VIEWPOINT

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Unlocking Latent Demand for Walking and Cycling Through the Use of Spatial Network Modelling



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The Global Trend Towards Walking, Cycling and Public Transport

Cities and countries throughout the world are investing heavily in walking, cycling and public transport infrastructure. Their general aim is to offer people a realistic alternative to driving and, in doing so, to pursue the multiple benefits that occur when people drive less, including improved physical health and economic wealth, reduced social isolation, carbon emissions, traffic volumes and congestion.

There is, quite reasonably, a debate about the best ways of doing so: Should cities implement high-quality cycling and public transport infrastructure? Should they invest in lighting and paving improvements? And how can these individual interventions work together as part of a wider urban system?

When we think about space, we tend to think about individual streets, parks or public spaces. Of course, the local design of cities matters: public spaces need to be well paved, landscaped and lit, and buildings need to engage with them. But what matters too is how these individual elements are connected at a wider scale, as spatial networks. The way streets, parks and public spaces connect can influence how easily people move between them, and how movement is distributed across the city.

This article explores how spatial networks facilitate walking and cycling in cities, and in doing so, how they enable a 'movement economy' that sustains public transport and urban employment. It describes proven techniques that can be used by cities to create spatial networks, and provides examples where these methods have been used in practice to transform urban mobility.

What Does Research Tell Us About the Importance of Spatial Networks?

1. Spatial Connectivity is Measurable
When it comes to encouraging more walking and cycling, space matters greatly—but perhaps in ways that aren't immediately obvious.

Over the last 50 years, academic research has found consistent relationships between more connected spatial networks and higher overall levels of walking and cycling.



Analysis of cycle movement in London in 1999: Warm colours indicate frequently used routes, cool colours indicate underused cycle routes and white routes were not used by respondents at all.
Image: Space Syntax Limited / Central London Partnership

Spatial connectivity can be measured using specially developed spatial algorithms that analyse street networks and identify the spatial hierarchy from more to less connected streets. The algorithms consider the different routes that can be taken between street segments across the network and identify both the metric distance—the shortest route in terms of the physical distance travelled, and the geometric distance—the simplest route between origins and destinations.

This second aspect of measuring distance is an innovative feature of these 'space syntax' models, without which correlations are much weaker. This seems to be the case because, when navigating cities, the human brain is thinking not only about how far away a destination is, but also how that destination can be reached in the least convoluted way possible. The lesson for street network designers is clear: keep it simple!

This can be particularly useful when deciding where to intervene. Space Syntax's work on cycling in Central London used spatial analysis alongside observed cycling patterns to identify routes, barriers and opportunities for improvement. Its London Pedestrian Routemap applied the same principle to walking, using research into walking patterns and spatial accessibility to identify key routes and strategic opportunities.

2. Spatial Networks Fuel the 'Movement Economy'

Research has shown time and again that more connected streets typically gather higher levels of movement than less connected ones and tend to correlate with the presence of more retail and commercial land uses. In other words, spatial networks organise movement patterns, which in turn influence land use patterns: shops locate along the most connected streets where people are going to be moving anyway; their presence then attracts even more movement. This reinforcing relationship between spatial connectivity, movement and land use distribution is often described as the 'movement economy'.

This relationship is typically stronger in historically evolved towns and cities than in car-dominated places that have been planned by siloed professionals. When urban settlements grow slowly and incrementally, they instinctively tend towards networks with highly connected streets lined by shops, businesses and civic buildings, or 'Main Streets', along which run

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public transport routes. These Main Streets are fed by multiple side streets lined by businesses and residential buildings. Side streets then lead into local street networks, where the predominant land use is housing, supported by schools and community buildings.

This also helps explain why density alone does not necessarily produce sustainable mobility. Research in the UK suggests that lower-density areas—those with fewer than 50 people per hectare—generally have drive-to-work mode shares of around 75%, with some significantly higher. People in these areas not only drive more, but also tend to drive further.

But does the reverse follow? Does higher density automatically produce more walking? Unfortunately, it is not that simple. Some of the densest places have among the lowest levels of driving; others have among the highest. What distinguishes many places with less driving is that they are not only denser, but also spatially networked across different scales.

Density creates proximity. Connectivity makes that proximity usable. To reduce car dependence, cities need both.

3. Main Streets Are the 'Secret Sauce' of Spatial Networks

Space syntax algorithms measure connectivity at different scales, picking out three key types of streets: a) those that are most important for channelling shorter, local journeys along them; b) those that are important for longer-distance movement; and, crucially, c) those that are important at both scales, or 'multi-scale places'. These multi-scale places often form the Main Streets of towns and cities. Their combination of local and wider movement also helps explain why many develop into successful commercial locations, making them key assets within the movement economy.

