PRT (personal rapid transit) Last Mile & Comprehensive New Mobility

- Steve Raney, Silicon Valley
  - Suburban focus, not downtown SF

- Moving Cooler re 2020, 2035 GHG
  - Increased fuel efficiency is key, but
  - Have to reduce driving (VMT).
Goal: maximize acreage of <50% SOV
Mobility Hub: transit, carshare, rideshare, bikeshare, scooters …
PRT: technology / what it is

• Ultra, 2getthere: robocars (could bump curb)
• Vectus: train-like
• Non-stop origin to destination, bypassing intermediate stations
  – Separate guideway (track) for stations versus main guideway
• Control system: manage many vehicles
• Driverless / full automation
  – Accurate location sensing, *lateral* and longitudinal.
2 operational systems, 2 more coming

<table>
<thead>
<tr>
<th>System</th>
<th>Miles</th>
<th>Stns</th>
<th>Pods</th>
<th>Trips/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2getthere Masdar</td>
<td>1.1</td>
<td>5</td>
<td>13</td>
<td>1,000</td>
</tr>
<tr>
<td>Ultra Heathrow</td>
<td>2.4</td>
<td>3</td>
<td>21</td>
<td>1,200</td>
</tr>
<tr>
<td>Vectus Suncheon</td>
<td>6.0</td>
<td>2</td>
<td>40</td>
<td>many</td>
</tr>
<tr>
<td>Ultra Amritsar</td>
<td>4.8</td>
<td>7</td>
<td>240</td>
<td>50K+</td>
</tr>
</tbody>
</table>

Cities21
Stanford Research Park

- Palo Alto, SV “dad”
- 25K jobs
- 50% paved, no sidewalks
- Commute Shed:
  - 47% within 2 miles of Caltrain
  - 49% w/i 10 miles
- 80% SOV, 11% pool, 1% rail
- 18 mi one-way
- 200 similar.

Cities21
PRT New Mobility (super TOD)

• Faster than a car
SRP PRT

• 5 mile system
  – 17 stations
• $75M
  – Capital cost
  – Vs. $3B R.E. value.
Comprehensive, Integrated Mobility
Door to Door

Delivery services, Personal activities, Business services

Train, HSR

Bus

Walk

Bike, scooter

Avego

Short carpool

• Improved match-making
• Shared parking, iPooling

Long carpool

PRT system

LAST MILE mid-day trips

Cities21
Stanford, Stanford Research Park, Google

- Single family homes: hopeless.
Market Research Results
(300 surveys)

• Palo Alto, Pleasanton office parks
• Solo commutes: 89% ➔ 45%
  – Carpool: 9% ➔ 32%, train: 0% ➔ 15.5% train
  – For 20K people, removes 6,600 autos (roughly)
    • @ 350 s.f. per space ➔ 50 acres ➔ in-fill (residential)
• 1.32 PRT trips/day/person ➔ 26K trips/day
  – Shuttle bus: 2K trips/day. Robocar feeder?
Gap: Transportation Pricing
Increase Driving Cost to cut VMT

• Pricing ➔ demand & votes for mobility
• Moving Cooler: $5/gal tax ➔ cut VMT 28%
  – Europe: $8/gal gas ➔ 33% less VMT than US
  – 4 big MPOs to state: Increase price to cut VMT
• CA Pain-free Driving Pricing Working Group
  – Biz lobby, enviros, agencies, Brown staff
  – PAYD insurance: Cut VMT 4% (8% other states)
  – $2 office pkng charge + $4 incent: 23% commute
  – Android + Connected Vehicle + Roadify.
Gap: carsharing

• Buy/lease dedicated fleet. Crud biz model
• Solution: Peer to Peer carsharing
  – SprideShare won enabling 2010 CA insurance regulation
  – Relay Rides (investor: GM)
  – Wheelz (investor: Zipcar, Bill Ford).
Gap: Research: Lots want 3 days carpool

- Researching PRT for MS in 2004
- Solution: Avego.
Thank you

• Video if time permits
Back up slides
Vulcans instead of humans

- Rational, well-informed voters
  - Land-use conversant, no science denial, no misinformation
- Regions control major city land use decisions
- 1992 (Rio): Vulcans unite to protect climate
  - By 2011, Vulcans meet 2035 AB32 target (50% of 1990)
- US gas price: $8 per gallon
  - like Europe ➔ 33% less driving. Ripples into policymaking
- $200/ton CO2
- Population reduction
- President Reich.
Family Energy Consumption – driving matters most
Urban vs. suburban

• Outlaw new single family homes.

