Road Building and Urban Change

A morphological and configurative explanation of how ring roads change the pattern of distribution of shops in city and town centres

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Abstract
This paper presents a new approach to the problem of how large road projects built in short time affect the spatial and functional structure of cities and towns. Ring roads are chosen for two reasons: They are clearly defined road projects, built in relatively short time. The interrelationship between road building and spatial and functional changes in town centres is scarcely understood although conjectures about their interdependence are not lacking.
Birmingham, Coventry, Wolverhampton and Bristol were chosen for case studies. The method of investigation is mainly Space Syntax method. The results are discussed with reference to planning processes and changes in land use.

First and foremost this paper discusses the structure of the street grid and the pattern of shops before and after the construction of a ring road.

This contribution is meant to set out in which way different types of ring roads affect the pattern of shops in town and city centres. The paper claims that a development of this sort can be explained best through a configurative analysis. The way in which a ring road is imposed upon a street grid and the specific manner in which this ring road is connected to the relevant streets decides upon the resulting pattern of shops.

Keywords:
street networks, ring roads, traffic planning, urban design

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Important Questions and Background

This paper tries answer the question of how ring roads change urban areas. Coventry, Wolverhampton, Birmingham and Bristol are chosen as case studies. I will investigate as to whether a change in the street configuration (physical, more precisely spatial changes of the town) affects the distribution of shops and retailers or not (functional changes of the town).

Up to now, little research has been done on new larger road projects and their impact on town centres. The relationship between road construction and spatial development in urban areas are poorly understood. Most researchers have treated these two aspects separately. Engineers have occupied themselves with questions as to how larger road projects produce changes in traffic flow and in the road net of towns. They concerned predominantly with the task to build a road net that will be able to carry the expected traffic flow. On the other hand researchers in architecture and urban planning have occupied themselves with solving the formal problem of implementing functions required in urban areas. So far, nothing has been done in order to understand how larger road projects contribute to changes in the spatial situation of towns and how they change the distributions of functions in towns.

The ring road has been chosen as topic because in most cases a clearly defined road project is carried in a relatively short amount of time. Usually, it takes 20 to 30 years to build a ring road, and most of them encircle town centres. It is worth studying how a ring road changes the dispersal of shops and retailers. Hence, the distribution of shops before and after the ring road's construction has to be identified.

Two questions, in a sense conflicting with one another, had to be set up before approaching the configurational issue. On the one hand, we want to know whether a ring road as such is attractive for the establishment of new firms and shops, or whether the spatial configuration of the street grid system decides where shops locate themselves. On the other hand, we would like to know whether a ring road is a road which forces heavy car traffic to travel around the town centres which in turn function as an attraction for new firms and shops. But, likewise, the spatial configuration of the road net might decide where shops establish themselves.In order to answer these questions one could choose towns some of which have shops around their ring road and some which do not. It will be fruitful to parallel their comparison with an analysis that applies Space Syntax method.

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Furthermore, one wants to know whether a ring road destroys the town centre as an attractive place to live at or to move through, or whether it could further opposite effects. The answer seems to depend on how ring roads are connected to the street configuration of the town centre. Earlier analyses of towns suggest that the relationship between the integration and connectivity of axial lines decides as to whether a town centre is an agreeable place with good vitality in the shopping streets (Hillier, Penn, Hanson, Grajewski and Xu 1993, p. 61). Most ring roads are imposed onto an existing road net. This precondition has impacts on the movement within the urban grid and on other transport interchange points like e.g. orientation from the railway station to the town centre.

Even so most ring roads have been constructed between 1955 and 1985, many towns still consider the ring road to be a solution for their heavy traffic problems. For some towns a ring road might be a way out while for others the implementation of a ring road could lead to a disaster. This particular context makes it important to gain a systematic insight into the way in which ring roads affect the spatial and functional aspects of town centres.

In general, the relationship between road construction and its impacts on use of and life in urban space have not been investigated sufficiently. Little has been written specifically about the relationship between these topics, and almost no research has been carried out on larger road projects and the spatial, functional and structural change of town centres. Even so adequate literature is scarcely available, conjectures as regards the consequences of larger road projects for urban life are manifold.

Different types of ring roads and their function

The main purpose of a ring road is to relieve the town centres from cross traffic. It is meant both to divert traffic that has no business in the town centres and to redistribute traffic bound in and out of town centres. Likewise, heavy transport should be led away from the town centre, and the flow of car traffic should be distributed via different areas into the centre of town. The ring road should improve the vehicular access to a town centre, it should offer better car traffic flow through the town as a whole. Ring roads built after the Second World War had to accommodate the anticipated growth in vehicular traffic. One must keep in mind that at the time when ring roads first were planned and built, one was expecting an explosion

in the growth of private car traffic. At that time, a ring road was regarded as a solution for the distribution of large numbers of cars. Furthermore, a ring road was believed to open up new opportunities for pedestrian streets in the town centre, areas almost free from heavy car traffic.