Crucially, in addition to being fed by side streets, Main Streets carry movement over longer distances through the wider urban network. In this way, Main Streets are fed by a dual movement economy: the local movement of pedestrians, cyclists and short vehicle trips, as well as the global movement of public transport and private vehicles travelling longer distances.

This dual economy is the 'secret sauce' of spatial networks. If local spatial networks are

isolated from each other, they may not generate enough footfall to support much retail. However, once connected by Main Streets, multiple local networks can achieve a critical mass: local movement that is turbo-charged by the larger-scale global movement.

How Can Planners and Designers Respond to These Research Findings?

These findings offer practitioners both a mindset and a methodology to identify spatial network potentials and to plan cities away from car-dominance towards walking, cycling and well-used public transport. As the 'lowest common denominator' of urban planning and design, space can also provide a common language between professional silos, helping different disciplines understand how their individual decisions interact.

1. Use Spatial Modelling Early in the Planning Process

Although complex modelling can be undertaken to factor in the effects of other influences—such as light and shade levels, footpath width and quality, or even building façade attractiveness—simple spatial models provide powerful tools in their own right, early in the planning process. This is especially important in data-poor situations when other information may not be available. Indeed, spatial layout information is sometimes the only data available at the early stages of designing a new urban area.

In these circumstances, spatial modelling allows for the testing and optimisation of designs at a much earlier stage than conventional traffic modelling. This space-first approach can be used to inform land uses, density distributions, street widths and public transport corridors.

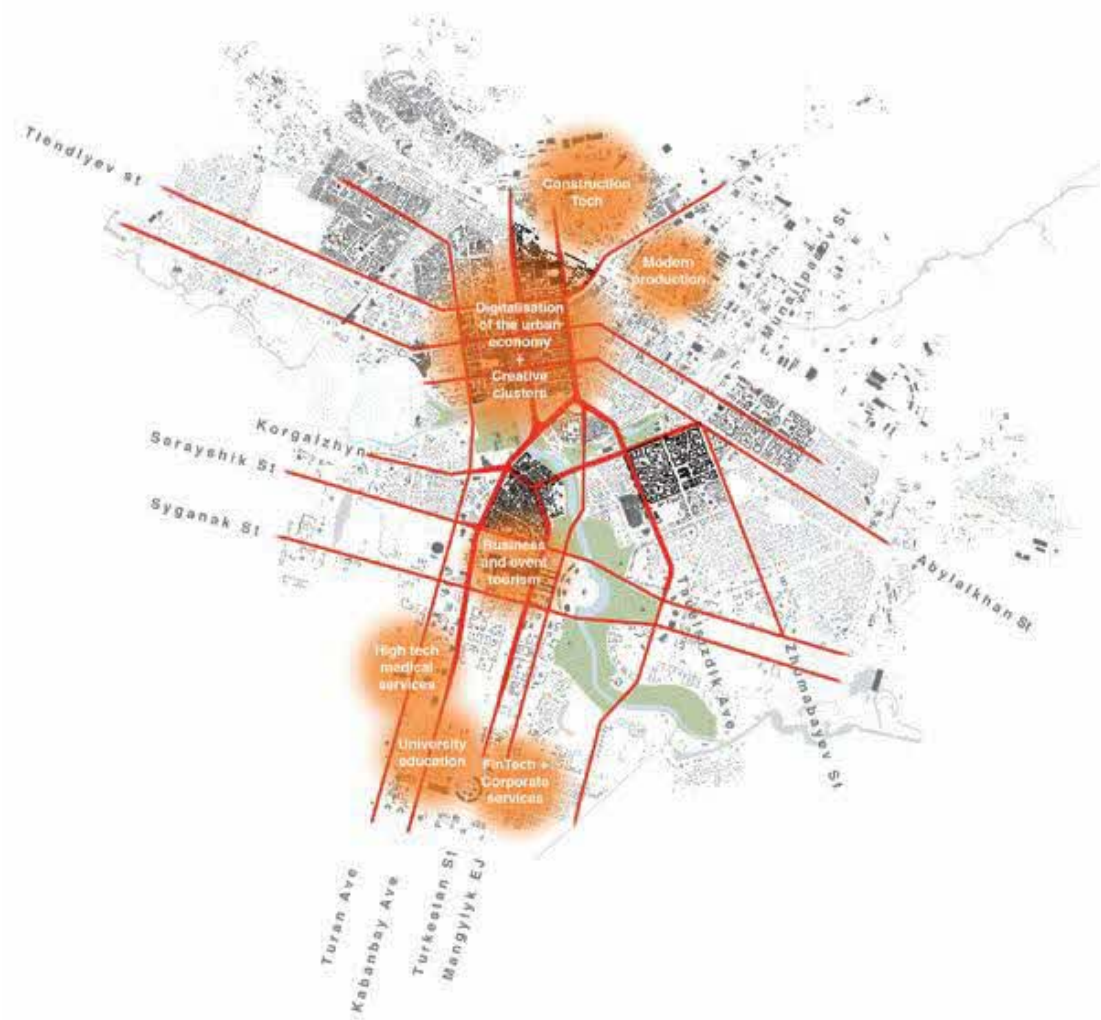
At a city-wide scale, this approach was used in Astana, Kazakhstan—where evaluation of spatial potentials informed a planning strategy covering land use, transport, utilities, street types and urban design. The ambition was to shift the city away from car dependence towards walking, cycling and public transport as genuine mobility options.

