and decline – 1920's, 1970's and 2010. To start with, the city's grid structure, by way

of the foreground network was examined, followed by the functional – spatial relationship, specifically that of industry.

A series of syntactic measures – choice, integration, ... – (Hillier 1996) were selected in order to understand and describe the logic of the city structure and explain some key relationships. The foreground network was studied through the measure of choice, which at a global level (R_n) sets the parameters for movement within the system. Then, a smaller radii (R_{1000}) was used to get a better picture of the local street network in order to identify where and how localised centres are formed as well as to understand the differing patterns of movement between the two scales.

Looking at the street network, central Turin (1926, R_n) is characterized by a highly regular grid structure stemming from the historic core, which extends outwards to the north, west and south. This pattern becomes less regular as it grows outwards, forming an interface between two overlapping structures: the regular grid from the core moving out, and a secondary more organic network from the countryside moving inwards. The outer network is connected to the inner grid by way of long axial lines, carrying primary movement.

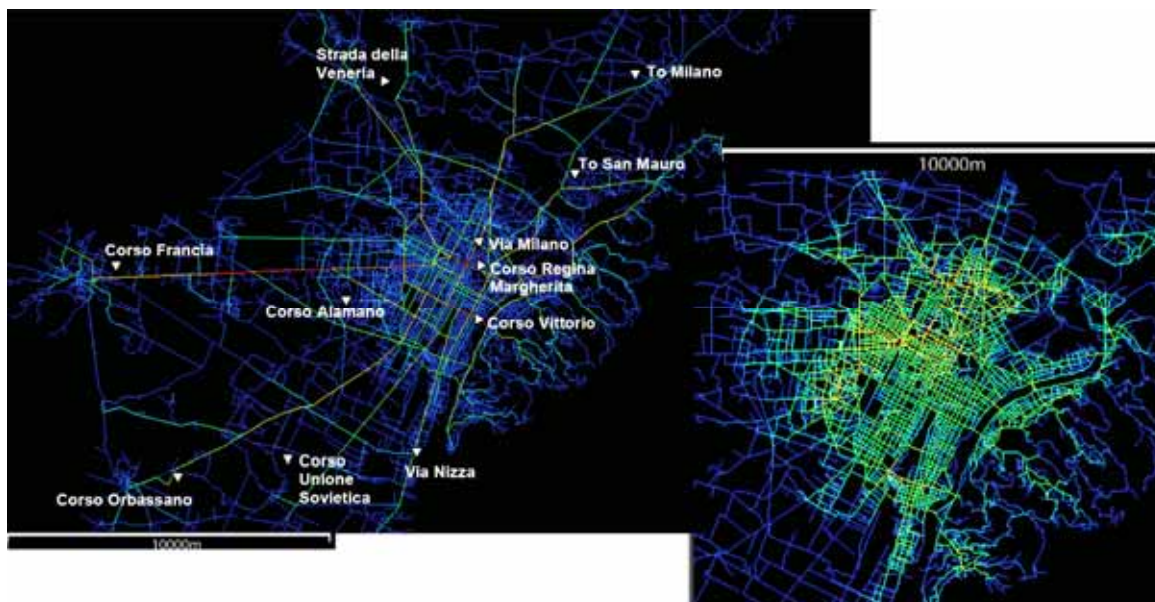


Figure 1 Global choice (R_n) measure and Choice R_{1000} : Segment Map Turin 1926

Starting with the global choice measure, in 1926, a series of intersecting lines can be observed that pick up the central grid structure.

Within the central area, the historic core has the highest values: bisecting streets Corso Regina Margherita and Via Milano, forming the Porta Palazzo square (intersection of the two roads), Turin's historic market place.

Further south along the grid, Corso Vittorio, traversing the city from east to west is also picked up in red, along with numerous parallel routes either side. This is attributed to the highly regular grid, which tends to distribute movement more evenly than irregular grids. A series of radial lines carry movement from centre to edge: Corso Francia (westward), Corso Orbassano (southwest), Corso Unione Sovietica and Via Nizza (south), Strada della Veneria (northwest), and the road to Milan in the northeast. We also see a lateral road outside the city, which, until 1912 was surrounded by the customs barrier (*cinta daziaria* from the 1906 masterplan). This ring road would have connected the surrounding villages without entering the city. Shifting

to a more local radius (R1000) a different picture emerges. The long axial segments previously identified in the global structure have now disappeared: a dense network of shorter lines in the central area as well as a selection of shorter lines in the surrounding network picking out the most likely 'through movement' paths at a local level. Here it is possible to recognize the 'seeds' of what are today some of the local centres of the quarters. In 1926, these constituted small neighborhoods or villages of a few streets. In this historic urban structure, some centres are bigger than others – for example Rivoli (historical village of the Savoy) – to the western limit of the system, is already quite sizeable compared to other surrounding areas.

The generic structure of Turin is made by a strongly centralised core with a network of centres linked to the centre by long radial lines set into a background network of residential space defined by shorter and deeper lines. As the system grows over time, this structure, to a large extent is maintained, despite urban expansion.

By 1970 greater urban consolidation has spread in most directions, resulting in a more widely distributed foreground network of global movement routes. Where the originally bisecting streets of Porta Palazzo in the historical centre had the highest choice value in 1926, there is now a decrease and a shift in high value to the west – Corso Potenza. This is attributed to 'centrality', the process by which centres shift over time as the network grows (Hillier 1999). Also, according to the concept of 'deformed wheel', Turin has to be aware of the internal core, which sustains present and future developments.

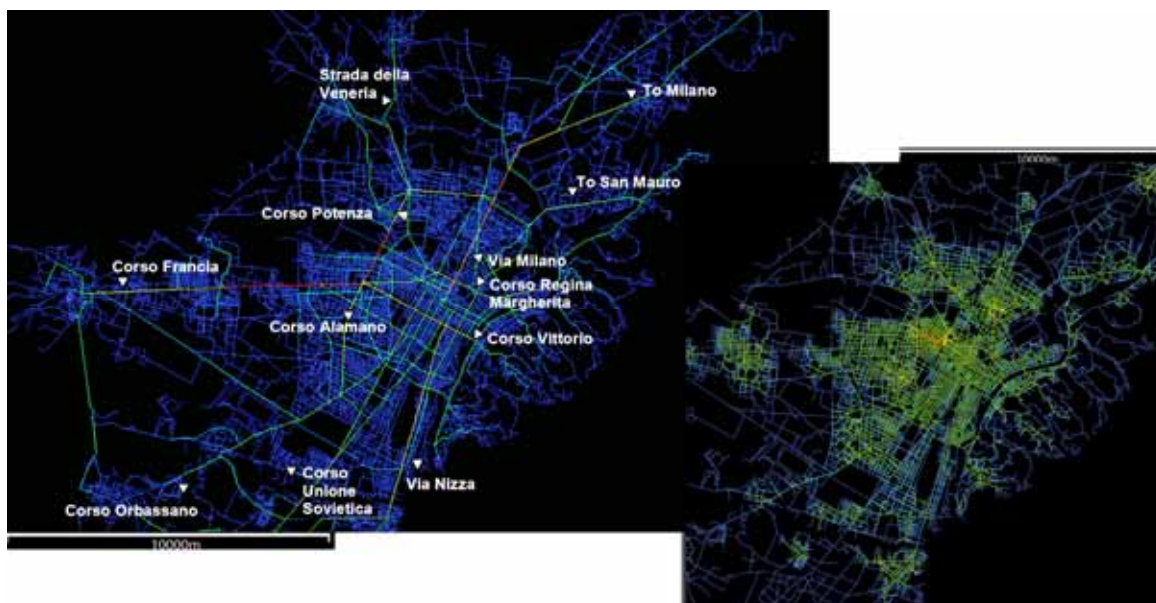


Figure 2 Global Choice (Rn) measure and Choice R1000: segment Map, Turin 1970

Further changes to the 2010 foreground system are identified by way of a new ring road – the freeway located outside the city boundary. Looking at the 1926 radial road, by 1970 it had largely broken. Given the completion of the freeway in 1976, the 1970 map suggests an outer network in transition – the old ring roads are making way for the freeway roads and their connectors – notably the western extension of Corso Margherita, and Allamano in the west. With the most notable post 1970 addition of the freeway along with its global connectors, the original global movement spokes in and out of the city are to a great extent maintained, despite the urban growth – largely constituted within the background structure – that has occurred over time.

At local choice, however, it is apparent that the 'seeds' emerging in 1926 have now developed into a number of sizeable centres.