Transportation Use
Household Use

<table>
<thead>
<tr>
<th>Household Type</th>
<th>Million BTU per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban Avg (240 MBTU)</td>
<td>125</td>
</tr>
<tr>
<td>Suburban Green (164 MBTU)</td>
<td>83</td>
</tr>
<tr>
<td>Urban Avg (143 MBTU)</td>
<td>28</td>
</tr>
<tr>
<td>Urban Green (89 MBTU)</td>
<td>20</td>
</tr>
<tr>
<td>Urban Multifamily Green (62 MBTU)</td>
<td>20</td>
</tr>
</tbody>
</table>
Efficient Human Settlement Patterns

• Reducing driving is BIG, BIG, BIG
  – Prius is good, but not sufficient

• For each person, minimize the distances in the triangle below (units: miles ➔ feet)

• Solution: fix suburb at a profit, spread like virus
  – Must innovate, need smarter Smart Growth.

Home ➔ Job ➔ Activities
Residents: PRT Grocery Shopping

• Hook N Go:
• 2 car family:
  – 1 car
  – PRT: errands
  – Carsharing.

Cities21
Behavior hole: Low Odometer Culture

- Big new residential complex
  - “Moving in” is a magic time of travel pattern change
  - Vs. “Can’t take away something you already have”
- Everyone signs a “visible to peers” low driving pledge
  - Entry condition to obtain housing
  - People are “self-consistent”
- Communities of Practice – expertise for green travel
  - Ex: Biking learning curve: route, gear, defensive
    - People love to share such self-discovered expertise
- Manufacture a tipping point
  - Folks want to be green, but it’s a mild desire …
  - New social norm. Positive peer pressure
  - Scale! Many trips leave from the exact same location
    - Carpool to grocery store (weird to ask in most communities)
    - Delivery services, etc.
Hole: Green Commute Housing Discrimination

• Priority access to new housing for green commuters
  – Waiting list

• The most cost-effective traffic reduction policy (ever). SF ↔ San Jose (swap)
  – Or, “Proximate Commute” for Starbucks workers

• Stanford West: 515 apartments
  – 396 Stanford, 96 hospital, 14 Palo Alto, 9 long commutes
  – 10% short-commute rent discount.
Wireless Commute Assistant
Big Sister knows where & who you are

GPS: tracking
NextTrain
TrakRide for carpools
HomeSafe, SpyKids
NextSpace for parking

Wi-payment

Customer support
QuickCar, < 5 minutes
Trip planning, travel advisory
Order a PRT vehicle.

Shared parking entry, QuickCar key
Easy PRT ticketing
Improved indoor reception

Cities21
“Hands-free” PRT ticketing

- Phone ➔ traveler ID to PRT gate (context!)
- Gate displays likely destination
- Traveler boards (or “pick a station” UI)
- Automatic account debit

Example: Jim uses 5 of 17 stations:
- If @ Caltrain {5AM-11AM} ➔ Intel (job)
- If @ Intel {10AM-2PM} ➔ [4 luncheon stations]
- If @ [lunch station] {10AM-3PM} ➔ Intel
- If @ Intel {3PM-7PM} ➔ Caltrain.
7:20AM: on time

7:25AM: 2 min late

SMS nudge to A at 7:10, 7:15

A departs OK
B is 2 min late
C delays 2 min

Encourages punctuality, courtesy.
Eliminates uncertainty.
NextTrain

- When to leave desk
- Race to train station
  - Worker must “win”
- PRT wait = fcn(demand)
- Slack

