RADIAL-CIRCULAR PARADIGM OF THE CITY: OLD-FASHIONED OR MODERN?

REFLECTIONS ON MOSCOW-WROCŁAW STREET PATTERNS COMPARISON

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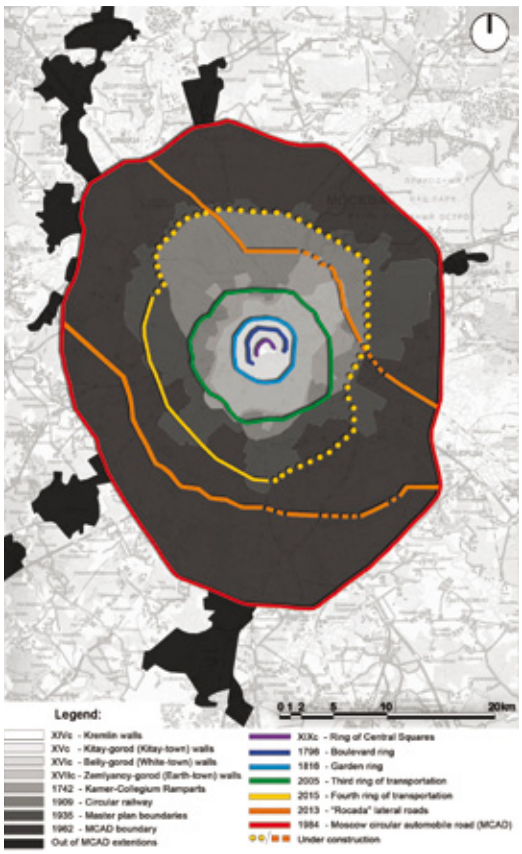
The focus of the EUSS workshop on plans to lay out a new avenue across quarters of mass produced housing in the southern part of Wrocław and to redevelop the Kazimierza Wielkiego street in the inner city happens to be the starting point of this article. The discussion on the reorganisation of the street network appeared surprisingly familiar to the Moscow planning agenda.

INTRODUCTION

> Very different by their size, population, history and culture the two cities share the same radial-circular typology of their street network. However the degree of its development is not the same – Wrocław has a much more intricate geometry of streets and its plan is not so straightforward as Moscow's system of rings and radiuses (Fig.1).



1. Moscow territorial growth and ring road development

Such similarity between so many different cities < has attracted my attention and led to a small study on parallels of their evolution. I had no ambition to make a deep and comprehensive analysis of the history, urban development problems and future plans of Wrocław and Moscow. The study is only an attempt to indicate common features and tendencies inherent in the radial-circular plan system and to identify successful approaches to cope with common challenges relevant to that urban form. Therefore the comparison focuses mainly on historic and present day city maps, supplemented by some general data on Wrocław's history which I managed to collect from the Internet.

My interest in the evolution of the radial-circular < system in Wrocław was also strongly inspired by the long range history of failed efforts to find alternatives to the constantly growing dominance of this street network pattern in Moscow. Each of its three structure plans approved for implementation in the 20th century – in 1935, 1971 and 1999 – was trying to introduce distinctive elements from radiuses and orbitals. Yet none of them were implemented. Instead more rings were added or reconstructed to provide greater traffic capacity. The recognisable urban form of contemporary Moscow derives from its five existing semi-circular and circular trunk roads and two motorways in the city and its metropolitan area which people in Russia sometimes call 'Lord of the Rings'. In fact while the city population has grown sevenfold during the last hundred years – from about 1,5 to 10,5 millions its spatial evolution was nothing but new rings and radial thoroughfares supported by several circular railways and, a radial-circular metro system.

It might indicate growing inertia either of the < thinking of planners or of the street network system itself whose geometry is increasingly determining future changes. A juxtaposition with Wrocław was an opportunity to analyse this issue, to scrutinise the advantages and problems of each city due to their urban growth under the conditions of a radial-circular system and to discover experiences which they can learn from each other.

HISTORIC PARALLELS AND CONTRAPOSITIONS

The street maps of Moscow and Wrocław show that their urban cores were not supposed initially to be part of a radial-circular urban from. Moscow's heart, the Kremlin has a triangular geometry of walls surrounded by an irregular system of squares and passages while the medieval core of Wrocław combines a rather regular orthogonal street pattern on the left bank of the Odra and an irregular one on the opposite side of the river, as well as on the river islands – its most ancient parts. Nevertheless the former finally gained a system where there are almost no other main streets but radial and circular ones and the latter is gradually increasing the significance of its circular thoroughfares.

The 'purity' of the radial-circular system of Moscow may look strictly determined by history and thus straightforward and inevitable like annual rings on a tree trunk. Conversely, Wrocław may seem to have just several bypass roads, thus leaving no room for a true comparison. However a sequence of recent changes in this city evidently leads to a new structure of main traffic routes. At the beginning of the 20th century only the remnants of the medieval fortifications were the remarkable exception of the linear character of the main streets crossing the inner city in east-west and north-south directions (Fig.2).

