Cities, Mobility & Complexity in a Post-Pandemic World

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MOBILITY IS A MEANS TO A GREEN, JUST, PROSPEROUS WORLD FUTURE
Presentation Outline

- Cities as complex systems.
- Cities & Transport.
- Disruption:
  - COVID-19 pandemic.
  - Urban informatics.
- Implications for change & future sustainability.

*Standing on the shoulders of giants.*
Cities are systems of systems

- Cities are complicated systems of interacting systems:
  - Economic.
  - Social.
  - Political.
  - Health.
  - Technical:
    - Transportation.
    - Information.
    - Energy.
    - ...

- They are embedded within even more complex biological & physical worlds.
They are also social networks:

- Cities are massive social networks, generating myriads of interactions (economic, social, cultural, political, …).
- The bigger the city, the more potential interactions there can be.
- These grow non-linearly with city size & generate agglomeration economies (scaling).

(Bettencourt, 2013)

(Bettencourt, et al. 2007)
Throughout history the location, size, shape and economic & social functioning of cities has been fundamentally influenced by transportation technology, infrastructure and services. Transportation networks literally give spatial definition to land and, by making the land accessible, they make it useful.
The transportation system “mediates” between all activities in space, influencing land development, the location choices of households, firms & other activities.

The distribution of people, businesses & activities, in turn, drives the demand for transportation.

“Transportation 101”

(Meyer & Miller, 1984, 2001, 2013)
Pre-Industrial Cities

- Pre-industrial cities were small, dense and extremely compact.
- Walking and animal-powered vehicles were the only options for intra-city travel.
- Wind and animal-powered transport were the only inter-city options:
  - Largely a person-based (individual) supply of transportation (other than the roads/streets).
Transport Revolution 1: Mechanized ("Industrial") Transport

- With the Industrial Revolution steam engines and, later, electrically-powered vehicles made mechanized transport possible for the first time, providing much higher-speed and higher-capacity transport services.
- This permitted the size of cities to expand dramatically, leading to:
  - Lower (but by modern standards still high) densities.
  - Vastly larger cities.
Transport Revolution 2: The Automobile Era

- Started in the early 20th Century, but not having full impact until after WWII.
- Much higher speeds, flexibility of use and its provision of an affordable personal means of transportation, the auto again revolutionized transportation by “freeing”:
  - People from fixed-service public transit.
  - Urban development to further spread out (“sprawl”) in a dramatically increased, indeed explosive, way.
System of Systems (2): Urban Activity & ICT

- But telecommunications also network people & activities together.
- There has always been a complex complementary/competitive (but, overall, synergistic) interaction between travel & communications.
- The pandemic has massively disrupted & accelerated this interaction.
Attractors

- Every system has one or more attractors, to which the system state will tend to converge (if left undisturbed).
- Attractors are an emergent characteristic of the system.
- The number & location of the attractor(s) depends largely on the system structure, in particular, its feedback loops.
- Once established, an attractor can be difficult to “break free from”.

The Lorenz Attractor
Urban Attractors (1): Pre-Industrial & Transit Cities

- Both the pre-industrial & transit (industrial) cities’ “attractor” is one of centralization & concentration of activities & travel flows.
  - Central places (Christaller; Losch).
  - Monocentric cities (Alonso).
  - Radial transit networks.
  - Intensive & mixed use of land.
  - Walkability.
  - Trip length minimization.
Urban Attractors (2): The Automobile City

- Low-density, dispersed population & activities.
- Extensive (often single-) use of land.
- Grid networks; many-to-many travel flows.
- “Edge Cities” (Garrow).
- Car-dependency; very limited walkability (*Suburban Nation*).
- Mobility maximization.

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*Perverse Cities*

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*Perverse Cities*
Urban Attractors (3)

- Both attractors exist within our cities, “competing” with one another.
- Relative “dominance” varies from city to city & country to country, but the auto-centric attractor dominates in most cases (especially in North America).
- Both support the “city as social network” paradigm, but often in very different ways.
Disruption!  
A third revolution?

- The transportation system was undergoing significant & numerous technology-based disruptions pre-COVID and will continue to be shaped by these post-COVID.
- And then came COVID-19, the biggest public health crisis in a century, which disrupted our economy and our daily lives in multiple & still-unfolding ways.
Major Disruptions

1. New technologies & services.
2. ICT, IoT, AI, Big Data.
3. Climate change.
4. Quest for social & economic equity.
5. Global urbanization.
6. COVID-19
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Challenging the status quo. “Business as usual” simply will not do. Driving the need for substantive change.
Disruptions: COVID-19 & Cities

- COVID-19 has been a “direct attack” on the whole *raison d’être* of cities:
  - To bring people together to interact.
  - To create massive positive feedback loops (social networks) generating both economies of scale and agglomeration.
  - To be “the containers of civilization” (Mumford, 1961).
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Pathways to change?
Urban Informatics: A brave new world. Solutions or new problems?