- TR: 6:35PM train is on time
- Every 30 sec, recalculate
  - TTAT: time to access train = 1 min walk + 1 min wait + 4 min PRT + 1 min walk + 2 min slack
  - LV = TR - TTAT
  - TM: current time
- Small beep @ 5, 2 min to LV
- NextTrain orders PRT vehicle 2 min before LV
6K vs 4K per capita VMT → gas tax
$8 gallon gas $\rightarrow 28\%$ less VMT

- $5$ gas tax increase is politically impossible
- Auto insurance by the mile $\rightarrow$ $1.67/gal$ increase $\rightarrow 6\%$ less VMT (Allen G VPPP)
- Workplace parking (UCLA’s Shoup)
  - $4/day$ incentive (pay workers to not SOV)
  - $2/day$ parking charge if you SOV
  - Revenue neutral to employers
  - Start small ($0.50$ incentive + $0.25$ charge) & ratchet it up gradually
  - $23\%$ less commute VMT.
• Is protecting climate equivalent to WWII?
Behavior Change – green culture

- WWII homefront vs. climate protection culture
  - Draft, big tax increase, unions thrive, air raid drills, etc, etc
  - Ration: Meat, butter, coffee, 3 gallons gas/week, clothes
  - Stopped: housing, appliances, cars, tires
  - Egalitarianism of consumption
  - 2050 CO2: humans must evolve socially: cooperate.
Green Commute Hsng Examples

• Stanford West Apts: 515 apts
  – Shuttle bus, biking, hostile to cars
  – 396 Stanford, 96 hospital, 14 Palo Alto, 9 long commutes
  – 10% short-commute rent discount
  – 2.6 MM less VMT/CO2 lbs./yr

• Redwood City: 800 mkt rate condos
  – 1 mi from dntn, bike path
  – Cities21 victory
  – Sell to greens: 4 months
    • No commute
    • All adults, 80% grn commute
    • One adult, 80% grn commute
    • Work within 4 miles. FHA test
    • Qs.
Suburban Smart Growth Stinks

- East Bay BART TOD: 40% transit commutes
  - Commute to auto-hostile San Francisco
- South Bay Caltrain TOD: 17% transit commutes
  - High driving residents “crowd out” green commuters
  - Non-TOD South Bay: 4% or less transit commutes
- Suburban LRT “TOD without the T” – Calthorpe
- Potential: Portland Pearl Dist:
  - 9 VMT/person/day vs 22 VMT for region
- Hence, make Smart Growth smarter:
  1. PRT as shuttle bus on steroids ➔ new mobility
  2. Green culture for new residential
  3. Green commute housing preference
  4. Driving / parking pricing.
Portland Pearl District
At 3-story mixed use, driving is less than half of typical U.S.: 
(mode share for all trips (errands and commute) is the % shown for auto, walk, transit, and bike)

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>% Auto</th>
<th>% Walk</th>
<th>% Transit</th>
<th>% Bike</th>
<th>VMT per capita per day</th>
<th>Autos per HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good transit + mixed use</td>
<td>58.1</td>
<td>27.0</td>
<td>11.5</td>
<td>1.9</td>
<td>9.80</td>
<td>0.93</td>
</tr>
<tr>
<td>Good transit only</td>
<td>74.4</td>
<td>15.2</td>
<td>7.9</td>
<td>1.4</td>
<td>13.28</td>
<td>1.5</td>
</tr>
<tr>
<td>Rest of Portland Region</td>
<td>87.3</td>
<td>6.1</td>
<td>1.2</td>
<td>0.8</td>
<td>21.79</td>
<td>1.93</td>
</tr>
</tbody>
</table>

Parsons Brinckerhoff. 2002. Factors for Success in California’s Transit-Oriented Development: http://www.dot.ca.gov/hq/MassTrans/tod.htm, Page 24, Table 2.1: 1994 Metro Travel Behavior Survey Results for Portland, Multnomah County, Oregon
2. Low Miles Community

• TravelSmart / SmartTrips / Travel Choice
  – Door to door / grassroots
  • Education about how to get out of car
  • Brilliant idea, but small, temporary behavior change. Not yet cost-effective.
Culture: Low Miles Community