2. Treat Spatial Networks as Critical Infrastructure

The consistencies in the historic urban record identified by research suggest a natural order to the spatial shaping of cities that can be nurtured in new plans and applied to existing places where planners are seeking to move people away from car-dependence. In other words, historically evolved cities reveal this 'natural order'—recurring relationships between spatial connectivity, patterns of movement and the distribution of urban activity.

Spatial networks are indeed sufficiently powerful to make the difference between active travel and public transport investments either thriving or failing. They should therefore be considered as critical infrastructure, to be sensitively handled through careful appraisal, design and impact forecasting.

The Southbank Centre in London—a nationally significant collection of cultural buildings—demonstrates this principle in an existing urban environment. Spatial modelling was first used to diagnose how a fragmented and disconnected



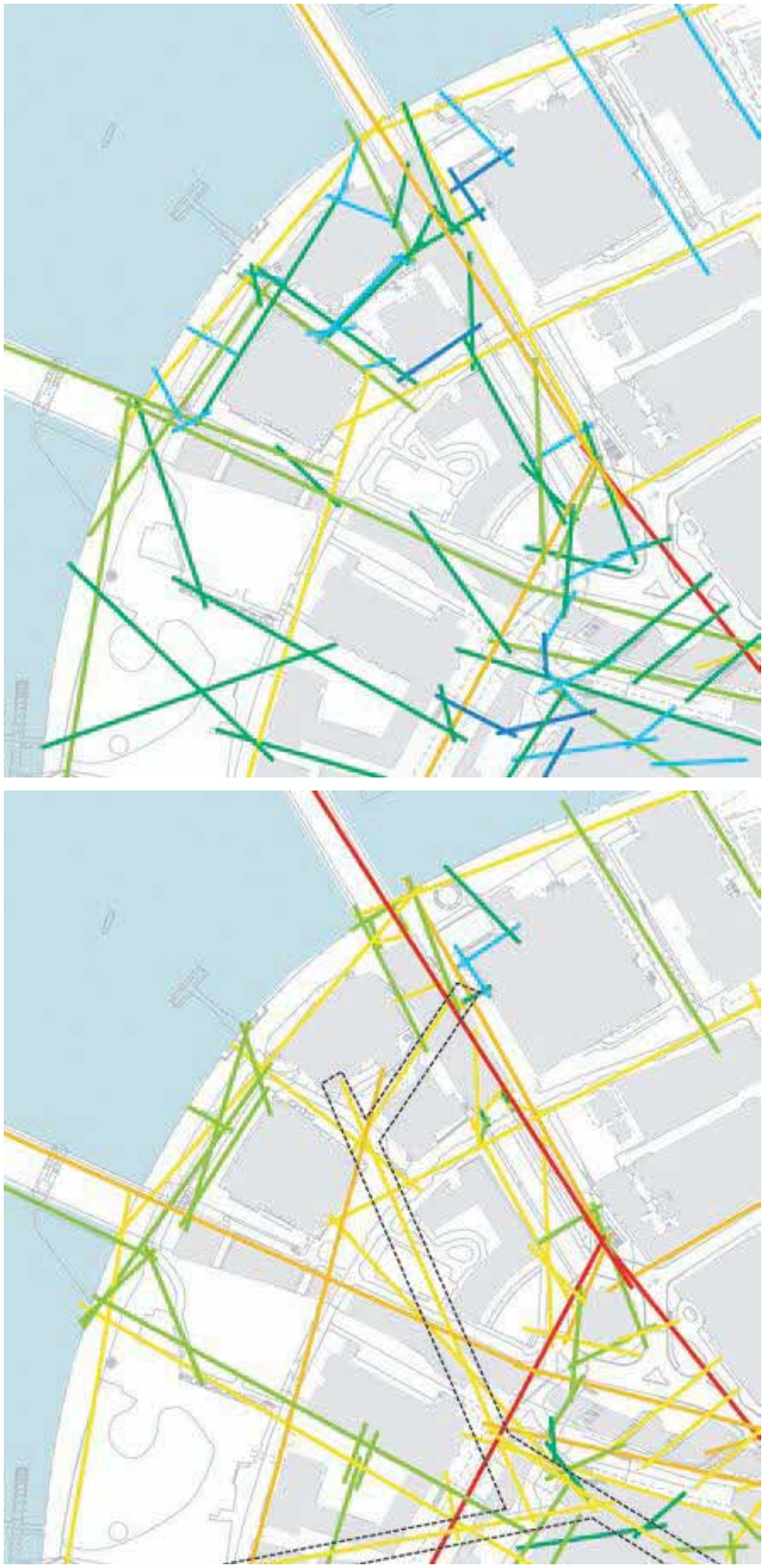
Spatial analysis of Astana showing the city-wide network and its spatial potentials. The analysis formed part of a wider planning strategy for the Kazakh capital.
Image: Space Syntax Limited

