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SMART PARKING MANAGEMENT FIELD TEST:

A BAY AREA RAPID TRANSIT (BART) DISTRICT

PARKING DEMONSTRATION

Interim Working Paper

Task Order 5101

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ABSTRACT

Smart parking management technologies may provide a cost-effective tool to address near-term parking constraints at transit stations. Smart parking management systems have been implemented in numerous European, British, and Japanese cities to more efficiently use parking capacity at transit stations by providing real-time information via changeable message signs to motorists about available parking spaces in park-and-ride lots. This working paper describes the interim results of a smart parking field operational test, which operated at a San Francisco Bay Area Rapid Transit (BART) District station in Oakland, California from December 2004 to April 2006. This working paper includes a literature review on the travel effects of smart parking-related systems, a description of the smart parking field operational test, user analyses (focus groups and surveys), and preliminary cost estimates of the field test.

KEY WORDS: transit, parking management, and intelligent transportation systems

EXECUTIVE SUMMARY

Smart parking management technologies may provide a cost-effective tool to address near-term parking constraints at transit stations. Smart parking management systems have been implemented in numerous European, British, and Japanese cities to more efficiently use parking capacity at transit stations by providing real-time information via changeable message signs to motorists about available parking spaces in park-and-ride lots. This working paper describes the interim results of a smart parking field operational test, which operated at the Rockridge San Francisco Bay Area Rapid Transit (BART) District station in Oakland, California from December 2004 to April 2006. This working paper includes a literature review on the travel effects of smart parking-related systems, a description of the smart parking field operational test, user analyses (focus groups and surveys), and preliminary cost estimates of the field test.

The user analyses indicate that the project is attracting new (14 percent) and infrequent BART commuters (25 percent). While some participants may drive further (two miles on average) to access the Rockridge BART station, where the field test is based, the magnitude of this increase is unlikely to off-set total auto travel reductions (an average of 18 miles) due to shifts from auto to BART for commute trips. Thus, it appears that the smart parking project is removing cars from the road during peak periods and drivers onto transit.

An estimate is made of the expenditures required to install and operate a system of size and design similar to the smart parking field test over a year and a half (six months for set up and one operational year). This includes capital expenditures on hardware equipment, required labor expenses, monthly expenses of operating equipment, expenses for communication and data security, as well as estimates of delivery and installation costs. The total costs are estimated to be approximately $800,000.

INTRODUCTION

In suburban areas, quick convenient auto access to park-and-ride lots can be essential to making transit competitive with the auto. Most people will only walk about one quarter of a mile to transit stations or stops, and fixed route bus or shuttle feeder services can be expensive and less convenient than the auto. In the San Francisco Bay Area, peak hour parking at most of the 31 suburban Bay Area Rapid Transit (BART) District stations has recently been at or near capacity.

Smart parking management technologies may provide a cost-effective tool to address near-term parking constraints at BART transit stations. Smart parking can be defined broadly as the use of advanced technologies to help motorists locate, reserve, and pay for parking. Smart parking management systems have been implemented in numerous European, British, and Japanese cities to more efficiently use parking capacity at transit stations. These smart parking systems typically provide real-time information via changeable message signs (CMS) to motorists about the number of available parking spaces in park-and-ride lots, departure time of the next train, and downstream roadway traffic conditions (e.g., accidents and delays).

To evaluate the feasibility of the smart parking concept in a transit context, public and private partners jointly launched a smart parking field test at the Rockridge BART station in Oakland, California on December 8, 2004. In this paper, the results of focus groups and an initial survey of smart parking participants are evaluated to understand participant: (1) demographic attributes, (2) commute needs and constraints, and (3) commute travel behavior. Importantly, an analysis of participant travel behavior before joining the smart parking project provides insight into the potential magnitude of increased transit ridership and auto access to transit, and the overall change in auto travel among participants. This paper begins with a literature review on the travel effects of smart parking-related systems, next the smart parking field test is described, then initial results from the user focus groups and surveys are discussed, next preliminary cost estimates of the field test are documented, and finally some conclusions are drawn from the initial user evaluation.

LITERATURE REVIEW

There appears to be only one published (English language) study that systematically evaluates the effectiveness of smart parking systems with respect to increasing park-and-ride lot use. Khattak and Polak (*1*) evaluate a real-time parking information system in Nottingham, England in which "real-time information was disseminated through the radio, while historical information regarding parking lots was disseminated though newspaper advertisements and leaflets" (*1,* p. 373). The results indicate that "drivers were more inclined to use the relatively under-utilized park-and-ride facilities instead of the city center car parks, if they received parking information from newspaper advertisements and leaflets" (*1,* p. 373). This study illustrates the importance of pre-trip information with respect to parking choice and increased transit use.

