Application of New Technology Product Research to New Suburban Commute System Design and Validation

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ABSTRACT

To provide improved alternatives to suburban solo commuting, a technologically-intensive door-to-door mobility service was designed for suburban commutes, with special emphasis on addressing attitudinal/psychological barriers. Literature Review, expert opinion, and GIS journey-to-work analysis influenced the initial conceptualization. Concepts were then iteratively refined through interview research. The final system concept was validated via stated preference surveys employing "gap analysis" to measure the importance of barriers and the effectiveness of proposed solutions. An elaborate "assembly-line" eight-step survey protocol was employed, featuring immersive, virtual-reality based respondent stimuli (information acceleration), full disclosure of psychological barriers, and customized door-to-door commute comparisons. Original contributions include: a) a unique combination of varied product research techniques for the design and demand forecasting of futuristic transportation systems and b) rich anecdotal descriptions of technology worker commute psychology.

PRODUCT CONCEPT / GOALS

Addressed is the formidable challenge of removing 25 percent or more of parked cars from suburban office parks. In the San Francisco Bay Area, suburban office park commute mode is roughly divided as follows: 78% drive alone, 16% shared ride, and 3% transit. (1) The proven method to reduce solo driving is charging for parking. A database of 41 U.S. transportation demand management (TDM) case studies compiled by the Environmental Protection Agency revealed nominal solo driving reductions of 16, 25, 28, 20, 16, 25, 34, and 25 percent with paid parking or parking cash-out regimens. No other known TDM technique produces a 15 percent reduction. (2)

This research explored whether commuters could be willingly coaxed away from driving alone. The author's TRB '04 paper describes the mobility system concept, which can be summarized as follows:

> *Proposed is a 20-station, elevated personal rapid transit (PRT) "shuttle" system for Palo Alto's 20,000-employee Stanford Research Park (SRP) major employment center, complementing and significantly increasing the attractiveness of commuter rail, carpool, vanpool, bicycle, and bus commutes. PRT provides non-stop, no-wait, 30 mph service for the commute's last two miles, and services mid-day trips. In addition to PRT, the proposal includes a very comprehensive "door to door mobility" service, called "D2D," that supplies both high technology (web/cellular) and "high touch" (personal) solutions to meet workers' complex transportation needs. D2D includes solutions to improve carpool and transit connections, increase the safety of carpooling with strangers, rapid car share/emergency ride home, and improved carpool matchmaking. The overall system is called "PRT+D2D."* (3,4)

Interview and survey scenarios are set in Year 2008, assuming: a) PRT technology had been commercialized and b) cellular infrastructure had continued its breakneck technological progression. Thus, the research is based on speculative assumptions. Nevertheless, technology market researchers regularly forecast emerging technologies a few years into the future.

PRT+D2D system economics and public policy considerations are avoided in this paper.

SIX-STEP PRODUCT RESEARCH

This study represents an application of technology market research and product design techniques to Silicon Valley suburban commuting issues. The "product" in this case is a complex transportation service

for commuters. The author's role was that of a Product Manager. An explanation of Product Marketing may be found in Kotler's popular MBA textbook, Chapters 4, 6, 10, and 15. (5)

The research consisted of a six-step process, illustrated in Figure 1. First, a thorough understanding of the customer (workers with technology jobs) and the commuting market was obtained via literature review (labeled "Literature" in Figure 1), via meetings with professionals ("Experts"), and via compilation of a GIS journey-to-work map ("Commute"), where 8,200 home addresses (commute trip originations) were plotted. Understanding technology worker commute attitudes was crucial in the system design. A review of attitudinally-based transportation studies is provided by Parkany. (6)

The author's TRB '03 paper describes methodology used to collect and plot the home addresses of SRP workers. Understanding the geographic distribution of commutes revealed line-haul possibilities. 47 percent of employees live with a 2-mile radius of a connecting commuter rail station. In addition, 28 percent of workers live within a five-mile radius and 49 percent live within a ten-mile radius of SRP. (7)

Second, the complex transportation service was conceived.

Third, 13 interviews were undertaken. This prospective customer feedback resulted in the fourth step, a refined product concept. Interviews provide rich anecdotes to improve a Product Manager's comprehension, retention, and intuition about commute issues beyond that obtained via literature review. Customers provide important insights, often brainstorming new product features. Cervero emphasizes the importance of "sweating" the details, “the difference between a good and bad transit system often boils down to getting the details right.” (8)

Fifth, 62 surveys were undertaken to validate the product concept (Step Six), to verify that the refined concept met the needs of the target market. The forecasting of futuristic multi-modal / new mobility alternatives is quite challenging. No methodology will produce a definitive answer, but stated preference provides the "least flawed" methodology to "predict the future." Fujii explains that stated preference surveys involving non-existing, unfamiliar alternatives lacking stable core preferences are especially problematic. (9) Stated preference is in common use in private-sector technology product research.

Although listed as part of the first step, meetings with professionals ("Experts") continued throughout the research. In all, there were more than 300 meetings with policymakers, transportation and planning professionals, academics, and wireless industry experts.

The web-based survey combined a number of concepts: a) providing full disclosure of the behavioral issues within the text of the survey – providing respondents with rich, educational text so they could quickly comprehend the challenge. b) three-fold questions conducive to gap analysis, presenting the problem, the proposed solution, and requesting comments. c) customized commute comparison of driving alone versus a multimodal alternative originating from their own home. d) elaborate protocol with scheduling, greeting, three exhibits, clipboard data collection with negotiated alternative selection, extensive interaction with educators, e-mailed comparison, at-desk respondent data input, and free lunch incentive.

This methodology deviates from rigorous scientific research in three important ways. First, the author was responsible for both system design and demand forecast. While common practice for Product Managers, these dual roles create a conflict of interest for defensible research. Second, the Product Manager designs the product with a "working" demand forecast / profit projection in mind. As the research progresses, the forecast evolves. The design and forecast are interwoven. Third, personal background biases Product Managers towards certain solutions, potentially eliminating viable alternatives from consideration.

Methodological Ancestry

MIT's "information acceleration" (IA) creates a virtual experience so that "the customer can react to a really new product as if she were now in the market of the future." Examples include creating a virtual electric vehicle showroom where potential customers can chat with salespeople and sit in the car. MIT found IA sufficient to make major management "go/no go" decisions, and to optimize marketing plans. Mercer Consulting owns the term's trademark. (25) In this study, portions of the commuter's PRT experience are visually simulated via a full scale PRT model and a virtual reality animation. In addition, narrative descriptions convey the D2D features.

Consulting firm Cambridge Systematics uses attitudinally-based surveys for market segmented structural equations modeling for forecasting existing transportation modes. (10,11) In contrast, this study used attitudinal results to address objections by all market segments. Cambridge Systematics Principal Consultant Chris Wornum was consulted on this methodology.

Ingmar Andreasson's PRT research also serves as a starting point. He provided potential riders with an immersive educational experience with a 3D virtual reality simulation inside a Raytheon PRT 2000 vehicle and conducted interview research on 13 respondents. (12)

Susan Shaheen's carsharing research also provides a baseline methodology. (13) Her challenge was to gauge reaction to carsharing by potential riders with no foreknowledge of carsharing, which was not operational anywhere in the U.S. at that time. Respondents spent considerable time being exposed to and learning about carsharing. Her "drive clinic" took respondents through a complete car sharing experience, enabling a fair evaluation of the service.

The product feature sets in the four ancestor studies were unvarying during the research, whereas PRT+D2D evolved during the first four steps.

Shaheen found that for car sharing research, it was essential to have ready answers for the objections that came up during the car sharing drive clinic. This insight informed the PRT+D2D survey philosophy, motivating thoroughness with attempted solutions for common commuting problems.

Like Shaheen, considerable effort was spent developing educational materials so that potential riders without foreknowledge could quickly provide valid feedback. The product research interviews corroborated the attitudinal literature and facilitated preparation of the survey instrument. By exposing survey respondents (who were primarily solo commuters) to corroborated objections to commute alternatives, the survey presents a realistic picture of these alternatives, working to dissuade respondents from preferring PRT+D2D. For example, the "class-based" objections workers have to local bus service were addressed in survey question 30:

> *"Taking the bus entails riding with strangers, which is uncomfortable for some folks. From previous research, we've found that folks rate commute buses and local buses differently. Commute bus riders are more 'considerate and professional' than local bus riders. They are less likely to carry on a loud conversation, use audio headsets that 'leak' out music, or convey a distracting odor. You should expect to experience a handful of unsettling local bus experiences every year."*

LITERATURE REVIEW: COMMUTE ATTITUDES

The literature review provided baseline understanding of commute issues. Carpool psychology literature reveals a large number of complex factors to overcome in order to reduce solo commuting. Each person will have a different set of relevant factors with a different importance attached to each. Thus “high touch” (personal) solutions are required that address an individual’s specific context. Each solo commuter that is a candidate for commute alternatives can be imagined as presenting a prioritized list of objections to overcome. Bonnano found the following to be important: confidence in the driver (some drivers only feel safe when they drive), ability to use travel time in productive activities, percent of time carpooler has to drive (driving load), in-vehicle comfort, and cell phoning in car (disruptive to other passengers). (14) The U.S. Census found: “Many candidates will have reservations about participating in carpooling if they feel themselves in danger of becoming committed to a carpool with objectionable fellow-riders.” In addition, issues include riding with the opposite sex, riding with someone of different socioeconomic class, messy people, irreconcilable political differences, type of radio music, and preference to open/close the window. (15)

Voorhees found that psychological profiles of carpoolers were statistically significant. Hard-core non-carpoolers object to relying on others and having others rely on them. They have a high psychological need for independence. (16) Attanucci found impersonal ridematching programs, matching total strangers, are destined to fail. The great majority of existing carpools are formed among coworkers who work in the same building. Only a large individual employer can offer meaningful, efficient, and responsive carpooling support services. (17) Bonsall found “The reduced personal flexibility associated with organized ride-sharing schemes makes them an unattractive option to all but a minority of commuters.” (18) Wood found “For short journeys (< 5 km) the inconvenience of carpooling is greater than the savings. A diversion of 1 km to pick up a passenger was perceived to be about as undesirable as driving an extra 5 km.” (19)

Shaheen found 53 percent of Bay Area commuters don’t like their commute mode and 50 percent find using a car is aggravating, implying that commuters are ready for a competitive solution. Shaheen has also found that giving up the personal trunk storage space in a car was important. (13)

The author found the analysis of affluent technology workers has not been emphasized in commuter behavior literature. "The cushy, cocoon-like technology worker drive alone experience in a fine German sedan provides many pleasant subtleties such as status, leather seat smell, lumbar adjustment, stereo system quality, hands free cell phone, and large trunk storage space. The pleasant experience makes it that much harder to entice these workers into alternatives." In addition, technology workers face the "time stamp" phenomenon. "Competitive workers strive to show proof of being the first worker to start and the last worker to stop every day. The urge to sacrifice personal life for company results in no end of gamesmanship. Thus commute alternatives must provide a way to earn early and late time stamps." (4)

INTERVIEWS: METHODOLOGY

"Round I" of the interviews began with hour-long interviews of seven commute alternative takers, conducted November 15-16, 2002. Commuting details and attitudes were elicited, then a PRT-based commute alternative was proposed. Detailed reactions to morning, mid-day, and evening trip making were recorded. The first round emphasized commute problems with some exploration of new mobility solutions.

A professional consumer market researcher, Janis Hom, assisted the interview research, refining the interview guide, conducting four of the interviews, and providing training in interviewing technique. During her career, Hom conducted more than 300 such interviews and served as brand manager for six out of ten top-selling children’s education software titles.

The interviews explored the detailed context of journey to/from work and mid-day trips, similar to the in-depth "situational approach" or "individualized marketing" used by Werner Brog's TravelSmart. (20,21) Brog's work emphasizes de-generating individual auto trips, whereas PRT+D2D concentrates on reducing parking demand, where all work-related trips are considered as part of a related whole.

INTERVIEW SUBJECTS

For the Round I interviews, seven subjects had research-oriented jobs with a company given the simple alias "Research1." Respondents were selected by Research1's Human Resources Department. The main selection criteria was "a long commute via a commute alternative," thus subjects were selected based on Human Resources staff member's informal knowledge of various employee's commuting patterns. Participation was voluntary; subjects were given a short study description, including an explanation of PRT, so undertook the interview with some foreknowledge. The seven Round I subjects are named for their origination city and commute mode: "BerkBART," "DanPool", "SJpool", "PleasPool," "FreBus," "DubSOV," and "SFpool"

For the Round II interviews, the six subjects worked for a different research company, given alias "Research2." Research2's commute programs manager recruited employees based on the criteria of short, drive-alone commutes. Subjects are named "mtnSOV," "mtnSOV2", "mtnBike," "redSOV," "sunSOV," and "carlosSOV."

INTERVIEWS: COMMUTE ISSUES

The interviews provided a rich set of findings, supported with concrete details that assist in understanding. Many of the interview findings led directly to survey questions. As SJpool points out, commute alternatives entail a significant lifestyle choice, coupled with a high degree of patience.

Having **productive time** is more important for technology workers than the general population. Says DubSOV:

> *"Productive time is key. First let's define levels of productive time. a) I get paid to invent things, to solve problems. So my most productive time is thinking time, when I might jot some things down on a paper pad. b) next is high bandwidth e-mail time where I might be writing a long e-mail or working on a document, c) next is checking voice mail and e-mail without answering back. d) talking on the phone might be as productive as #b, but my cell connection is usually so noisy that it's hard to have a productive conversation. In my SOV commute, I do #c, so I don't actually have super productive time when I'm driving."*

BerkBART and DubSOV are willing to undergo a slower but more productive alternative compared to SOV. For some, this is a real trade-off. The repeated catchphrase that indicates productive time is "time goes fast."

Sleep (or just relaxing with eyes closed) counts as productive time for DanPool, DubSOV, PleasPool, and FrePool. Note that sleeping on transit like BART, where your stop is not the last on the line, has a slight stress component as people are anxious about sleeping through their stop. On express buses, the culture tends to be supportive to the point where people look out for each other. But PleasPool only feels safe sleeping in a carpool, not on the bus.

Transfers are problematic. Says BerkBART: "When I'm on the train or bus, I'm not aware of time passing. When I'm transferring, I'm very aware of time. It's a nonlinear time function for me. I hate to wait, just like everyone else. I'll optimize away from train to bus transfers." Transfer time is low productivity time. Says PleasPool, "The bus is not as flexible. A carpool waits 5 minutes for you, the bus won't. The bus introduces stress in making a connection."

Shuttle buses are problematic. The two bus shuttle feeders serving SRP represent two of the largest obstacles to reducing drive alone commutes. While raving about the friendly and accommodating bus drivers, respondents complain about time penalty, infrequent schedule, ride quality, exhaust fumes, and cost.

- **Time penalty**: MtnBike complains about the time it takes to travel the last mile from the Caltrain station. The wait for the shuttle is too long and then the trip is too long. Says CarlosSOV, "It takes as long to get from the Caltrain station to my office via Deer Creek Shuttle as it does to get from San Carlos to the Caltrain station."
- **Infrequent schedule**: CarlosSOV has only a few times a day when she can take a bus shuttle to Caltrain. Caltrain runs much more frequently than do the shuttles, which makes it hard for CarlosSOV to make the connection, especially when leaving early. Conversely, the always-available PRT shuttle is very enabling to her.
- **Ride quality & exhaust fumes**: CarlosSOV: "Deer Creek Shuttle is worse than Line 88 for both exhaust and for ride quality. The exhaust is really bad, I get dizzy. Deer Creek buses have worse suspension. Line 88 takes fewer turns because it is bigger."
- **Cost**: Given the low frequency and slow trip speed, CarlosSOV objects to paying the $1.40 one-way Line 88 cost.

At another major Bay Area suburban job center, Bishop Ranch, a lunchtime 15-passenger shuttle bus for transporting workers to the adjacent shopping center was halted due to poor ridership. In 1995, the shuttle carried only 420 passengers per month, requiring a subsidy of $10 per trip. In addition, Walnut Creek's Route 104 was also cited as a shuttle that was intended to bring office workers to downtown retail, but had failed. Lunchtime service was cut back to 40-minute headways. (22) Workers place a very high value on their lunchtime "free time," so waiting for a shuttle bus that then makes additional stops is not something that technology workers will abide.

The rare, truly **horrible commute experiences**, such as "4 hours to go 9 miles," live in the memories of commuters for the rest of their lives, coloring their attitudes. It is hard to overstate the damage such anomalous commutes cause.

> *I had a nightmare commute. I missed the Line 88 bus and it took forever to recover. I was attempting to leave early to make it home for my daughter's softball game, so it was very important to me to get home. I called the SamTrans (transit agency) 800 number and they were helpful. They suggested a bus for me to take. But, it went by on the neighboring street without my knowing it. The bus route map for that line shows two different routes that it takes, and I guessed wrong. I finally caught the next bus. I figured that Redwood City was a transit hub, so I got off there to make a bus connection home. But that stop actually had very few connections. The commute ended up taking from 2:30 to 6:30, and I missed the softball game. Knowing that I missed buses and made bad decisions just ate at me as the hours went by. I was angry, stressed, and frustrated. – CarlosSOV.*

Motion sickness was a concern for 4 out of 7 Round I people, with bus travel contributing to a far higher level than carpooling. Where reading is limited, productivity is reduced. Two mentioned pleasure reading as counting as productive time.

Stress is a major issue for DubSOV, BerkBART, PleasPool, and FreBus. Adding carpool members can reduce driving load, which two believe reduces stress. "I hate to drive. It is unnerving. I hate tailgaters," – BerkBART.

> *"Stop and go traffic is frustrating. I'd rather take a longer route for a smooth ride. A major benefit of HOV lanes for me is eliminating stop and go driving. The big thing is that reduced stress puts 'fewer miles on me.' Stress savings is the big thing. Driving alone was rough. I got to work and didn't feel ready to work. When I got home after my SOV commute, I was exhausted. I'll never drive by myself again." – PleasPool.*

Cost. DubSOV compares out of pocket expense and finds SOV is much cheaper than transit: $5 in SOV gas per day versus $15 for a BART/bus commute. In contrast, economists calculate a $32.90 SOV cost, at $0.35/mile fully depreciated cost over 94 miles. Alternately, three others find compelling carpool cost savings: "Carpooling means less wear and tear on my car," - DanPool. "I mostly carpool to reduce gas and toll charges." – SFpool.

Compatible carpool mates. Whereas carpooling ride matching may be more of a mixed bag across the Bay Area, interviewees repeatedly described a homogenous, professional group of people within the research park who were all superficially compatible. Thus SRP seems to have an advantage in forming carpools. - DanPool and SJpool.

