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Sustainable Urban Mobility

Transport for the North
Northern Evidence Academic Forum

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Sustainable Urban Mobility

Mobility that allows people to move around in a safe, convenient, and pleasant manner, and that promotes personal health and wellbeing while having a limited impact on the environment.

Overview

1. **Context**

The changing nature of travel.

The triple crisis (and role of sustainable urban mobility).

The response - The Sustainable Mobility Paradigm | Built Environment and Health and Wellbeing.

The role of spatial planning in supporting sustainable urban mobility.

2. **Evidence** from the (a) Understanding Walking and Cycling study (b) cycle BOOM study

3. **Summary** reflection

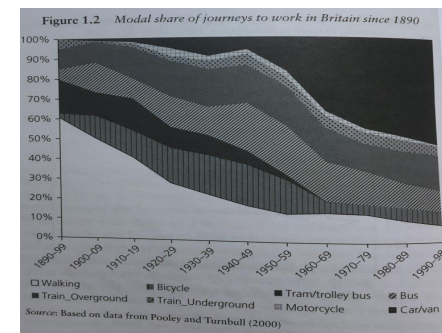
The changing nature of travel

Until industrial revolution people travelled much less – a few kms a day.

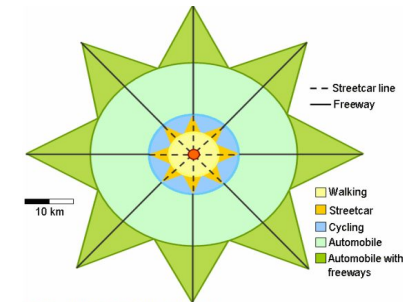
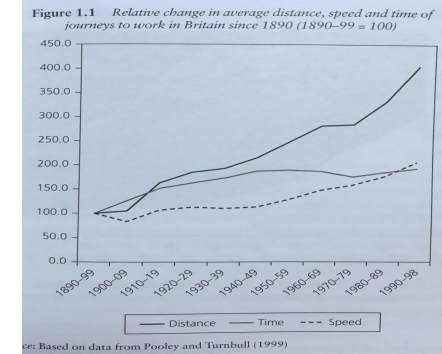
Trend in travel reflects a change in transport technology, activity patterns and travel behaviour.

Growth in home to work distance and dramatic increase in speed enabled by car since the 1950s.

Time-space compression (Harvey, 1989) Speeding up and spreading out precipitated by technology, communication, economic structure.



Source: Bertolini, L (2017) Planning the Mobile Metropolis. Figure 1.1 [p3] & Figure 1.2 [p4]



Source: Adapted from P. Huggill (1992), p. 213.
One Hour Commuting According To Different Urban Transportation Modes

The Mobility Dilemma

Built a society that depends on mobility but this comes at a cost

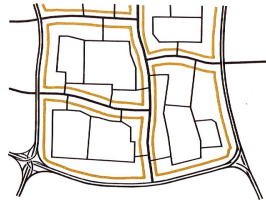
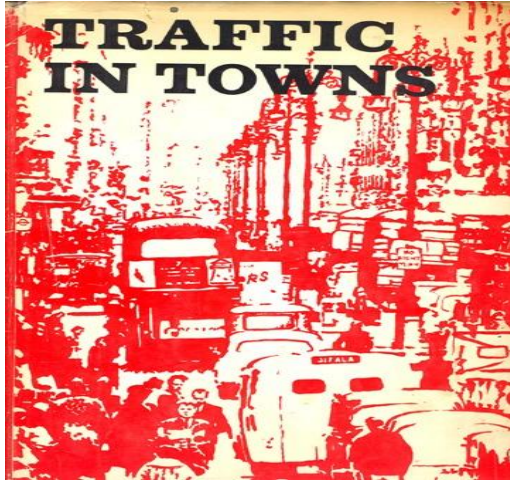
BENEFITS

- Increase in range of 'choice' on where and how to live work and spend leisure time.
- Increase in quantity and diversity of available goods and services.
- For most part, improved the standard of living.

COSTS

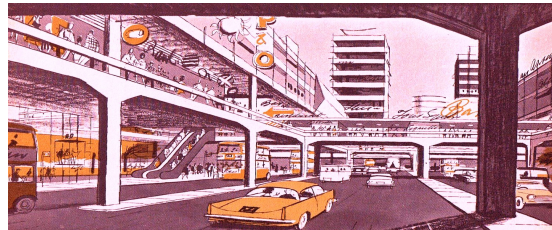
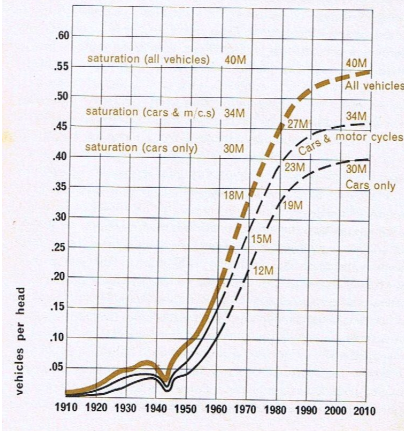
- Environmental costs: depletion of resources; emission of greenhouse gases and local pollution; disruption of natural ecosystems.
- Social costs: traffic related KSIs; severance of communities; social exclusion; erosion of public space; decrease liveability; sedentary lifestyles-obesity; airborne related diseases.
- Economic costs: productivity loss due to congestion; disproportionate investment in roads to keep car system going.

Buchanan Report: Traffic in Towns, 1963.



Primary distributors
District distributors
Local distributors
Environmental area boundaries

4. Future growth of numbers of vehicles. These curves indicate the probable trend assuming no drastic restrictionary measures are applied, and allowing for the future growth of the population.