Another study that suggests the potential significance of pre-trip traffic information with respect to mode change was conducted by Conquest *et al.* (*2*). In this study, on-road survey data were collected (3,893 motorists) and evaluated to examine the effect of traffic information on driver behavior. The study found that 23.4 percent of respondents would not change their

mode, route, or departure time, but 50 percent were receptive to pre-trip information and as a result might alter their mode, route, or departure time (*2*).

Opinion surveys of the Frottmaning, Germany and Toyota, Japan smart parking systems are generally described in the literature. Cervero (*3*) reports that German Ministry of the Interior surveys cited the highway park-and-ride displays (CMS) in the Frottmaning system as the main reason many motorists have shifted from driving to taking the train to work. A survey about the Toyota system indicated that after six months of operation: (1) 95 percent of respondents were aware of the signs; (2) 71 percent made use of the information; (3) 87 percent thought the system was helpful; and (4) 32 percent of those who used the system lived outside the city (*4*).

There is also limited evidence on the effect of parking capacity at transit stations on transit demand (*5*). One empirical study of parking-constrained commuter stations in the Chicago area (Metra) suggests that each additional parking space may generate between 0.6 to 2.2 additional transit users (*5*). The author notes "on the margin, new riders may use parking spaces a bit more intensively than the average (e.g., carpools may be more common), but it seems unlikely that an additional parking space could attract as many as two new riders" (*5*, p. 575). In a separate study, Ferguson reports that "a market research study undertaken by Metra in 1985 identified a lack of parking at surburban rail stations as the single largest factor contributing to the observed ridership losses" (*6*, p. 108). Moreover, a more recent survey conducted for a Metra smart parking management project indicates that parking availability affects transit ridership (*7*). The survey found that "although about 58 percent of all riders surveyed stated that they would simply park farther from the station if the parking lot nearest to the station was full, 18 percent of the riders stated that they would drive to their destination if their only choice was to travel to the next station downstream" (*7*, p. 2).

FIELD TEST

The smart parking field test at the Rockridge BART station involves two real-time user interfaces: two CMSs that display parking availability information to motorists on an adjacent commute corridor into downtown Oakland and San Francisco (Highway 24), and a centralized intelligent reservation system that permits commuters to check parking availability and reserve a space via telephone, cell phone, Internet, or personal digital assistant (PDA). The system integrates traffic count data from entrance and exit sensors at the BART station parking lot with an intelligent reservation system to provide accurate up-to-the-minute counts of parking availability. BART provided 50 spaces to be used in the smart parking field test, which were previously reserved by BART for use after 10:00 am only and are now available prior to 10:00 am. Initially, 15 of these spaces are available for advanced reservations, and the remainder (less a buffer of five spaces) is available for same day, en-route reservations. In addition, one user is allowed only three parking reservations during a two-week period. Those who use the system for en-route reservations call in their license plate number via cell phone when they park in the smart parking lot. The research team worked with BART enforcement personnel to ensure that those parking in the smart parking lot either have: (1) advanced reservation parking permits or (2) license plate numbers that match those provided to the enforcement personnel in real-time via PDA for en-route reservations. The smart parking service was free until October 2005 when BART implemented a service fee.

FIGURE 1 Images of smart parking field operational test.

An analysis of highway travel times was collected before and after the installation of the CMSs along Highway 24, which was specifically required by the California Department of Transportation permit authorizing their installation. This limited travel time data did indicate some somewhat longer travel times over the two time points; however, observational analyses over a six-month period did not indicate traffic slowing related to the CMS. Please see Appendix A for a detailed discussion of the method and findings employed in this analysis.

INTERIM FOCUS GROUP AND SURVEY RESULTS

In this section, the authors provide early findings from the smart parking field test, including focus group and survey results.

Focus Groups

To explore the initial travel effects, parking preferences, and system technology of the smart parking field test, two focus groups were conducted in May 2005 in Oakland, California. Participants involved in the Rockridge BART smart parking field test were asked about the effect of the program on their commute and level of satisfaction with system features and design. In total, 13 women and ten men participated in the two focus groups; 18 of the 23 participants commute regularly into downtown San Francisco. The focus group summaries are provided in Appendix B, and the focus group instruments are available in Appendix C.