SFpool, a female who carpools with co-workers, indicates **compatibility can be complex**:

> *"I don't know if I'd carpool with strangers. I'm looking for people who are close to my age, not irritating, live within 5 minutes of my house, provide parking at their house. Someone I feel comfortable with – not a CEO where I'd have to be 'on' first thing in the AM. I wouldn't feel comfortable alone with a strange male in the car. A capability to anonymously screen people with a photo and description could assist my selection. I'd seek out 20-something women."*

SJpool reinforces the **gender-based safety** issue, stating that males are OK alone with strangers where females are not. A stranger carpool of 2 men and 1 woman can still work. In contrast, PleasPool is quite willing to carpool with strangers and indicated that she would not search through personal information to select carpoolers, even if it was provided.

MtnSOV explained compatibility as follows, "If you provide a carpool member who is dependable, reliable, and compatible, then I'll carpool. The social aspect is important."

Relying on others and having others rely on them. Says BerkBART: "Regarding Vanpools. It is hard to meet at a certain time. I've heard that it is a hassle. You're hostage to the schedules of others." DubSOV had same issues, "I wouldn't want to be part of a group and have the group depend on me."

Fear of being **stranded at work** at night. The need for an emergency ride home is uniformly rare. Stranding came up only once in six years for one person. Research1's emergency ride home program is used only two or three times per month by all 1,000 Research1 employees (SJpool). Though it occurs rarely, the associated anxiety is real, large, and lurking in the subconscious. Being stranded is perceived as creating a slow, problematic commute home – there is a penalty associated with missing the normal commute. Where a "solid" alternative exists, anxiety is lessened.

A major challenge is serving **evening activities** in the origination cities. If, instead, activities are captured within SRP or if commuters can connect to their auto in their home city before starting their journey to their activity, then there is no problem. But, where the first evening destination is an activity that is a half-mile or more away from home, then commuting alone to work provides a car to access both the activity and home. Once the evening activity is over, tired commuters need to get home from the

activity as fast as by car, and "non-PRT" suburbs have no alternative to satisfy this need. RedSOV brought out this challenge for his scheduled large-group athletic activity.

Compounding RedSOV's evening activity problem, he requires **personal storage** of a large equipment duffle bag that cannot easily be transported via commute alternatives.

INTERVIEWS: MODE SHIFT

Round 2 respondents were currently commuting seven times out of 30 daily commutes per week using commute alternatives. When provided with a PRT+D2D based alternative, this small sample stated they would take commute alternatives 24 times out of 30 per week, a drive alone mode share decrease from 77 to 20 percent. For Round 2 respondents, PRT+D2D alternatives were slower than driving alone, but never by more than 100 percent. Respondents had explored transit alternatives in the past, but these were always more than 100 percent slower, sometimes 250 percent slower. Thus previous transit options without PRT were not competitive.

SURVEY: LOGISTICS

A two-year, ongoing relationship with one SRP company, the Electric Power Research Institute (EPRI), led to that company's participation in the survey. Obtaining commitment to undergo the survey's disruption required a series of meetings, leading to a presentation and subsequent agreement with their Chief Operating Officer. Ten other major SRP employers were contacted, but none could be convinced to participate.

Negotiations with cafeteria, facilities, information technology (IT), and human resources (HR) staff were required to ensure smooth survey operation. The cafeteria was instructed to process free $8 lunch printouts from respondents who had completed the entire 25 minute survey – the luncheon incentive motivated subjects to persevere through the detailed questions. To set up the PRT full scale model, facilities management required a structural analysis (concluding that the model could withstand 21 mph winds) and proof of a $1M commercial liability insurance policy.

A simple, automated process was established for IT staff to enable EPRI employees to schedule themselves for the survey in 15-minute time slots. A "shared, simultaneous" access spreadsheet was created and placed on a companywide network file server.

HR staff electronically publicized the survey, providing a live link to the scheduling spreadsheet. Response to the e-mail requests was rapid. For the 1,000-person job site, 30 employees signed up within 24 hours of the first e-mail, and the schedule was oversubscribed within 24 hours of the second e-mail, which introduced the free lunch offer. Employees self-selected in response to the e-mail request. Of the 66 respondents who undertook the educational program, 62 completed the web-based survey. 56 out of those 62 took advantage of the free lunch.

SURVEY PROTOCOL

The survey regimen exposed respondents to a variety mixed-media educational tools: the full scale model, virtual city animation, printed Powerpoint slides, interactive question and answer with experts, and a web-based survey with substantial educational content. The educational program traversed multiple sensory

paths into respondents' brains, attempting to increase comprehension. To reduce respondent fatigue, the protocol was broken up into separate steps, most having an element of fun.

The survey emphasized how technology benefited individual commuters; that is, commuters learned about the benefits in their specific context, rather than experiencing in-depth technological explanations. The educational program attempted to counter many commuters' experiences with bus and train transit, which leads to mis-perceptions about PRT. In essence, commuters are biased against commute alternatives because of their past experience with currently available alternatives. PRT was called a "rapid electric shuttle," a more benefit oriented and application specific description than "PRT."

The survey "assembly line" started at 6:45AM on the morning of April 30, 2003. The survey protocol went as follows:

Greeting

Approximately two employees arrived at the lawn by EPRI's Building Two within a five-minute window every 15 minutes. Two "educators" took turns greeting people and leading them through a ten-minute educational session. Both had more than two years of exposure to PRT and had assisted in the development of the survey. Both were gifted with strong interpersonal skills and presented a balanced portrayal of PRT, following a short script. The talents of these two were essential to the protocol's success.

Full Scale Model

The educators took respondents on a walking educational tour. The first stop was at the PRT full scale model, which had been set up on the lawn by Building Two. The model is a 33' long x 16' high x 3' wide lightweight, portable replica of elevated PRT guideway. (23) Respondents were led to walk under the guideway. Educators explained the system.

Demographic Information

From the full scale model display, respondents walked to the office space housing the 3D virtual city. On that walk, educators took down demographic information about each respondent, using a one page pre-survey instrument. Information collected included e-mail, home address (with last two address digits zeroed to protect privacy: 1487 Pitman becomes 1400 Pitman), commute distance, morning commute origination departure time, gender, and current commute mode split.

Animations and Benefits

A major sub-project of the full PRT+D2D study was the creation of a three-dimensional virtual reality (3DVR) replica of SRP buildings and streets combined with an accurate 300-vehicle PRT microsimulation – a PRT video game. The VR world was modeled in 3DS MAX and then exported to DirectX for real-time playback.

Once respondents arrive at the office space, educators show them the first PRT animation. This animation demonstrates some important PRT concepts such as three-person vehicle capacity, easy-to-use fare box interface, and intermediate station bypass. Next, educators interactively demonstrate the 3DVR SRP virtual city, taking a trip from one station to EPRI. Employees could easily recognize the EPRI

campus, with its distinctive architecture. The virtual city helped respondents place the electric shuttle system in a specific Palo Alto context. Next, educators took respondents through some printed PowerPoint slides. These reinforced electric shuttle benefits (high level of service: no waiting, faster than a car, reduced mid-day stranding), showed the PRT alignment serving the research park, and introduced the concept of the new mobility service. During this time, respondents asked free form questions. Before respondents left, educators negotiated with respondents to select the best commute alternative mode for comparison. The intent was to select the most time-competitive alternative, provided that commuters weren't strongly predisposed against it. This alternative was noted on the pre-survey instrument.

Commute Comparisons

Periodically, pre-survey instruments were collected for the creation of commute comparison scenarios. Each scenario compared driving alone versus the selected alternative, commuting from the home address to EPRI. Scenarios were formed using various web-based "driving directions" and trip planning services, as well as transit agency rider phone hotlines were contacted to form these scenarios. Scenarios were sometimes adjusted based on Year 2008 assumptions provided by Santa Clara County's Valley Transit Authority (VTA). Time and cost were calculated – discount monthly train passes were regularly assumed.

Once a custom commute comparison was complete, it was e-mailed to the respondent with a live link to the survey:

> *Greg,*
>
> *Your comparison scenario is:*
>
> *Home: 1400 Pitman St., San Carlos*
> *Commute Distance: 13.7 miles, leave: 7:30AM*
> *Drive alone commute time: 27 minutes*
>
> *ALTERNATIVE:*
>
> *1) 0.4 mile trip to Caltrain San Carlos. You can drive (and park), bike, or walk. Walking takes about 6 minutes, depending on your speed. Driving and parking would take about 2 minutes.*
> *2) Wait at the Caltrain station 2 minutes.*
> *3) 17 minute caltrain ride.*
> *4) Take electric shuttle to EPRI, 1 minute walk, 4 minute trip.*
> *total time, walking to caltrain: 32 minutes.*
> *Cost: $1.50 for roundtrip electric shuttle. Using caltrain $57 monthly pass, $2.30 per day rountrip.*
> *Total: $3.80 per day*
>
> *Please take the survey at http://www.cities21.org/epri.htm*

The pre-survey instrument data was hand-entered into a database for later "joining" with the web survey database.

Web-based Survey Taken at Desk

Within anywhere from 4 to 48 hours of the education program, respondents clicked on the live link to take the web-based survey. Upon completion, the last survey page was printed and brought to the

cafeteria for the free $8 lunch. Respondents generally spent 10 minutes on education (not counting access and egress) and 25 minutes on the survey. Including time spent setting up the full scale model, the survey team spent 40 minutes in support of each survey, a very labor intensive process.

SURVEY DESIGN

Survey questions attempted the complex task of educating commuters about the attitudinal problems they were likely to face. Questions often led off with paragraphs of educational content before the question was posed. Because of this, the 7,200 word survey takes longer than is desirable to complete - an artifact of presenting a fair portrayal of commuting challenges. Survey respondents were assumed to be college-educated, and the survey text is written at a high level. Respondents were treated as mature individuals and given full disclosure of psychological barriers to commute alternatives.

