2011 may be a breakout year for iPooling (smartphone ridesharing/carpooling). Peer-reviewed AP020 iPooling papers may help to advance this space. Hence it is important for the call to be more prescriptive than usual, to encourage important research findings/results that contribute to the state-of-the-practice.

There will be multiple 2011 pilot projects:
- $400K Seattle Avego SR520
- ~$175K FHWA Value Pricing Pilot Program for Santa Barbara, serving the Isla Vista college town to Santa Barbara City College student commute
- $1.5M San Francisco Bay Area MTC Climate Innovations grant for three counties: Sonoma, Marin and Contra Costa.
- A new round of FHWA Value Pricing Pilot Program grants will be awarded, including funding of new iPooling pilot projects.

Too rarely have transportation planning techniques been applied to iPooling analysis. This call specifically asks for more transportation planning rigor. This call requests iPooling feasibility studies or papers that examine one or more aspects of feasibility that would appear in more lengthy feasibility studies. FHWA has requested that the Santa Barbara project develop a “concept of operations.” This is to be commended, as a “ConOps” would typically be part of a larger feasibility study. 15 failed dynamic ridesharing pilots have been tried in the past, but few of these 15 would have been granted “notice to proceed” had a rigorous travel demand forecast been undertaken. Indeed, the previous 15 pilots each yielded less than 5 rideshares per day.

There are a number of instant / dynamic ridesharing companies with product offerings: Avego, Zebigo, Carticipate, nuride, Zimride, piggyback, PickupPal, etc.

Some important distinctions:
- With “instant” ridesharing, a ride may be arranged 10 minutes before the trip commences.
- With “dynamic” ridesharing, a ride may be arranged two days in advance.
- With “Avego-style” instant ridesharing, drivers drive along a fixed route every weekday, with designated Avego stops. Riders walk from their building to the stop, in order to obtain rides.

1. iPooling travel demand forecasting
Papers could examine some or all of the following:

- For SR520 or Santa Barbara, establish the size of the travel vectors, using Census Transportation Planning Package 3 TAZ-level flow data.
- Simulate system operation for SR520 or Santa Barbara using CTPP3 data by creating a realistic distribution of drivers and riders with trips originating via a realistic temporal distribution.
- Obtain more precise employee/student origination/destination address data. Simulate system operation using realistic distributions. A helpful procedure for “anonymizing” employee address data is provided in “Privacy-Protecting Commute Shed Study,” TRB 2003, http://www.cities21.org/CommuteShed_TRB_111502.pdf. For this simulation, the research might assume that driver and rider start times follow a Poisson distribution.
- There are many, many simulation complexities. Not all drivers take a route that works for all riders. Not all riders will accept an offered match from all drivers (based on reputation rating or perceived gender safety issues). Public transit often serves the same, so riders will often look for a ride for a few minutes and then take transit if they don’t receive a ride. The ConOps may also allow for a taxi or some other paid driver to “sweep” up any stragglers. Many employers provide guaranteed ride home services. Some riders have first and last mile problems – not all riders get dropped off within easy walking distance of their destination. Some iPooling corridors are “unbalanced” in that one commute direction has more of a last mile challenge than the other direction.
- Verify simulation travel demand analysis with the region’s MPO’s travel demand forecaster/modeler and other experts. Interview these experts and report back findings.
- There is some possibility of modeling iPooling driver commute flows as new bus routes and then running the resultant routes thru the regional travel demand forecasting model. The set of new bus routes will run between two instant ridesharing “stops” and will service all the iPooling stops in-between. Each pair of start and ending iPooling stops results in a slightly longer or shorter bus route. Driver departure time over the applicable bus route can be based on some reasonable distribution and can be used to approximate bus route headway. Given the resultant set of bus routes, these routes can be added into the regional travel demand forecasting model, to generate the total market for rides that could be given by the set of iPooling drivers. Note that new bus route travel time should be much faster than traditional bus service as the iPooling-driver-modeled-as-a-bus will rarely stop at an intermediate iPooling stop.
- Validate simulation analysis against pilot program operational results.
- Predict whether initial and long-term pilot project incentives will be effective. The “equation” for benefit or “economic utility” of travel is: Travel utility = f(travel time, travel cost, travel experience {hassle, stress, comfort, entertainment value}, parking hassle, parking cost, reliability). In three very rare cases – San Francisco Bay Bridge casual carpooling and DC/Houston slugging, the utility of carpooling is greater than the utility of single occupancy vehicle driving, util(HOV) > util(SOV). Interview skeptical experts as to their opinions about the efficacy of iPooling incentives.
- Conduct new product qualitative and quantitative research to predict travel demand, placing the product concept within the context of how the product will work for the specific journeys that a respondent will undertake. Probe how effective the incentives are. For examples of applicable interview research and quantitative survey research, see “Application of New Technology Product Research to New Suburban Commute System Design and Validation,” Transportation Research Record #1927, http://www.cities21.org/NewTechProdMtkng_TRB_111504.pdf
- Given simulation and iPooling travel demand forecasting, what is the distribution of expected rider wait times? If a rider initially tries for a ride twice and fails to match both times, a certain percentage may quit the pilot. Based on some quitting rule, how many riders should be expected to quit? What is the expected vehicle occupancy for participating drivers? Is there a “straggler problem” towards the end of the commute period where riders have a lower chance of finding a ride?
- “Day 1” is defined as the day when a) riders use the system under the assumption that the full range of drivers and other alternatives are available and b) riders expect that there is a high chance that they will receive a timely ride offer. Many days of training a system buildup may occur before Day 1. Based on system simulation, should the pilot be expected to succeed on Day 1. Success could be defined as “the average driver provides one ride.”
It is felt that there are many grad students that are familiar with transportation simulation and queueing theory, to the point that iPooling travel demand forecasting should make for an interesting semester project.