Questionnaires were administered before the start of each focus group, and the results indicated that participants in these focus groups were most likely to have been between the ages of 24 and 59, with an average age of 43 years; live with a spouse and a child or children; have two commuters in their household; have a Bachelor's degree or a graduate/professional degree; use Internet and cellular phones regularly, with half also owning a PDA; and have a yearly household income of $175,000.

In the focus group discussions, participants commented on their travel and system preferences. Most participants used BART as their primary commute mode and had positive experiences with it; those who drove alone or took the bus were frustrated and did not like what they thought was a lack of reasonable commute alternatives. A majority of participants drove and parked at Rockridge BART as their primary access mode. Before smart parking, their concerns included uncertainty about finding a guaranteed spot, inconvenience at having to wake up early, and concerns about safety on side streets where they parked. Because of the smart parking field test, more people did take BART for their primary mode more frequently. However, several people drove further to park at the Rockridge station (and access the smart parking system), and one person changed her access mode from bus to car. Participants offered four main suggestions to improve the program include: (1) use a transponder or FasTrak™ device for payment; (2) expand smart parking to all BART stations; (3) change use restrictions;

and (4) convert existing monthly reserved paid parking (where many spots were observed to be empty) to smart parking.

Survey Results

The final evaluation of the smart parking field test at the Rockridge BART station will include "before" and "after" user surveys, focus groups, and in-person interviews. The analysis presented here is based on 285 "before" surveys completed by participants before the end of June 2005. Because this is a research project, all users are required to complete a questionnaire when they initially join the smart parking project to continue using the service. Analysis of survey results provides insight into the demographic attributes, commute travel needs and constraints, and commute travel patterns of participants.

Demographic Attributes

A number of demographic trends are suggested by the initial survey responses (see Table 1, below). More women than men have participated in the program (60 percent). The most common age range of respondents is between 41 and 60 years old (47.5 percent) and 24 to 40 (42.5 percent). Generally, participants are highly educated (51.2 percent have a graduate degree or higher) and have a relatively high income level (52.4 percent have a household income of more than $110,000 per year). Eighty-eight percent of respondents regularly use a cell phone; over 80 percent regularly use the Internet at work, and about 40 percent regularly use a PDA. The most common household type is comprised of one or two adults with a child or children (40.7 percent).

TABLE 1 Demographic attributes of survey respondents.

Gender (N=285)	**Percent**
Female	60.0
Male	40.0
Age (N=280)	**Percent**
0 – 23	5.3
24 – 40	42.5
41 – 60	47.5
61 – or older	4.7
Household Structure (N=285)	**Percent**
Self only	20.7
Self with spouse/partner only	32.6
Self with/out spouse/partner and child(ren)	40.7
Self with roommate(s) or other	6.0
Education (N=285)	**Percent**
Graduate/Professional	51.2
College	42.8
Grade, High, and Trade School	6.0
Job Type (N=285)	**Percent**
Professional/technical	57.2
Manager/administrator	22.8
Homemaker or other	20.0
Income (N=254)	**Percent**
Under $49,999	10.3
$50,000 - $79,999	18.5
$80,000 - $109,999	18.9
$110,000 or more	52.4
Technology Use (N=285)*	**Percent**
Mobile Phone	88.1
Internet at Work	81.4
Internet at Home	84.6
PDA	38.9

Income total sums to 100.1% rather than 100.0% because of rounding error.
*Technology use does not sum to 100%, as users were encouraged to indicate all methods used.

Commute Needs and Constraints

The survey results indicate that most respondents use the smart parking system and BART to commute from the East Bay to downtown San Francisco (83.7 percent). Congestion on freeways in this corridor is severe, and the cost of parking in downtown San Francisco is high. Seventy percent of respondents report that they pay for workplace parking at a modal monthly cost of $325, a daily cost of $12, and an hourly cost of $3. Moreover, some respondents spend a considerable amount of time searching for a parking space (i.e., 11 minutes or more according to ten percent of respondents) and then walking to their place of work (i.e., 11 minutes or more for eight percent of respondents). Approximately 40 percent report parking at their place of work on a regular monthly or weekly basis.

Almost 81 percent of respondents report that they work full time; 74 percent state that they work five days a week, 52 percent work 41 or more hours a week, and 29 percent work 31 to 40 hours a week. Among those who work five or more days a week, about 17 percent must commute from home directly to a different work location one or more days a week, and 25 percent do so one to two days a month, as indicated in Table 2 below.

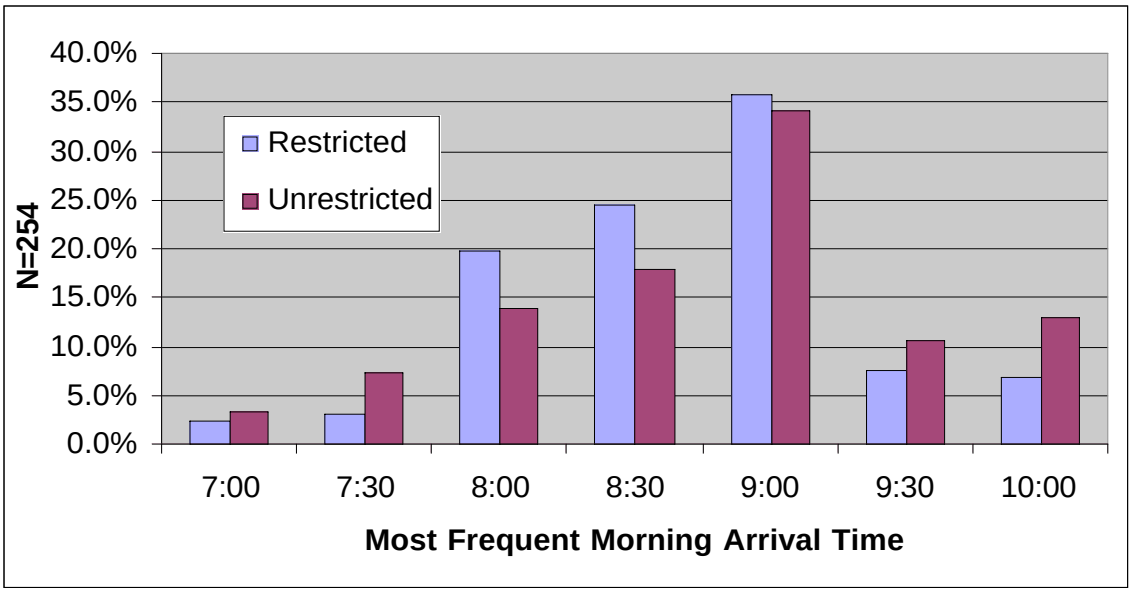
TABLE 2 Frequency of working five or more days a week and commuting from home to a different location (n=232).

Frequency	Percent Commuting from Home to Different Work Location
Less than 1 day per month	58.2%
1 - 2 days per month	24.9%
1 - 3 days per week	11.6%
4 - 5 days per week	4.7%
> 5 days per week	0.4%

Total sums to 99.8% rather than 100.0% because of rounding error.

Just over half of the respondents indicate that they may arrive at work on their own schedule, as depicted in Figure 2 below. Respondents are most likely to arrive at work between 7:30 and 9:00 am; however, those without requirements are somewhat more likely to arrive before 7:30 am and after 9:00 am than those with requirements. Respondents also indicate that they are slightly more likely to drive alone than take BART, if they arrive between 7:30 and 8:30 am in the morning.

FIGURE 2 Most frequent morning arrival times by respondents with restricted and unrestricted work schedules.



In-person interviews conducted on-site with participants at the Rockridge BART station suggest that one reason for the 9:00 am arrival time preference is that women and men with children under the age of 16 (28.8 percent of respondents) have to drop their children at school or daycare between 7:30 and 8:30 am, and thus smart parking provides them the option to take BART by making an advanced reservation. Previously, their only choice was to drive to work

because unpaid parking at the Rockridge station typically fills by 7:30 am. The drive-alone and carpool primary mode share for these families is higher than their BART mode share by 8.1 and 10.2 percentage points, respectively.

Commute Travel Patterns

It appears that the smart parking program is attracting new BART commuters; approximately 14 percent of respondents had not used BART to commute prior to joining the smart parking project. In addition, as indicated in Table 3 (below), a sizable number of current BART users could use BART more frequently for both primary and secondary commute travel (25 and 64 percent, respectively). New or more frequent BART commuters may increase their use of transit for non-work travel; a significant correlation among survey respondents was found between frequency of BART commute use and frequency of transit use for non-work travel (Chi-Square Likelihood Ratio at the 0.07 significance level).

TABLE 3 Primary and secondary long-haul commute mode by frequency.