A second professional researcher, Jim Galanis, reviewed and commented on the survey instrument, and explained the gap analysis approach. Galanis is a Ph. D. Senior Market Researcher with 20 years of primary research experience, for target audiences anywhere from consumer WiFi users, to rapid transit users, to energy utility CEOs. Galanis found the survey to be unique to his experience, because of the lengthy questions and educational content present within the survey instrument.

The pre-survey education and survey questions attempted to "reassure away" objections about the Year 2008 assumptions, guiding respondents to focus on the impact of the product offering on their lives, not on whether the promises about the state of technology in Year 2008 would come true. For example, one respondent was concerned out power outages on the PRT system, "How do you get people down from the tracks if the power goes out." Our educator directed the respondent to assume that all of these sorts of issues would be handled satisfactorily.

Survey branching

The survey begins with 1) a review of some of the benefits of PRT + D2D, 2) requests an e-mail address for an eventual database “join” with the pre-survey instrument data, and 3) a query as to the respondent’s best commute alternative. The survey then presents the respondent with a set of questions tailored to their particular commute alternative. The relative complexity of carpooling attitudes requires more questions than the other modes. Biking/walking is next in complexity. The train and bus attitudinal issues are very similar.

A flow chart depicting the survey instrument flow is shown in Figure 2.

Once the alternative-specific questions have been asked, respondents return to issues that all commuters face, regardless of mode. Three common issues are addressed, then the respondent states the number of PRT rides they plan to take, and their planned new commute mode split assuming PRT + D2D is available.

Three questions per issue

Each commuting issue is presented as a series of three questions. The first presents the attitudinal problem and asks how important the problem is. The second frames a solution to the problem, and asks how effective the solution is in addressing the problem. The third question requests comments about the problem/solution.

The problem/solution question pair for each attitudinal issue allows for “gap analysis” (calculation explained in the section entitled "SURVEY RESULTS: CARPOOLING GAP ANALYSIS" below) to examine the importance of problems and the effectiveness of proposed solutions. Where an issue is judged an important problem with an ineffective solution, then there is a service gap that needs to be better filled. Gap analysis is a common analytical tool, pioneered by the Boston Consulting Group.

The Likert scale for numerical responses about importance and effectiveness was chosen to be 0 to 10, providing more nuanced response than a typical 1 to 5 scale.

Please see Table 1, the Survey Instrument, Questions 12-14 regarding carpool compatibility, for a representative sample of the three question sets.

Countering the Social Desirability Effect

The Social Desirability Effect causes survey respondents to overstate their adoption of beneficial technologies. However, in Question 1, the effect is addressed directly,

> *"For 80 percent of employees in Year 2003, commuting by driving alone is the best choice to meet their needs. In this survey, please provide us with your most thoughtful answers and opinions. There is a tendency to feel PRESSURE to embrace new things – we’d prefer that you take a skeptical view and point out flaws."*

The survey instrument is provided as Table 1.

SURVEY RESULTS: MODE SHIFT & RIDERSHIP

62 SRP employees completed the Year 2008 Scenario survey. The respondent group skewed towards driving alone, with 89 percent choosing this option (and 9.6 percent carpool), more auto-centric than typical for Bay Area suburban commuters. When presented with the Year 2008 hypothetical commute alternative scenario, only 45.6 percent chose to drive alone (32.1% carpool, 15.5% commuter rail, 4.2% bus, and 2.6% bike/walk). Survey respondents chose to take 1.32 PRT rides per day, both commute and lunchtime trips. The study is not scientifically rigorous, but may be sufficient to motivate risk-taking private sector investors to invest in PRT companies. Some investors value time-to-market over methodological rigor.

SURVEY RESULTS: CARPOOLING GAP ANALYSIS

There is no single unique method to measure gaps, but all methods produce similar conclusions. In this study, gaps are constructed as follows. From the set of respondents provided with the carpooling alternative, we select those that chose to carpool 60 percent or more of the time. Gap Importance is the percent of these "60%+" carpoolers who rate the importance of the problem above average (greater than 6). Gap Effectiveness is constructed by examining the resultant set of 60%+ carpoolers with importance greater than 6, and finding the percent of those where the solution is relatively effective. Relatively effective is where effectiveness is within two of importance, IE if importance is 8, then effectiveness must be 6 or greater. Results are shown in Figure 3.

The three most important problems (reliability, compatibility, and proximity) were well-solved. These solutions were validated as very important parts of the D2D service offering. The least important problem, "carpool chit-chat," was poorly solved.

SURVEY RESULTS: COMBINED GAP ANALYSIS

Whether they were presented with carpool, train, bus, or bike/walk as a commuter alternative, all respondents faced the same set of three problem/solution question pairs at the end of the survey. For commuters who stated their preference to take commute alternatives 60% or more of the time: stranding (79% very important) was well solved (67% effective) and trunk storage (moderately important – 45%) was moderately well solved (47% effective). Commute alternatives do NOT provide a viable solution (8% effective) to the important problem (63% very important) of complex end-of-day trip chaining.

SURVEY RESULTS: TRAIN TIME ADVANTAGE

Respondents who preferred train to driving alone were presented with commute comparison scenarios where the train alternative had a relatively small time disadvantage, typically 30 percent compared to driving alone, IE a 26 minute train+PRT commute was preferred to a 20 minute drive alone commute. Coincidentally, VTA's own travel demand model generates high transit ridership for a 30 percent disadvantage, with ridership falling precipitously from there. (24)

Respondents who had train as their best alternative but chose to drive alone had a similar distribution of train time disadvantage. When presented with this small time disadvantage, more people than not chose train over driving alone. In today’s commuting world without PRT, the train commute time disadvantage is larger and other attitudinal irritants are more pronounced, resulting in lower train mode share.

The 13 interview respondents indicated a greater stated willingness to incur a time penalty to avoid auto trips, generally varying from a 25 to 100 percent time penalty. Remarks CarlosSOV, "I love to read. I would trade a 30-minute auto commute with NPR on the radio for a 45 minute Caltrain reading session with a 15-minute connection any day." This represents a willingness to undergo a 100 percent time penalty.

Besides the influence of productive time and stress reduction, Shaheen believes that the choice of commute alternatives provides a healing and somewhat hidden psychic benefit, IE there is also a "willingness to be green."

FOLLOW-ON RESEARCH

This survey's surprising results formed the basis of a winning grant proposal for a follow-on study at a second office park. The new proposal includes the following research "team:" an office park general manager, four transit agencies, four non-profit organizations, two transportation consulting firms, and a large technology corporation that committed to 225 employee surveys. The proposal plan calls for a more scientifically defensible study featuring: a) larger sample size and improved respondent selection and b) "fresh" and independent analysis of the research methodology, instruments, protocol, and educational program.

OVERALL RESEARCH FINDINGS

- Creating a willing 25 percent (or greater) reduction in suburban office park autos is possible, but very difficult, requiring significant effort and innovation.
- **30 percent time penalty.** Provided a higher level of service is provided than is currently available, many people will be willing to undertake a slightly longer commute via an alternative in order to obtain increased productive time and reduced stress.
- By solving the critical last mile problem, PRT shuttle service is an **enabler** of commute alternatives, but not a **cure-all**. PRT by itself will not address enough of the myriad of individual commuter issues to attract significant ridership.
- The interviews reinforced the complexity of the challenge. Each commuter has a **unique basket** of attitudes/issues with differing levels of importance attached to each. There is no "one size fits all" solution. Solutions that work for some have no impact on others. Shaheen agrees that a **comprehensive** solution is required. "Comprehensive" entails providing a very broad array of service features for customers to pick and choose from.
- In alternatives, it takes a complex, multi-layered, technology-intensive solution to replicate the convenience, flexibility, and simplicity that is taken for granted when driving alone.

ACKNOWLEDGEMENTS

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REFERENCES

1. Rides.org 2001 Bay Area Commute Survey.
2. EPA's Best Workplaces for Commuters division has compiled a spreadsheet with 41 TDM case studies that can be found at: http://www.cities21.org/tdm.htm.
3. Steve Raney, *Suburban Silver Bullet: PRT Shuttle + Wireless Commute Assistant Using Cellular Location Tracking*, TRB '04. Accepted for publication Transportation Research Record. http://www.cities21.org/PRT_Wireless_TRB_111503_web.doc
4. Steve Raney. *Suburban Silver Bullet: PRT Shuttle + New Mobility Halves Solo Commutes*. Masters Thesis, U.C. Berkeley City Planning Department. August 2003. http://www.cities21.org/silver_bullet.htm.
5. Philip Kotler. Principles of Marketing, Tenth Edition. Chapters 4, 6, 10, and 15 (Market Environment, Consumer Behavior, Developing New Products, Communications Strategies).
6. Emily Parkany, Ryan Gallagher, Phillip Viveiros. *Are Attitudes Important In Travel Choices?* TRB 2004. www19.homepage.villanova.edu/emily.parkany/ATTITUDES03_10%5B1%5D.doc
7. Steve Raney, *Privacy-Protecting Commute Shed Study*, TRB '03, http://www.cities21.org/CommuteShed_TRB_111502.doc
8. Robert Cervero, The Transit Metropolis: A Global Inquiry. Island Press, 1998.
9. Fujii, S., & T. Garling. *Application of attitude theory for improved predictive accuracy of stated preference methods in travel demand analysis.* Transportation , Vol. 37, 2003, pp. 389-420.
10. Cambridge Systematics. *TransitWorks, An Innovative strategy developed by the San Diego MTDB for increasing the role public transportation plays in meeting our regions's mobility needs over the next 20 years*, http://www.sdcommute.com/MPs/TransitFirst/PDFs/FinalReport.pdf