2. iPooling transportation safety

Transportation safety preamble

In the US, new-within-the-last-50-years transportation technologies such as automated people movers, personal rapid transit, and iPooling are held to a high safety standard, with zero fatalities tolerated. Under the zero fatality standard, 100-year-old technologies such as “driving an automobile on a road,” LRT/streetcar, commuter rail, and bus transit would not pass US safety certification and would not be allowed to operate. For driving, occurrences such as drunk driving, cell phones in cars and screaming children in the back seat would require extreme mitigations – cars would have breathalyzer ignition systems, in-car cell phone jamming, no back seats, and child passengers would be prohibited.

In standard safety practice, a hazards analysis is undertaken to quantify the frequency and severity of hazards. Mitigations are undertaken to move from red to blue in Table 3 below:

<table>
<thead>
<tr>
<th>Severity</th>
<th>Frequency</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>&lt;0.01 per year</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Minor</td>
<td>&lt;1 per year</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Serious</td>
<td>&lt;8 per year</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>Major</td>
<td>&lt;12 per year</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Single Fatality</td>
<td>&lt;12 per year</td>
<td>7</td>
<td>14</td>
<td>21</td>
<td>28</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>Multiple Fatalities</td>
<td>&gt;12 per year</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>

Probabilistic fault trees are developed for each hazard, typically based on standards such as IEC 61508: "Functional safety of programmable electronic safety-related systems." These fault trees are typically designed so that a series rare occurrences must simultaneously occur for a hazard to instantiate. For example, four occurrences with a probability of occurring once every two years may need to cascade to create a particular hypothetic hazard, but the combined probability of four simultaneous occurrences might be less than one occurrence in one million years. While no safety process can eliminate all risk, modern safety practices reduce the frequency of severe hazards to an acceptable level in a cost-effective and rigorous manner. Rigorous safety cases developed by private sector companies are regularly accepted by risk-averse public sector entities and provide assurance that these public entities have not acted negligently. “ASCE 21” is the US safety standard for automated people movers and personal rapid transit. All ASCE 21 safety cases follow the safety regimen described in this section.

With that lengthy preamble given, iPooling papers could examine some of the following:

* Describe how the invisible hand of Capitalism motivates private sector iPooling firms to develop robust, redundant safety systems to assure anxious members of safe rides. Examine the invisible hand applied to customers, how prospective members would demand a persuasive safety explanation before joining the system.
• iPooling hazards analysis, with severity and frequency. Interviews with experts would further inform such an analysis.

• For each iPooling hazard, develop probabilistic fault tree hazard mitigation. Consider for example the probability of a cascading series of five simultaneous, unlikely occurrences leading to an in-vehicle assault in the Avego SR520 pilot. What is the probability of the five redundant safety measures simultaneously failing?
  o Occurrence 1: The Seattle population has a certain low probability of axe murders. The Avego pilot might limit participation to major employers east of Lake Washington, including Microsoft, Amazon, and Google employees. As a condition of employment, Microsoft employees undergo a thorough background check, including a police background check. The invisible hand of Capitalism is such that Microsoft is loathe to hire employees that pose a threat to other employees.
  o Occurrence 2: In the US, it has been found that hitchhiking has a low probability of axe murdering. iPooling prevents anonymous hitchhiking, acting as an axe murdering deterrent, as the chance of an axe murderer being caught is much higher.
  o Occurrence 3: SR520 Avego iPooling offers drivers the opportunity to make safe in-vehicle gender mix selections, including preventing the occurrence of a vehicle with one male and one female. The probability of unsafe in-vehicle gender mix is accordingly lowered.
  o Occurrence 4: SR520 Avego iPooling has a reputation rating system. Members who give off an “unsafe vibe” will be scored lower, and will eventually be “ranked out” of the system. The probability of “bad vibe” members participating is accordingly lowered.
  o Occurrence 5: Avego iPooling can detect route deviation and route deviation may be an early indication of an assault. Such automated flagging of anomalous occurrences acts as a deterrent, lowering the probability of route deviation.