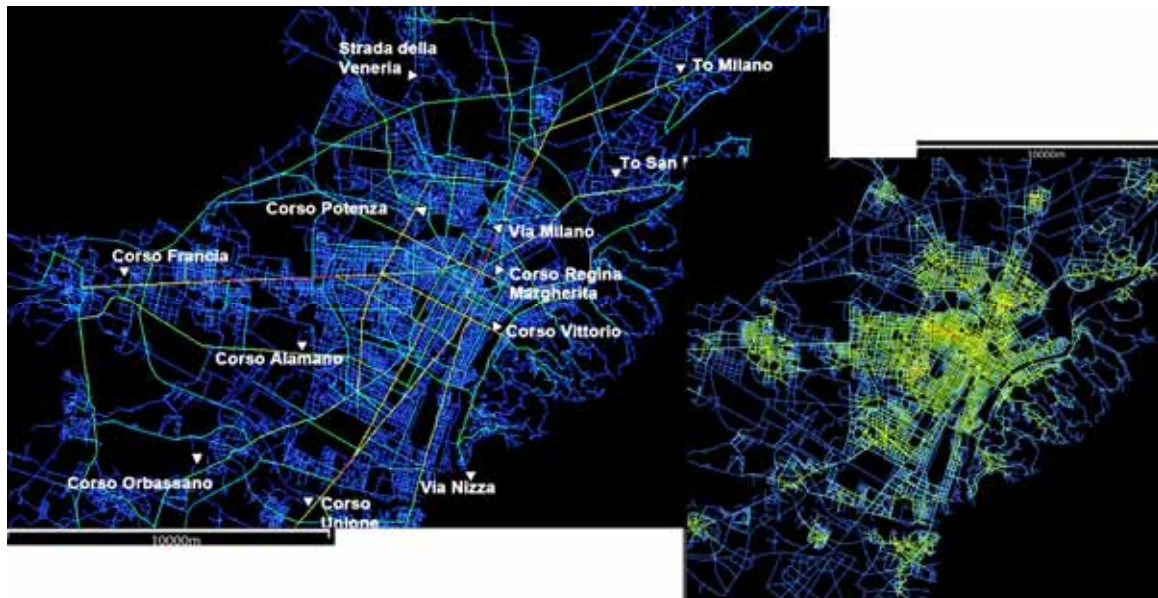


Figure 3 Global Choice (R_n) measure and Choice R1000: segment Map, Turin 2010

According to Hillier, town centres are articulated where grid intensification coincides with the globally strong alignments (Hillier 2009). Local properties are interrelated to global properties so that each centre is defined in relation to the system as a whole. This is picked up through local choice measure R1000, with the concentration of convex centres located along the global routes. In fact, a number of these formations become visible by 1970, which continue to grow more 'convex-like' by 2010, with newer ones emerging as grid intensification continues. While this gives a clear indication of the emergence of centres, a comprehensive study of each local centre is not covered in this article. However it is important to say that town centres and their emergence help explain the city's configuration in relation to functional distribution, in this case industry.

As stated above, movement – by way of local and global networks, becomes key, not just because it gives shape to the overall spatial system, but because it influences functional distributions within space by way of the Movement economy (Hillier 1996).

4 CASE STUDY: INDUSTRIAL SYNTACTIC ANALYSES

The syntactic analysis focused on the functional – spatial relationship related to industrial distribution. The aim was to find the clustering logic of industrial distribution (linear logic, disperse logic, detached logic and so on...). As the main literature has shown, movement is influenced by the spatial configuration of the urban network. According to Hillier, the 'movement economy' impacts the functional distribution of land use: a spatial system emerges, and as it does so it generates movement patterns, influencing land use distributions. These in turn create 'multiplier effects' – i.e. influencing further distribution of certain land uses to certain areas with further feedback on the local grid as it adapts to further development (Hillier 1996). This explains why land uses such as shops and markets seek movement rich locations within the grid, and other uses such as administrative or business zones are located in quieter zones in close spatial proximity to

the live centre. Examining the distribution of industry, it was initially assumed that industrial distribution is heavily dependent on the foreground network, such that it may facilitate the transportation of materials as well as workers to and from industrial areas and into the wider network.