A ring road is defined to be a main part of a town's road and street structure that encircles its central core. Most ring roads are planned and imposed upon an already existing town structure. The type of ring roads that will be examined in this paper is the new ring road that breaks into an existing structure and creates a totally new road structure. In most cases, old slums, old factories, and shabby areas with low property values gives room to new road constructions. It seems that such changes affect the whole street structure of a centre of town as well as the vicinity of the ring road.

Two contradictory views on the relationship road building and functions

In 1960 Mr Colin D. Buchanan was appointed by the British Minister of Transport to make a study on long-term development of motor traffic in urban areas and its effects on cities. This report, known as The Buchanan report, argued that most of the European towns and cities had a street structure inadequate to face the predicted explosive rise in car traffic.

The report's understanding of functions assumed in particular that "the function of the network would be to serve the environmental areas and not vice versa" (The Buchanan report 1963, p. 60).

Apparently, this means that a high number of different functions in town centres favours intense traffic of both people and cars. Function is thus taken to be an attractor for movement. The report takes urban environments of high quality to be safe to move through and to be free from traffic noise and pollution. However, there is little understanding of how functions like retailers and shops establish themselves along the network and how they respond on where people move, whether by car or by foot.

The Buchanan report did not consider the idea of ring roads to be a means to relieve town centres from vehicular traffic. The ring road was taken to be a road constructed for its own sake, and to organise traffic away from the town centres. Therefore the report proposed a hierarchic distribution of different kinds of road distributors which should canalise movements from locality to locality.

The report was aware of the role of streets to "give access to buildings, to give light and air and that they are setting for architecture and they are backbone of the everyday surroundings for many people" (The Buchanan report 1963, p. 73).

The report's understanding of streets correlates little with the proposed solutions for central shopping areas, where pedestrian movement and car traffic are separated. The Buchanan report had a negative view on ring roads. But still, its proposal to distribute different kinds of roads distributors hierarchically was as inappropriate as the city engineers ideas regarding the relationship between street grid and distribution of shops. Subsequently, it turned out that those large road plans and planned centre areas did not function as they were supposed to. Apparently, it is not sufficient to create a centre with shops and to hope for that people will come thereto so that its social life will flourish.

The other view has it that an urban centre is never stable, but consists in a process. The distribution of functions is dependent on the spatial configuration of the street and road net. Hillier and his colleagues at the Space Syntax laboratory propose that there is a relationship between the physical form of cities and the economic processes taking place in them. In his view these aspects are interrelated by space. The relevant processes involve reciprocity; i.e.

they depend on each other (Hillier 1996, p. 42). Moreover, Hillier, Penn, Hanson, Grajewski and Xu have recognised configuration, movement, and attractors as 3 determinants of the way in which shops situate themselves within the urban network. First of all, shops present themselves in streets where most people move. Apparently, shops tend to become attractors for the people's urban movement. Attractors and movement may influence each other, but they do not influence the configuration of the urban grid. On the other hand, the grid seems to influence movement and attractors (Hillier, Penn, Hanson, Grajewski and Xu 1993, p. 31). Considering the situation of Wolverhampton, Coventry, Birmingham and Bristol before their ring roads were built, the shops as well as the configuration were attractors for movement towards and within the centre of town. If the ring road changes the configuration of the grid, then it is worth noticing as to whether the distribution of shops is changed. Due to lack of time, bar counting was not carried out. So, the emphasis will lie on the relationship between aspects of attraction and configuration. More precisely, the present work will concern functional and spatial aspects of the ways in which ring roads change the dispersal of shops.

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More recently, Hillier proposed that configuration generates attraction (Hillier 1999, p.108). Centrality is defined not to be a state, but a process with both spatial and functional aspects (Hillier 1999, p.109) "Successful life centres require both a global position in the settlement, and compact and inter-accessible local layout conditions. This is the basics shape of centrality" (Hillier 1999, p.119). While integration analysis measures topological centrality, a "2 steps analysis" shows how much of a local area is covered 2 steps away from an axial line (local grid conditions). The 2 steps analysis will be an important tool for understanding how from a functional as well as spatial point of view a ring road changes shopping streets.

The method of investigation

Space Syntax can answer questions concerning the configuration of a grid. The results of configurational analyses can be compared with the actual distribution of localities, e.g. shops. It is possible to contrast it with the changing distribution of localities before and after a ring road is built. Another useful method of assessing how streets are used consists in walking through the relevant town centres after most of their shops are closed, and to inspect how their distribution correlates with an axial analysis. Bar counting is yet another effective and useful method to test out how different streets are used. However, to employ this method either requires a large amount of time or a lot of personal resources.

As Coventry and Bristol were heavily bombed in 1940, a registration of functions dating from 1955 is likely to give a distorted picture of the situation before the ring road's construction. However, a registration of all four towns was carried out in 1940. All four towns managed to finish a map of their centres before the war broke out. Due to strict copyrights rules, it was impossible to obtain more than an A-4 copy of the maps scaled 1:10000 of these towns. They all date from around 1940 and 1955. Hence, only the area around the centre and the vicinity of the ring road could be analysed. The scope of the area on which the global analyses are based can slightly distort the result as to which lines get the most integrated values.