“There are absolute limits to the amount of traffic that can be accepted in towns, depending on their size and density, but up to those limits, providing a civilised environment is to be retained or created, the level of vehicular accessibility a town can have depends on its readiness to accept and pay for the physical changes required.... The choice is society’s”

The UK policy response to projected traffic growth



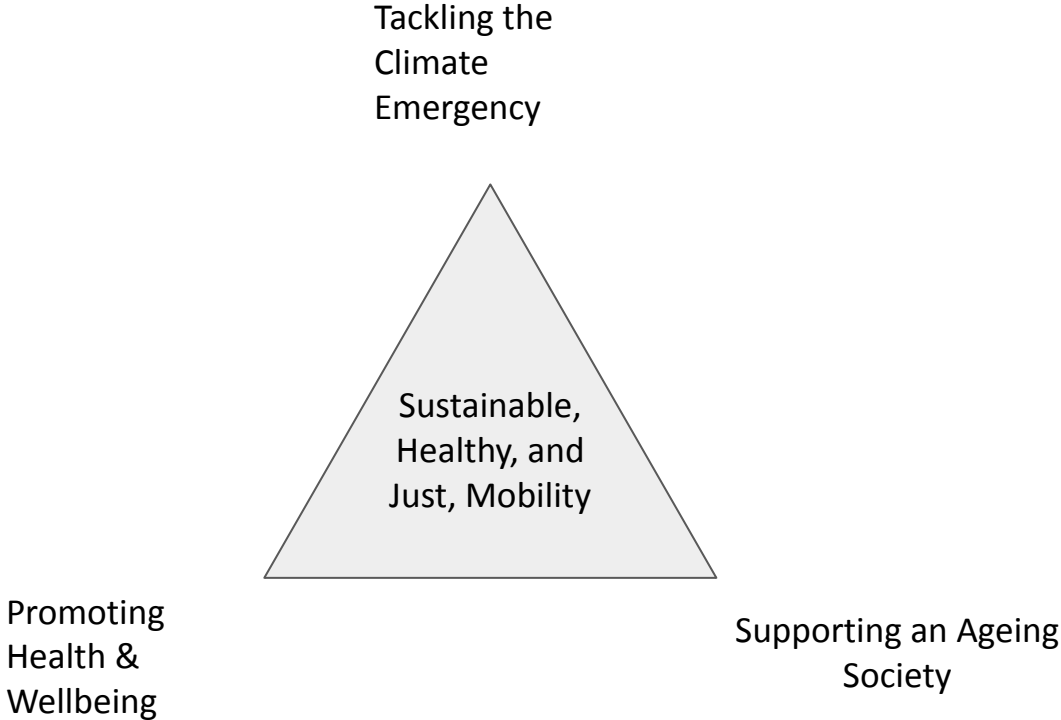
The Sun on 21 July 1998

'Traffic in Towns' Report (1963) recommends comprehensive redevelopment incorporating new network of urban motorways and distributor roads enclosing 'environmental areas'.

During 1960s, 1970s & 1980s, UK Government response was to invest in expanded highway networks.

Since 1990s general a break with that way of thinking e.g. PPG13, Prescott's 1998 Integrated Transport White Paper.

The Triple Crisis: The role of transport and mobility



The Sustainable Mobility Paradigm

Banister D (2008) The Sustainable Mobility Paradigm, *Transport Policy*, 15, 2.

Questioned the underlying principles of conventional transport planning that can lead to degradation and disparities in health and environmental sustainability.

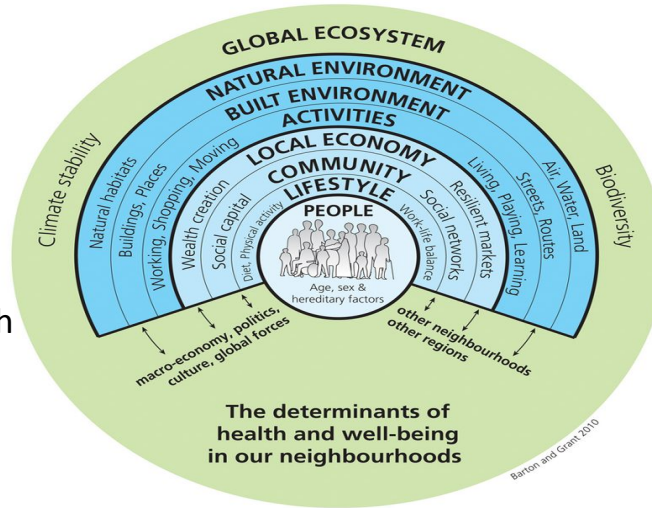
Mapped an alternative **sustainable mobility paradigm** within which to investigate the complexity of cities that focuses on four key challenges in the field namely:

1. **reducing the need to travel** through the use of Information Communication Technology (ICT);
2. a **modal shift away from private cars** towards walking and cycling and public transport;
3. implementation of **land use policies** that reduce distance to activities; and,
4. **technological developments** in vehicle design and efficiencies.

Challenge of achieving this paradigm is **gaining public confidence and acceptability** (which in turn generates political acceptability) to support these measures through an active process of involvement that is truly participatory and inclusive.

Built Environment and Health and Wellbeing

Widely believed that built environmental design supportive of active mobility could help to promote moderate physical activity, delay biological ageing and age-related conditions, and improve overall health and wellbeing.



Experts in public health, planning, and transport, are now focused on how healthy and sustainable transport systems can be achieved, and how health disparities between wealthy and more deprived areas can be closed.

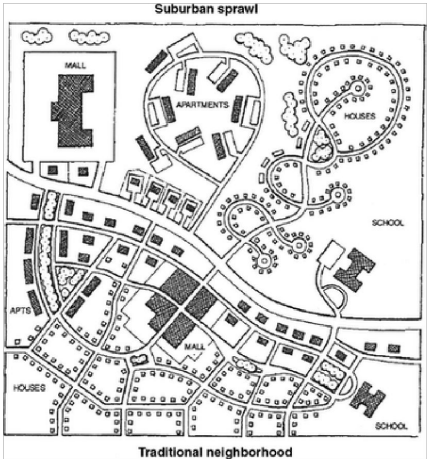
For example, see landmark study published by Professor Sir Michael Marmot and his team – Marmot et al. (2010) *Fair Society, Healthy Lives: The Marmot Review*

Spatial Planning: Compact Urban Form

Policy makers trying to encourage more walking and cycling through different measures.