Primary (N=266)	**BART**	**Drive Alone**	**Carpool**	**Bus**	**Total Frequency**
< 1 day per week	4.0%	13.2%	0%	0%	4.9%
1-2 days per week	10.6%	7.9%	0%	14.3%	9.4%
3-4 days per week	36.4%	34.2%	62.5%	57.1%	39.1%
≥ 5 days per week	49.0%	44.7%	37.5%	28.6%	46.6%
Total Mode Share	74.4%	14.3%	6.0%	2.6%	100.0%
Secondary (N=154)	**BART**	**Drive Alone**	**Carpool**	**Bus**	**Total Frequency**
< 1 day per month	7.3%	24.1%	23.8%	25.0%	17.0%
1-3 days per month	52.7%	39.7%	0%	33.3%	45.1%
1 day per week	25.5%	22.4%	19.0%	8.3%	19.6%
2 days per week	12.7%	6.9%	4.8%	16.7%	11.8%
≥ 3 days per week	1.8%	6.9%	13.7%	16.7%	6.5%
Total Mode Share	35.9%	37.9%	32.7%	7.8%	100.0%

Note that total mode share does not sum to 100% because some modes were omitted from this table.

Prior to joining smart parking, the largest primary long-haul commute mode share among respondents was for BART (74.4 percent), followed by drive-alone (14.3 percent), carpool (6.0 percent), and then bus (2.6 percent), as depicted in Table 3. For the secondary long-haul commute mode, drive-alone has the largest share (37.9 percent), followed by BART (35.9 percent), carpooling (32.7 percent), and then bus (7.8 percent). Secondary commute BART use is approximately half of the mode share of primary commute BART use. For primary commute travel, respondents use BART and drive-alone most commonly five or more days a week, and most use carpool and bus drive-alone three to four days a week. For secondary commute travel, most respondents use BART three days per week to one day per month, and those who use drive-alone, carpool, and bus do so most frequently three or less days a month.

The results presented in Table 3 also suggest that the secondary commute mode is associated with a higher drive-alone mode share. If the auto is used for secondary commute travel because it is needed to conduct personal business before or after work and this activity may be conducted with an auto parked at a home-end BART station, then it is possible that the smart parking service may allow some respondents to take BART instead of driving. Because the

drive alone mode is used relatively frequently for the secondary commute (38 percent use it one or more days per week), shifts to BART may produce noticeable reductions in auto travel. Table 2 (above) suggests that a sizeable number of these secondary commute auto trips may be used to commute directly from home to an alternate commute location; 41.6 percent of respondents do so with somewhat regular frequency.

Most project participants already drive and park or are dropped off at BART (86.9 percent); 12.9 percent report using carpool, bus, walk, bike, and other modes to access BART with some frequency as depicted in Table 4 below. The Rockridge BART station is downstream for approximately 23 percent of respondents' most frequently used station, and thus some of these respondents may be driving more to access parking at the Rockridge station. However, the difference between the mean distance from home for respondents, whose most frequently used home-end BART station is not the Rockridge station, is only two miles. Moreover, 14.3 percent of respondents drive-alone with regular frequency for their primary commute mode, and 37.9 percent for their secondary commute mode; the average vehicle miles traveled for both of these commutes is 18 miles as depicted in Table 5 below. These results suggest that while there may be some increase in auto access mode share and auto travel distance to the BART station among participants, the magnitude of this increase is not likely to completely off-set the total reduction in auto travel resulting from a shift to long-haul BART trips.

TABLE 4 BART access mode share by frequency.

Frequency (N=246)	**Drive & Park**	**Dropped Off**	**Carpool**	**Bus**	**Walk, Bike & Other**	**Total**
Only occasionally	6.3%	14.3%	25.0%	0%	0%	6.1%
1-3 days per month	14.5%	14.3%	0.0%	25.0%	4.2%	13.4%
1-3 days per week	19.3%	0.0%	25.0%	25.0%	29.2%	19.9%
4-5 days per week	55.1%	71.4%	50.0%	50.0%	62.5%	56.1%
> 5 days per week	4.8%	0.0%	0.0%	0.0%	4.2%	4.5%
Total	84.1%	2.8%	1.6%	1.6%	9.7%	100%

Total sums to 99.8% rather than 100.0% because of rounding error.

TABLE 5 Average minutes and miles for long-haul primary and secondary commute mode by frequency of use.