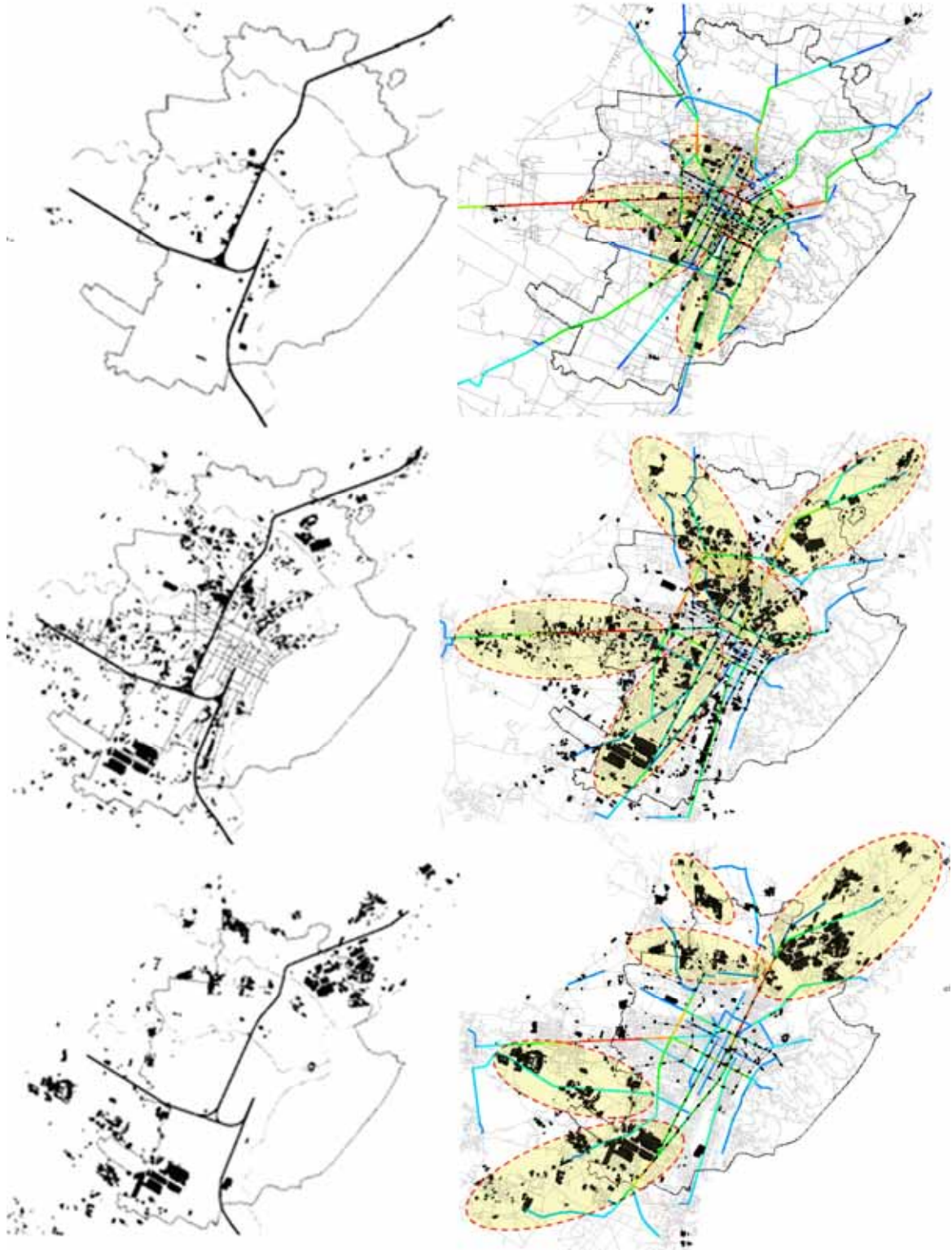


Figure 4 Diagram of industrial units and cluster concentrations highlighted in yellow with a selection of most relevant choice measures

Starting with 1926, and without considering areas beyond the city limits, three distinct clusters of industrial growth are identified.

The first cluster sits immediately north of the city historic core, spreading west to east along the river from the intersection between the Dora River and the northern railway line. From historical accounts, traditional manufacturing such as textiles and armaments were located in this area. A second cluster is located further south along the same railway line (the 19th century western city edge). The third area is in the southeast of the city: bound by the southern railway line and the River Po to the east.

Upon first observation, the main organising logic at this point appears to be proximity to the railway lines and water. Overlaying the industrial layout with the segment map however, in the majority of cases industry is nestled either between the railway lines and/or the river, and along or within close proximity to global choice routes. There is a linear pattern of industrial distribution alongside the railway lines, it is possible to see that high choice routes run parallel to the tracks. This suggests that the railway infrastructure is embedded within the city's movement network, meaning that those industries seeking proximity to the railway lines also benefit from proximity to global movement. Furthermore, in the early twentieth century, Turin had a comprehensive tram network system. The tramlines were traced over the system and overlaid onto the segment map. It is possible to highlight that the main tram routes follow the global choice routes and the shorter tramlines coincide with the more local choice routes (picked up at R1000), further enhancing movement efficiency between industry and transport infrastructure.

Regarding the remaining industry within the city that appears more fragmented and randomly located, almost all are located either on or in close proximity to the global choice routes of highest value. In particular, there are a number of units located within the western fabric of the city – an area under rapid expansion characterized by a less regular grid structure. Again, industry is located either on or close to global routes identified in the segment map. Combining all industrial units in the system, and creating a 500 metric 'buffer' around the top 10% global routes, the analysis found that 82.18% of units are located within these parameters.

From these results it is maintained that for industries that did not depend on the proximity of the railways or water, configuration played an important part, spreading in a linear fashion along global choice routes, setting the stage for future industrial settlement.

By 1970 – Fordist organisation at its peak – two overriding patterns emerge: firstly, industrial activity is heavily intensified within the confines of the city: the areas previously identified in 1926 – the traditionally industrial Borgo Dora north of the city has extended further north towards the Stura River, and significant linear consolidation along the railway lines has developed. Secondly, a distinct pattern emerges from the outer edges of the city centre spreading outwards into the surrounding periphery.

This pattern is consistent in all areas – from the north, west and southern edges of the city; as the central agglomerations spread outwards they take on a very linear form. Overlaying industry with Choice, the dispersal follows along or within close proximity to the main global choice routes. Measuring the relationship between global choice routes and industrial distribution, a very high 59.26% of industrial units are located within 500m of the highest 10% global choice routes highlighted on the segment analysis.

Returning to the city area, as more industry is rapidly introduced into the system the previously linear patterns in 1926 have consolidated into thicker agglomerations of almost entirely industrial areas, which, as they grow, start to occupy areas, which configurationally would benefit from other land use functions. Syntactically, this is shown by the high amount of industry in the north and western parts of the city occupying high local choice segments. This explains the overwhelming appearance of industry that

characterized Turin's city in the second half of the twentieth century. This is also supported by the value of 18.09% of industrial units found to be located within 500m of the highest 10% local choice segments.

Is it possible to hypothesize that as industry settled along global routes in close proximity but not in the 'live centre', as highlighted locally, they continued to expand (due to the manufacturing boom) into dense agglomerations, in places occupying parts of the network that, all things being equal, would have carried other land-uses?

Following the beginning of decline after the 1980s, the transformations are equally substantial. One part of the system has experienced massive deindustrialisation, yet another has experienced new industrial growth.