• Dual physical/cyber community
  – Not anonymous.
• EBay’s online community phenomenon
  – Make friends, achieve social status
  – Self polices bad behavior
• “Better neighbors”
  – Better neighbors theory: Dumpy college dorm
  – Better neighbors ➔ real-estate profit
  – Would you want to live here?
• Small good deeds made easy. Q’s
3 Stage Path to Sustainability

- Can’t go straight there
- 1) Populist: (convenient) Consciousness raising, light bulbs, Prius, green building
  - Less human land expansion
- 3) Profound: 2050. 80% reduction, less people, accurate pricing, renewable NRG, vegetarian, local food, anti-materialism, lower GNP, social cooperation/enlightenment, etc.
My UCB thesis: PRT for biz parks

• MBA, CS masters. Old for DCRP, SFH in Palo Alto, young daughter. Silicon Valley product marketing – ability to get stuff done, cold call
• Had a DCRP thesis/quest 2 years before. 300 meetings
• Business plan – how many people will ride it, farebox, real-estate $ increase, etc.
• 200 page thesis
  – 6 TRB papers
  – iPooling patent
• → EPA study: PRT for Pleasanton’s biz park
• → Job: ULTra PRT (Heathrow)
• Boring at dinner parties.
Customer-Centered Product Research

- Literature
- Experts (100+ mtngs)
- Commute

Product Concept → Interviews

Refined Concept → Surveys → Validation

- UC Berkeley’s Deakin says we need it. Silicon Valley style
- Anthropological w/ Vulcan mind-meld
- New technology bias
  - High touch / community building is natural
- Start with rough business case in mind and refine.

Cities21
Results: Carpool preference: Gap analysis

- Reliability / GPS cell apps
- Compatibility / dating service
- Proximity / 20K candidates
- Private time / productive time
- Personal support + web chat
- Chit-chat / silence

Cities21
Knowledge worker research

• Large suburban solo driving reduction is hard
  – 80% SOV to 79% SOV is hard
  – But, SOV is “least worst,” not loved
  – SOV: no-brainer background task
  – Charging $6 per day for parking works ($9 gas)
  – Pay $4 per day not to park - fails
  – Current carpooling: “fampools”

• Value of time
  – Commute: 50% of hourly. Lunch: 200%
  – Waiting under uncertainty, 3X
  – Tysons circulator: SAIC to Panera, 500’

• Each commuter: basket of objections.
Knowledge worker commute

- 30% time penalty: OK (20 min SOV vs. 26 min alternative)
- Traditional carpool psychology is complex:
  - Matchmaking: anonymous, superficial rejection (web dating)
  - Sleep, uncertainty stress, and safety are important
- Customer support: eliminate nightmares
- Mid-day stranding: mtngs, lunch, shop
- PM Stranding: want “no penalty” emergency ride home
- Good commute: “time went fast.”
PRT Activity Center Benefits

• Lower cost of living (lower driving cost)
• Less energy/resource consumption
• Reduced CO2 production
• Lower taxes (efficient infrastructure)
• More exercise (walking)
• More social connections ➞ happiness
• Less time wasted commuting ➞ happiness
• Stop human wildlife habitat onslaught (land gobbling).
Lonely, unread seamless mobility papers

- Cities21 web, “library” tab
  - Hopefully provides “foundational” PRT mobility papers
- Suburban Silver Bullet: PRT Shuttle and Wireless Commute Assistant with Cellular Location Tracking, TRR #1872
- Application of New Technology Product Research to New Suburban Commute System Design and Validation, TRR #1927
- Major Activity Center PRT Circulator Design: Hacienda Business Park. TRR #2006
Big Picture: “D2D Seamless Mobility Inc”

- Hypothetical: Google Android
  - Maps driving/transit directions, GTFS
  - RideFinder
  - Beta use own solution
  - Acquire Avego, nuride
  - Acquire carsharing company
  - Acquire PRT company
  - Regional private bus system
  - Parking, pay-per-mile IT
  - Partner with real-estate trusts to capture value

- Wireless Artificially Intelligent commute assistant.