Frequency	Average	
Primary (N=266)	**Minutes**	**Miles**
< 1 day per week	31	26
1-2 days per week	32	19
3-4 days per week	32	18
≥ 5 days per week	33	16
Total (standard deviation)	32 (15)	18 (11)
Secondary (N=154)	**Minutes**	**Miles**
< 1 day per month	36	16
1-3 days per month	40	18
1 day per week	48	19
2 days per week	31	13
≥ 5 days per week	25	18
Total (standard deviation)	39 (18)	18 (9)

ESTIMATED CAPITAL, OPERATION, AND MAINTENANCE COSTS

This section describes estimates of the expenditures required to install and to operate the smart parking field test. These estimates are based on information obtained from consultations with a senior representative of ParkingCarma™ and equipment vendors. Because much of the equipment was donated, the discussion centers on the hypothetical expenses that would have been incurred had all equipment been purchased at market price. The importance of this assessment stems from the need to begin the evaluation of the cost effectiveness of such a system were it to be more widely implemented.

The Field Test Hardware

The three major hardware components of the information collection and relay system include: (1) groundhog sensors (six), (2) local base units (two), and (3) master base unit (one). Plastic barricades are also required to channel traffic over the sensors. In addition, a DSL line must be connected to the master base unit to send the information collected by the system to a central data center (through the Internet). The system then sends this information to two CMSs, which then receive messages from ParkingCarma™ about the number of parking spots left in the lot. For the first six months of the program, both CMSs were operational approximately 75 percent of the time, while only one was working 25 percent of the time due to a sign malfunction. The total capital cost for the equipment used in the field test is estimated to be approximately $70,000. The price of this hardware is regional and distributor specific, however, the variation is not large and thus approximate estimates are possible. The approximate capital costs for the field test hardware components are summarized in Table 6 below.

TABLE 6 Approximate capital costs for the field test hardware components.

Equipment	Quantity	Cost per unit
Ground Hog Sensors	6	$1,400
Local Base Units	2	$4000
Master Base Units	1	$4000
Changeable Message Signs	2	$19,000
DSL Line (installation)	1	$500
Total	For all units	$58,900

Source: Interview with a Nu-Metrics representative; Price list from Consolidated Traffic Controls, Inc., a Texas-based distributor of Nu-Metrics Products; Interview with Craig Theron, Product Manager at US Traffic Corp, a Quixote Company.

The component costs listed in Table 6 do not include the costs of delivering and installing the equipment. Thus, while the per unit costs sum to approximately $60,000, consultations with ParkingCarma™ suggest that the total costs for on site equipment is closer to $70,000 for all expenses related to hardware.

The Voice Recognition System

The software required to operate the voice recognition system was donated by Microsoft and the hardware was donated by Intel. The purchase of these materials would have amounted to about $20,000 in capital expenditures. In addition, there was significant cost in the customization of the software to the needs of the smart parking operation, about $125,000. The operation of the interactive voice response (IVR) system, which actually speaks to the users, carries a monthly expense of approximately $500 per month. The system currently used can handle 25 calls at one time. Table 7 summarizes the capital and operational expenses of the voice recognition system.

TABLE 7 Capital and operational expenses of the Voice Recognition System.

Equipment	Cost	Frequency
Voice Recognition System Hardware	$20,000	One time cost
Software Customization	$125,000	One time cost
Interactive Voice Response operations	$500	Per month

Source: Interview with senior representative of ParkingCarma™

System Communication Components

The smart parking system requires several system communication components. One important component is the website through which users make online reservations. This website costs about $1,000 per month to operate, which is higher than typical websites. Because of the sensitivity of data communications, extra expenses are incurred to ensure that the reservation system and general communications can not be hacked. In addition, a secure data center in San Jose is used to store system data. The location of the data is physically inaccessible and can

only be accessed with a specific password sent from a specific Internet protocol address. Communications to the variable message sign are sent from this data center. The cost of calling out of the data center to the changeable message sign is $0.40 per call, which typically yields a monthly expense of $150. In addition, calls are made to the CMSs during the morning commute hours to ensure that the correct number of spaces is displayed. This communication occurs over a cellular line and is a monthly fixed cost of $80 per sign. Finally, a DSL line at Rockridge costs approximately $100 per month. The total monthly costs of communication are summarized in Table 8 below.

TABLE 8 Monthly communication costs.

Category	Cost	Frequency
Website	$1000	Per month
Secure Communication	$150	Per month
Cellular Sign Connection	$80	Per month per sign
DSL line at Rockridge	$100	Per month

Source: Interview with senior representative of ParkingCarma™

Labor Costs

The current smart parking system requires three types of labor to operate including: executive, technical, and customer support. A senior executive with technical knowledge is required to manage the system and troubleshoot technical and managerial matters, which range from institutional and legal interactions to ensuring that communications to the message signs function properly. Such an executive would command a salary of about $125 per hour. In addition, customer support for user complaints and conflicts is required for three hours per weekday during the peak morning commute period when the smart parking service operates. These morning hours would eliminate the potential for many other full-time jobs and thus the hourly wage would most likely be higher than customer support labor for a full-time position. It is estimated that the salary for a customer support technician would be about $35 per hour. Finally, a supporting engineer is required to assist the executive on technical issues and also to maintain the online reservation system. This person would be full-time and be paid about $60 per hour. If the smart parking system expanded, more engineers, executives, and customer support technicians would be necessary.

For the period encompassed by the interim report, the field test had run for a year and a half, including six months for set up and about a year of operation. Full-time employees (the executive and technician) invested about 3,060 hours into set up and operations over this time period. The customer support technician is needed for three hours a day during the full operational phase. Hence, a total of 765 hours would be the expected time investment of that position. The following table summarizes the outlined positions, their salaries, the expected number of hours invested into the system over 1.5 years (assuming 255 days of work per year at 40 hours per week) and total cost.

TABLE 9 Labor costs for 1.5 years.

Position	Salary	Hours	Total Cost
Senior Executive	$125 per hour	3060	$382,500
Supporting Engineer	$60 per hour	3060	$183,600
Customer Support	$35 per hour	765	$26,775

Source: Interview with senior representative of ParkingCarma™

CONCLUSIONS

A number of key findings can be drawn from this analysis of the smart parking field test focus groups and surveys regarding participants' demographic attributes, commute needs, and constraints. The typical smart parking participant is a woman between the ages of 41 and 60, with one or more children and a high level of education, income, and technology use. Most participants need to commute from the East San Francisco Bay to the downtown where parking is scarce and costly. Many participants are also required to commute on a regular basis to an alternate work location directly from home. The typical work arrival time for participants is between 8:00 and 9:00 am; however, those who can arrive at work based on their own schedule are more likely than those who have fixed arrival times (before 7:30 am and after 9:00 am) to avoid peak traffic. It also appears that parents may be using the smart parking service because it allows them to meet their morning childcare schedules; this may suggest that parking pricing may be more equitable than free parking for this population segment due to constraints that make it impossible for them to pay for parking with time rather than money.

Some interesting insights into the potential travel effects of the smart parking project are garnered from the analysis of participant travel behavior before they began using the service. The project appears to be attracting new BART commuters; approximately 14 percent of respondents had not used BART to commute prior to joining the project. Moreover, at least 25 percent of those who commuted by BART could use it more frequently. New or more frequent BART commuters may increase their use of transit for non-work travel; a significant correlation was found between frequency of BART commute and transit use for non-work travel. Finally, the results also suggest that while there may be some increase in auto access mode and travel distance to the BART station among participants, the magnitude of this increase is not likely to off-set the reduction in total auto travel resulting from modal shifts from drive-alone to BART. Thus, it appears that the smart parking project is taking cars off the road during peak periods and moving passengers onto transit.

Finally, an estimate was made of the expenditures required to install and operate a system the size and design similar to the smart parking field test over a year and a half (six months for set up and one operational year). This includes capital expenditures for hardware equipment, required labor expenses, monthly expenses of operating the equipment, expenses for communication and data security, as well as estimates of delivery and installation costs. The total costs are estimated to be approximately $800,000.

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Appendix A: Changeable Message Signs and Highway Travel Times

Introduction

An analysis of the effect of the smart parking changeable message signs (CMSs) on highway travel times was undertaken to comply with the following requirement in the California Department of Transportation permit authorizing their installation:

> Permittee to collect travel time data between the westbound Route 24, Acalanes on-ramp, and the westbound Route 24, Telegraph off-ramp at 6:30, 7:00, 7:30, 8:00, 9:00, and 9:30 am on Tuesday, Wednesday, and Thursday two weeks prior to implementation of project.
>
> Permittee to collect travel time data between the westbound Route 24, Acalanes on-ramp, and the westbound Route 24, Telegraph off-ramp at 6:30, 7:00, 7:30, 8:00, 9:00, and 9:30 am on Tuesday, Wednesday, and Thursday within the month following the implementation of the project.

In this appendix, the methodology and results of the data collection effort are presented.

Methodology

The CMSs used in the smart parking field test are called Vu Pointe CMSs and are a product of National Signal, Inc., a division of the Quixote Corporation. The sign panel, where the message is displayed, is about six feet tall and 9.5 feet wide. The sign is solar powered and is mounted onto a trailer with an orange metal frame. The Vu Pointe CMSs are typically used for roadside message displays during construction operations.