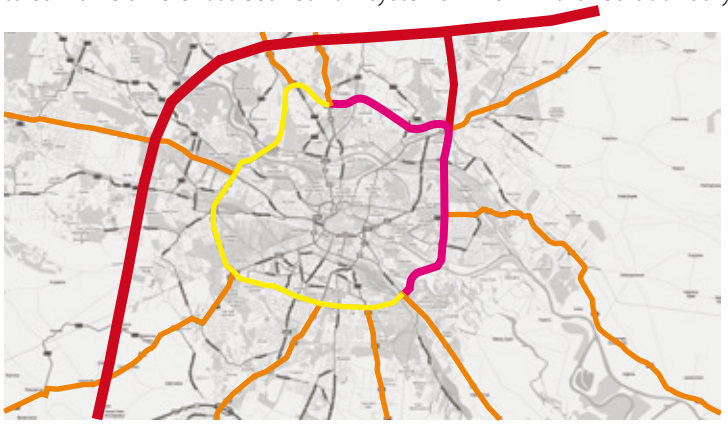
The current plan of Wrocław displays a much greater domination of radial and circular traffic routes. During the post-war period an internal ring was created in the city's central part.

A further one may be created soon as a combination of two already existing western bypasses and a new eastern one. A new road connection across residential blocks, as well as a new peripheral bypass under construction towards the 2012 football championship on the west of the city will continue that long-term tendency. Will it determine the future development of Wrocław for years ahead through adding more bypasses later and converting them into rings similar to the ones of Moscow? Or, in reverse, does the experience of Wrocław demonstrate the possibility to combine different street network systems which Moscow could think about? In other words do contemporary Wrocław and Moscow show two different phases of an inertial development of a radial-circular system or alternative variants of its evolution and its role in the city structure?

In answer to these questions a simplified hypothesis of the evolution of the street plan of Wrocław was put together and compared with the history of Moscow's urban development. As the history of any ancient city is complicated being influenced by many geographic, political, economic and other circumstances and factors the study focuses only on the ones which have played an important role in the development of the radial-circular elements of the city plan. Therefore the stages of development described below may not exactly coincide with acknowledged historic periods.

Wrocław is older then the Russian capital. According to commonly accepted dates of the foundation the two cities they were established in 1000 and 1147 respectively although both already existed long before that. However due to past historic disturbances of Wrocław and probably its specific river geography the city's urban core on the southern side of the Odra has acquired its present form later in the 13th century when Wrocław became the capital of the Duchy of Silesia and subsequently obtained self-government rights. In turn, Moscow has become a capital of a small county at that time instead of a tiny border fortress and has started its long path of territorial growth. Both cities were burnt down by Mongols: Moscow – in 1238, Wrocław in 1241. Thus trends of urban evolution that shaped the two cities into their current urban forms started almost simultaneously which facilitates their comparison.

The two cities were founded as wooden fortifications on the confluence of two rivers (in the case of Wrocław it was two branches of the Odra). The starting point of Wrocław was the flat Ostrów Tumski island while Moscow's first settlement was situated at a high point 30 m above the river. According to archaeological excavations the first fortified boundary of the future Russian capital had



2. Prospective radial-circular routes development in Wrocław. Red - motorway bypass, orange - access roads, yellow - existing innercity ringroad, pink - planned segment of innercity ringroad.

a bulb-like shape that followed the topography of the hill top. A little later when the city expanded its fortifications it took a triangular shape more fitted to the geometry of the site and resembled the outline of the first settlement of Vratislavia – future Wrocław.

> Thus, the ancient urban from of the cities were influenced by a common tradition of adapting settlements to the natural landscape to enhance their defence capacity. As both cities were part of the frontier defence was an important issue and determined the similar features of the city plans and positions.

> Before radiuses or rings were established some distinctive characteristics of the future urban development were formed at that time due to their location. Strategically Wrocław occupied the crossings of two international medieval trade routes: to the north the Amber road leading north and the west-east route leading from the centre of Europe to Kiev Rus. It was a 'transit' town from the very beginning and that factor has strongly influenced the direction of city growth. As a result after building-up the area on Ostrów Tumski island the predominant vector of city growth was redirected southward where a new part of the city was established. Its new market square was placed right on the crossing of two main trade routes and the orientation of a new rectangular grid of streets followed their directions. Presently, the prevailing directions of transit traffic flows remain the same. Wrocław is still suffering from transit goods traffic crossing the city centre along a north-south axis which is associated with the east-west motorway several kilometres south of the centre.

> Polycentrism of medieval Wrocław was another remarkable distinction of its urban core. It was a result of geography and complex relationships between municipal, state and religious authorities that were enhancing links across the river between the new urban core on the southern riverside while the old one on Ostrów Tumski island became the residence of a bishop in 1000.

< Contrary to this main trade route, Moscow was linked to the river itself while the roads coming from the hinterland to the city were connecting it with villages or greater and older cities in neighbouring Kiev Rus (one of them considered to be a founder of Moscow). It became a prerequisite of a more radial character of incoming roads and further urban growth along these routes. However, originally, like in Wrocław, its main market – the Red Square today – was also a place where two routes were crossing. One of them followed the Moscow river. Later it gave way to more significant hinterland connections meeting at the market square and another route perpendicular to it that led to the only bridge over the Moscow river situated there.

< Unlike Wrocław, the fortified core, the Kremlin of Moscow, had walls on the river side too and no roads were entering it directly from the main river. The main market was situated outside the fortifications due to the topography and probably also to the need of the economy for space beyond the city walls. That location made the centre easily accessible for residential areas which were located on both inside and outside the walls of the Kremlin. When in danger the inhabitants of the suburbs left their wooden dwellings and waited beyond the fortifications until it was over. Afterwards they returned back and rebuilt their homes. Thus, the main transit routes were not intersecting in the city core. This feature was later enhanced by the establishment of the tsars' metropolitan residences inside the city walls and by new markets alongside the walls on the outside accessible from different directions. In winter time a temporary fair on the frozen river linked all markets into one great 'shopping area' around the Kremlin, thereby constituting probably the first 'ring' of the city. As the only fortified part the Kremlin was concentrating the main administrative and religious complexes (Fig. 3).

< Having started from a very similar, almost identical origin the two cities reached dissimilar urban forms soon afterwards, long before the introduction of the first radial-circular elements. Wrocław was

3. Moscow plan of 1520s by S.Gerbershtein. Couloured engraving from atlas printed in Cologne in 1575

source:
http://historic-cities.huji.ac.il/russia/moscow/maps/braun_hogenberg_II_47.html

planned to be connected to the hinterland into a polycentric system and its street pattern led the transit traffic across the city centre. Conversely, Moscow preserves an irregular street pattern with a tendency to enhance radial directions. Its triangular fortified core is adapted to the landscape accordingly to Russian tradition. It is monocentric with the main transit routes passing it by.

> Towards the end of the 16th century the fortifications of medieval times were already completed both in Wrocław and Moscow indicating the limits to growth which the two cities had reached at that time (Fig.4 & 5).

> The fortified belts which became the foundation of the radial-circular street network were significant elements of the urban structure, regardless of all the characteristics of the previous periods of development. Since its reorganisation on the southern bank of the Odra Wrocław seems to have been growing slowly, judging by the size of its new area outside the inner channel where the street pattern differs from the inner city part. However, until the end of the 16th century the city was outbidding Moscow with its pace of erecting surrounding walls. On the map of Wrocław the channel located at the place of today's Kazimierza Wielkiego street seems to be a moat of the previous fortified border of the city, outlining already at that time a new regular plan which probably dates back to the 13th century. What shaped the fortified inner city of Moscow can be related back to 1538 when the wall of the eastern Kitay-Gorod suburb was completed. Before that, the Kremlin was the sole stronghold surrounded by the suburbs that appeared already in the 14th century left outside the city fortifications.

> Moscow has grown to a bigger scale than Wrocław and that led to the construction of new peripheral walls made of stone in 1586-1593 to encompass a new city area called White-town (Beliy-Gorod). This wall became the first true semi-circle of the city plan and shaped the limits of Moscow's spatial structure, very similarly to Wrocław's urban core on the southern Odra bank. Both cities have got curved irregular lines of outer fortifications facing the hinterland which included an inner city and a less densely built-up peripheral belt separated by the old moat or channel (in Moscow the internal walls have been preserved while in Wrocław they seem to have been demolished). It is remarkable that in both cases the urban pattern of the central part was by no means radial, contrary to the periphery where the streets were drawn in more radial or diagonal directions, determined by the position of the gates in the external wall and the bridges. However, in Wrocław this trend was less marked due to its smaller size and fewer city gates on the southern border (probably for hydrographic or political reasons).

< The enlarged urban core of Moscow became more polycentric. It included administrative and religious centres in the Kremlin and commercial installations and palaces of the aristocracy in Kitay-Gorod. Like in Wrocław a main market on Red Square was now inside the fortifications and the most important exit road leading to the north started from there. Inner city areas inside intermediate moats were comparable – about 1,0x0,8 km in Wrocław and approximately 1,2x1,4 km in Moscow. Broad easements separating walls from outer residential quarters were a special feature of Moscow that enhanced the circular elements of its plan. They were made for military purposes and to prevent the spreading of fires between different parts of the city.

< The radical step towards the radial-circular system was only taken at the very end of 16th century in Moscow when the first full circular wall around the whole city area was erected (1591-92). Its construction was a reaction to the raid of the Crimea Tatar king conducted upon Moscow who burnt down a suburb which had remained outside the White-city walls. It was 15 km long and made of timber. The new belt of the city area got the name of Earth-city. Since then Moscow became indeed very distinctive in terms of its radial-circular urban pattern unlike during previous times. The urban structures of the two cities had become distinctive again.

4. Map of Wrocław of the end of XVI century by Matthäusa Seuttera, based on a plan by M. Meriana

source:
http://www.oss.wroc.pl/dzialy/kartografia/kartografia.html

5. Map of Moscow of the end of XVI century (so-called 'Peter's drawing')

source:
Русское градостроительное искусство. Древнерусское градостроительство X-XV веков/ВНИИ теории архитектуры и градостроительства; Под. общ. ред. Н.Ф.Гуляницкого.-М.:Стройиздат, 1993.-392с.-с.246-247.

> A majority of researchers consider the construction of the last ring of Moscow's fortifications as the final phase of the typical growth process of Russian medieval cities established on hills between two rivers, although Moscow is the only city which had truly reached that highest level. The juxtaposition of Moscow's development with the history of Wrocław which displays the same process of multiplying outer belts without concentric radial roads suggests an alternative hypothesis. The full circle wall could have been a result of a particular coincidence of historic circumstances. If an enemy raid had not occurred on Moscow its outer ring would not have been constructed which would have left open alternatives to the progressing radial-circular system. Conversely, Wrocław would probably have constructed a new ring of fortifications if it had gained the same size as Moscow at that time (about 1925 ha).

> Despite their dissimilar history, culture and geography the driving forces of radial-circular elements during medieval times were common to both cities. There was a need to apply the most rational and economic form of external wall to reduce a costly length of fortifications. That principle was successfully applied to almost any initial form of city plan confirming its flexibility and adaptability. This period also displays some principles of radial-circular street patterns development that remains relevant today:

- Initially, circular walls were surrounding the city and later streets replacing them were connecting peripheral urban areas, such as the channel embankments in Wrocław where the Kazimierza Wielkiego street is located today.
- The introduction of semi-circular and especially circular walls was changing the street patterns towards a more radial or diagonal character, due to the location of fewer external gates. With the increasing number of outer walls the probability of a radial character of the streets became higher.
- The extension of the total city area was always a prerequisite of replicating circles or semi-circles on the city periphery.

< The further expansion of the radial-circular street pattern of the two cities was rather dissimilar up to the second half of the 19th century, although some changes were common. While all circular walls were demolished already at the turn of the 17th century in Moscow the outer ramparts and moats of Wrocław occupied a large portion of the city until the end of the 18th century (Fig. 6).

< Nevertheless the belt of fortifications did not impact on further urban expansion as a shift to a radial-circular pattern. The street network of the city continued to follow a grid pattern along prevailing east-west (today Olawska and Ruska streets) and south (today Świdnicka street) directions. Main streets were still intersecting at the old market square. The inner channel-moat was filled in and built-up which diminished its significance in the city plan. The area of external fortifications from medieval times were transformed into public green areas in which the role of transportation did not seem of great importance. Indeed it was not a radial-circular street system but ring like streets and parks inserted into the irregular grid of streets and subordinated to it.

< Unlike Wrocław, Moscow has produced a truly radial-circular system of main streets during medieval times and its role was enhanced by several reconstructions during the 18th century and at the beginning of the 19th century. The old walls of White and Earth towns were demolished like in many other European cities and transformed into Boulevard and Garden rings which became major promenades and traffic routes connecting different parts of the city. The ramparts (not walls) around the Kremlin and Kitay-Gorod built at the beginning of the 18th century, one century later, were transformed into a ring of main public squares of the city. The main radial streets and circles were architecturally accentuated and improved to form the true basis of the urban space. But while size and population of the city had grown dramatically no new circular roads were added. The extension of Moscow's periphery followed the directions of the main external transport connections to the north, east and south that made its plan less symmetrical.

6. Map of Wrocław dated by 1806

source:
http://www.napoleon-series.org/images/military/maps/1806/breslau.jpg

These trends stretched the overall urban area along the south-west and north-east directions which was fixed by the new border of the city established in 1742 through the construction of the 'Rampart of Kamer-Collegium'. It was not made for military purposes but as a customs border and remained the official city limit until the beginning of the 20th century (Fig. 7).

> The industrial era turned both cities into important manufacturing centres and brought railways and tram lines as new features to urban life. Railway terminals were located around the historic urban core and concentrated on the periphery in both Wrocław and Moscow. As each city had several railway lines semi-circular connections between them followed soon afterwards. They constituted an increase of radial-circular elements of the city plan and were a prerequisite of further progress later. In Wrocław the semi-circular railway line surrounded the urban core from south to north via western suburbs, having continued probably by accident the city's medieval tradition (Fig.8).

> All bypasses constructed later in Wrocław followed the same direction, including the road to the 2012 football championship stadium now under construction. Connections between radial railway lines were developed in Moscow in the same manner as in Wrocław, but additionally a special circular railway ring was constructed in 1903-08. Since then and until 1930 it was also used for passenger traffic. It was stretching to the north from the city centre alongside the prevailing sector of suburban growth of that time. In the 1930s that line became a new city limit (Fig.9).

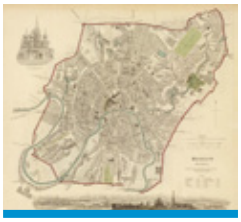
> A hundred years later a new motorway ring will be designed following this outline. In Wrocław prevailing routes of urban growth have slightly changed too, as it became a centre of radial incoming transport routes (Fig.10).