layout was suppressing pedestrian movement and limiting the use of its economic and cultural assets. The results of the diagnostic work led to the testing and refinement of plans to radically transform the Southbank Centre. A space-first approach was taken to simplify the internal layout of the entire estate and stitch it into its wider urban context in order to generate a 'movement economy' that is today characterised by vibrant public spaces lined with bars, cafés and restaurants.

3. Be Prepared to Think Differently

Spatial network research—in particular, the importance of mixing local and global movement to fuel the movement economy—has implications for contemporary planning and urban design. It challenges the mindsets of professionals who have often been educated to separate global and local movement networks. Consider the sterile residential streets of many new towns, encircled by fast roads but poorly connected to them, or bypasses that remove through traffic but also the passing movement that previously contributed to the local economy.

The lesson is not that all movement should be brought back into every street. Rather, the effects of changing movement at one scale need to be considered at other scales too. A spatial-networks-first approach challenges these long-held practices of partitioning, separation and isolation. It asks what should be connected, at what scale, and for whom—rather than assuming that separation will always produce better outcomes.



Spatial accessibility at the Southbank Centre before (top) and after (bottom) the redesign. The previously fragmented layout resulted in low levels of spatial accessibility (shown in green and blue). Simplifying the pedestrian network into fewer, more direct routes significantly increased accessibility.
Image: Space Syntax Limited

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4. Accommodate the Slow Car

A further challenge concerns the urban design of Main Streets, where different scales of movement need to be accommodated.

First, the economic benefits of connected spatial networks will only occur if through traffic moves slowly enough for walking and cycling alongside it to remain comfortable. A maximum speed of 30 km/h is now typical in cities that have implemented such measures. Main Streets that accommodate the 'slow car'—with narrower kerb-to-kerb dimensions, narrower traffic lanes and landscaping—can create a 'visual friction' that helps to enforce lower speeds.

Second, public transport and private vehicles need opportunities to stop so that their occupants can convert from being global to local economic actors. There is no point implementing a slow-speed design strategy if the presence of through traffic cannot be harnessed. This means providing more accessible on-street transit stops rather than hard-to-reach transit hubs as well as on-street or near-street parking, carefully integrated within a pedestrian-first approach to urban design.

Conclusion

For cities looking to shift away from car-dominance, it is not enough simply to promote the benefits of doing so in terms of health, carbon emissions and economic advantage. Cities must also invest in the infrastructure to make walking, cycling and public transport a realistic possibility. This means good-quality footpaths, bike lanes, transit vehicles and transit stops, as well as attractive landscapes that shade their users. It also means architectural and planning codes that deliver mixed-use neighbourhoods and buildings that meet the ground with 'active' frontages onto Main Streets rather than blank walls onto highways.

However, these elements do not operate independently. Their effectiveness depends on the spatial networks in which they are embedded. Using modelling to identify spatial potentials, develop strategies and test their effectiveness can help cities unlock the natural, latent demand for people to walk, cycle and take public transport—and make better use of the streets, public spaces and urban assets they already have.