Fortunately, all four towns possess a rich photographic documentation of most of their streets before the war. According to the directories from the 1930s and from 1955, most of the shopping streets correspond to the old pictures. Other functions like for example pubs, post offices, industry, churches, town halls, clubhouses, theatres, cinemas, leisure centres, hotels and banks are easy to register. Most of them can be identified on old and new maps

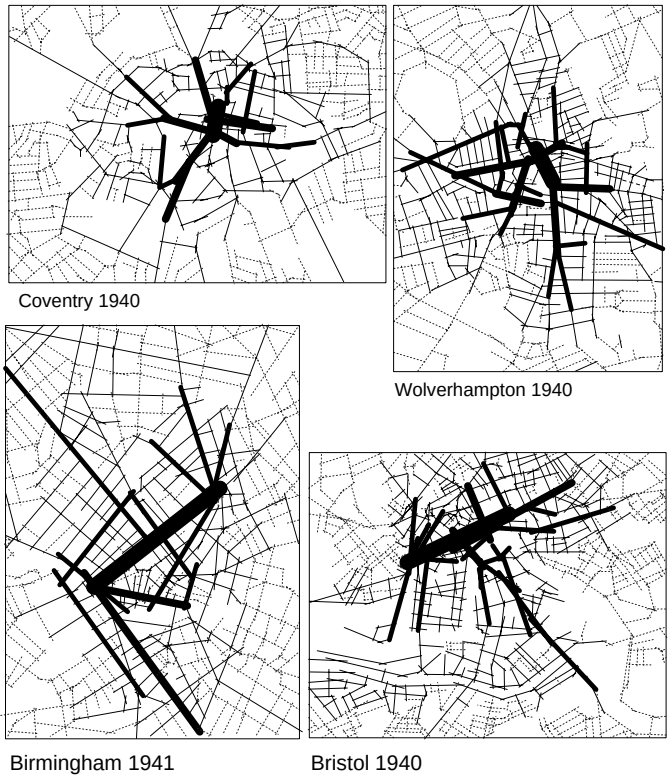


Fig. 1. The global axial analysis of Coventry, Wolverhampton, Birmingham and Bristol around 1940.

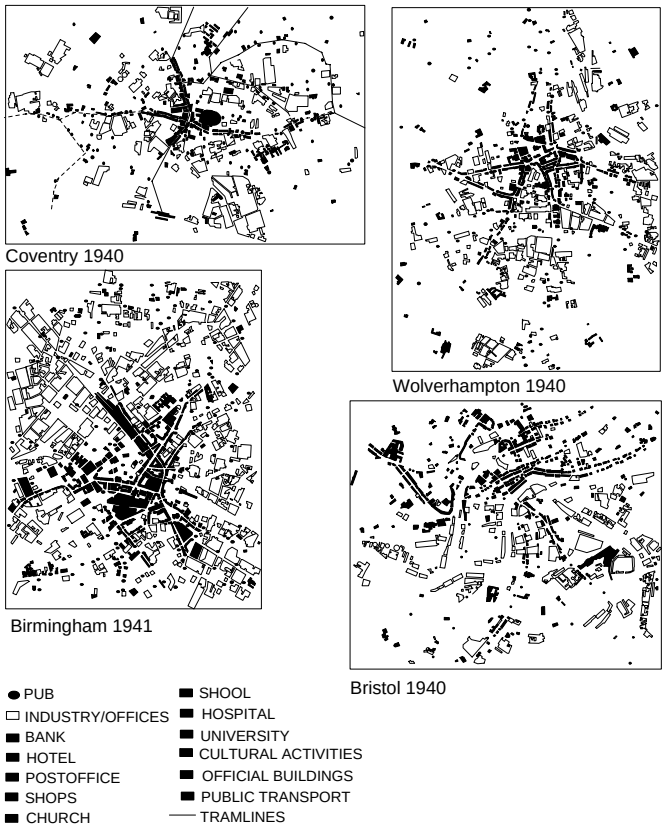


Fig. 2. The functional situation in Coventry, Wolverhampton, Birmingham and Bristol around 1940.

scaled 1:1250. For an improved registration of the placement of shops, these directories were a useful source.In all four cases, the ring road has been imposed upon different kinds of street grids. By using Space Syntax method and by comparing the results of its application with actual land use changes, it becomes possible to explain in a general way how ring roads affect town and city centres.

The analysis of the four towns and cities

It is obvious that a ring road changes the configuration of the street grid. The way in which a ring road is imposed upon an existing street grid pertains to the sense in which the ring road affects the pattern of shops. The analysis of Bristol seems to indicate two things: the difference between the highway and the boulevard standard on a ring road, and the way in which the ring road is connected to the street grid affect the pattern of shops.

Fig. 1 shows the global integration of the grid of all four cases around 1940. Fig. 2 shows the pattern of functions for all four cases in 1940. The black pattern of shops can clearly be seen from the functional registration. Except for the case of Birmingham, the central shopping areas are located along the most integrated axial lines. The shops in Birmingham are located along the second best integrated streets with the highest density of axial lines that can be reached in a short metric distance from the main lines. The pattern of shops has a linear shape in all four cases. In the centre of Birmingham the shops form two beady rings. Thus there is a correlation between the spatial and functional situation in the 1940 analyses.