Walking and cycling more sensitive to distance between activities.

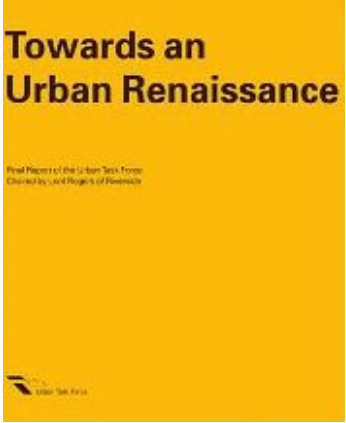
Generally assumed that densely populated areas where there is a mix of activities located within a highly connected street network encourages more walking and cycling.



Source: Drawing by Duany Plater Zyberk as shown in Spielberg F. The traditional neighborhood development: how will traffic engineers respond? ITE J. 1989;59:17.!



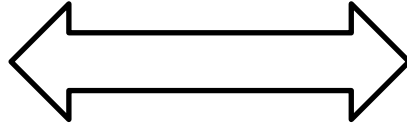
Source: Fig2.8 in TaUR. Andrew Wright Associates



A vision of well-designed, compact and connected cities that support a diverse range of land uses and that integrate public transport, walking and cycling and reduce the need for car use.

Transport both the product of land use activity and the determinant.

Land use activities as the source of travel ('trip generation')



Transport configuration determines pattern of travel ('trip distribution')

Inter-action between land use and transport underpins case for integrated spatial planning.

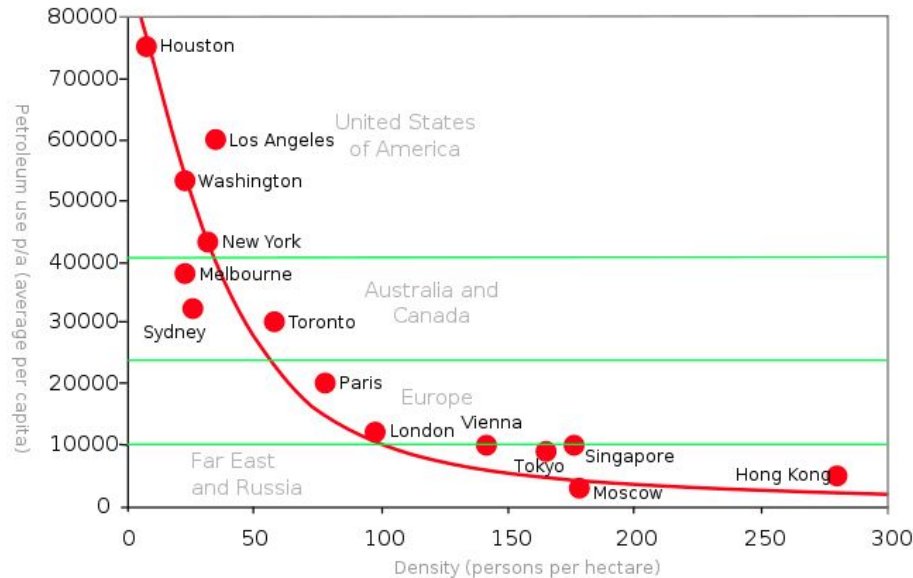
"Just as changes in kind or intensity of land use by establishments brings pressures for changes in the channels of movement, changes in channels tend to affect the distributions of establishments by altering existing paths of movements and avenues of accessibility."

Mitchell and Rapkin (1954, p131)

Newman & Kenworthy's Classic Study

Relationship between Transport and Land Use

A commonly used study of 32 cities by Newman & Kenworthy in 1989 concluded that there was a strong link between urban development densities and petroleum consumption.



Annual petroleum use per capita adjusted to US MJ (1980)
After Andrew Wright Associates, small section taken from 'Towards an Urban Renaissance',
Urban Task Force Partnership, 1999, © DETR, 1999

The contribution of Newman and Kenworthy to the planning field is undeniable. They were among the first to study the relationship between the built environment and transportation outcomes. Their work in the late 1980s, and that of Robert Cervero at about the same time, spurred a whole new area of academic inquiry. The relationship between the built environment and travel has become perhaps the most heavily researched topic in urban planning (Ewing and Cervero 2010). Newman and Kenworthy's iconic image of private transport energy use versus density, shown in Figure 1, has been reproduced in countless scholarly articles and government reports. While others had previously written about the interaction of land use and transportation, their work made the bidirectional relationship more tangible and quantitative.

(Ewing et al. 2017)

Cervero and Krockelman's 3Ds

Robert Cervero Kara Kockelman (1997) Travel demand and the 3Ds: Density, diversity, and design
Transportation Research Part D: Transport and Environment Volume 2, Issue 3, September 1997, Pages 199-219

Density

Diversity

Design

“The research finds that density, land-use diversity, and pedestrian-oriented designs generally reduce trip rates and encourage non-auto travel in statistically significant ways, though their influences appear to be fairly marginal.”

Ewing et al. Update on Newman and Kenworthy

Ewing, Reid & Hamidi, Shima & Tian, Guang & Proffitt, David & Tonin, Stefania & Fregolent, Laura. (2017). Testing Newman and Kenworthy's Theory of Density and Automobile Dependence. *Journal of Planning Education and Research*. 38.