11. Maren L. Outwater, Steve Castleberry, Yoram Shiftan, Moshe Ben-Akiva, Yu Shuang Zhou and Arun Kuppam. *Use of Structural Equation Model for an Attitudinal Market Segmentation Approach to Mode Choice and Ridership Forecasting*. TRB 2003
12. Ingmar Andreasson, *PRT - a Suitable Transport System for Urban Areas in Sweden? A thematic research programme,* performed during the years 1994-97. http://www.zeenergy.net/leantransit/kfbR98_38.pdf , Chalmers University of Technology, Gothenburg, Sweden.
13. Susan A. Shaheen, *Dynamics in behavioral adaptation to a transportation innovation : a case study of Carlink--a smart carsharing system*, 1999. U.C. Davis Ph.D. dissertation.
14. Bonnano, Sperling, and Kurani. *Consumer Demand for Automated Private Travel: Extrapolations from Vanpool User Experiences*. UCD-ITS-Research Report -93-22.
15. U.S. Census Bureau, *Census Use Study and the County of Los Angeles present Carpool, an approach to large-scale carpooling using DIME technology*. 1974.
16. Voorhees, *A Study of Techniques in to Increase Commuter Vehicle Occupancy on the Hollywood Freeway, Final Report*. 1974.
17. Attanucci, *Analysis of Carpooling Behavior and the Formulation of Carpool Incentive Programs*, 1974.
18. P.W. Bonsall, *Carpooling in the USA: A British Perspective*. 1979.
19. K. Wood, *Carpooling, Travel to Work at an Isolated Site.* 1979.
20. Werner Brog, *The Situational Approach – An Alternative Model Concept. Theoretical Foundations and Practical Applications.* 7th Australian Transport Research Forum, March 17, 1982. Hobart, Tasmania, Australia.
21. Bruce James, Werner Brog. *Increasing Walking Trips through TravelSmart Individualized Marketing*. World Transport Policy & Practise, Volume 7, Number 4, 2001. pages 61-66.
22. Robert Cervero, John Beutler. *Adaptive Transit: Enhancing Suburban Transit Services.*. UCTC Working Paper #424. University of California Transportation Center, Berkeley, CA 94720.
23. Cities21 Full Scale PRT Model. http://www.cities21.org/PRTmodel/UCTC.htm
24. Interview with Chris Augenstein, Santa Clara County Valley Transit Authority Senior Transportation Planner.
25. Urban, Hauser, Qualls, Bohlmann, Chicos. *Information Acceleration: Validation and Lessons from the Field*," Journal of Marketing Research, #34, 1997. pages 143-153.

LIST OF TABLES AND FIGURES

FIGURE 1: SIX-STEP RESEARCH PROCESS

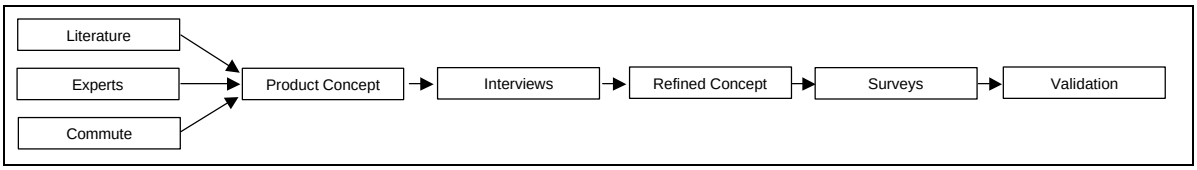

FIGURE 2: SURVEY DESIGN

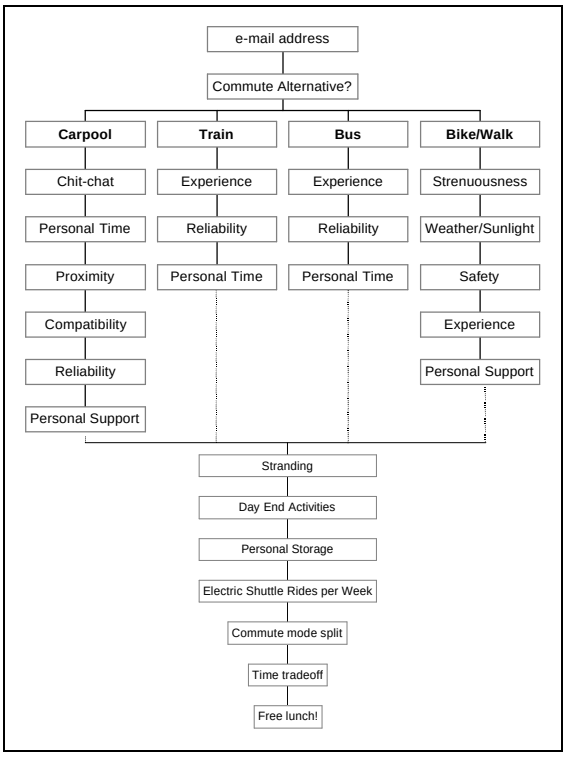

FIGURE 3: CARPOOL GAP ANALYSIS

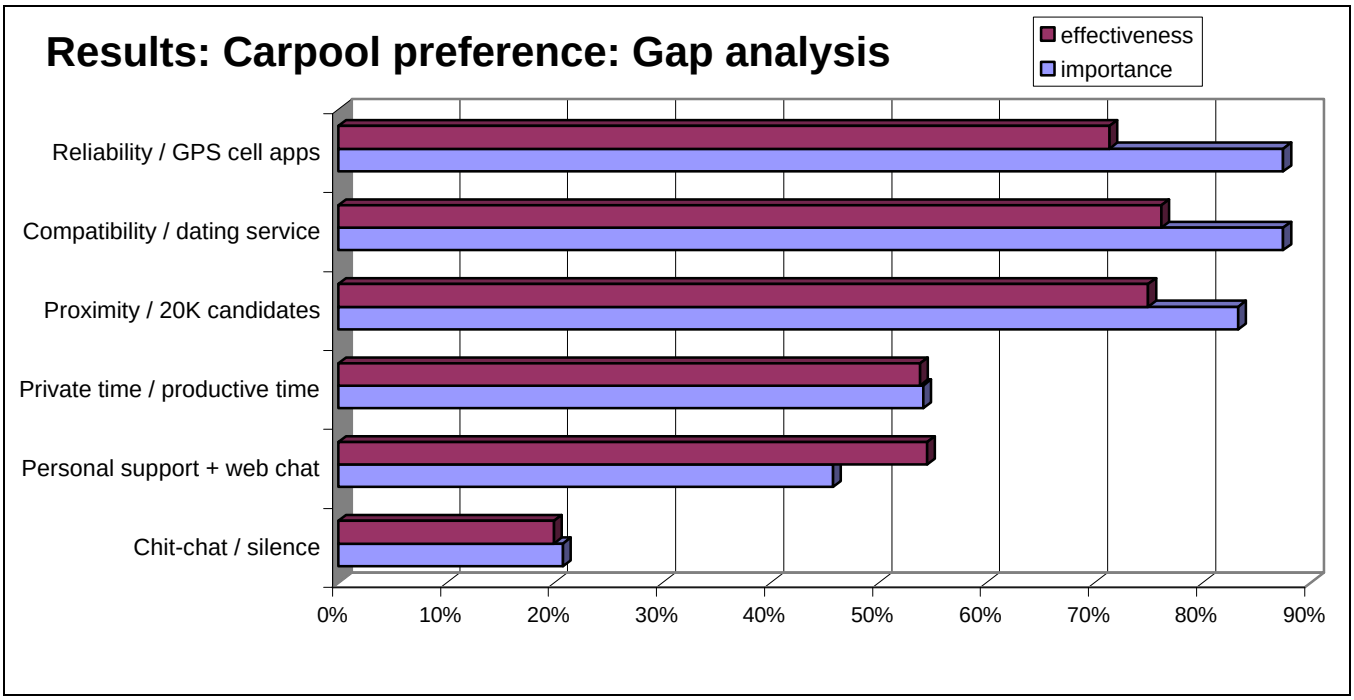

TABLE 1: WEB-BASED SURVEY INSTRUMENT

Title: SRP Electric Shuttle + D2D Survey

Questions marked with an asterisk ('*') are mandatory response.

PAGE 1: Introduction

Thank you for participating in our short educational program, featuring the 3D animation and full size monorail model (click for a picture).

Our survey should take 30 minutes or less to complete. Some alternatives are shorter than others. Print out the last page to receive your free lunch.

Below is the hypothetical scenario for you to keep in mind during the survey:

Our imaginary company is called D2D MOBILITY. We provide you with door-to-door mobility from home to work and back, and errands in-between! We are a partnership of concerned organizations working to make commute alternatives as convenient and flexible as driving alone. Partners include transit agencies; City of Palo Alto; Stanford; large local employers; and key service providers including a cellular phone service, local taxi company, car sharing service, a rental car firm, bicycle coalition, grocery service, RIDES ridesharing service, Waiters on Wheels, and PurpleTie.com (web based pickup/delivery of dry cleaning, photos, etc.).