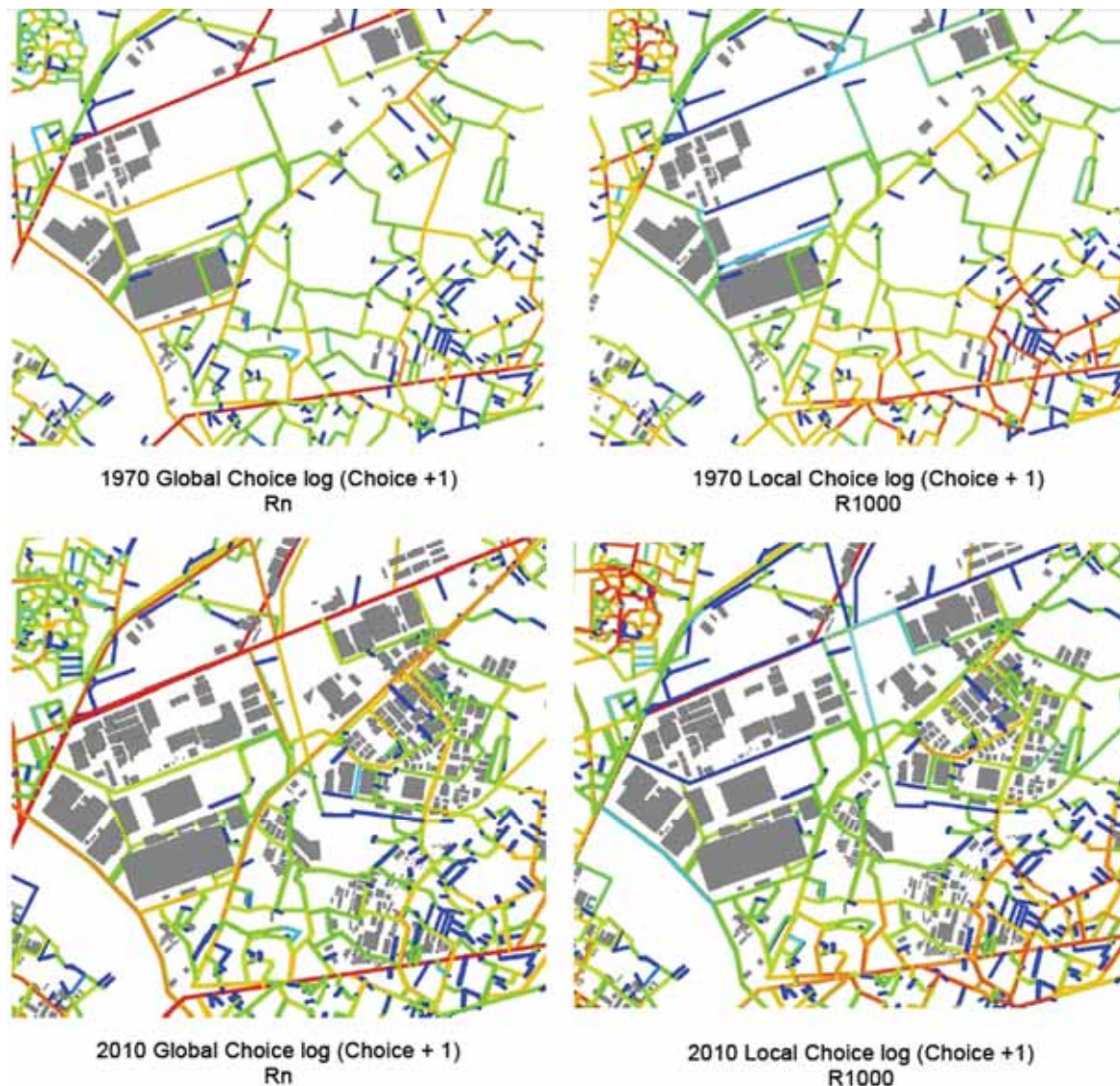


Figure 5 The biggest industrial site of Turin Metropolitan area. Comparison of local choices in a cluster expansion period

By 2010 a reversed pattern of industrial distribution is presented. With the exception of the largest plants in the system – FIAT Mirafiori to the south and IVECO to the northeast, with their adjoining agglomerations – the city centre is almost entirely devoid of industry. The remaining industry is located on the boundary edge of the city, and when viewed as a complete picture forms agglomerations that cross the administrative boundaries. They are positioned at the edge of two systems: the edge of the city, and the edge of the

surrounding town centres. Syntactically, comparing the 'Fordist' period and the 2010 maps, linear pattern has formed discrete clusters. Global movement routes again play an important role, as the clusters are located off a portion of one of these segments, often nestled between two choice segments. Overlaying the freeway (also picked up by global choice) we see a visible correlation between the freeway and the clusters. Unfortunately it was not possible to obtain a statistical correlation isolating the freeway routes, however regarding the overall relationship between industry and global choice, it was found that 2010 displayed a lower, yet still high value of 38.6% of industry settling within 500 m from global choice routes. Examining local choice measures, the transformation from linear to clustered form in relation to the surrounding centres is even more visible. By comparing the 1970 segment map to today, in the transition from linear to cluster, the relationship to local movement is less varied than in 1970, with industry consistently nestling in low local movement areas.

Comparing the 1926-1970 periods to the 1970-2010, much of the grid intensification took place between the first phases of study. Thus, in broad terms we can assume that land use and grid intensification was occurring as a 'live' process.

As these centres grew over time, industry, as it happened within the city, sought the most peripheral areas in relation to the town centres. These have emerged as almost entirely mono functional clusters with weak local properties bound by high global properties (Pescarito area), from a spatial dimension, grid intensification and the movement economy explain how this process takes place: linear agglomeration takes its cue from global properties of the network, and island clustering, once settled according to global network, depend on local grid conditions.

By extension, it would seem that linear dispersal represents a 'first phase' of (industrial) organization, and 'island clustering' a subsequent phase. These conclusions are based on observing local and global patterns illustrated on the segment analysis, but would need to be further substantiated by more detailed empirical evidence. However, it is possible to draw some evidence from the significantly lower value of 7.62% of industrial units located within 500m of the highest 10% local (R1000) choice routes .

4.1 LOGIC OF CLUSTERING FROM 1970 ONWARD

In examining Turin's industrial evolution, there has been a dual process occurring since the 'crisis point' from the late 1970s onwards: significant deindustrialization by way of vacant and decommissioned sites within the city boundary, and at the same time, a process of industrial clustering along the edges between the city and wider metropolitan area. Up to the 1970's, industry was widely dispersed within the city centre – particularly the northern and western parts of the city. This is further supported by the high 38% of street segments containing industrial land use.

However by 1989, nearly 1 million m² of industrial land stood vacant and abandoned (Dansero 1996). By 2005, almost all of it had been reused.

Studying the breakdown of transformation, what role, if any, did configuration play as to the capacity for transformation of industries? In order to examine the role of configuration and industrial transformation more closely, industrial units were converted into points correlating land use values with syntactic values (these points represented the phases before and after transformation - ie. industrial peak, those sites lost through deindustrialization and those remaining after post-industrial transformation). A comparison was then made between the R-values for each set of points. However, no significant correlations emerged, making it difficult to ascertain the role of configuration in industrial transformation.