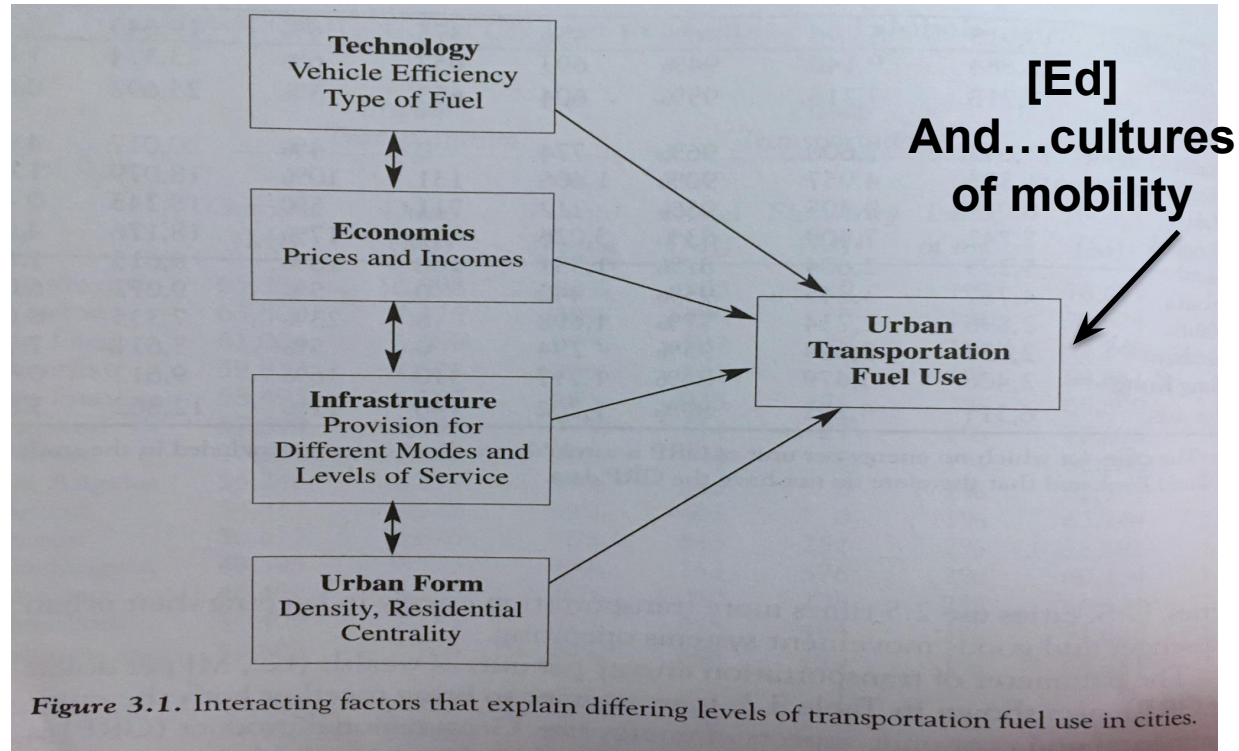
Abstract

This study tests four hypotheses related to the much-cited work on density and automobile dependence by Newman and Kenworthy, using multivariate analysis and data for 157 large US urbanized areas. We find that density alone explains only a small fraction of the variation in vehicle miles traveled (VMT), and many confounders account for the differences in automobile dependence. We also find that it is not the localized density of individual neighborhoods that causes VMT to be lower in compact urbanized areas but rather the relative accessibility of neighborhoods to the rest of the region.

Important co-founders – personal income & highway capacity.

More than density - distribution of population (e.g. in relation to employment) and land use mix.

Interacting Factors that explain different levels of transport fuel use in cities



Source: Fig 3.1 p72 Newman and Kenworthy

Research agenda on 'walkability' and 'cyclability'

Research centred in urban planning and transportation field but major increase interest amongst health science researchers given concerns about sedentary lifestyles.

Obesogenic environments

Active travel

Walkability

Approaches include comparison of neighbourhoods in relation to their 'walkability' and 'cyclability' and correlation and regression analyses of large datasets.

Cyclability

Tends to support hypothesis that built form affects levels of walking and cycling (Saelens et al., 2003)

Understanding
WALKING & CYCLING

OXFORD
BROOKES
UNIVERSITY

LANCASTER
UNIVERSITY




UNIVERSITY OF LEEDS

3-Year project completed 2011

To develop better **understanding** of the **complex** ways in which households and individuals make **everyday travel decisions** about **short trips** in urban areas

To provide **new evidence** of how different individuals and households make decisions about walking and cycling and how they respond to different interventions by focusing on neglected areas of micro-scale household decision making , within the context of the **built environment**.



Hybrid approach using multiple-methods across four different English cities



262 separate transcripts/1.5 million words of text

Self-reported travel behaviour linked to spatial analysis

Understanding WALKING & CYCLING OXFORD BROOKES UNIVERSITY LANCASTER UNIVERSITY UNIVERSITY OF LEEDS

Dear householder

The University of Leeds, in partnership with Lancaster University and Oxford Brookes University, are carrying out research on short journeys in your local area and need your help in completing this survey.

Completing this survey:

- Gives you a chance of winning £200, a £25 gift voucher or a £15 gift voucher.
- Will only take 15 minutes to complete,
- Will not cost you anything to return – a freepost envelope is included, so no stamp needed,
- Will help us to understand more about transport in your local area and help improve it.

No data will be passed on to or shared with any organisation outside of the project team, and will not be sold on. All data will be reported anonymously and is confidential.

Please return completed questionnaires in the **FREPOST** envelope provided.

All completed questionnaires received on or before the 7th of October 2009 will, if you wish, be entered into a prize draw: one 1st prize of £200, five 2nd prizes of £25 gift vouchers and ten 3rd prizes of £15 gift vouchers. The prize draw will be drawn on the 6th of November 2009, and the winner will be notified by post or e-mail. Please tell us below whether you would like to be entered into the draw, select which vouchers you would like if you win a 2nd or 3rd prize, and provide your contact details.

Yes, please enter me in the prize draw...

If I win a 2nd or 3rd prize I would like a voucher for (choose 1 only)...

...Argos... <input type="checkbox"/>	...Mothercare... <input type="checkbox"/>
...HMV... <input type="checkbox"/>	...M&S... <input type="checkbox"/>
...Boots... <input type="checkbox"/>	...Waterstones... <input type="checkbox"/>
...Millers... <input type="checkbox"/>	

No, I do not want to be entered in the prize draw...

Name:.....
Address:.....
E-mail:.....