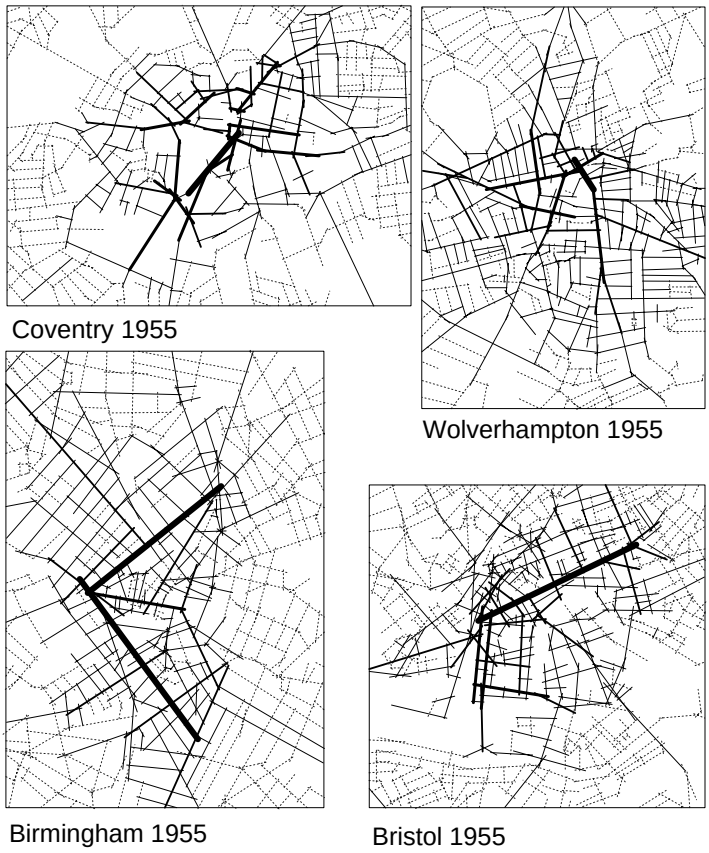


Fig. 3. The global axial analysis of Coventry, Wolverhampton, Birmingham and Bristol around 1955.

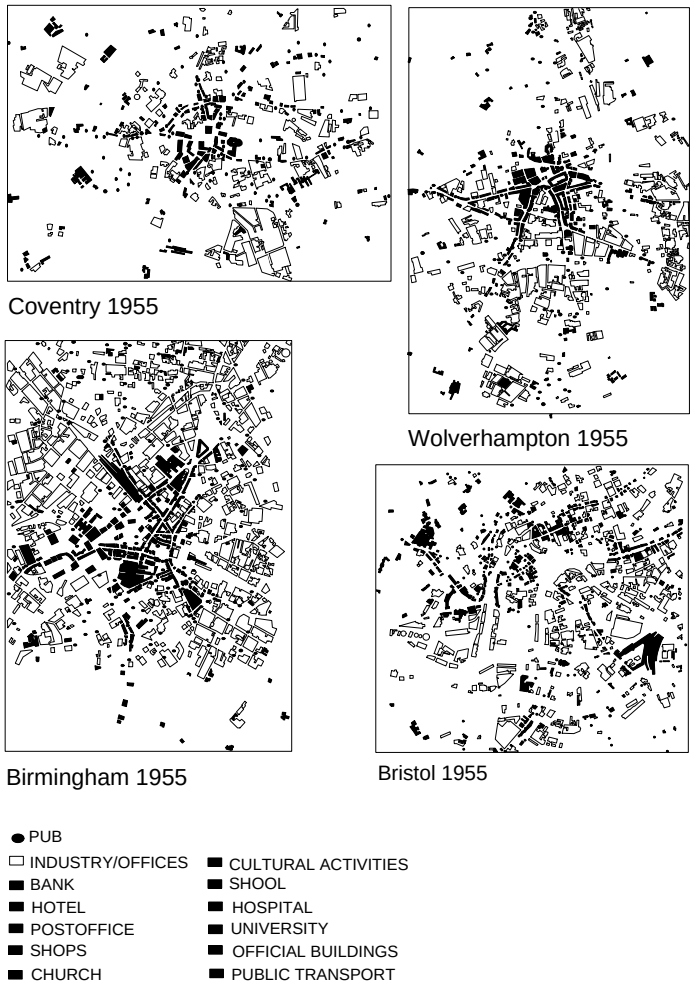
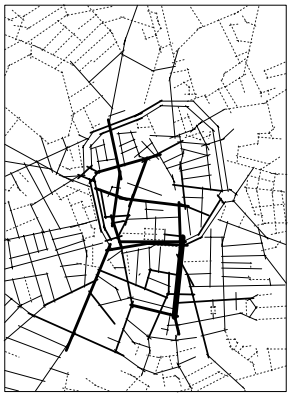


Fig. 4: The functional situation in Coventry, Wolverhampton, Birmingham and Bristol around 1955.