Moreover, comparing industrial streets segments that have been transformed into new uses, (Ex Industrial streets) to current industrial streets, all show higher mean values. Segment Length and Metric step depth² show that industry tends to be located in street segments of higher length compared to non-industrial streets, as well as the system as a whole. Industry is also located in areas of greater step depth than those without industry. Step depth, in segment analysis, follows the shortest angular path from selected segments to all other segments within the system, thus it confirms again the shift of industry from close proximity to global choice routes to areas nestled deeper in the system when measured from the global movement routes.

Comparing ex-industrial streets to non-industrial streets, all syntactic measures tested were consistently higher in ex industrial streets segments compared to non-industrial streets. Metric depth (Rn) measured much lower in industrial streets at 407.193 compared to 711.179 confirming the trend for more recent industry to seek deeper locations compared to in the past.

A summary of spatial-physical properties can be drawn from the logic of industrial cluster development:

- During the period of economic growth (1926-70), global choice measures coincide with railway accessibility in the positioning of industrial sites. There is a correspondence between global movement, industry and the railway system.
- During the period of economic growth (1926-70), industrial clustering emerges through linear expansion. Clusters become denser and expand but they occupy land within the city core that is syntactically suitable for other uses.
- During the period when industry relocates from the city to edge (1980-2010; knowledge society), linear clusters become islands of discrete clusters.
- Linear clustering depends on global choices measure while island clustering is influenced by local choices measures. The latter is visible in 1926 and 2010 period of analysis; it shows a locally introverted morphology that reinforces the cluster.
- Shifting from industrial to other uses, the configuration displays higher mean values in the deindustrialized sites and a preference for new industrial sites to be situated in areas with long segmented length and step depth.

These are general and flexible rules, however they can orientate how clusters cooperate and adapt within a resilient planning policy.

5 CONCLUDING REMARKS

As explored through Scott, Harvey and others, space is central to industrial production, and the relationship changes over time according to transitions within the cycle of production. The study found that spatial configuration contributed to understanding the logic of industrial distribution. Furthermore, spatial configuration elucidated the relationship between industrial land use with regards to the pattern of the cities as a whole.

In the urban evolution of Turin it was found that industry moved and re-agglomerated over the three time frames studied. It began as a linear process within the city and evolved into clusters towards the city edge and surrounding towns. It was found that choice – a measure of movement throughout the system – played an important role. In particular during the early years of industrial growth and as Fordist accumulation took hold, reaching its peak around the 1970s, a significant proportion of industry was located along the primary (global) movement routes. This figure became smaller over time as Fordism reached its maturity and a new

² Syntactic measures which are directly connected with the length of the linear nature of urban spaces.

era of organisation took hold: industry spread, initially in a linear fashion away from the city, to form new agglomerations, favourable to the demands of flexible specialisation and smaller interrelated industries. Such arrangements are supported by configuration, with syntactic evidence of global and local choice routes indicating a pattern of industrial settlement: industrial clusters located in 'islands' of weak local choice values routes situated in close proximity or leading off high value global choice routes.

Despite deindustrialisation that characterised Turin's city centre throughout the 1980s, industrial sites have transformed to accommodate the emergent 'knowledge society' (Torino Internazionale 2006). Industry left the core, and despite a period of decay and social unrest, the city has regained its image as a safe, vibrant, and culturally rich centre for its citizens. How does this investment on the centre reconcile with its surrounding periphery? Returning to Sieverts, he suggests that it is to a great extent because of this one sided love that issues pertaining to an 'unloved suburbia' remain unchallenged (Sieverts 2003, 17). For this reason, the division between city and countryside is maintained, despite the changing urban and social reality. Turin's masterplan argued for a '*polycentric city open, able to unite people rather than isolate them.*' (Torino Internazionale 2006). Syntactic analyses displayed an overriding monocentric structure that persists. If the 'non-places' of semi agricultural landscapes scattered with freeways, supermarkets and monofunctional industrial parks dominate the outer suburban belt, how have the recent changes addressed this world? While further detailed investigation of these areas would be required to ascertain a more complete view of the relationship, the results from this study concur with Sievert's view, that while readapting to the needs of the 'knowledge society' which occupy the city core, the focus has again returned to the city, leaving unanswered questions relating to the surrounding environment.

It is possible to conclude, however, that configurational analysis has demonstrated the powerful contribution of space in facilitating post-industrial change. Currently, a new public organization is studying the new Strategic Plan for Turin³. It is suggested that spatial configuration, by way of the interdependence between local and global networks, can further assist and should be taken into consideration when future questions pertaining to the surrounding urban territory are raised and new planning strategies are proposed.