• Examine the safety regime imposed by the public sector in the SR520 pilot and the reasons given for this safety regime. Survey experts as to whether this safety regime is perceived as “rational” or “unduly burdensome with deleterious side-effects for recruiting.”

• Public transit safety information can be readily obtained. For an SR520 pilot participant who iPools to Microsoft in the morning and then takes public transit back to Seattle in the evening, how many times more dangerous is public transit compared to iPooling.

• Compare iPooling and public transit safety to traditional regional ridematching (carpool matchmaking) systems, such as 511 Rideshare in the San Francisco Bay Area. What safeguards are implemented for traditional ridematching systems? Is there credit card identification? Are carpool trips tracked? Is safe arrival verified? Are users rated? Does the traditional ridematching system even maintain a relationship with people within the ridematching database? What is the safety record of traditional ridematching? Have there been high-profile incidents? Lawsuits?

• Compare perceived rider group dynamics and associated safety for Seattle public transit versus SR520 iPooling. It is interesting to note a comment from a Seattle-based anthropologist researcher from a Fortune 100 company. A finding was made that attractive Seattle females did not have a satisfactory experience when using public transit, because they were repeatedly “hit on,” which created the perception of an unsafe travel experience.

3. Success Factor Analysis

For a pilot program, analyze the impact of various factors that contribute to success or failure. Factors could include:

• Smartphone or platform penetration for the target market. (Some apps are smartphone-specific, others run on mobile web browsers, reaching a larger audience.)

• Use of evangelism techniques and psychological persuasion to create pilot members with higher-than-average commitment. “Pizza parties” to indoctrinate new members, visible-to-peers pledge signing ceremonies, social networking, educational efforts, and “higher group status for the most effective members” are examples of techniques that have been proposed for different pilots.

• Will the activities and training leading to “Day 1” be successful? For example, Avego-style training may include drivers picking up “Avego ghosts.”
• How well does the ConOps integrate iPooling with other complementary modes such as
  vanpooling and transit. If circulator transit systems serve some of iPooling stops, how large is the
  resultant catchment area?
• How effective is the ConOps marketing plan?

4. Explore algorithmic identification of promising iPooling corridors

See the NJIT’s bus stop optimization algorithm. (Need a professor. Is this in my EPA final report?)

NJIT has an algorithmic bus station selection algorithm that can take advantage of fine-grained data. Can
a variation on this approach be used to algorithmically identify promising iPooling corridors? Please see:
  • Chien, Steven, Branislav V. Dimitrijevic, and Lazar N. Spasovic, Bus Route Planning in Urban
    Grid Commuter Networks
  • Optimization of Multiple-Route Feeder Bus Service: Application of Geographic Information
    Systems. Steven I-Jy Chien, Feng-Ming Tsai, and Edwin Hou. Transportation Research Record
    1857.

5. Applicable papers and presentations:

• TRB AP020 Jan 2011 Committee Meeting PPT: iPooling Industry Status.
• SF to Silicon Valley Instant Ridesharing with San Bruno Transfer Hub. TRB January 2010
  (pending for TRR publication). ABSTRACT: A concept of operations is provided for an innovative
  instant ridesharing service to exploit the large San Francisco (SF) Bay Area major employer
  commuter flow from SF to Silicon Valley. While the concept of filling empty seats in cars seems
  obvious, 15 previous dynamic/instant ridesharing pilots have failed to develop critical mass. The
  proposed service differs from past attempts as follows: a) It targets a large commuter flow vector
  rather than a two-dimensional area, resulting in a higher probability of ridematches. b) It uses a
  mid-commute transfer hub to further increase ridematching probabilities. C) It offers a viable
  business model providing $40 per day per commuter cost savings to Silicon Valley employers. D)
  It uses psychological persuasion principles to obtain higher participant commitment. E) It uses
  daily financial incentives to motivate participants. F) Via extensive participant training, it
  emphasizes immediate high system utilization on the first day of operation. Paper:
  http://www.cities21.org/TRB_SFtoSJ_iPooling_with_Hub.pdf  (3.5MB)
• Initial Santa Barbara instant ridesharing grant proposal: