Harmonization Management System

Bern Grush
UTTRI, June 28, 2018

Supported by:

Automated and Shared mid-century

Automobility 2018

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The End of Driving
1st Edition
Transportation Systems and Public Policy Planning for Autonomous Vehicles

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Code: “ATR30”
There are two markets for automation
(Only two SAE engineering levels really matter for now)

- **No automation**
  - Market 1
  - Level 0
  - Historical

- **Driver assistance**
  - Market 1
  - Level 1
  - Fading

- **Partial automation**
  - Market 1
  - Level 2
  - Transitional

- **Conditional automation**
  - Market 1
  - Level 3
  - Now

- **High automation**
  - Market 2
  - Level 4

- **Full automation**
  - Market 1 & 2
  - Level 5
  - Far away

**Self-driving personal**
- Market 1: sell cars

**Driverless robotaxi**
- Market 2: sell rides
Social impact of Market 1 — Sprawl

What happens to land-planning if AVs reduce the consumer pain of congestion?

Market 1: sell cars
Personal automation
Job reach (related to sprawl...)

Market 1: Personal automation

Benton Harbor, Michigan

Elmira, New York

Gary, Indiana

Wilmington, Delaware

Images from 2018 America’s Workforce and the Self-Driving Future (Securing America’s Future Energy —SAFE)
Social impact of Market 2 — Transit

What happens when robotaxis cost the same as the bus?

What happens when robotaxis cost less than the bus?

Market 2: sell rides

Public automation
Market 2 has Two Outcomes

1. Commercial & competitive
   - Congested
   - Transit ridership falls

2. Harmonized & integrated
   - Optimizable
   - Heavy transit sustained
Future of motorized automobility

- Buy a personal vehicle (Market 1)
- Use commercial fleet services (Market 2)
- Use public transit fleet services (Market 2)

"...a war brewing ...between the automotive sector and the transit sector” re who will deliver shared-mobility, autonomous, electrified services.”

Josipa Petrunic, Canadian Urban Transit Research and Innovation Consortium (CUTRIC)
PKT expected to grow 3x 2010-2050
Can we serve this with the same fleet size?

- Same vehicle count;
- Higher number in shared services;
- Higher occupancy per vehicle.
Preparing for automated vehicle fleets

Acquire and operate?  Or Specify and regulate?

Risk
- Tech obsolescence
- Diffusion
- Outcome
- Timing
- Acceptance
- Costs
- Funding
- Mixed driving
- Resilience

Scale
- Affordable?
- 150,000 vehicles to serve 25% of PKT demand in GTHA in 2030s
- ~$ 10 billion

Flexibility
- Achievable?
- Demanded by riders
- Hard to achieve with current transit mindset and metrics

Competition
- ...for riders, roadspace, parking, funds
- ...among public transit, commercial services and private cars
- Why compete?
HMS is a software platform

Offers transportation demanders/managers the ability to specify and regulate commercial transportation supply in the digital transportation era.
Multiple Commercial Transportation Providers
Decide fleet & service offerings
- Seek growth and profit
- Multiple service products
- Market for brand

Transportation Managers
Decide fleet performance
- Seek sustainability
- Social justice
- Environmental justice
- Employment justice

Deliver trip services

Maximize business value

HMS intelligence services

Regulate supply & demand

Maximize Smart City value

HMS intelligence services

HMS Management System

1. Performance targets
2. Trip-data feed into HMS
3. Performance data (fleet)
4. Compute subsidies & road fees
5. Data & advice: subsidies/fees

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HMS enables transportation managers to manage ride providers in the Platform Economy.

Transportation Managers

**HMS (B2B)**

Ride Providers

**MaaS (B2C)**

Riders

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Many to many to many.

- Employer
- Retailer
- School District
- City or Region - a
- City or Region - b
- City or Region - c
- Disability
- Fuel
- Occupancy
- Reputation
- Route
- School drop off
- Ride Provider - 1
- Ride Provider - 2
- Ride Provider - 3
- Seniors' mobility
- Time of trip
- Transit catchment
- Transit desert
- Transit pick/drop
- Wait time

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Purpose of HMS

HMS: software platform
Offers transportation demanders/managers the ability to specify and regulate commercial transportation supply in the digital transportation era.

1. Specify transit performance requirements
2. Regulated by transportation managers
3. Set and manage subsidy budget *(road-use fee?)*
4. Open to all ride providers and services
5. Simplify procurement process
6. Service resilience
7. Coverage for social equity
8. Uniform analytics
9. Data-learning from other cities
10. Increases business opportunities
Thank you!

Transportation Suppliers

Harmonization Management System

Transportation demanders
Build a New Program

Select the type of program you would like to create.