The YEAR IS 2008, but you haven't aged! You still have the same job, live in the same place, and the people around you are the same. The economy has picked up, to the point where traffic is back to the peak level we saw in Year 2000. So traffic is worse than it is today, but we haven't hit complete gridlock. Gas prices are the same. The High Occupancy Vehicle lane network is the same, Caltrain and bus service are faster and more frequent. A few new bus routes have been added. If you didn't own a cell phone in 2003, you own one now, and have it nearby at all times. The cell phone works reliably everywhere, including building interiors.

A RAPID ELECTRIC, ELEVATED SHUTTLE services Stanford Research Park buildings, connecting with buses, Caltrain, bike/carpool parking, California Avenue stores, YMCA, banks, Fry's, and Stanford hiking trails. New California Avenue enterprises have sprung up to serve your errands and activities more ably (including day care). The shuttle system provides the fastest way to get around, faster than via car. The three-person vehicles are always waiting for you at convenient stations – there is no waiting. The vehicles travel non-stop to your destination, avoiding the auto traffic below. You either ride alone or with people you choose. Stations are located in the middle of corporate campuses, not down by the street. The vehicles are comfortable, quiet, smooth-riding, and exhaust-free. The system is safer than driving on the streets below and can robustly withstand large seismic events.

LET'S BEGIN THE SURVEY!

Please provide your e-mail address. This is the way we track your specific commute details. Our PRIVACY POLICY: we may send you up to three e-mail messages about the survey; for instance, to compliment you for a valuable survey comment or to provide a web link to the final demand analysis report. We will not give your e-mail address out to any third parties. We will not contact you about anything except the survey.

*** 1. PLEASE ENTER YOUR E-MAIL ADDRESS _____**

Over the last six months, we've conducted in-depth interviews about commuting with Stanford Research Park employees. From these interviews, we've developed some proposed solutions to commuting problems that were described. You may find that you'll know more about commuting after taking this survey.

For 80% of employees in Year 2003, commuting by driving alone is the best choice to meet their needs. In this survey, please provide us with your most thoughtful answers and opinions. There is a tendency to feel PRESSURE to embrace new things – we'd prefer that you take a skeptical view and point out flaws.

* 2. You have received an e-mail message comparing one of four commute alternatives to driving alone. (Whether you currently drive alone or use a commute alternative, please proceed with the survey.)

Which commute alternative was provided? **Carpool Train Bus Bike/walk**

<Survey jumps to the appropriate page>

PAGE 2: Carpool

* 3. CHIT-CHAT Problem: Unlike public transit, carpooling usually creates an expectation for chit-chat. For some, this means awkward silence or forced conversation. For others, it means forcing yourself to be cheerful when you're not a morning person. In considering carpooling, how important of a concern is addressing the chit-chat problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 4. CHIT-CHAT Solution: With D2D's ridematching service, you may specify a "quiet car" that is free from chit-chat, freeing you for activities like working, napping, or relaxing. The "quiet car" rule is used successfully in Bay Bridge "casual carpooling." How effective do you believe this solution will be in solving the chit-chat problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

5. OPTIONAL: Comments about the chit-chat problem/solution? **<free-form multi-line text entry>**

* 6. PERSONAL TIME Problem: When you drive alone, you can engage in a variety of private behaviors: sing off-key opera at the top of your voice, talk to yourself, make intimate cell phone calls, etc. When you carpool, you lose that freedom. For many people working in stressful jobs, the drive alone to work is where they "psych up" for the day. The drive home is where they "decompress" from their workday and transition to a different state of mind. Some have characterized this time as "the only time I have to myself." In considering carpooling, how important of a concern is addressing the personal time problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 7. PERSONAL TIME Solution: Being a carpool passenger can provide more productive use of time than driving alone. You can jot notes down on paper, close your eyes and practice relaxation breathing, take a nap to increase your energy level, etc. Many people find being a passenger reduces their stress. How effective do you believe this solution will be in solving the personal time problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

8. OPTIONAL: Comments about the personal time problem/solution? **<free-form multi-line text entry>**

* 9. PROXIMITY Problem: There are multiple arrangements of carpools and vanpools to choose from, depending on the number of people you share a ride with, and how complicated pick-up and drop-offs are.

Many short distance (less than 15 miles) carpools consist of housemates commuting to the same office location. Many long distance carpools (more than 15 miles) consist of people commuting to the same office location. Some of these long distance carpools feature three carpoolers who drive from 5 to 10 minutes in the morning to park at a shopping center, then get into a single car to carpool to work.

If you want to form a carpool/vanpool, it is often hard to find people who live nearby, work at the same office location (or at an adjacent office), and share compatible hours. Often, people are unwilling to carpool with workers from other companies within the research park, because this entails making drop-offs, stopping at extra stop lights, and even backtracking. There are 20,000 workers in Stanford Research Park, but people often limit their ridesharing search to the 500 to 2,000 employees who work at their office location.

In considering carpooling, how important of a concern is addressing the proximity problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 10. PROXIMITY Solution: For short distance carpools, D2D promotes the formation of two-person carpools comprised of acquaintances living within 10 blocks, working anywhere in the research park. With 20,000 employees to choose from, there are plenty of neighbors to choose from. Passengers are picked up at their residence. On the way to work, the car is parked in a convenient parking lot, and the two people may use the electric shuttle to travel to their offices.

For long distance carpools, the solution works in the same way – the electric shuttle provides 20,000 employees to rideshare with, probably shortening the morning pick-up distance.

We won't delve into other ridesharing scenarios in this section, but keep in mind their are other forms that may work for you, such as driving your toddler to a day care facility, and taking a vanpool with 5 other parents from there. In considering carpooling, how effective is this solution in addressing the proximity problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

11. OPTIONAL: Comments about the proximity problem/solution? **<free-form multi-line text entry>**

* 12. COMPATIBILITY Problem: There are many potential "social" problems with carpooling: driving habits, radio tastes, political views, social differences (gender, financial status, etc), smoking, heavy perfume, cramped/messy cars, cell phone use, temperature/window opening preferences. There have been carpools where members were "fired." In considering carpooling, how important of a concern is addressing the compatibility problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 13. COMPATIBILITY Solution: D2D will provide a sophisticated ridematching system, similar to dating services like match.com and datemeister.com. Each potential carpooler will provide: a picture; personal, job, and car descriptions; various preferences; and work start/end time. You will be able to anonymously screen and reject incompatible people, without causing hurt feelings. Your preferences will exclude very incompatible people from viewing your information; for instance, many women prefer not to carpool with men and would exclude men from accessing their information. If you'd like, D2D will subsidize a "get to know you" lunch between yourself and a potential carpooler to ensure compatibility. Your goal is to find a pleasant acquaintance, not a best friend. Stanford Research Park employees provide a large, well-educated pool of people to select from. D2D will provide commonsense "rules of carpool etiquette" about windows, smoking, cell phones, stopping for gas, and default radio station, that serve as a starting point for courteous interaction. Carpools join and break as people change jobs, work hours,

and after-work activities, so you might use the ridematch system once every 12 to 24 months. How effective do you believe this solution will be in solving the compatibility problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

14. OPTIONAL: Comments about the compatibility problem/solution? **<free-form multi-line text entry>**

* 15. RELIABILITY Problem: With a carpool, you have rely on someone to get to work and vice versa. Would you be concerned about getting a flat tire, causing someone else to be late for work? Carpoolers are typically reliable within a couple of minutes in the morning. For the ride home, more things come up that vary the schedule. You might find yourself torn between completing a last e-mail or packing up and leaving. You might consistently cause someone to wait a couple of minutes or vice versa. In considering carpooling, how important of a concern is addressing the reliability problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 16. RELIABILITY Solution: Year 2008 cell phones have a graphical display and can provide your precise current location to D2D. These features help D2D help you. D2D can automatically nudge people to make their carpool connection via automatic reminders and by checking location to make sure people have moved from their desk. The nudges will come silently to the cell phone as short text messages - they will be persistent, but not annoying. You will be able to monitor the progress of carpoolers. The uncertainty of whether to work on that last e-mail will be eliminated – you'll know if the other carpooler has left their desk. If one person will be 5 or 10 minutes late, they can touch a few buttons on their cell phone (or use the web) to reliably notify the other person, even if something comes up at the last second.

If you get a flat tire, touch a few buttons on the cell phone and easily notify bosses, order a tow truck, etc. D2D is your trusted backup, taking final responsibility to get people to/from work, including dispatching taxis or any of a number of creative solutions.

In addition, your company is a member of D2D and is culturally supportive of carpooling. Your company encourages carpoolers to leave at the same time every time, which may mean bringing work home at night. Your company might supply a laptop but have you pay for a broadband home internet connection. How effective do you believe this solution will be in solving the reliability problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

17. OPTIONAL: Comments about the reliability problem/solution? **<free-form multi-line text entry>**

* 18. PERSONAL SUPPORT Problem: Changing away from driving alone is hard. You'll face a number of problems, some of which may require considerable time and effort to solve. It is as if you have to become a "commute alternatives" expert. Some have described the switch away from driving alone as a lifestyle change. Some of the problems you may face might include: how do I make the carpool environment the most comfortable/productive for me? How do I resolve an interpersonal issue within the carpool? Is there someone I can talk to about their carpooling experiences before I make the leap? In considering carpooling, how important of a concern is addressing the personal support problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 19. PERSONAL SUPPORT Solution: D2D will organize volunteers in your city who are committed to providing the personal touch to encourage you. They will be selected for their listening and people skills. They will have some great tips for you from their experience and will personally ensure that your first week of carpooling is successful, checking up on your experience with phone calls. In addition, D2D will sponsor a web-based "commute community" where you can anonymously post questions and have employees help you. People who have invested the time to solve commute problems tend to be very happy to share their insight with others, in order to prevent others from exerting time and effort to research a solution. If you want advice on the best personal, portable audio device, this is the place. If you need to vent, this is the place. How effective do you believe this solution will be in solving the personal support problem? (0 = not at all effective, 10 = extremely effective) **0 1 2 3 4 5 6 7 8 9 10**

20. OPTIONAL: Comments about the personal support problem/solution? **<free-form multi-line text entry>**

<Survey jumps to Page 6: combined>

Page 3: Train

* 21. TRAIN EXPERIENCE Problem: Changing away from driving alone is hard. You'll face a number of problems, some of which may require considerable time and effort to solve. It is as if you have to become a "commute alternatives" expert. Some have described the switch away from driving alone as a lifestyle change.

