How networks are shaping Tshwane
Introduction and Context – Part I

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Structure of Presentations

Introduction: AFD – Urban Morphology Institute – Gauteng universities and Research Institutions program of cooperation

• **Part I- Introduction and Context**
  – Spatial Structure, Networks, Urban Morphology, and Resilience
  – South Africa and Gauteng Urban System
  – Urban Morphology of the City of Tshwane

• **Part II- Tools for urban network analysis**
  – Application of simple metrics and network analysis

• **Part III- Tools for urban network analysis**
  – Application of Space Syntax and Dual Approach
  – Future research and policy implications
Introduction
AFD – Urban Morphology Institute – Gauteng universities
and Research Institutions
Program of cooperation
Spatial Structure, Networks, Urban Morphology, and Resilience
Why Spatial Structures?

• An urban spatial structure is defined by:
  – The average density (consumption of land per person)
  – The spatial distribution of densities and population
  – The pattern of daily trips

• It is deficient when (Bertaud 2008):
  – Commuting distances for a significant part of the population are too long to be travelled within a reasonable travel time or/and at a reasonable cost
  – The spatial distribution of population and the pattern of trips are incompatible with the main mode of transport affordable to the poor
Defining spatial structure: the pattern of trips

THE MOST COMMON URBAN SPATIAL STRUCTURES

The Classical Monocentric Model,
- strong high density center with high concentration of jobs and amenities
- radial movements of people from periphery toward center

The "Urban Village" Model
- people live next to their place of employment
- people can walk or bicycle to work
- this model exists only in the mind of planners, it is never encountered in real life

The Polycentric Model
- No dominant center, some subcenters
- Jobs and amenities distributed in a near uniform manner across the build-up area
- Random movement of people across the urban area

The Composite Model
- A dominant center, some subcenters
- Simultaneous radial and random movement of people across the urban area

*Order Without Design* Bertaud 2006 (unpublished)
3D representation of the spatial distribution of jobs in Gauteng area showing the dispersion of jobs on a very wide area mostly in the center and North.
Spatial distribution of population in Gauteng (2001 census) compared to Jakarta, London and Paris

- Jakarta (Jabotabek) 16 M people
- London: 7 M people
- Paris: 8 M people
- Gauteng: 8.7 M people

Source: Bertaud 2008
Why Networks?
Gauteng urban networks trajectory

from Euclidean space segregation
to topological space segregation

• From open grids segregated by spatial distance To
closed disconnected forms segregated by spatial logic

• Disconnected and fragmented metropolitan area
  reflecting the values and spatial behavior of a
disconnected and fragmented society

• Evolution from open connected forms (grids) where
  segregation was created by spatial distance to closed
disconnected forms where segregation is locked in the
urban form.
Why Urban Morphology?

• An urban morphology is defined by:
  – The socio-spatial patterns of interaction between people and activities
  – The network of streets that reflects the social patterns
  – The plot subdivisions
  – The land use patterns
  – The topography
  – The built environment
Alexandra: the very low standard housing filling the vacant space within the older formal housing is a typical example of demand driven informal housing.
Gauteng: Sebokeng

Sebokeng sample density

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total area</strong></td>
<td>17.51 ha</td>
</tr>
<tr>
<td><strong>formal stands and houses</strong></td>
<td>431 units</td>
</tr>
<tr>
<td><strong>people per formal house</strong></td>
<td>5 people</td>
</tr>
<tr>
<td><strong>Total population</strong></td>
<td>2,155 people</td>
</tr>
<tr>
<td><strong>Design density</strong></td>
<td>123 p/ha</td>
</tr>
<tr>
<td><strong>Back yard shacks</strong></td>
<td>0.8 per stand</td>
</tr>
<tr>
<td><strong>Total backyard shacks</strong></td>
<td>345 units</td>
</tr>
<tr>
<td><strong>People per backyard shack</strong></td>
<td>3 people</td>
</tr>
<tr>
<td><strong>people in backyard shacks</strong></td>
<td>1,034 people</td>
</tr>
<tr>
<td><strong>Total real density</strong></td>
<td>182 p/ha</td>
</tr>
</tbody>
</table>
- Alexandra, Sebokeng, Turin and Prague represented at the same scale (400 meters side).
- Repetition of detached identical units versus composition of the urban fabric at different scales

- In South Africa, design densities are modified by backyard shacks that represent demand driven land use prevailing over designed land use but this bottom up process fails to create an emergent urban spatial order.
What is resilience?