- **First-/Last-Mile**
  - Support connections to transit hubs

- **Seniors Mobility**
  - Support options for those who can no longer drive

- **Special Needs**
  - Support for those who require assistance
  - Coming soon

- **Custom**
  - Design a new program from scratch
  - Coming soon

**Contract Name**: Richmond Hill First-/Last-Mile

**Start Date**: 2018-05-01

**End Date**: 2018-10-31

**Total Budget Cap**: $25,000

Next
Choose Location
Select target and catchment areas to include.

Set Target Area  Set Catchment Area

Note: Increasing target area will improve use, decreasing will improve accuracy. Increasing catchment area will improve use but can increase costs exponentially.

Location Name  Richmond Hill Transit Station

Next
# Define Subsidy Limits and Amounts

Enter eligibility criteria and incentive amounts.

## Limits

<table>
<thead>
<tr>
<th></th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time of Day</strong></td>
<td>6:30 AM</td>
<td>10:00 AM</td>
</tr>
<tr>
<td><strong>Days of Week</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trip Distance</strong></td>
<td>Any</td>
<td></td>
</tr>
<tr>
<td><strong>Occupancy</strong></td>
<td>Any</td>
<td></td>
</tr>
</tbody>
</table>

## Amounts

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed credit per ride</td>
<td>$5.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>Credit per kilometer</td>
<td>$0.15</td>
<td>$0.15</td>
</tr>
</tbody>
</table>

Example: With a fixed credit of $5.00 and a per kilometer credit of $0.15, a three-kilometer ride would receive $5.00 plus 3 x $0.15 ($0.45) for a total of $5.45.
## Review Program

Verify program details and estimated outcome.

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Richmond Hill First/Last-Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Budget Cap</td>
<td>$25,000</td>
</tr>
<tr>
<td>Program Dates</td>
<td>May 1 2018 to Oct 31 2018</td>
</tr>
</tbody>
</table>

| Location                  | Richmond Hill Transit Station |
|------------------------------------------------------------|
| Additional Limits | None                           |
| Subsidy Amount     | $5.00 + $.15/km                |

### Estimated Results

- **Total rides supported**: 3,000
- **Average TNC vehicle occupancy**: 1.7
- **Total subsidy expenditures**: $12,000
- **Average catchment distance**: 1.9 km

### Estimated Impacts

<table>
<thead>
<tr>
<th>Transit Ridership</th>
<th>Congestion</th>
<th>Parking</th>
</tr>
</thead>
<tbody>
<tr>
<td>13% improvement</td>
<td>5% improvement</td>
<td>9% improvement</td>
</tr>
</tbody>
</table>

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Program Outcome Report
Completed program.

Program Name: Oakville Seniors Pilot Project
Location: Oakville City Centre
Total Budget Cap: $150,000
Additional Limits: Age (65+), Licence (No Licence)
Program Dates: Aug 1 2018 to Jul 31 2019
Subsidy Amount: $5.90 + $1.15/km

Program Results

<table>
<thead>
<tr>
<th></th>
<th>Total rides supported</th>
<th>Average TNC vehicle occupancy</th>
<th>Total subsidy expenditures</th>
<th>Average catchment distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uber</td>
<td>5,765</td>
<td>1.6</td>
<td>$8,943</td>
<td>2.5 km</td>
</tr>
<tr>
<td>Lyft</td>
<td>3,988</td>
<td>1.6</td>
<td>$4,011</td>
<td>2.2 km</td>
</tr>
<tr>
<td>FaceDrive</td>
<td>902</td>
<td>1.1</td>
<td>$409</td>
<td>1.3 km</td>
</tr>
<tr>
<td>InstaHyde</td>
<td>1,254</td>
<td>1.2</td>
<td>$333</td>
<td>0.8 km</td>
</tr>
<tr>
<td>Taxify</td>
<td>1,172</td>
<td>1.5</td>
<td>$645</td>
<td>1.7 km</td>
</tr>
</tbody>
</table>

Program Impacts

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Estimate</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents Served</td>
<td>+13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident Rate</td>
<td>-5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking</td>
<td>-2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seniors with access</td>
<td>165%</td>
<td>157%</td>
<td>105%</td>
</tr>
<tr>
<td>Unlicensed ratio</td>
<td>51%</td>
<td>63%</td>
<td>14%</td>
</tr>
<tr>
<td>Road accidents / month</td>
<td>84</td>
<td></td>
<td>1015</td>
</tr>
<tr>
<td>Percent involving seniors</td>
<td>7</td>
<td>14</td>
<td>1.5</td>
</tr>
<tr>
<td>Parking capacity filled</td>
<td></td>
<td></td>
<td>88%</td>
</tr>
<tr>
<td>Curbside dropoff ratio</td>
<td></td>
<td></td>
<td>88%</td>
</tr>
</tbody>
</table>