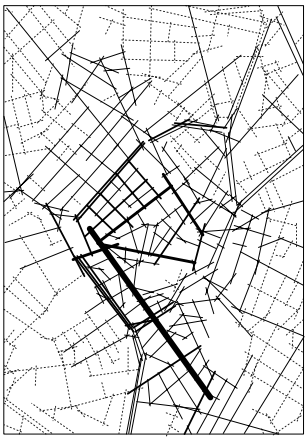
Fig. 3 shows the global integration of the grid of all four cases around 1955, and fig. 4 shows the pattern of functions around that time. Almost no change occurred in the situation of Birmingham and Wolverhampton as regards the structure of the grid and the structure of the shops. The black pattern of shops looks distorted in the case of Bristol and Coventry. However, in the case of Coventry shops are still located along the most integrated lines. Coventry was busy at that time to implement its ambitious new visionary plans for the town centre. The fact that the municipality refused to give building permissions to shopkeepers and retailers in order to rebuild Bristol's old shopping area can explain why there is little correlation between the pattern of shops and the global analysis of the grid.

Fig. 5 presents a global configurational analysis of the vehicle routes of all four cases in 1997. In comparison with the situation in1940 and 1955, the ring road in all four cases made the streets in the city or town centre appear more segregated in the global axial analysis. In all four cases the highest integration values tend to move to the well-connected crossroads between the ring road and the town or city centre.

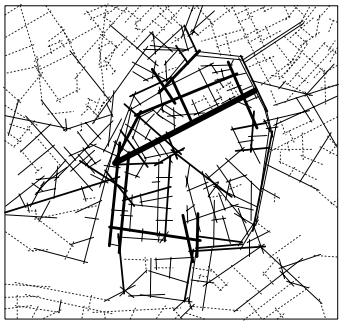
Coventry 1997



Wolverhampton 1997



Birmingham 1997

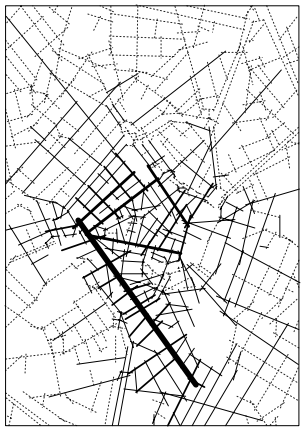


Bristol 1998

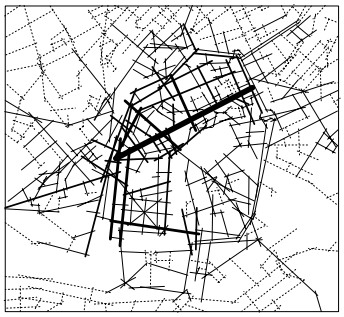
Fig. 5: The global axial analysis of Coventry, Wolverhampton, Birmingham and Bristol around 1997.

Coventry 1997 Pedestrian routes

Wolverhampton 1997 Ped. routes



Birmingham 1997 Ped. routes



Bristol 1998 Pedestrian routes

Fig. 6: The global axial analysis of pedestrian routes of Coventry, Wolverhampton, Birmingham and Bristol around 1997.

Fig. 6 shows the situation for the pedestrian routes. The most integrated lines are almost the same, except in the case of Coventry. Now, this town has separated movement routes for pedestrian and vehicles through most of its town centre and in the vicinity of the ring road. Fig. 7 shows the towns' functional situation around 1997. In all cases the black coloured pattern of shops has changed from having a linear structure to a more convex compact pattern. Interestingly enough, one of Bristol's two centres has still kept its linear pattern. It is located in the area of the ring road that has a boulevard standard instead of a highway standard.The highway standard of a ring road tends to separate the outside areas from the city centre. This increases the number of steps between these streets and the city centre. Shops located in those areas tend to close down. Likewise, shops located along streets inside a ring road that loose their catchment area tend to close down. The most important shopping streets located inside a highway standard ring road tend to exhibit a more compact distribution of shops. It consists of larger shopping precincts where several shops can be reached at short distance from each other.

On the other hand, the boulevard standard of a ring road contributes to keeping the connection between the outside streets and the city centre. The situations of Bull Ring in Birmingham and St. Augustin's parade in Bristol have one thing in common. The ring road was built right through these shopping areas. In the case of Birmingham the highway shaped ring road cut off the connections between the shopping street and the centre and it also reduced the topological and metric extension of Bull Ring. In the case of Bristol, the ring