> This position started to influence the directions of the street network grid in its periphery and formerly equal growth in all directions changed in favour of expanding along south-west north-east directions (Fig.11).

In spite of substantial increases in size and population, no new elements were added to the radial-circular street system in both cities since the end of the 16th century and up to the post-war period. This can be interpreted as an absence of need in Wrocław because its grid network was working efficiently, and in Moscow because the high flexibility of its system enabled existing trunk roads and rings to be constantly adapted to new conditions and scales.

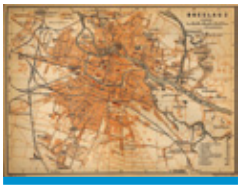
The development of the radial-circular street pattern accelerated only during the second half of the 20th century in both cities. Many centuries after Wrocław had filled in the channel and demolished its medieval walls Moscow added again new circular roads. It can be assumed that the growth of car traffic became a driving force of the further development of the radial-circular street network. Approaches used in each city were different according to local conditions but in both cases they were used very persistently over time and again following the patterns of the Middle Ages. No doubt, urban planners had no intention to develop their city in the same way as centuries ago. Nevertheless, often real improvements took place following a geometry of their historic predecessors or making use of streets which had been created centuries ago.

The interpretation of the radial-circular street progress in Wrocław after the second world war is based on an analysis of street network alterations since 1943. This was possible due to retrospective data obtained by Google Earth software. It is likely that all up-to-date street reorganisations were done during communist times, except the Millennium Bridge extension. Three bypasses of its urban core from the south-west, inserted subsequently into the city plan from the centre to the periphery are currently shaping the radial-circular character of the city street network. Two of them used the footprint of the historic walls and ramparts which had remained 'dormant' as radial-circular elements during centuries. It seems as they were biding their time to be reused again.



7. Moscow within limits of Kamer-Collegium rampart. Map of 1836

source:
http://www.archeologia.ru/modules/gallery/displayimage.php?pid=1583&fullsize=1



8. Map of Wroclaw / Breslau. 1910

source:
http://www.lib.utexas.edu/maps/historical/baedeker_n_germany_1910/breslau_i_1910.jpg

10. Map of surroundings of Wroclaw / Breslau. 1900

source:
http://www.awesomestories.com/images/user/faa756cfb7.jpg

9. Moscow within limits of circular railway line. 1930.

source:
http://www.etomesto.ru/img_map.php?id=24

11. Map of Wrocław/ Breslau 1920.

source:
http://www.kartenmeister.com/preview/map/images/BreslauStadtplan1920.jpg

> The first one was the Kazimierza Wielkiego street that has 'restored' the outline of the inner moat by demolishing the buildings erected on its place. It was possible to 'exclude' a part of the medieval centre from the system of transit routes unlike during all its history. It seems that the driving force of the reconstruction was not only that car traffic was exceeding the capacity of old streets, but also an intention to keep the urban core pedestrian-friendly and preserved in its historic state which made it necessary to pass the traffic around it. Thus, the old axis of Oławska-Ruska street was 'switched' to widen Kazimierza Wielkiego street, going around the city centre for centuries. This gave birth to the renaissance of the radial-circular system in Wrocław.

> Two other bypasses were created by curvilinear connections to the already existing streets. The connection of Marszałka Piłsudskiego street and the western part of the boulevards along the remnants of the outer medieval moat permitted to constitute the first inner city ring. It included also new streets along the north embankment of the Odra and provided a circular movement between the radial streets that have been developed since the 18th century and appeared in the city plan at the beginning of the 20th century. However its geometry resembled more a square than a ring. The typical outer bypass, an extension of Hallera street was evidently aimed to redirect the traditional north-west south-east transit flow out of the inner city to diminish the load on the inner ring and Kazimierza Wielkiego street. All new connections passed through the 19th century suburban neighbourhoods that were badly damaged during the siege of Breslau in 1945.

> However due to the new political situation in Europe since the end of 1980s the inner ring has become part of two external transit traffic flows on the national E261 and the international Via Baltica road E67. Both are directing transit traffic across the city to the newly reconstructed European route E40 running to Germany several kilometres south of Wrocław. It made the inner ring not only a distributor of city transport but turned it into a part of regional and national transport infrastructure. So the new bypass will follow the previous trend of development and will go across western outskirts of the city to diminish north-south transport flows. Ultimately, problems of transit would only be solved by a full circle motorway which will probably be constructed in the near future. If this happens it would manifest a new level of development of the radial-circular system in Wrocław as it would combine the inner and outer rings with radial and semi-circular roads overlapping the old grid network of streets. Plans to rebuild Kazimierza Wielkiego street and to restore the integrity of the medieval city look very promising, as they will completely halt transit transport in the urban core of the city and make it less attractive to shopping malls and office expansion. <

Unlike Wrocław, Moscow faced transport problems already in the 1930s as its population grew rapidly from 1,5 millions to 4,5 millions since the beginning of the 20th century. As a core of a radial-circular system already existed it was used to cope with this problem. Contrary to Wrocław, in Moscow there was no 'second' grid system of streets, therefore all plans were envisaged as a development of rings and radiuses alongside an alternative system of connections supporting them. It is thus pertinent to compare plans and real developments that have taken place during the last century. <