Taking the train entails riding with strangers, which is uncomfortable for some folks. From previous research, we've found that folks rate the Caltrain experience high compared to BART and bus. Caltrain riders are more "considerate and upscale" than BART or bus riders. They are less likely to carry on a loud conversation, use audio headsets that "leak" out music, or convey a distracting odor. You should expect to experience a handful of unsettling train experiences every year.

You will not be expected to strike up a conversation with the person next to you, nor are you required to make eye contact with other train passengers – public transit does not create a social expectation.

Caltrain is significantly noisier than riding inside a car. The seats are comfy with a high backrest that facilitates reading. 2/3 of folks sit next to someone, and 1/3 have a private seat. You can assume you'll be able to find a seat and not have to stand. Driving to Caltrain and parking may be a hassle.

Your first few experiences with Caltrain may be stressful, as you struggle to get the hang of things. Once you do, taking Caltrain won't require much thought.

In considering the train, how important of a concern is addressing problems with the train experience? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 22. TRAIN EXPERIENCE - PERSONAL SUPPORT Solution: D2D will organize volunteers in your city who are committed to providing the personal touch to encourage you. They will be selected for their listening and people skills. They will have some great tips for you from their experience and will personally ensure that your first Caltrain week is successful, checking up on your experience with phone calls.

In addition, D2D will sponsor a web-based "commute community" where you can anonymously post questions and have employees help you. People who have invested the time to solve commute problems tend to be very happy to share their insight with others, in order to prevent others from exerting time and effort to research a solution. For example, if you want advice on the best personal, portable audio device, this is the place. If you need to vent, this is the place. How effective do you believe this solution will be in solving the chit-chat problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

23. OPTIONAL: Comments about the train experience problem / personal support solution?
<free-form multi-line text entry>

* 24. RELIABILITY Problem: With Caltrain, you have to rely on Caltrain's schedule. Trains are typically reliable within a couple of minutes. Every once in a while, there's an equipment problem that delays your commute. Scheduled transit also brings about the "cutting it too close" problem, where you leave for a the train too late or get delayed on-route, missing your train by seconds. When you get to the station, there's the added stress of not knowing when your train will arrive. In considering the train, how important of a concern is addressing the reliability problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 25. RELIABILITY Solution: In Year 2008, Caltrain provides frequent service, operating every 15 minutes during commute time, and every 20 minutes during mid-day and in the evening to 10:30PM.

Your D2D enabled cell phone smoothes away some problems via silent, short text messages. You are notified of train delays, often before you leave for the train. You can also configure your D2D phone to "nudge" you to leave for the train and/or to monitor the train's progress so that you'll know when you REALLY have to put down your morning paper and coffee and hustle out your front door. For your trip home, your D2D phone will calculate when you need to shut down your computer to hop on the electric shuttle to connect to Caltrain. These services are also available via the web. Year 2008 cell phones know your precise current location – this is communicated to D2D to assist your commute.

When there is a major train delay, D2D is your trusted backup, taking final responsibility to get people to/from work, including dispatching taxis or any of a number of creative solutions.

In addition, your company is a member of D2D and is culturally supportive of Caltrain commutes. Your company encourages you to leave work at a regular hour to catch the train, which may mean bringing work home at night. Your company might supply a laptop but have you pay for a broadband home internet connection. How effective do you believe this solution will be in solving the reliability problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

26. OPTIONAL: Comments about this reliability problem/solution? **<free-form multi-line text entry>**

* 27. PERSONAL TIME Problem: When you drive alone, you can undertake a variety of private behaviors: sing off-key opera at the top of your voice, talk to yourself, make intimate cell phone calls, etc. When you take Caltrain, you (hopefully) lose that freedom. For many people working in stressful jobs, the drive alone to work is where they "psych up" for the day. The drive home is where they "decompress" from their workday and transition to a different state of mind. Some have characterized this time as "the only time I have to myself." In considering the train, how important of a concern is addressing the personal time problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 28. PERSONAL TIME Solution: Being a Caltrain passenger can provide more productive use of time than driving alone. You can jot notes down on paper, close your eyes and practice relaxation breathing, take a nap to increase your energy level, etc. Many people find being a passenger reduces their stress. How effective do you believe the solution will be in solving the personal time problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

29. OPTIONAL: Comments about this personal time problem/solution? **<free-form multi-line text entry>**

<Survey jumps to Page 6: Combined>

Page 4: Bus

* 30. BUS EXPERIENCE Problem: Changing away from driving alone is hard. You'll face a number of problems, some of which may require considerable time and effort to solve. It is as if you have to become a "commute alternatives" expert. Some have described the switch away from driving alone as a lifestyle change.

Taking the bus entails riding with strangers, which is uncomfortable for some folks. From previous research, we've found that folks rate commute buses (like DB Express) and El Camino Real buses differently. Commute bus riders are more "considerate and professional" than El Camino bus riders. They are less likely to carry on a loud conversation, use audio headsets that "leak" out music, or convey a distracting odor. You should expect to experience a handful of unsettling El Camino bus experiences every year.

On the El Camino bus, there is no social expectation - you will not be expected to strike up a conversation with the person next to you, nor are you required to make eye contact with other bus passengers. However, because of regular ridership leading to social familiarity, some folks enjoy the option of playing cards or chatting on commute buses.

Commute bus seats are very comfortable. El Camino bus seats are less so.

Bus riders sometimes find that their ability to read is hindered by minor motion sickness brought on by the motion of the bus.

Your first few experiences with the bus may be stressful, as you struggle to get the hang of things. Once you do, taking the bus won't require much thought. In considering the bus, how important of a concern is addressing problems with the bus experience? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 31. BUS EXPERIENCE - PERSONAL SUPPORT Solution: D2D will organize volunteers in your city who are committed to providing the personal touch to encourage you. They will be selected for their listening and people skills. They will have some great tips for you from their experience and will personally ensure that your first bus week is successful, checking up on your experience with phone calls.

In addition, D2D will sponsor a web-based "commute community" where you can anonymously post questions and have employees help you. People who have invested the time to solve commute problems tend to be very happy to share their insight with others, in order to prevent others from exerting time and effort to research a solution. If you want advice on the best personal, portable audio device, this is the place. If you need to vent, this is the place. Interested in motion sickness remedies (wrist bands, acupressure, diet, ginger, peppermint oil, etc), this is the place. How effective do you believe this solution will be in solving the bus experience problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

32. OPTIONAL: Comments about the bus experience problem / personal support solution? **<free-form multi-line text entry>**

* 33. RELIABILITY Problem: Taking the bus, you have to rely on the bus's schedule. Buses are typically reliable within a couple of minutes. Every once in a while, there's an equipment problem that delays your commute. Scheduled transit also brings about the "cutting it too close" problem, where you leave for the bus too late or get delayed on-route, missing your bus by seconds. When you get to the bus stop, there's the added stress of not knowing when your bus will arrive. In considering the bus, how important of a concern is addressing reliability? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 34. RELIABILITY Solution: In Year 2008, El Camino buses operate frequently during commute hours and less frequent service during mid-day and to 11PM. However, commute buses operate on a restricted schedule - you only have two or three schedule choices, and they are not available if you work late.

Your D2D enabled cell phone smoothes away some problems via silent, short text messages. You are notified of bus delays, often before you leave for the bus. You can also configure your D2D phone to "nudge" you to leave for the bus and/or to monitor the bus's progress so that you'll know when you REALLY have to put down your morning paper and coffee and hustle out your front door. For your trip home, your D2D phone will calculate when you need to shut down your computer to hop on the electric shuttle to connect to the bus. These services are also available via the web. Year 2008 cell phones know your precise current location – this is communicated to D2D to assist your commute.

When there is a major bus delay, D2D is your trusted backup, taking final responsibility to get people to/from work, including dispatching taxis or any of a number of creative solutions.

In addition, your company is a member of D2D and is culturally supportive of bus commutes. Your company encourages you to leave work at a regular hour to catch the bus, which may mean bringing work home at night. Your company might supply a laptop but have you pay for a broadband home internet connection. How effective do you believe this solution will be in solving the reliability problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

35. OPTIONAL: Comments about the reliability problem/solution? **<free-form multi-line text entry>**

* 36. PERSONAL TIME Problem: When you drive alone, you can undertake a variety of private behaviors: sing off-key opera at the top of your voice, talk to yourself, make intimate cell phone calls, etc. When you take the bus, you (hopefully) lose that freedom. For many people working in stressful jobs, the drive alone to work is where they "psych up" for the day. The drive home is where they "decompress" from their workday and transition to a different state of mind. Some have characterized this time as "the only time I have to myself." In choosing the bus, how important of a concern is addressing the personal time problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 37. PERSONAL TIME Solution: Being a bus passenger can provide more productive use of time than driving alone. You can jot notes down on paper, close your eyes and practice relaxation breathing, take a nap to increase your energy level, etc. Many people find being a passenger reduces their stress. How effective do you believe this solution will be in solving the personal time problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

38. OPTIONAL: Comments about the personal time problem/solution? **<free-form multi-line text entry>**

<Survey jumps to Page 6: Combined>

Page 5. Bike/Walk

In year 2008, sufficient bike lockers will be provided for Palo Alto, Mountain View, Los Altos, and Menlo Park bikers, at convenient electric shuttle station locations for "bike -> electric shuttle -> office" commutes.