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Table 1: A Rough Calculation of Expected Fleet Size, Estimated Costs to Service 25% of the GTHA PKT with Robo-Vehicles Circa 2030

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTHA population 2030 (projected)</td>
<td>8.5 M</td>
</tr>
<tr>
<td>25 percent of pop (Roland Berger suggested 27% of PKT in robo taxis)</td>
<td>2.125 M</td>
</tr>
<tr>
<td>Annual PKT per person (less than current U.S. 13,500 VKT to be conservative for ride-buyers, assume ride buyers purchase fewer km than car-owners travel)</td>
<td>12,000</td>
</tr>
<tr>
<td>Total annual PKT for 25%</td>
<td>25.5 B</td>
</tr>
<tr>
<td>Current per vehicle occupancy (in passenger vehicle (U.S.)</td>
<td>1.59</td>
</tr>
<tr>
<td>Total annual VKT for the 25% at this (current) occupancy</td>
<td>16 B</td>
</tr>
<tr>
<td>Target occupancy (mixture of 2-, 4-, 6-, and 12-person vehicles comprising 50, 25, 20 and five percent of the fleet respectively, and operating on average at 50% occupancy (including deadheading which means 55% occupancy when occupied if deadheading is at 10%)</td>
<td>2</td>
</tr>
<tr>
<td>Total annual VKT (by converting PKT to VKT at the target occupancy)</td>
<td>12.75 B</td>
</tr>
<tr>
<td>Daily duty hours of a vehicle (estimated: daily work cycle including deadheading and waiting for riders; excludes charging, parking when not in use)</td>
<td>16</td>
</tr>
<tr>
<td>Speed km/h, estimated from current transit ~2015 (top vehicle speed is the posted speed, but most actual travel is in-city, with traffic stops, pickups, waiting, heavy traffic, lights, etc);</td>
<td>24</td>
</tr>
<tr>
<td>Daily km potential: all in, stops, pickups, top speed, etc. (duty cycle x speed)</td>
<td>384</td>
</tr>
<tr>
<td>Annual km (daily km x 365)</td>
<td>(This may be high at first, so larger relative fleet may be needed at start ...)</td>
</tr>
<tr>
<td>NYC taxi annual (for comparison only; this indicates that 140,160 is only slightly high, since robo vehicles are more optimized than human-driven)</td>
<td>112,000</td>
</tr>
<tr>
<td>Estimate Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
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</tr>
<tr>
<td>Floor estimate: Number vehicles to cover total VKT; assume perfect operation, average day</td>
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</tr>
<tr>
<td>Ceiling estimate: assume 15% (of the ride-buying 25%) of the population is in a vehicle at the annual peak hour, the fleet would need to serve 3.75% of the population concurrently</td>
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</tr>
<tr>
<td>Peak-to-Average estimate: use 1.6 x floor [Sweet] requires 146,000 vehicles. (The factor of 1.6 was taken from a traffic study of the Toronto area (this accounts for annual or weekly peaks, not the annual peak!))</td>
<td>146,000</td>
</tr>
<tr>
<td>Calculated estimate: the average between the ceiling and the peak-to-average. Such a fleet might incur slightly longer queues at some annual peaks (Christmas shopping, Halloween night) but would have spare capacity to meet short-wait promises, otherwise</td>
<td>152,000</td>
</tr>
</tbody>
</table>

(Note: there is no buffer for vehicle failures or scheduling and distributions shortcomings.)

Average annual vehicle cost (capex+ opex+ 0.2FTE @ 80K) *
* Assume Capex and Opex (excluding staff costs) for a vehicle is $50,000 per annum including support equipment. Assume fleet operations (fuel/energy, management, payment systems, security, police and emergency, maintenance (repairs and cleaning), oversight, stewards on the minibuses, map maintenance, roadway watchdogs) require 1 FTE per 5 vehicles. Average staff salary and overhead per FTE is $80,000 per annum, or $16,000 staff expense per vehicle (30,500 jobs for a fleet of 152,000).

Total annual cost given above peak, but no buffer; implies occasional waiting times | $10.1 B

Cost per PKT (no contingency, no profit) | $0.39
AV-Eras
(Diffusion varies by geography & governance)
Car Buyers now

Car Buyers early automation 2020s (evidence? “History”)

Car Buyers planner’s stated preference 2030s-2040 (evidence? “Hope”)

Ride Buyers

Ride Buyers