- **Dynamic resilience**: the system is able to recover from an endogenous or exogenous shock or stress.

- **Structural resilience**: the system absorbs a shock (natural catastrophe, change of civilization) by an adaptive complexification process.

- **Adaptive resilience**: The system evolves constantly far from the equilibrium and constructs new structures while keeping memory of its previous states.
Key scales for urban sustainability

City scale
- Compact
- Connected

Community scale
- Walkable
- Accessible

Block scale
- Mixed use
- Diversified
Lattice (tree) or semi-lattice

- Alexander (1965): Cities may reflect lattice (no overlaps) or semi-lattice (overlaps)

  City should not be a tree
  
  Need to allow for social & spatial overlaps
Resilience and arborescence
Resilience and loops (The leaf paradigm)
South Africa and Gauteng Urban System
The two charts provide quantitative informations on the distribution of the global urban system. The above chart is the same as the bottom chart, but population and rank are plotted according to their logarithm and tend to align.
Country scale

South Korea (2010)

Japan (2010)

\[ y = -1.0131x + 16.079 \]
\[ R^2 = 0.9841 \]

\[ y = -0.7103x + 15.622 \]
\[ R^2 = 0.9908 \]
Regional scale

China (2010)
The South African urban system is dual
Log Rank Log Size analysis of South African Cities in 2001

Census 2001

\[ y = -0.759x + 15.022 \]
\[ R^2 = 0.9146 \]

\[ y = -0.2689x + 15.064 \]
\[ R^2 = 0.7422 \]
Log Rank Log Size analysis of South African Cities in 2011

\[ y = -0.513x + 14.585 \]

\[ R^2 = 0.9441 \]

\[ y = -0.2511x + 15.311 \]

\[ R^2 = 0.9925 \]
Gauteng spatial structure

– *Differs from most other major metropolis*

– *Main characteristics (Bertaud 2008):*
  
  • *Extremely large footprint*
  
  • *High density residential settlements far away from employment areas*
  
  • *Employment areas dispersed in clusters through the region*
Gauteng density map (Census 2001)
 Scaling down to Tshwane
Tswahne density map (census 2001)
Gauteng - Profile of population Density in the built-up areas 2001
Compared to the density profile in built-up areas in 1990 (Witwatersrand only)

Source: Bertaud 2008
Density distribution in the 1000 densest km² of Gauteng, out of 16,000 km² in total
Comparison of Seoul (South Korea) and Gauteng in the densest 600 km². The densest 600 km² in Seoul host more people (10 million people) than all Gauteng 16,000 km² (9 million people)
Jobs in Gauteng are concentrated in the center and north but spread over a wide area at low job densities. 50% of jobs are located in areas where the job density is lower than 10 jobs per hectare.

Source: Bertaud 2008
The fragmented urban spatial structure of Gauteng and labor markets

- A labor market is efficient when it is integrated, when it is fragmented it looses its efficiency (Bertaud 2008).

- Gauteng fragmented spatial structure fragments labor markets, and contributes to a high unemployment rate for the poor.

- Integration of labor markets requires that all jobs be potentially physically accessible to all adults within a reasonable commuting time (Zahavi’s rule states 1 hour two ways, which is realized in the world competitive cities) and at a reasonable cost (below 8% of income). The poor cannot fully participate in the labor market when
  - They are spatially dispersed beyond 1 hour commuting time from employment areas or
  - when transport costs represent more than about 8% of income;

- Spatial dispersion decreases economic opportunity for the poor and reduces the economic efficiency of the entire city.
Only when we understand the underlying factors influencing urban morphology/fragmentation can we put our city back together not just physically but also socially.
The fragmented map of wealth in Tshwane (gated communities)
The fragmented map of poverty in Gauteng
The spatial distribution of households living below the poverty level in Gauteng
Urban Morphology of the City of Tshwane
Introduction

• Comparative typology analysis between various areas in the City of Tshwane and International Examples