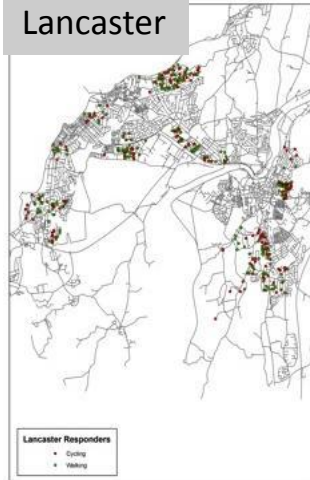
If you would prefer to fill in this survey online instead, please go to www.ls.leeds.ac.uk/walking, and enter the code that appears in the bottom right hand corner of the address label on the freepost envelope. Please recycle this questionnaire and return envelope.

Thank you.

This questionnaire is also available in large print or Braille on request. Please telephone 0113 343 5333 to request a copy.

If you have any queries about this questionnaire please telephone the University of Leeds on 0113 343 5333

Lancaster



Lancaster Responders

- Cycling
- Walking

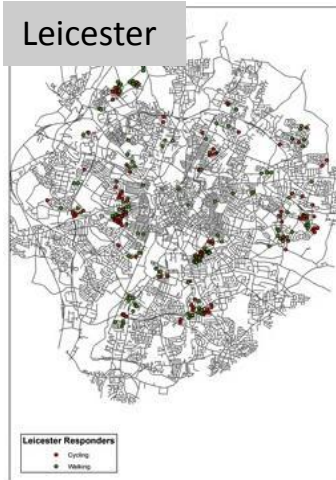
Leeds



Leeds Responders

- Cycling
- Walking

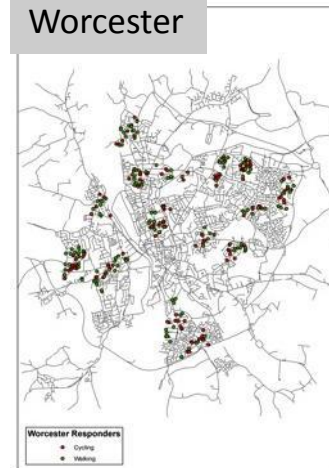
Leicester



Leicester Responders

- Cycling
- Walking

Worcester



Worcester Responders

- Cycling
- Walking

Responses (n=1417) to geo-coded social survey.

Self-reported number of walk/cycle journeys by purpose over a 'typical week'.

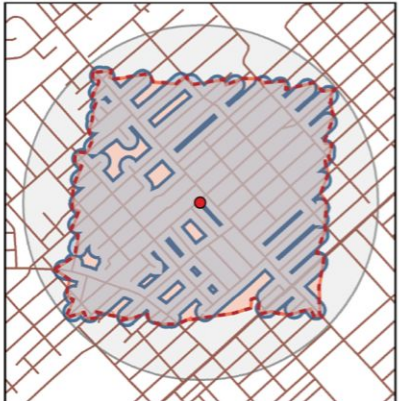
Spatial analysis: network buffer approach

Created 800m network buffer for walking and 2400m for cycling to represent average distance covered for 10 minute walk (at ave. 5kph) and 10 minute cycle (at ave. 15kph) to access activity from home.

“Greater associations between land use and walking were found using the line-based road network buffer suggesting that these buffers may be more sensitive than circular buffers to detect associations with walking.” (Oliver et al. 2007)

“Distances of less than ½ mile between residences, shops and employment and to regional transit services are desirable if walking is to be a competitive mode of travel.” (O’Sullivan & Morrall, 1996)

Average distance walked 1.1km and cycled 4.7km (National Travel Survey, 2009)

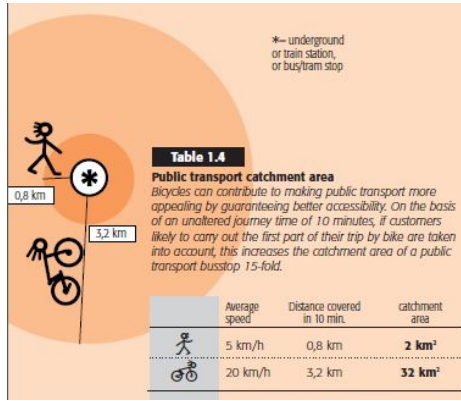


A. Dense Urban Road Network

B. Lower Density Suburban Road Network

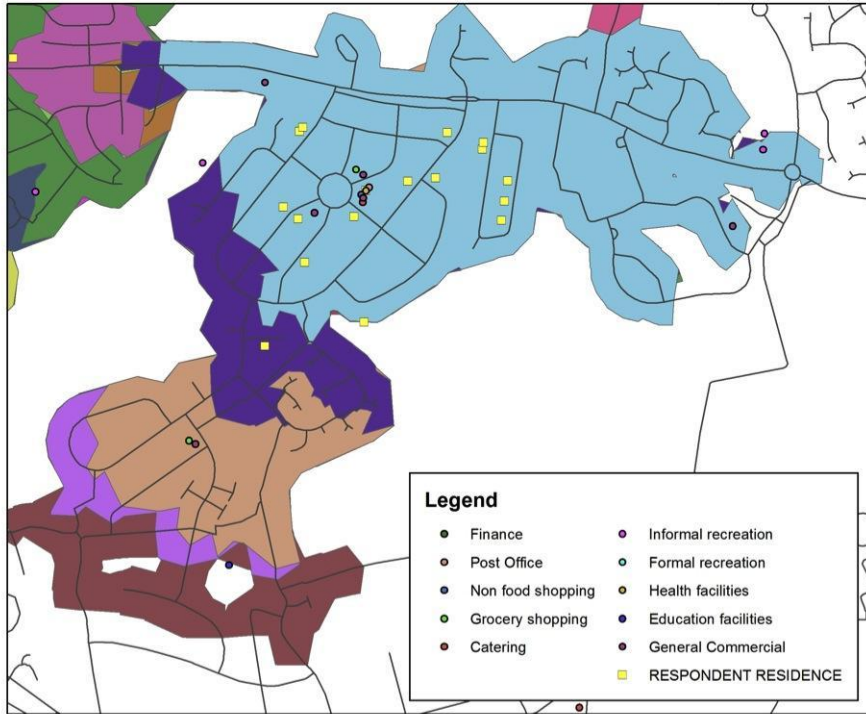
Modeled using travel "as the crow flies":
 [Grey circle] Circular buffer
 Modeled using travel along roads:
 [Red dashed line] Polygon-based network buffer
 [Blue solid line] Buffered line-based network buffer