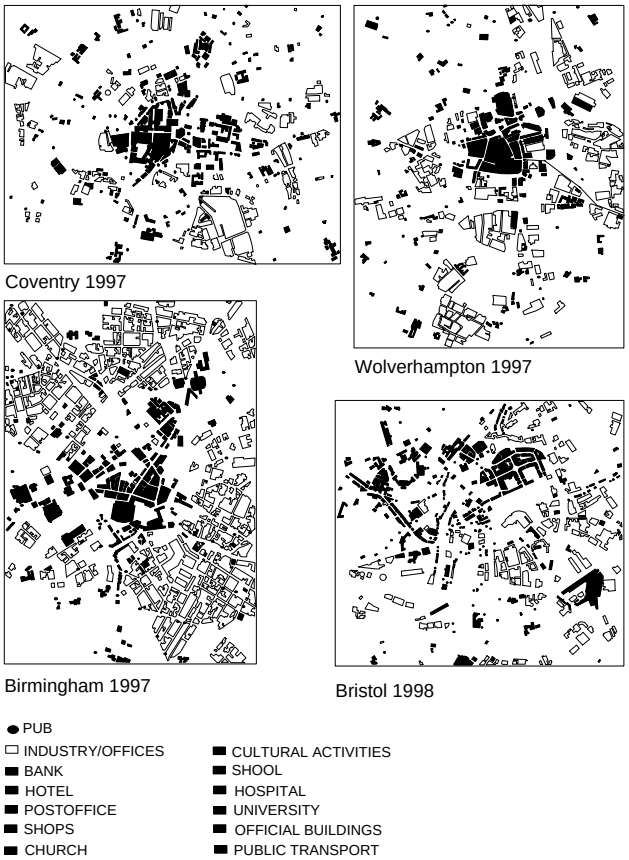
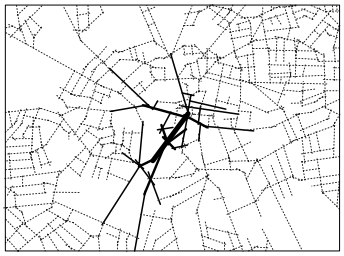
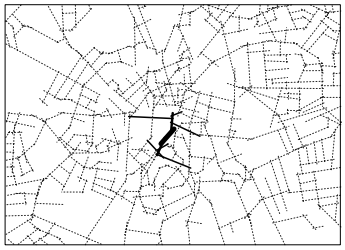


Fig. 7: The functional situation in Coventry, Wolverhampton, Birmingham and Bristol around 1997.



1941

1955



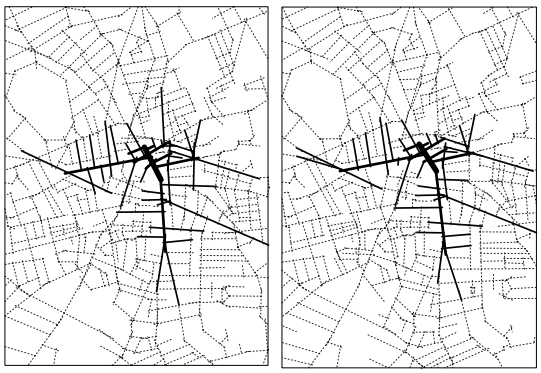
1997 Pedestrian routes

17.10

Fig. 8: 2-Steps analysis from Herford Street, one of the main shopping streets in Coventry 1941 - 1997.

road did not affect the shopping area at all.The location of shops tends also to move to the most integrated areas. With and without large configurative changes on the street grid, shops still tend to locate themselves along the most integrated axial lines.

Fig. 8, 9, 10 and 11 show the extension and the structure 2 steps away of all the main shopping streets. It is obvious that the ring road has cut off the extension of all those streets where the ring road has a highway standard in the 1997 analyses. In the case of Coventry (fig. 8), the planned town centre also contributed to a reduction of the topological and metric extension of Hereford Street in the 1997 analyses. In the other 3 cases, the pattern of the lines has become slightly more compact and



1941 1955

1997 1997 Pedestrian routes

Fig. 9: 2-Steps analysis from Dudley Street, one of the main shopping streets in Wolverhampton 1941 - 1997.