- Urban informatics technology (data, computing, analytics, technology, services) is changing:
  - New mobility technologies & services.
  - Transportation system behaviour:
    - System management & performance (supply).
    - Travel behaviour (demand).
  - Our ability to observe & understand urban systems.
- The pandemic rapidly accelerated many of these impacts.
New technologies & services

- Connected
- Autonomous
- Electric
Transportation System Control & Performance

- Real-time network operational control.
- Road pricing.
- Parking control.
- Transit priority.
Informatics & Travel Behaviour

- New IT technology (data, computing, software, platforms) having a pervasive effect on travel behaviour.
- The pandemic as accelerated many trends & broken old ways of doing things – i.e., it has been truly disruptive.
- IT impacts include:
  - Real-time information impacts.
  - Activity location choice.
  - Trip generation.
  - Residential location.
  - Auto ownership.
  - EV impacts:
    - Charging/range issues & impacts on travel patterns.
  - CAV impacts: who knows?
A Third Revolution? Shifting Attractors? (1)

- Most technology-based “innovations” are, at best, neutral, and, often, reinforcing wrt attractors:
  - Most mobility services (currently at least) reinforce auto-centric travel at the expense of transit & active travel.
  - Route guidance apps, etc. may make current systems somewhat more efficient, but do not change basic behaviour.
  - Real-time traffic control “efficiencies” reinforce auto-centric travel.
  - Transit control lagging in many cases.
The pandemic has fundamentally altered the home-work commuting relationship.

How this “new normal” will stabilize remains to be seen.

It may, however, reinforce more dispersed settlement patterns, to the detriment of traditional central places.

– Implications for travel (especially transit)
– Implications for the functioning of urban economies / social networks?

May not “change the attractor” but is providing scope for continuing growth of urban areas (more people, employment, etc. w/o commensurate growth in traffic -- bending but not breaking the curve).

“Physics of transport” remains – parameters may change somewhat.

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**Toronto Central Area Office Occupancy Index**

October 1, 2023

- **Peak Day**: 66%
- **Low Day**: 26%

Index calculated as a percentage of pre-COVID occupancy.

The index is supported by the City of Toronto, Downtown Yonge and Downtown West BIA. It is a measure of the percentage of office employees returning to the office compared to the number of employees who would normally have come to their offices pre-COVID. For a detailed description of the calculation please contact Ian Dobson at idobson@srraresearch.org

Source: SRRA (2023)

https://srraresearch.org/covid/category/Occupancy%20Index
Similarly, the pandemic has rapidly accelerated e-commerce, etc.

Impacts on:
- Travel, especially road-based trips.
  - Substituting delivery vehicles for person-based “shopping” trips.
- Urban economy (retailing, entertainment, …).

Again, would appear to be reinforcing the road-based attractor, not altering it.
A Third Revolution? Shifting Attractors? (4)

- EVs may decarbonize transport.
- But, this will not, in itself, shift the attractor to address many other important transportation issues:
  - Congestion.
  - Economic productivity / vitality / competitiveness.
  - Quality of life.
  - Equity.
  - Preservation of farm land & “natural areas”.
A Third Revolution? Shifting Attractors? (5)

- CAVs: Who knows?
- But most likely they will reinforce the auto-centric attractor.
A Third Revolution? Shifting Attractors? (6)

- Massive, dynamic data are available in ever-increasing volumes concerning all aspects of urban life, including travel.
- AI-based data analytics & computing power are enabling us to “see” and (hopefully) understand the city as never before.
- Telecommunications are increasingly substituting for travel in ways not seen before.
  - Virtual, rather than physical, accessibility.

Tracking residential relocations during the pandemic with cellphone data
A Third Revolution? Shifting Attractors? (7)

Technology, in the form of new mobility services, etc. is not, in and of itself, going to generate a “third revolution” – i.e., a fundamental change in “the urban attractor”.

This is going to need a “revolutionary” new approach to urban design that:

– Shifts the attractor away from auto-dominance to more “sustainable” modes of travel.
– Is able to accommodate continuing urban growth (population, economic activity) with a much “lighter footprint” wrt:
  • Land.
  • Environmental impact.
  • Quality of life (social equity).

I.e., the “third revolution” (if it is to happen) will be one of land use / urban form “driving” the land use – transport interaction, not the reverse (which has been the case throughout history to date).

– Not an easy (or a quick) thing to achieve!
A Third Revolution? Shifting Attractors? (8)

- What role can data & data analytics play in this re-invention of the transportation – land use interaction & urban design?
  - Balancing virtual and physical accessibility & interactions.
  - Re-inventing public transportation.
  - Restoring housing affordability.

- How can a system of systems approach help us to find the “leverage points” to shift the city attractor to greater sustainability?
  - Role of generative design?
And, a final word …

- “Complete communities” / “15-minute cities” are one starting point for this discussion. But:
  - These are new labels for ideas that have been around for decades (at least).
- Need a **systems approach**.
- Need to recognize:
  - The “realities on the ground”.
    - Political.
    - Economic.
    - A huge investment in existing buildings, infrastructure, etc.
  - Scalability at the regional level.
  - Practical pathways from “here” to “there”.

![Diagram of interconnected systems including Demographics, Land Use, Economy, Transportation, Accessibility, Mobility, Productivity, Quality of Life, Congestion, Pollution/GHG, Accidents, Loss of Land.](https://example.com/diagram.png)
Thank you.

Let’s discuss!

“We know a tremendous amount about how the world works, but not nearly enough. Our knowledge is amazing; our ignorance even more so.”


“Find the beginning, the slight silver key to unlock it, to dig it out. Here then is a maze to begin, to be in.”