[Red dot] Survey Respondent
 [Red line] Roads



Source: European Commission (1999)

Land use activities within buffer [Diversity]

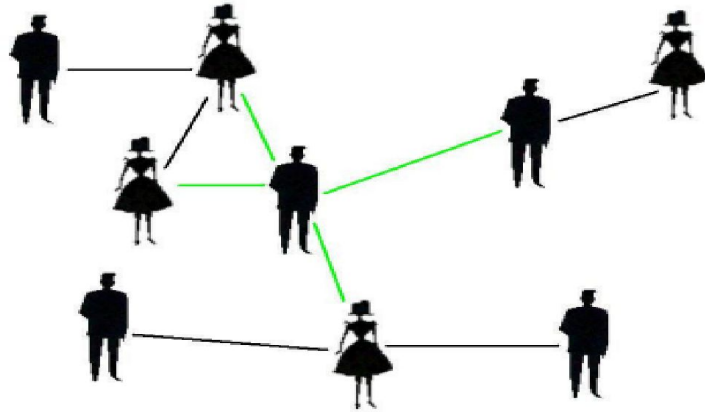


OS MasterMap Address Layer 2 and associated OS Base Functions used to map ten everyday activity typologies using GIS.

1. Finance
2. Post/admin
3. Non-food retail
4. Food retail
5. Catering
6. Informal Recreation
7. Formal Recreation
8. Health
9. Education
10. General Commercial

Shannon's Entropy Index used as measure of presence and diversity of activities within buffer and provides a value of between 0 and 1 (where 0 represents presence of a single activity and 1 indicates an even presence across the ten activities).

Local measure of **connectivity** of network within buffer [Design]



Intersection density – total number of nodes within a buffer.

Street density – total length of route within a buffer.

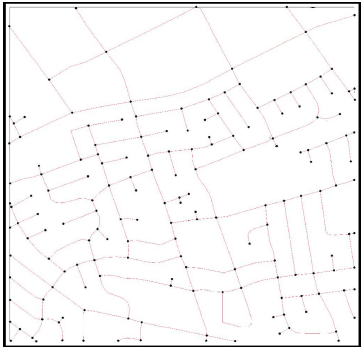
Average degree – average number of links per intersection within a buffer.

Global measure using **centrality**



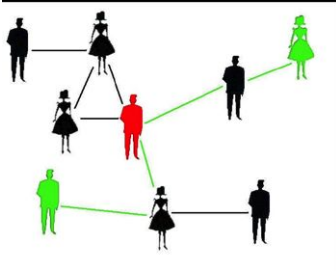
Geographic analysis of street network using *centrality* measures to investigate structural properties - Multiple Centrality Assessment (MCA) cf. Porta, S. et al. (2006).

Road centrelines used as the basis on which to construct the series of node (intersections) and edges (links) that make up the network (using Ordnance Survey Integrated Transport Network (OS ITN) layer)



Generates a series of centrality indices based on topographical properties (**relation** between nodes/connections) and also their spatial properties (**distance** between nodes/connections)

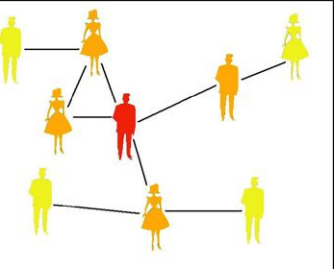
Centrality measures



Betweenness Centrality (Freeman 1977)

Being like a “bridge” between two nodes?

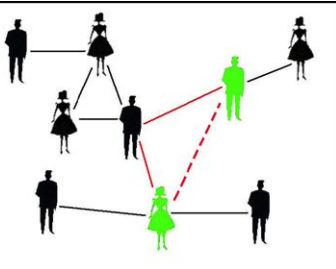
A street segment is central if it is traversed by many of the shortest paths connecting all the pairs of nodes.



Closeness Centrality (Sabidussi 1966)

Or being more “close” to other nodes?

How close each node, or street intersection, is to all others along the shortest paths in the network.



Straightness Centrality (Crucitti 2006)

Or how much you are in a straight line with others?

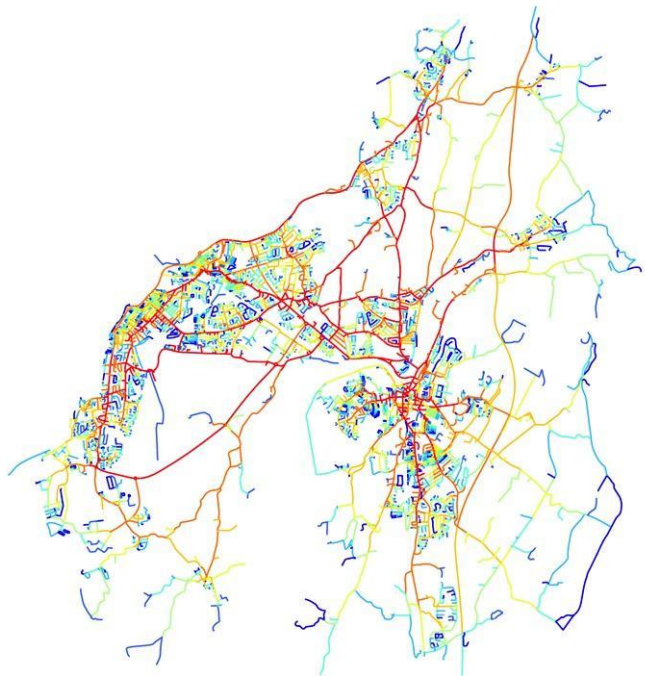
How much the real paths that connect each node to all others deviate from a virtual straight path.