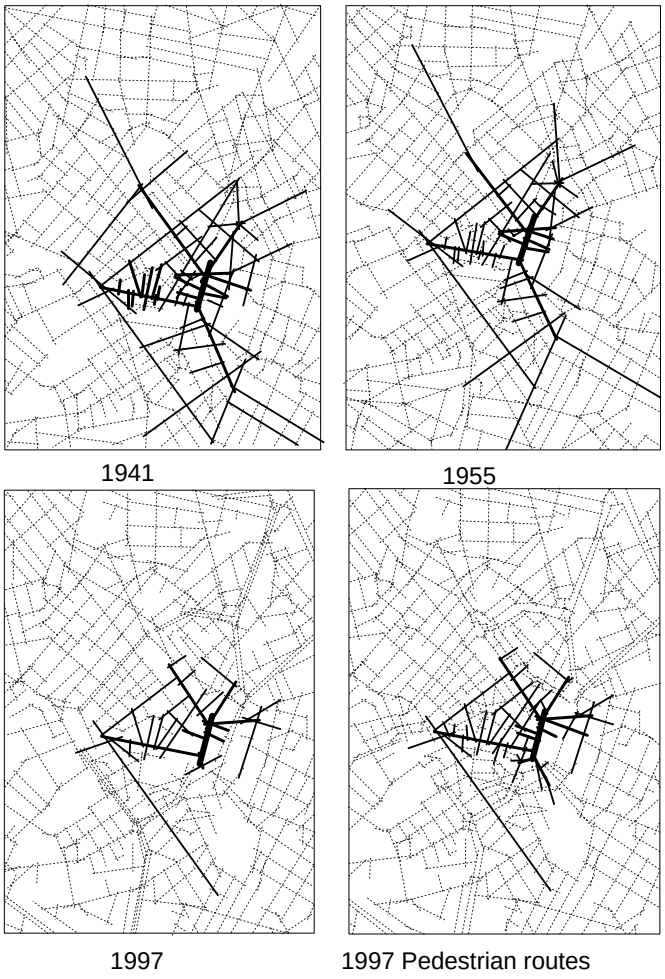


Fig. 10: 2-Steps analysis from High Street, one of the main shopping streets in Birmingham 1941 - 1997.

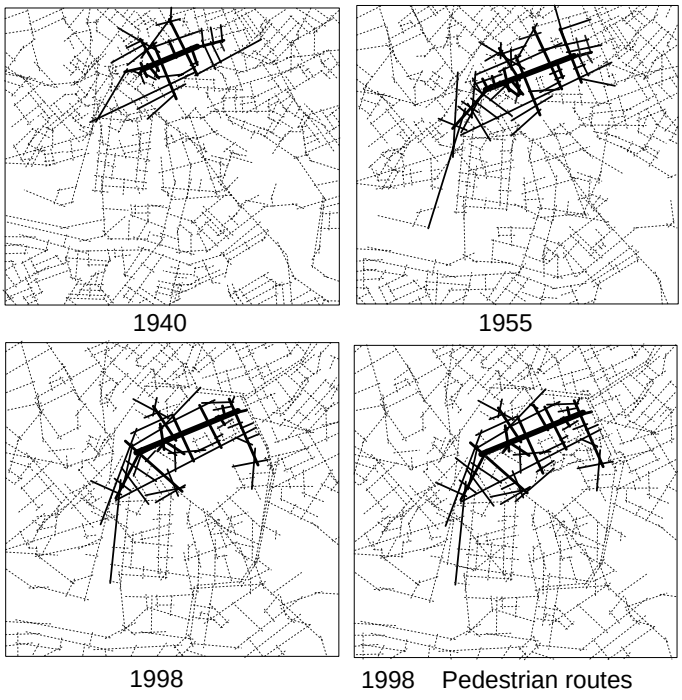


Fig. 11: 2-Steps analysis from Broad Mead, one of the main shopping streets in Bristol 1941 - 1997.

convex. Correlated with the pattern of shops, the shopping areas have become more clustered together in areas where most shops can be reached in a short metric distance.

Figure 12 presents for all four cases a 2-steps analysis from all the parts of the ring road. The figure shows how much of the centre and how many of the shops can be reached from all parts of the ring road. Coventry's ring road is very badly connected to its centre while Bristol's ring road is well connected to all the shops in the city centres. Functionally, the centre of Coventry is "dead" in the evening, while Bristol is full of nightlife activities by then. In Birmingham, New Street, Colmore Row, Hill Street and Colmore Row can be reached within 2-steps from the ring road. After closing hours of the shops, one feels safe to walk in these areas. The rest of the streets make one feel unsafe to walk through in the evening. The same can be said about Wolverhampton. The streets that cannot be reached within 2-steps from the ring road are unsafe in the evening.

How the result relates to the two contradictory views on the relationship road building and functions

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The analysis of Coventry, Wolverhampton, Birmingham and Bristol has shown that the location of functions depends on the configuration of the grid where movement takes place.

First of all, the four case studies have thus shown that it is the configuration of the street grid that decides where shops tend to locate themselves. The pattern of the lines of the grid decides as to whether the pattern of shops will get a linear or a convex structure. A successful shopping area requires a position among the highest integrated streets. It has to have a dense