Scale of analysis:
• City/ Metropolitan Scale
• Neighbourhood Scale
• 1600m X 1600m (1 square mile)
• 800m X 800m
• Block and Building interface
Morphological Typology in the City of Tshwane

Case study areas

• Suburban (Irene, Brooklyn, Newlands,
  – Grid Model
  – Enclosed and Gated Communities
• Township (Mamelodi)
  – Informal Township area
  – “RDP”/ Formal Township area
• Rural (Hammanskraal)
• Inner city of Pretoria Tshwane
  – Grid model (Central Pretoria)
  – Fine grain grid (Marabastad)
Tshwane a City of Broken Glass?
Source: City of Tshwane IDP 2013/14
Gated communities: concentrated

Gated off areas take up ±2.3% of the area of the City of Tshwane
Selected area of concentration
Concentration of different types
Concentration of different types
Selected study areas
Brooklyn
Brooklyn: unit of analysis
(800 x 800 m blocks)
Does not lend itself to large enclosures
Irene
Irene: unit of analysis
(800 x 800 m blocks)
Newlands
Case 2: Newlands
(enclosed area)
Newlands: Unit of analysis (800 x 800m block)
Most of Pretoria east: suburban layout
The evolution of the suburban tree

Salat (2012)
Silver Lakes
Silver Lakes: unit of analysis
(800 x 800 m block)
Walnut Creek: 107 intersections  Zambezi Country Estate
Walnut Creek: 107 intersections

Woodhill estate
## The evolution of the suburban tree

<table>
<thead>
<tr>
<th>Indicator</th>
<th>What is being calculated</th>
<th>Brooklyn</th>
<th>Irene</th>
<th>Silver Lakes</th>
<th>Newlands</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intensity</strong></td>
<td>Surface occupied by road network (%)</td>
<td>9.1</td>
<td>15.4</td>
<td>24.8</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>Nodes per km²</td>
<td>31.6</td>
<td>28.1</td>
<td>12.5</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>Cyclomatic complexity of the car grid (per 0.64 km²)</td>
<td>25</td>
<td>26</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Average distance between intersections car grid (m)</td>
<td>150</td>
<td>152</td>
<td>224</td>
<td>147</td>
</tr>
<tr>
<td></td>
<td>External Connectivity (How easy is it to get outside of the area)</td>
<td>34</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Connectivity</strong></td>
<td>The mean distance between two destinations (nearest major shopping centre – straight line distance)</td>
<td>&gt; 1 km</td>
<td>&gt; 1 km</td>
<td>1 - 2 km</td>
<td>&gt; 1 km</td>
</tr>
<tr>
<td><strong>Proximity</strong></td>
<td>The number of different uses</td>
<td>&lt; 6</td>
<td>&lt; 6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Number of road hierarchies</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Diversity</strong></td>
<td>The number of different uses</td>
<td>&lt; 6</td>
<td>&lt; 6</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
The evolution of the suburban tree
The evolution of the suburban tree

Should it be considered as a new type of urban morphology or just the ultimate manifestation of suburbia?

Adapted from Salat (2012)
The evolution of the suburban tree

Evolution of modernistic planning in Tshwane
Should gated communities be considered as a new type of urban morphology or just the ultimate manifestation of suburbia?
“Township” and Rural Areas

- Apartheid separation
- Economic and Social separation
- Informal vs Formal
- Formalisation Processes
Ahmedabad: 2700 intersections

Mamelodi
Comparison of Settlement Typologies in Gauteng using GTI 2.5m Land Cover
Grid Resilience & Subdivisions

1859

2013
Change from open grid to closed loops

1859

2013
Marabastad

40m

70m
Pretoria Central

140m

240m
Barcelona: 168 intersections

CBD of Tshwane
The Contrast between interface and use

Informal Trader
Mobile Street Trader
Chain Store/National Retailer
Arcade/Shopping centre route

Convenience Store
Wholesale
Speciality Retail

Individual Shop
Speciality Retail

LEGEND
Small Blocks with subdivisions and mixed uses

Informal Trader
Mobile Street Trader
Chain Store/National Retailer
Arcade/Shopping centre route

Convenience Store
Wholesale
Speciality Retail

Individual Shop

LEGEND
Thank you for your attention!