Assigning centrality values

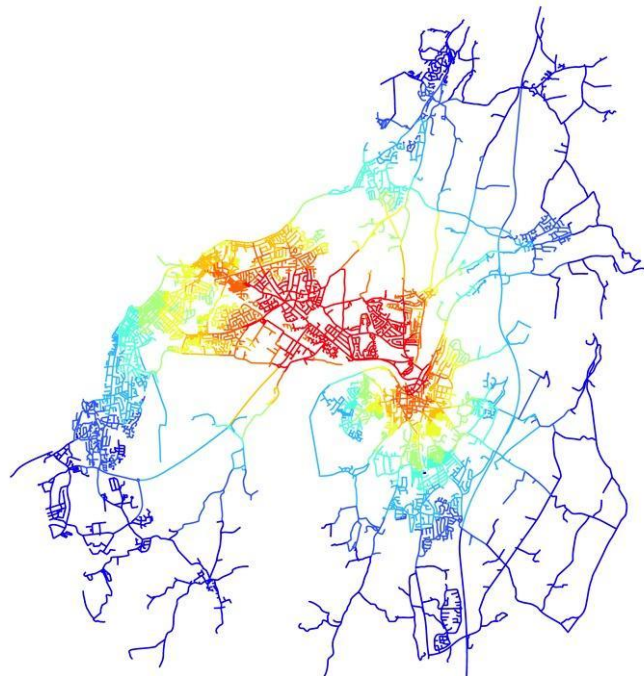


Lancaster centrality visualisation

Betweenness Centrality



Closeness Centrality



Summary of Findings

Access to activities

Positive (though weak) correlation between access to activities within an 800m network buffer and frequency of walking journeys.

No correlation between access to activities within 2400m network buffer and frequency of cycling journeys.

Connectivity of street network

Local measures

Positive (though weak) correlation between street density and walking but no correlation with cycling.

No apparent correlation between intersection density or average link per intersection for either walking and cycling – though the picture for walking is mixed.

Global measures

Positive (though again weak) correlation between betweenness, closeness and walking but not much evidence that either are significant for cycling.

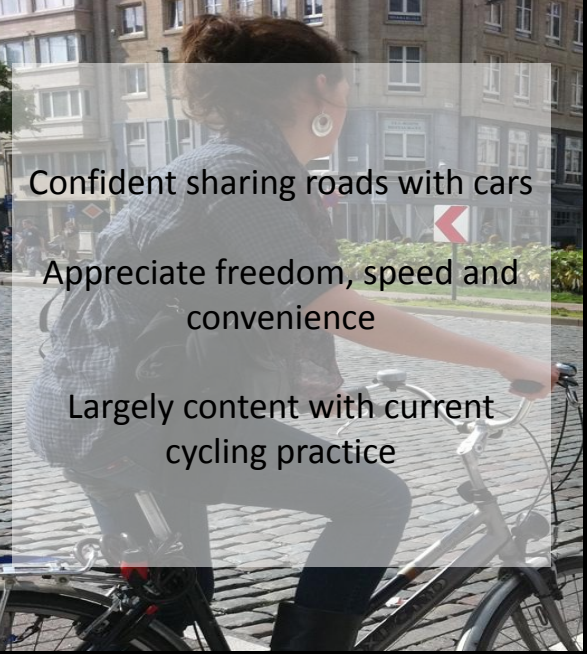
Conclusion from UWAC Social Survey linked Spatial Analysis

1. Presence and diversity of activities and (particularly) network connectivity are only weakly associated with frequency of non-work related walking trips and there appears to be no significant relationship with cycling.
2. In policy terms this may suggest that design of urban structure is *important but insufficient* on its own to affect behaviour change (at least in the UK context).
3. A combination of measures is required that make walking and cycling short distances the default option for many.

Summary of discourses (following application of Q-Methodology)

Jones T, Pooley C, Scheldeman G, Horton D, Tight M, Mullen C, Jopson A, Whiteing A, 'Moving around the city: discourses on walking and cycling in English urban areas.' *Environment and Planning A* 44 (6) (2012) pp.1407-1424

A: Cycling Sanctifiers



Confident sharing roads with cars

Appreciate freedom, speed and convenience

Largely content with current cycling practice

B: Pedestrian prioritizers




Support more restrictions on car use in urban areas

Support cycling but uneasy cycling in traffic

Support segregated infrastructure

C: Automobile Adherents



Content with current mobile practice

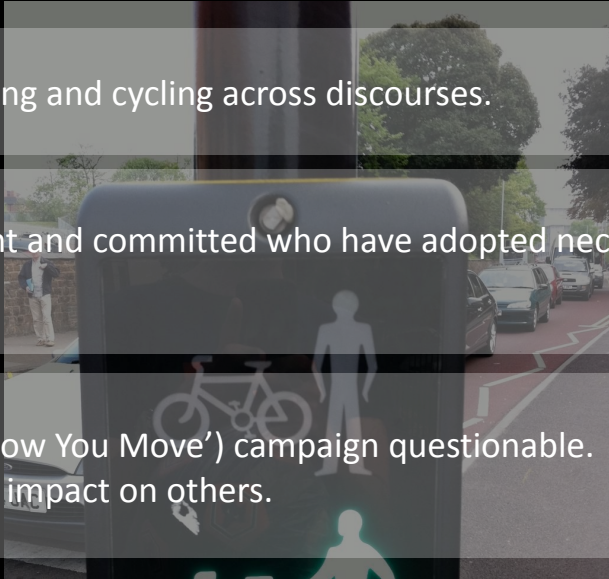
Believe most people can exercise choice

Support cycling and walking [but as long as it doesn't impinge on motoring]

Challenge for policymakers



General sympathy with aim to get more people walking and cycling across discourses.



Everyday cycling currently performed by the confident and committed who have adopted necessary coping strategies - the 'survivalists'.

Choice agenda (epitomised by Worcester's 'Choose How You Move') campaign questionable. Moving around is relational – ways of moving around impact on others.

Policy makers need to hold more sophisticated dialogue with public in order to develop mandate that will allow the implementation of robust measures that promote walking and cycling in the city



PROMOTING WALKING AND CYCLING

New perspectives on sustainable travel

Colin Pooley with Tim Jones, Miles Tight, Dave Horton,
Griet Scheldeman, Caroline Mullen, Ann Jopson
and Emanuele Strano

Policy Press, 2013.

Policy goal	Main responsibility	Example policy measures
Create a safe physical environment for pedestrians and cyclists where most people feel comfortable either walking or cycling.	Local Authorities, voluntary and community agencies	Fully segregated cycle paths Restrictions on vehicle speeds and access Pavement widening Effective pavement maintenance and cleaning
Encourage motorists to be more aware of the vulnerability of pedestrians and cyclists and thus reduce perceptions of risk associated with active travel	National Government	Adopt 'strict' liability for motorists as is found in much of continental Europe
Reduce trip distances in urban areas by providing more retail, social and educational facilities close to residential areas, and facilitate access to such services.	Local Authorities, private businesses, voluntary and community agencies	Restrict out-of-town retail developments Strict land-use planning control Encourage development of neighbourhood and community-based facilities Provide cycle parking and storage facilities
Create a social and economic environment in which active travel (walking or cycling) is seen as achievable by most people for short trips in urban areas	National Government, Local Authorities, employers, voluntary and community agencies	More flexible working hours for parents of young children Family-friendly welfare policies Community-based schemes for child care, school transport etc. Cycle storage facilities in all homes
Promote the normality of walking and cycling	Local Authorities, National Government, voluntary and community agencies, media, employers, educators	Campaigns to demonstrate that walking and cycling are not only for super-fit specialists but are to some degree possible for most people for some journeys




cycle BOOM
Design for Lifelong Health and Wellbeing

Summary of Key Findings and Recommendations

EPSRC
 OXFORD BROOKES UNIVERSITY
 SCHOOL OF PLANNING AND DESIGN
 UNIVERSITY OF READING
 UNIVERSITY OF THE WEST OF ENGLAND

BOX 9 Lindsey's left-turn

"If the pavement is clear and it looks safe to me I will be on the pavement, but always keeping a beady eye out for pedestrians, I give way to pedestrians". (Lindsey, 70s, Oxford).



LINDSEY APPROACHES SIGNALISED JUNCTION TO MAKE LEFT TURN. 1

"I actually think it is SAFER to get round that corner before this bit [opening traffic] especially if there are buses there."

SCOOTERS PAST STATIONARY CYCLIST. 2

"I stopped a bit, thought about it, and then thought, 'oh my God, this is going to take ages because they are very slow these lights'."

...JUMPS RED LIGHT AND RIDES UP DROPPED KERB ONTO PAVEMENT. 3

"So I stopped up there onto the pavement..."

NAVIGATES PAVEMENT WITH CAUTION... 4

"...across there... and then back down again. Not a very good thing to do."

...AND RE-JOINS THE ROAD. 5

"I can see that that would probably get me a heck more from the Police but it didn't feel too bad to me."

LINDSEY REFLECTS ON THE DESIGN OF THE JUNCTION... 6

"It is a shame they couldn't have put a left-turn bicycle path, that would have signed round a bit of the pavement there, because then they could have put in a left turn for bicyclists even if not for four wheeled traffic."

...AND DESCRIBES HER FEELINGS AFTER SAFELY NEGOTIATING THE JUNCTION & REACHING THE CYCLE TRACK. 7

"...and then we are into safety, I have a sigh of relief when I get to that point. (you have) to be hyper-vigilant."

Cycling alongside motor traffic perceived to be risky particularly HGVs and buses.

Dissatisfaction with quality of cycle infrastructure.

Anxiety when sharing paths with pedestrians.

Lack of coherence in terms of expected manoeuvres.

Adaptation to personal capability and environmental conditions inc. rule breaking.



RTPI AWARDS FOR RESEARCH EXCELLENCE WINNER 2017

cycle BOOM was the winner of the Royal Town Planning Institute's (RTPI) Award for Academic Research Excellence 2017



3-year project completed 2016
See www.cycle-boom.org



Figure 30. Separated Cycle Paths – the Netherlands uses red colour and texture on its cycle paths throughout the country so inhabitants are clear on the distinction between cycle paths and pedestrian paths. (Photo: Tim Jones)



Figure 31. Junctions – Low level signals – the Statutory Instrument Traffic Signs Regulations and General Directions now permits measures that can support older cycling (Photo: Sustrans UK)



Figure 36. Convenient 'front-of-house' cycle storage, Houten, NL. (Photo: Tim Jones)

- Dedicated (separated/segregated) cycle infrastructure.
- Improved junctions and crossings - low level cycle signals.
- Low speed zones - less hurried cycling.
- More consistent and coherent design and surface quality.
- Catering for different types of cycle & cyclist (e.g. public hire schemes).
- Private and communal cycle storage at new developments (and retrofit).

Summary

“How can cycling [and walking] be encouraged as a healthy, sustainable, and safe mode of transport?” [for short journeys in urban areas]

→ **Reduce the car’s widespread domination of urban space**

Transport system stacked against cycling.

[The car’s] “monopoly is hard to get rid of when it has frozen not only the shape of the physical world but also the range of behaviour and of imagination” [Illich, 1973, Tools for Conviviality, p 55]

→ **Normalise cycling**

To cycle is ‘abnormal’. We need to **disregard** notion of ‘vehicular cycling’ that caters for a ‘velomobile elite’ and that has shaped cycling advocacy and transport policy in the UK and USA.

→ **Build a proper cycling system**

Requires a leap in ambition.

→ **Embrace and integrate electric micro-mobility**

E-cycles can democratise cycling and promote health and wellbeing.

THANK YOU!

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