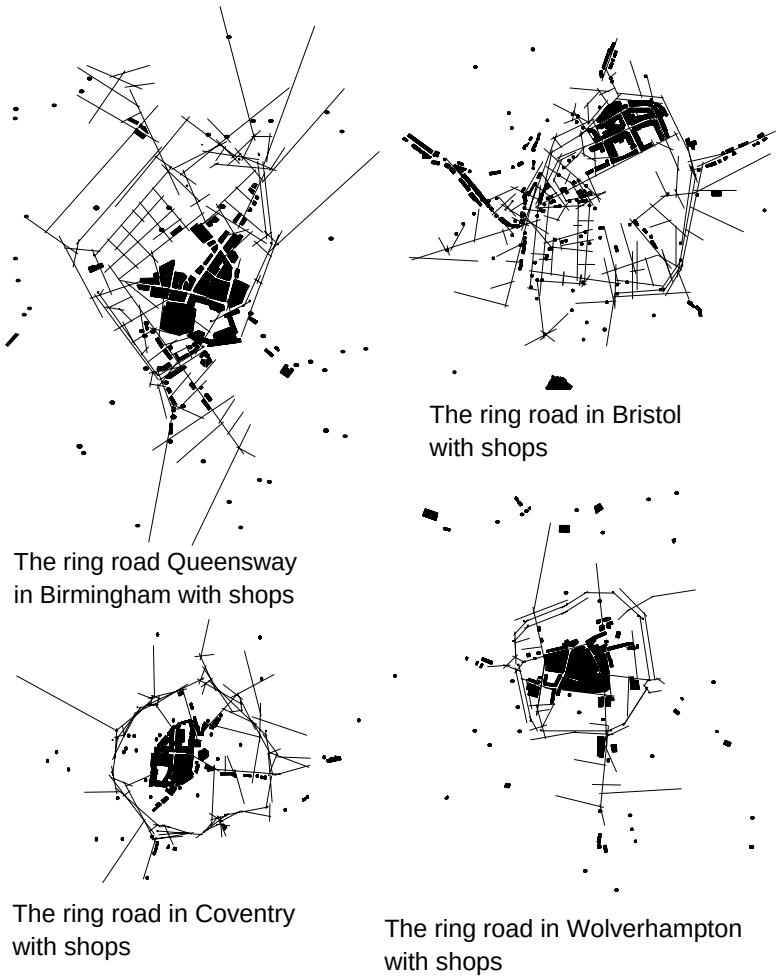

Fig. 12: 2 Steps analysis from all parts of the ring road in Birmingham, Bristol, Coventry,and Wolverhampton.

structure with a high number of axial lines connected to it such that it can be reached from a short metric distance. According to the view presented in the Buchanan report, shops as such are attractors of urban movement. However, bad local grid conditions can favour a negative development so that finally shops tend to close down. This is the case with the shops located in the shopping precinct of Coventry. The same holds of the Bull Ring shopping centre in Birmingham.

As regards the relationship between road building and the distribution of function, all four case studies have provided empirical evidence that at least do not falsify basic assumptions of Space Syntax theory. The according method has managed to describe in which way ring roads affect town and city centres as regards the pattern of shops and the configuration of the grid in different town and cities.

The present investigation offers an answer to its guiding question: In which way does a ring road affect the structure and functions of town centres? It depends on how the ring road is connected to the street grid it is imposed upon. If the ring road is well connected to all the streets in its vicinity it will not affect the pattern of the shops in the town centre. The western part of the ring road in Bristol with its high connectivity did not affect the linear shape of the shopping streets leading into the city centre. If, however, the ring road has few connections to the grid it is imposed upon, and if it also cuts off streets that lead to the town centre, then shops tend to close down in areas located outside the ring road. This is the case with most of the old shopping streets in all four cases provided the relevant part of the ring road has a highway standard.As regards the configuration of the grid, the pattern and degree of global integration tend to move towards the ring road. In all four cases, the integration values have decreased for several important streets in the town and city centre. The mean local and global integration values of the town centres of Birmingham and Bristol have reduced due to the ring road. Functionally it resulted in most successful shopping streets tend to be on the lines a few steps away from the ring road. This is the case for all four towns.

For the local grid conditions of the shopping streets in the town and city centres the following results were obtained: if the ring roads cut off their extension, then it is probable that the pattern of the shopping area changes from a linear to a convex structure. Shops tend to disappear along streets that have lost their topological and metric extension. Likewise, if the number of axial lines reduces in a short metric distance from the main shopping street, shops tends also to close down. If the number of axial lines and the number of beady rings increase in a short metric distance from a shopping street, then the pattern of shops tends to be more clustered together. In these areas larger successful shopping centres tends to locate. This is the case of Wolverhampton.

Conclusions and openings

The construction of a ring road has a comprehensive impact on a city's structure. Until now a systematic understanding of changes in configuration can offer the best explanation of the possible effects of ring roads on town centres.

Apparently, it is not the ring road that attracts the establishment of new retailers and shops, but the way in which the ring road is connected to the urban grid on which it was imposed. Furthermore axial configuration seems to be a decisive key for understanding in what way a ring road changes a town. The construction of a ring road amounts to a configurable change of the urban grid. This means that the movement routes change, and this, in turn, affects the locations of different functions.

An answer to the question of how ring roads change urban areas seems to ensue from an understanding of the axial configuration of the street net. It can explain whether and why a ring road might cause social malaise in the town centre. The centre of Coventry is a centre planned with the purpose to separate pedestrian and car traffic. The result is not just an effect of the ring road, but of a separation of functions such that visibility and adjacency do not correlate well with natural movement patterns for pedestrians.

Whether a ring road is a good for the town centres or not, seems to depend on at least two issues: the kind of grid it is imposed upon and the way in which this imposition comes about. Dominating street axes of the city centre will keep their high integration values if they are well connected to the ring road. This is the case in Wolverhampton.

The configurative analysis of the street grid seen together with the pattern of functions offers a rather detailed understanding of the way in which larger road projects affect the areas and land use in their vicinity as well as in the town centres. Space Syntax can identify the configurative changes, while the registration of functions can confirm the configurative explanations. Until now a systematic understanding of changes in configuration can offer the first explanation of the possible effects of ring roads in city and town centres.

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