REFERENCES

- Are M., Venere M. (2006) *Il Riuso di 128 Area Industriali a Torino: Conclusione del Monitoraggio 1989-2005*, Tesi di Laurea, Facoltà di Architettura, Politecnico di Torino.
- Bazzanella L., Caneparo L., Corsico F., Roccasalva G. (2012) *The Future of Cities and Regions: simulation, scenario, Governance and Scale*, Springer.
- Castells M. (1989) *The Information City*, Blackwell, Oxford.
- Corsico F., Roccasalva G. (2005) "Visu-an-alyse indicators of urban quality. The crucial role of forecasting Scenarios in sustainable decision making processes", *International Conference for Integrating Knowledge and Practice, Life in The urban Landscape*, Gothenburg.
- Dansero E., Giaimo C., Spaziante A. (2008) *Se i Vuoti Si Riempiono; Aree Industriali Dismesse: Temi e Ricerche*, Alinea, Firenze.
- De Rossi A., Durbiano G. (2006) *Turin 1980-2011; Its Transformations and its Images*, Allemandi, Turin.
- Gartman D. (2009) *From Autos to Architecture; Fordism and Architectural Aesthetics of the Twentieth Century*, Princeton Architectural Press, Princeton.
- Hall P. (1998) *Cities in Civilisation*, Phoenix Giant, London.
- Harvey D. (1978) "The urban process under capitalism: A Framework for Analysis", *International Journal of Urban and Regional Research*, 2(1-4), 101-131.

³ 'Torino Strategica' took the legacy of 'Torino Internazionale' and is studying new strategies for the Metropolitan Area of Turin.

- Harvey D (1990) *The Condition of Postmodernity*, Blackwell, Oxford.
- Hillier B., Hanson J. (1984) *The Social Logic of Space*, Cambridge University Press, Cambridge.
- Hillier B. (1996) *Cities as Movement Economies*, Cambridge University Press, Cambridge.
- Hillier B. (1999) "Centrality as a process: accounting for attraction inequalities in deformed grids", *Urban Design International*, 4, 107-127.
- Hillier B., Netto V. (2001a) "Society as seen through the prism of space-outline of a theory of society and space", *Proceedings of the 3rd International Space Syntax Symposium*, Atlanta, 13.1-13.27.
- Hillier B. (2007) *Space is the machine: a configurational theory of architecture*. Space Syntax, London.
- Hillier B., Turner A., Yang T., Park H.-T. (2007) "Metric and topogeometric properties of urban street networks: some convergences, divergences, and new results", *6th International Space Syntax Symposium*, Istanbul, Turkey.
- Hillier B., Vaughan L. (2007) "The City as One Thing", *Progress in Planning*, 67(3), 205-230.
- Hillier B. (2009) "Spatial Sustainability in Cities; Organic Patterns and Sustainable Forms", D. Koch, L. Marcus, J. Steen (eds.), *Proceedings of the 7th International Space Syntax Symposium*, KTH, Stockholm.
- Hillier B. (2009) "The Genetic Code For Cities – Is it simpler than we think?", *Conference on Complexity Theories Of Cities Have Come Of Age*, Keynote Paper, TU Delft.
- Hillier B., Turner A., Yang T. Park H. (2010) "Metric And Topo-Geometric Properties Of Urban Street Networks; Some convergences, divergences and new results", *The Journal of Space Syntax*, 1(2).
- IRES (2008) *Carta del territorio: La Proposta del Piemonte per un nuovo governo del territorio regionale*, IRES, Torino.
- Jacobs J (1969) *The Economy of Cities*, Pelican Books, Gretna.
- Maggi M., Piperno S. (1999) *Turin, The Vain Search for Gargantua*, Working Paper, 124, IRES, Torino.
- Nelson G. (1939) *The Industrial Architecture of Albert Khan*, Architectural Book Publishing Company, New York.
- Sieverts T (2003) *Cities without Cities: An Interpretation of the Zwischenstadt*, Spon Press, London, New York.
- Torino Internazionale (2006) *Second Strategic Plan for Torino's Metropolitan Area*, downloaded <http://www.torino-internazionale.org/EN/>.
- Turner A. (2004) *Depthmap 4: a researcher's handbook*, Bartlett School of Graduate Studies, University College London, London.
- Yang T. Hillier B. (2007) *The fuzzy boundary: the spatial definition of urban areas*. Istanbul Technical University, Istanbul.

ACKNOWLEDGEMENTS

The essay is due to a collaboration between Giuseppe Roccasalva and Amanda Pluviano and images are elaborated for this article and adapted from her Master's thesis at The Bartlett, UCL.

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