Since that time three master plans were approved, including the one currently in force. Regarding radial-circular components the plan of 1935 (Fig.12) suggested the following main ideas: <

- converting the semi-circular Boulevard ring into a full ring,
- transformation of the most important radial streets into avenues by widening and extending them outward from the centre,
- construction of two additional rings: one as a 'backup' of the Garden ring at a distance of 0,5-1,5 km outwards and another one running along the circular railway and connecting green areas at the city periphery (named Park ring),

12. Moscow transportation scheme accordingly to the masterplan of 1935

source:
Bachiev et al., 2008

- introduction of direct linear streets in the inner city between the main transportation nodes, including railway terminals,
- development of a new south-western part of the city based on a rectangular street network instead of a radial-circular one,
- combining several opposite radiuses into intersecting diagonals connected by old and new rings,
- developing a metro system.

> The implementation of that plan was interrupted by the war limiting real changes which followed it. Main achievements were launched, such as three radial metro lines and the construction of new avenues that facilitated connections between the centre and remote residential districts. The Garden ring was cleared off trees and became a main city thoroughfare. It retains that status today. The idea of penetrating the urban core by intersecting diagonals was never realised. The metro system that works on the basis of the same idea proved effective as it now copes with more than 8 million passengers per day. However, an important difference with car traffic are the dead-end sidings of radial metro lines and not using the metro for transit passengers who cross Moscow's metropolitan area. Thus, there are no external transit flows in the way diagonal or lateral streets are connected to the regional road network in Wrocław.

> The next step of Moscow's development strongly enhanced the radial-circular system and seems to have made it less flexible to accommodate any alternative solutions. The construction of the outer ring – the Moscow Circular Automotive Road (MCAR) – in 1962 has delimited further expansion of the city which had already incorporated several smaller towns of its surroundings. Its construction was aimed to organise transit traffic and especially transportation of goods going through Moscow. Without that transit flows would have followed the internal Garden ring to turn from one radius to another, resembling the current situation in Wrocław. Yet, at that time most of the goods were being moved by railway and MCAR was not very loaded.

< In 1971, the next plan introduced a very sophisticated transportation system of high-speed motorways and city thoroughfares passing alongside the old city centre (Fig.13).

< Two other rings were envisaged more or less coinciding with proposals of the plan of 1935, but in practice none of these proposals were realised. There were many reasons for that, including lack of resources for such a large project. It also raised protests of many citizens and professionals as new roads were often proposed to cut across natural green areas and historic parts of the city. However, the strongest factor that stopped the plan was the very slow growth of car use that was a notable feature of the socialist economy with its quite moderate level of consumption. Real traffic loads were much lower than presumed. It was more effective to concentrate real efforts on further growth of metro lines and radial avenues instead of changing the overall city transport system radically.

< During the 1990s the motorisation growth rate has increased threefold and the population increased from 8,4 million to more than 10 million inhabitants (accordingly to the 2002 census). In spite of constructing the new motorway circle – the Third Traffic Ring (TTR) – and several new radial routes the city experienced a heavy transportation crisis. The present state of development displayed in Fig.1 shows serious problems:

- The internal Garden ring remains the most congested ring as is it is the shortest connection between radial avenues even after the construction of TTR.
- The inner city became a place of concentration of offices and administration due to its superior accessibility secured by the radial-circular geometry of the street pattern.
- Despite recent reconstruction and widening to five lanes in each direction Moscow's outer ring is overloaded as well, as it serves not only interstate and inter-regional transit traffic, but works also as internal ring for the Moscow metropolitan area and connects suburban cities adjacent to MCAR with a total of 5 million

13. Moscow transportation scheme accordingly to the masterplan of 1971

source:
Bachiev et al., 2008

population. This area became spontaneously a main suburban shopping area, attracting more traffic in turn and aggravating the situation. Nonetheless transit traffic across the city is not a real problem in Moscow.

- Main radial directions are overloaded.
- Connections between neighbouring districts alongside internal rings are restrained due to low density of the street network and insufficient network geometry.

> The plan in force stipulates the construction of a Fourth Transportation Ring and two 'rocades' – lateral roads in southern and northern parts of the city. However, the new Mayor had questioned the effectiveness of this plan.

LEARNING FROM HISTORY

> The overall evolution of the street-pattern in both cities examined here divides into roughly four periods of development. It has started from phase 'zero' when the prerequisites of its future development were created. Later, during the 'basic' phase the first elements of the system were introduced in city plans. The 'intermediate' phase started with the replacement of the medieval fortifications by boulevards, avenues or residential quarters until the motorisation era accelerated the development of the radial-circular system to adapt cities to car traffic.

> Phase 'zero' of both Wrocław and Moscow manifests several prerequisites which supported the further development of the radial-circular street pattern. First of all there was a compact urban core situated on a flat relief. No semi-circular walls would have been possible, unless the new centre of Wrocław had been moved from the islands and river embankments to the hinterland and Moscow had been enlarged enough to include lower lying areas around the hill it had initially occupied. However the triangular form of the Kremlin proves that the radial-circular pattern was not the only option, and the core could have been large enough to make a curvilinear outline of the walls more favourable compared to irregular patterns.