* 39. STRENUOUSNESS Problem: Some bike commuters prefer a shorter trip than the one they face from their home to their office. Some bike commuters feel that that hill Southwest of Hanover is too steep, and it would make them sweat, which they prefer not to do. Some explain that commute is about transportation and is separate from their workout, which is all about sweating. These same considerations apply to pedestrian commuters. In considering biking or walking, how important of a concern is addressing the strenuousness problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 40. STRENUOUSNESS Solution: Use bike to navigate thru residential streets and then use the electric shuttle to traverse the research park. This shortens bike commute distance and eliminates strenuous hill climbing within the research park. How effective do you believe this solution will be in solving the strenuousness problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

41. OPTIONAL: Comments about the strenuousness problem/solution? **<free-form multi-line text entry>**

* 42. WEATHER/SUNLIGHT Problem: In the past 50 years, Palo Alto averages 34 days with rainfall greater than 0.1" (a sprinkle) and 10 days with rainfall greater than 1/2" (a shower). Thus, biker commuters face a few days of rain every year. Likewise, sunrise and sunset do not always accommodate bikers who prefer to ride when the sun is out. November thru February is stingy with evening daylight; sunset falls between 4:55PM and 5:57PM. March and October are on the edge of darkness, depending on when workers leave the office; sunset occurs at about 6:21PM. October thru February fails bikers who desire sunlight before 7:00AM. Winter temperatures may be unpleasant for some bikers. Some summer temperatures may be too hot, depending on commute time. These same considerations apply to pedestrian commuters. In considering biking or walking, how important of a concern is addressing the weather/sunlight problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 43. WEATHER/SUNLIGHT Solution: There are a number of solutions: A) Drive to work on dark or rainy days, and bike ride on more pleasant days. B) Your employer is a member of D2D, so might support shorter winter work hours (possibly provided that you continue your work when you get home), C) Make the investment in rain gear and/or high-powered bike lighting. How effective do you believe this solution will be in solving the weather/sunlight problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

44. OPTIONAL: Comments about the rain/darkness problem/solution? **<free-form multi-line text entry>**

* 45. SAFETY Problem: Some potential bikers/walkers are discouraged by the noise and speed of cars on El Camino, on Page Mill, on Foothill, and in the rest of the research park. You should expect that sleepy drivers won't see you a few times per year - a defensive approach is recommended. In considering biking or walking, how important of a concern is addressing the safety problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 46. SAFETY Solution: Use bike to navigate through quiet residential streets and then use the electric shuttle to safely traverse the research park. How effective do you believe this solution will be in solving the safety problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

47. OPTIONAL: Comments about the safety problem/solution? **<free-form multi-line text entry>**

* 48. BIKE/WALK EXPERIENCE Problem: Changing away from driving alone is hard. You'll face a number of problems, some of which may require considerable time and effort to solve. It is as if you have to become a "commute alternatives" expert. Some have described the switch away from driving alone as a lifestyle change.

Biking and walking to work is rare, accounting for less than 1% of commutes to the research park.

Your first few experiences with biking or walking may be stressful, until you get the hang of things.

In considering biking or walking, how important of a concern is addressing problems with the biking/walking experience? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 49. BIKING/WALKING EXPERIENCE - PERSONAL SUPPORT Solution: D2D will organize volunteers in your city who are committed to providing the personal touch to encourage you. They will be selected for their listening and people skills. They will have some great tips for you from their experience and will personally ensure that your first bike/walk week is successful, checking up on your experience with phone calls.

In addition, D2D will sponsor a web-based "commute community" where you can anonymously post questions and have employees help you. People who have invested the time to solve commute problems tend to be very happy to share their insight with others, in order to prevent others from exerting time and effort to research a solution. If you want advice on the best rain gear, bike route (did we mention the area's extensive network of bike paths?), bike accessories, this is the place. If you need to vent, this is the place. How effective do you believe this solution will be in solving the biking/walking experience problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

50. OPTIONAL: Comments about the bike/walk experience problem and the personal support solution? **<free-form multi-line text entry>**

Page 6. Combined

Section 6 covers issues shared by all commute alternatives. The section ends with summarizing questions.

* 51. STRANDING Problem: Driving alone to work provides freedom to run errands at lunch, drive to a business meeting, make an emergency trip home, work late and then zoom home after a long day, and take a car ride somewhere on an impulse. On the days you take a commute alternative, you have much less of this freedom. In considering commute alternatives, how important of a concern is addressing stranding? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 52. STRANDING Solution: The electric shuttle eliminates some of this stranding, connecting you to California Avenue stores, YMCA, banks, Fry's, and Stanford hiking trails. New enterprises have sprung up on California Avenue to better serve your needs.

D2D provides inexpensive loaner cars, rented by the hour + mileage. You can reserve one on the web, take the elevated shuttle to a loaner car lot, and drive away - all in less than 5 minutes. For business meetings, your company will fund the loaner. You can rent anything from a gas/electric hybrid car to a luxury sedan (additional cost applies). If an important work project keeps you working late, you can drive a car home and bring it back the next day – when you work late, you aren't penalized with a convoluted trip home. You pay only for gas for these rides home.

Some convenient services bring items such as dry cleaning to your workplace, eliminating the need for some trips. Because your company is a member of D2D, the culture is supportive of commute alternatives. Co-workers will more readily drive you places.

How effective do you believe this solution will be in solving the stranding problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

53. OPTIONAL: Comments about the stranding problem/solution? **<free-form multi-line text entry>**

* 54. DAY END ACTIVITIES Problem: You have one or more activities you do after work. Can you carpool home, then go to your activities? You can change clothes at home and keep any gear for your activity in your car's trunk. If so, then the commute alternative doesn't present a day end problem. Or, is your activity located somewhere where you wouldn't first stop at home? Can you get a ride to your activity via commute alternative, but then will it be inconvenient to get home from the activity? Before-work activities may present the same sort of problem. In considering a commute alternative, how important of a concern is addressing this day end activity problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 55. DAY END ACTIVITIES Solution: There may be no solution for you. Driving alone could be your best option on your activity days. If this is the case, select a low effectiveness score below. If you can think up a solution in your context, select high effectiveness, and describe in the comments. Effectiveness of this solution? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

56. OPTIONAL: Comments about day end activities problem/solution? **<free-form multi-line text entry>**

* 57. PERSONAL STORAGE Problem: Is your car interior or trunk filled with personal items, gear for your activities, tools for your hobby, or an emergency kit for natural disasters? Is it a problem to be without these items? In considering a commute alternative, how important of a concern is addressing personal storage problem? (0 = not at all important, 10 = extremely important): **0 1 2 3 4 5 6 7 8 9 10**

* 58. PERSONAL STORAGE Solution: Carry these items around with you in a big duffle bag or store one set in your car and one set at work. How effective do you believe this solution will be in solving the personal storage problem? (0 = not at all effective, 10 = extremely effective): **0 1 2 3 4 5 6 7 8 9 10**

59. OPTIONAL: Comments about the personal storage problem/solution? **<free-form multi-line text entry>**

* 60. ELECTRIC SHUTTLE RIDES PER WEEK: How many electric shuttle trips will you take per week? Example: On Monday, you connect to/from Caltrain to work via electric shuttle: 2 trips. On Tuesday you drive alone to work, and take the electric shuttle to/from California Avenue for lunch: 2 more trips. Weekly total is 4 trips. _____ **<numerical field>**

61. OPTIONAL: Comments about # of E-Shuttle rides per week? **<free-form multi-line text entry>**

* 62. COMMUTE "MODE SPLIT": What percent of the time will you drive alone to work? Example: drive alone 4 out of 5 days per week and take an alternative 1 out of 5 days per week: 80%. If you work more or less than 5 days per week, please select other and do the math (you might want to show your work in the comment field below). If you bike or walk, but avoid rain or darkness, please adjust your mode split accordingly. (See question #42 for details about weather/sunlight.) **<pull down list: 0 % (0 out of 5 days), 20%, 40%, 60%, 80%, 100%, Other (please specify)>**

63. OPTIONAL: Comments about commute "mode split"? **<free-form multi-line text entry>**

64. OPTIONAL: Did we miss any major issues that need to be addressed to make your commute alternative more attractive? Any general comments you'd like to end with? **<free-form multi-line text entry>**

Page 7. Thanks!

Thanks from the electric shuttle demand analysis project team: The Electric Power Research Institute; U.C. Berkeley Transportation Planning Professors; Palo Alto design firms IDEO, Mindtribe, and Velocity 11; Palo Alto transportation non-profit Cities21 (part of the San Francisco Foundation); national transportation non-profit the Advanced Transit Association; geographic information systems experts GreenInfo Network; and the Anthony-Maymudes Foundation.

Please print out this page and bring it to the EPRI cafeteria for your FREE $8 LUNCH for completing the survey! To assist our bookkeeping, please print your name below (in pen) in front of cafeteria staff.

Free lunch offer expires May 7, 2003 - please use this right away!

Your name: _____