Botte, Markus (2008)

The connection of urban morphology and travel behaviour:

A geo-spatial approach to measuring interactions of Transit Oriented Development and activity-travel behaviour

Introduction - Key Issues

“Hypermobility” phenomenon of 21 Century Society (imbalanced mobility)

Diverse Relationships:
• Spatial Structure / Characteristics of the Built Environment
• Socio-economic, Personal / Household Characteristics
• Preferences, and Multifaceted Structures of Individual (Travel) Behaviour
• Etc.

Multiple Implications:
• Urban Sprawl, Crowding, Social Segregation, Congestion
• Environmental Degradation, Pollution and negative Externalities
• Challenge and Opportunities of Expanding Economic Opportunities
• Etc.

→ Increased Complexity (e.g. Urban Economics, Transport Systems Analysis, Travel Behaviour Analysis)
Flexible Framework

FROM: Monocentricity (Alonso, 1964)
(disc-shaped model = CBD and surrounding residential regions)

→ Changes in technology, accessibility and individual behaviour e.g. improved transportation and communication networks and system components

TO: Polycentricity (Garreau, 1992, Edge City: Life on the New Frontier)
(agglomeration / clustering = utility gains - “Knowledge Spillover”)

“In today’s world manifold activities and factors influence the choice of location and travel decisions and human activities in space and time”
(e.g. residential self selection, employment, lifestyle, socio-economic factors, etc)
Human activities in space and time

Individuals’ daily activity and travel patterns are complex and involve multi-dimensional decisions

- Activity-related choices, such as activity type, activity duration, starting time, and location choices.

- Travel-related choices, such as travel mode and route choices.

- Choice constraints

Since no one can perform all activities at the same time, the choices and constraints require trade-off and consideration in sequencing of activities and resource allocation
Multidimensional composites cannot be measured directly. Choice decision analysis of human travel behaviour requires the connection to spatial information (distribution/concentration/spread) and temporal dimensions (e.g. time spent on activity).
The Link to TOD - Western Australian Perspective

• Population Growth  (Migration (interstate/international), Fertility Rates, Global Economy (Resources Boom))
• High level of Suburbanisation / Urban Sprawl
• Housing Affordability
• Infrastructure Construction Costs
• History of sporadic Public Transport Investments
• Car Dependency and HH car reliance
• Environmental Sensitivity
• etc.

OPPORTUNITY: Transit Oriented Development (TOD)
The Challenge - Some Key Research Objectives

• How can we identify measurable linkages between urban form and travel activity patterns, the impact of travel behaviour on urban environment and quality of life (e.g. how do we measure the degree to which TOD opportunity leads to residents reducing their car travel and replace this with public transport)?

• How can we derive new tools for integrated strategic urban planning and public policy making to prescribe, identify and measure a degree of TODness reflected in the urban fabric, such as in proposed (re-)developments?

• What metrics can be used to more accurately define activity-travel patterns and the urban space used to satisfy daily household needs?

• What features need to be included in TOD to be an effective tool against excessive motorised transport and congestion in urban areas (e.g. how accessible are the amenities and transport)?

• To what extent is good TOD decreasing car travel whilst increasing the uptake of walking and cycling in urban areas (active transport)?

• How strong is the impact of self-selection (personal attitudes and attributes) on travel behaviour, compared to provision of mixed land use and public transport services?
Key Research Area

Three Station Precincts

- Greenfield / Private Sector Model - Wellard
- Land Agency Model - Cockburn Central
- Brownfield / transit interchange - Bull Creek

Household Surveys*:

- Pre-rail station opening (2006)
- Post-rail station opening (2007)
- Longer term post-rail station opening (2008-9)
- GPS based travel diaries

Data - “Real-world” test of research model

*Data collected through the Australian Research Council (ARC) linkage project (2006-2009): ‘Impacts of Transit Led Development in a New Railway Corridor’
Spatial Cognition and Activity Spaces

• Concepts such as the micro-geographical activity space were initially developed during the 1970s as suitable methods in a wider approach to describe spatial perception, spatial awareness and spatial usage (activity) of travellers.

• They can be used to analyse the spatial arrangement of travel (realised or potential) in context with the underpinning household and individual travel needs and choices.

• Those concepts have since been circulated in the research community for describing travel potentials, spatial knowledge, geographic thinking/reasoning, or realised/observed travel and related spatio-temporal changes.
Activity Space Concept

• The Activity Space encompasses the location of daily activities that ensure realisation of the activity-travel needs & desires within an acceptable time and cost constraint.

\textit{It reflects spatial processes that cannot be captured in classical demand models, and takes account of time limitations (generalised costs).}

• It endeavours to symbolise observed or realised time-travel patterns using one easily comprehensible geometric indicator (observed or realised distribution of places visited within a certain space and frequented over a period of time within a given time and cost budget)

• It can be built at the individual or household level, being a behavioural measure of the interaction between travel demand and the available transport services.

• The geometry, size, and inherent structure of activity space is believed to be strongly conditioned by the determinants of the household basic places (home and work or other frequently visited activity centres are usually the pegs for scheduling daily activities), further, by the accessibility provided by the transport network and the time constraints (institutional or personal).
Advantages of Activity Space Concept

- Enables conjoint and multi-directional examination of the households’ activity-travel needs, the urban fabric and transport network services, and the situational constraints and preferences of the population.

- Enables analysis of the relation of various configurations of TOD to transport mode, route choice, the spatial shape, extent, and orientation of activity travel behaviour, whilst accounting for individual characteristics/attitudes.

- Accounts for activity-travel behaviour at household level and provides links to built environment and transport characteristics in a dynamic manner.

- Provides measures/items needed for assessing the degree of “TOD-ness” and its success (likely impacts on travel behaviour, measured as activity spaces) in a holistic model symbolised by smooth parametric surfaces.

- Links spatial/geographical data analysis with traditional modelling approaches, such as discrete choice modelling and multivariate data analysis, to study spatial associations within multiple temporal dimensions.
Activity Space - Known Formulations

- Standard Distance
- Confidence ellipse
- Kernel Density
- Shortest path band
- Minimum spanning trees, buffers
- Polygon of activities
- three-dimensional
Confidence Ellipse derived from Activity Locations
Kernel Densities
Kernel Densities - 1970 to 2000 - Zürich (CH)
Activity Spaces - New Geometries

- Superellipse
- Cassini Oval
- Bean Curve
Application
Degree of TODness?? - Thank You - IDEAS?
QUESTIONS?