< In both cases, the first elements of the future radial-circular street pattern were the walls and not the radial streets. It seems that the directions of streets have not been a very important prerequisite of introducing the 'outer rings' at the 'pre-automotive' era. Circular belts could have been easily applied to any urban core regardless of the internal structure or its street pattern. Certainly cultural issues were important too in the selection of the fortification geometry, taking into account the Chinese tradition of rectangular city plans or the Roman way of building military camps. Therefore, it seems that the Russian and Polish-German attitudes to this initial step were rather similar.

< While the circular character of the city limit had apparently an impact on a more radial street pattern it was not enough on its own. Wrocław's history displays a long period of suburban growth beyond the fortifications without apparent radial directions. A geometry of external connections in general and the possibility of transit across the city core in particular were likely key factors affecting the geometry of the street network. In this respect the two cities presented two apparent alternatives in medieval times. It is possible to conceive them as 'pass-through diagonal' model in Wrocław and 'dead-end radial' model in Moscow (of course the former north-south and east-west directions were not strictly speaking diagonals, but this term correctly reflects the possibility to cross the city through its centre). The former allowed to ignore the outline of historic walls and to continue development along the previous grid of streets formed in the inner city. The location on a busy transit route seems to be a restraining factor too in shaping the radial directions of streets, even when circular streets existed already in the city plan. In Wrocław that factor was strong enough to influence the geometry of the outer fortification, as it was something between a rectangular and a circular form, due to the extension of the transit movement along the east-west axis.

< To some extent the type of inner city determines the role and significance of the urban core. The Kremlin

and the adjacent Kitay-Gorod concentrated the most important functions of the city and became a final destination, thus promoting radial street directions.

> This tendency to a radial character of the streets became only apparent in the plans of the two cities when the second belts of fortifications were introduced. For a long time, Wrocław had no significant urban areas beyond its outer walls, as the 17th century panoramic view of the city demonstrates. There was no periphery where new radial streets could have been developed following the rhythm of the city gates. Thus the growth of suburbs around the city core facilitates the radial-circular development pattern.

> In spite of many driving forces discovered it appeared difficult to identify definite factors or prerequisites that made the development of a radial-circular street pattern inevitable. The strongest step that shaped the foundation of the present urban form of Moscow was a first full circular line of fortification. But it is arguable that it was absolutely inevitable. It is possible to imagine that the threat of enemy attack was never used to develop a full ring. Instead of building a long circular wall around the new periphery of the city a semi-circular fortification on the opposite bank could have been erected. Later the development of prevailing directions could have made the city network of streets more linear. Conversely, it is difficult to envisage that a rectangular or triangular wall pattern would have been selected to protect the city if there was a need for a further fortification of peripheral quarters. It is also difficult to predict whether the municipality of Wrocław would have liked to protect the suburbs on the opposite Odra bank and what type of geometry they would have selected. The latter probably depends on the time when it would have happened. Medieval times seem to encourage replicating semi-circular forms while later on more complicated system of ramparts would have been chosen. However, it would be rather impossible to create a radial-circular street pattern in a city located on a seashore, in a mountainous area or on the intersection of strong transit routes (but as Wrocław displayed later, this became very likely in the era of motorisation).

While no new rings or radial directions were developed during the 'intermediate' phase it was remarkable how old urban spaces were able to adapt to new needs by replacing the surrounding function of rings to connect peripheral parts to the city. The Wrocław experience also demonstrates the possibility of reversing the development of initial elements of radial-circular systems. It means that theoretically Moscow could have follow the same approach if there had not been sufficient open land for external growth. Probably it could have saved its centre from office intrusion centuries ago. <

Today the radial-circular systems of the two cities have reached different stage of evolution. After the completion of the outer ring in 1960s Moscow had reached its 'mature' state. It had already all the key elements of the radial-circular system: radial thoroughfares, an inner ring to connect sectoral parts of the city and to redistribute internal transit and an outer ring to redirect external transit. Its centre retained a model of transit formed already in medieval times and reached its 'ideal' form when the only transit car flow across the Red Square finally ceased before the second world war. Later developments have not brought revolutionary changes and were aimed generally at raising the density of the existing street pattern. Until the rapid growth of cars that system worked very well and was sufficient for a city with many millions of population. Wrocław seems to be moving in the same direction and its current state seems to have proved that until the outer-ring will be completed transit across the city will not be halted. Its centre changed its model to the one of Moscow as its has almost closed its urban core to internal transit and this tendency will continue if Kazimierza Wielkiego street is truly redeveloped to its former state. Thus, to some extent Moscow models the remote future of Wrocław if it sustains population growth. Nevertheless, Wrocław has developed its <

rings and radiuses on top of the older street pattern while more recently Moscow has adopted a fresh look at its transportation problems. This gives rise to new 'intercity' parallels exposed below:

- The main problem of Moscow is its concentration of about 62% of its working places in its centre. It is probably a result of placing the Garden ring too closely to city centre. History seems to have played a mean trick to enable the use of a ready ring of medieval times instead of creating a new one at a greater distance or implementing what the master plan of 1935 had suggested. As Wrocław's centre is much smaller it was pedestrianised and its first ring was not placed along the old ramparts keeping this area for recreation functions. Reversing Kazimierza Wielkiego street into a local road will make the city centre even less suitable for office complexes, although some office development has already appeared there. It is thus possible to think of a radial-circular model which artificially curbs the traffic capacity of the streets in the central part to force out offices to the middle ring area and to make the city centre more public and residential.
- The Moscow experience demonstrates that when a new peripheral ring is constructed it balances different directions of urban growth inside it and makes them equal instead of enhancing previous prevailing vectors. Moreover the outer-ring had a tendency to become soon internal as it provokes active commercial construction activities alongside it. These trends will have an opportunity to evolve in Wrocław as well when its new ring is constructed.
- Two additional rings in Moscow – the third and the fourth - were managed to be routed along older streets, across industrial areas or along railway connections, thus avoiding intrusions into residential areas. In order to preserve green areas and historic parts tunnels and bridges were built, taking into account lessons of the implementation of the 1971 master plan. The new traffic link in the southern part of the Wrocław discussed at the EUSS seminar will penetrate residential areas using the morphology of mass produced residential areas that have tremendous open spaces between multi-storey buildings. Both approaches might be applicable to other parts of the city.
- Transit flows in Wrocław will display similar features to the Moscow 'rocades' if they are linked to external directions.
- The 'dead-end radial' model of the city centre increases traffic loads on the central ring as a main distribution tool and rises the intensity of traffic in radial directions. While the grid of older streets in Wrocław still supports direct connections between neighbouring city areas further development of the radial-circular system will demand an increase of the radial streets traffic capacity to keep sufficient density of main thoroughfares as it has become evident in Moscow when it was expanding spatially.

MOSCOW-WROCŁAW RADIAL-CIRCULAR SYSTEMS: CONCLUSIONS

This overview of the evolution of the radial-circular street pattern in two very different cities has identified some basic principles of what is in effect a universal urban form that should be taken into account in the planning of any such city.

- **The radial-circular system is truly inertial**: after the first ring in Moscow the next steps of its development were only a multiplication of circular roads, while in Wrocław the growth of that system was steered through a sequence of south-western bypasses. In Moscow, all efforts to radically modify it at a mature state of development have been failing. Its apparent model of growth by adding outer rings and extending radial thoroughfares is supported by the basic principle of urban peripheral growth. Both in Moscow and

Wrocław history shows that this system has prevailed and superimposed itself to previous street patterns while there are no examples to the contrary in a city plan. Wrocław's history demonstrates the rapid restoration of its radial circular system after having been unnecessary during centuries. After the first ring is achieved further development on the city periphery tends to have a cyclic character. The rigid street pattern first weakens beyond the ring and makes growth along prevailing radials possible. The subsequent introduction of a new ring restores a symmetrial urban form. Car traffic amplifies each of the three main elements of the system – rings, core and radiuses – and is promoting the development of more of them.

- **At the same time it is adaptive**: it can be easily combined with, or superimposed over other street patterns. While its development has always a tendency towards an 'ideal' web shape it could be reached by a set of different elements: rings, by-passes or curvilinear connections within a regular grid iron of streets. Its development can follow either outward (from the city centre to the outskirts) or inward (from the outer ring to the intermediate rings).
- **It is effective but has a trick to be avoided**: the radial-circular system proved to be an effective tool to redirect external transit by means of outer rings, to connect peripheral areas and to protect the urban core of the city from transit transport with a 'dead-end radial' model. Many transportation problems of Moscow are caused not by the geometry of the system but by insufficient density of rings and radiuses. However spatial extension of the circular radial system leads inevitably to increased congestion of the internal rings. The closer they are to the centre the more convenient it is to switch transport traffic between radiuses. To keep pace with city growth the internal ring of the system has to become soon similar to the transport infrastructure around CBDs in American cities which occupies tremendous space and isolates central quarters from the rest of the city. Provision of such infrastructure is apparently impossible in historic cities without the complete destruction of its most valuable inner areas. Another alternative could be the use of the 'pass-through diagonal' model that permits the intersection of the most important routes in the inner city, in order to diminish the traffic load on the internal rings and to shorten the time of moving among remote peripheral districts. However this approach requires large scale transformations of the city centre as well. It already takes place in Moscow where some historic squares are turning into interchanges and green avenues are becoming noisy motorways. So the 'trick' is the contradiction between the task of keeping the core of the city untouched which got started with the development of the radial-circular system in Wrocław while preserving the effectiveness of the overall system which requires a core as a big interchange linking all radiuses and diagonals.

Sooner or later each city which has this type of street pattern will need to find its own way out of that contradiction. Some solutions were outlined above and others are yet to be found in Wrocław and Moscow.