The CMSs were situated along the westbound corridor of Highway 24. One was placed right before the Fish Ranch Road exit, which is about a third of a mile from the eastern entrance of the Caldecott Tunnel. After the tunnel, there was another sign placed at the southbound exit of Route 13. This sign was located about three quarters of a mile before the College exit, which is where drivers diverting to the Rockridge BART station exit the highway.

The data were collected in a manner consistent with the language of the permit with the exception of the timing of the data collection (i.e., exactly two weeks before the start of the project and one month after) because of unexpected project delays and problems with the data collection in December 2004. On November 2, 4, and 4, 2004, and on April 5, 6, and 7, 2005, researchers entered Highway 24 going westbound at the Acalanes on-ramp. (Note these data were also collected in July 2004, and then the project was postponed, so the before data are from November 2004.) Researchers began data collection trips at the precise times stated in the permit. They then recorded the times at which they passed three checkpoints (the two CMS locations and the Telegraph exit) to the nearest minute. These checkpoints were:

- The Fish Ranch Road exit (east of the Caldecott tunnel),
- The College exit (west of the Caldecott tunnel, but east of Rockridge BART), and
- The Telegraph exit (west of Rockridge BART).

The researchers exited the highway at the Telegraph off-ramp and looped back to begin another trial at the next 30-minute time slot. This data collection method offered three observable data points for each time interval, both before and after the sign was activated. The units of the data consisted of the time difference (in minutes) it took for the researchers to travel from the start of the test corridor to each of the three check points. These check points were chosen for their nearness to relevant points of interest in the project. The Fish Ranch Road exit is the approximate location of the first sign. The College exit is a little after the second sign and is where drivers need to exit the highway to access the BART station. The Telegraph exit is the first westbound exit after the station.

Analysis of the data consisted of comparing average travel times to each checkpoint both before and after the sign was activated. These averages are supposed to show whether there were any major differences in travel times during the three days in which the study was conducted and whether such differences were consistent with the location of the sign or with the specific hours in which the sign was activated. The sign is activated from 7:30 to 9:40 am.

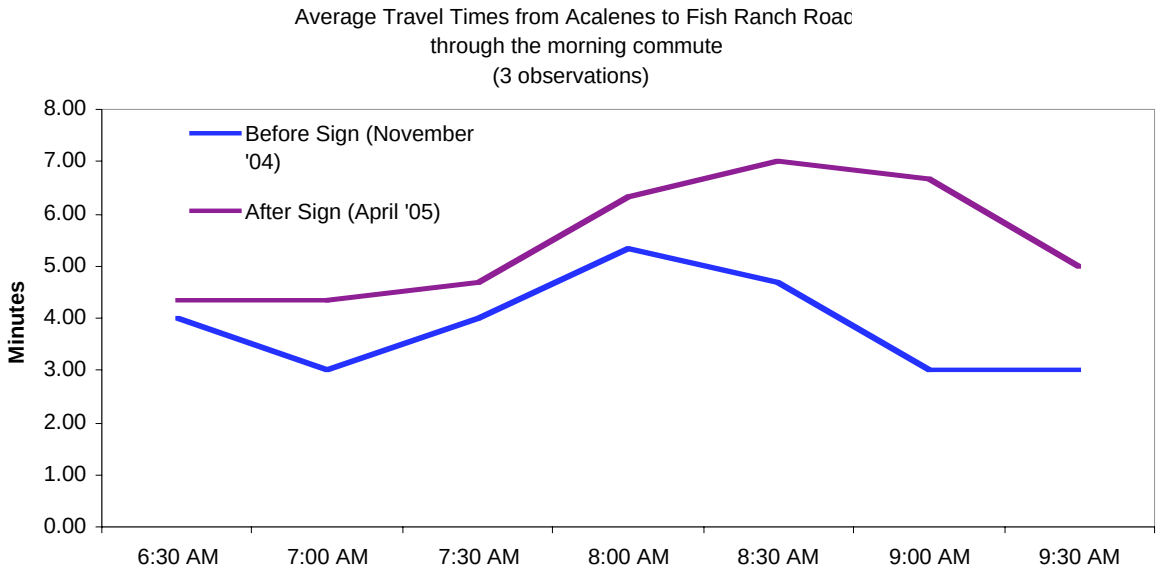
Results and Discussion

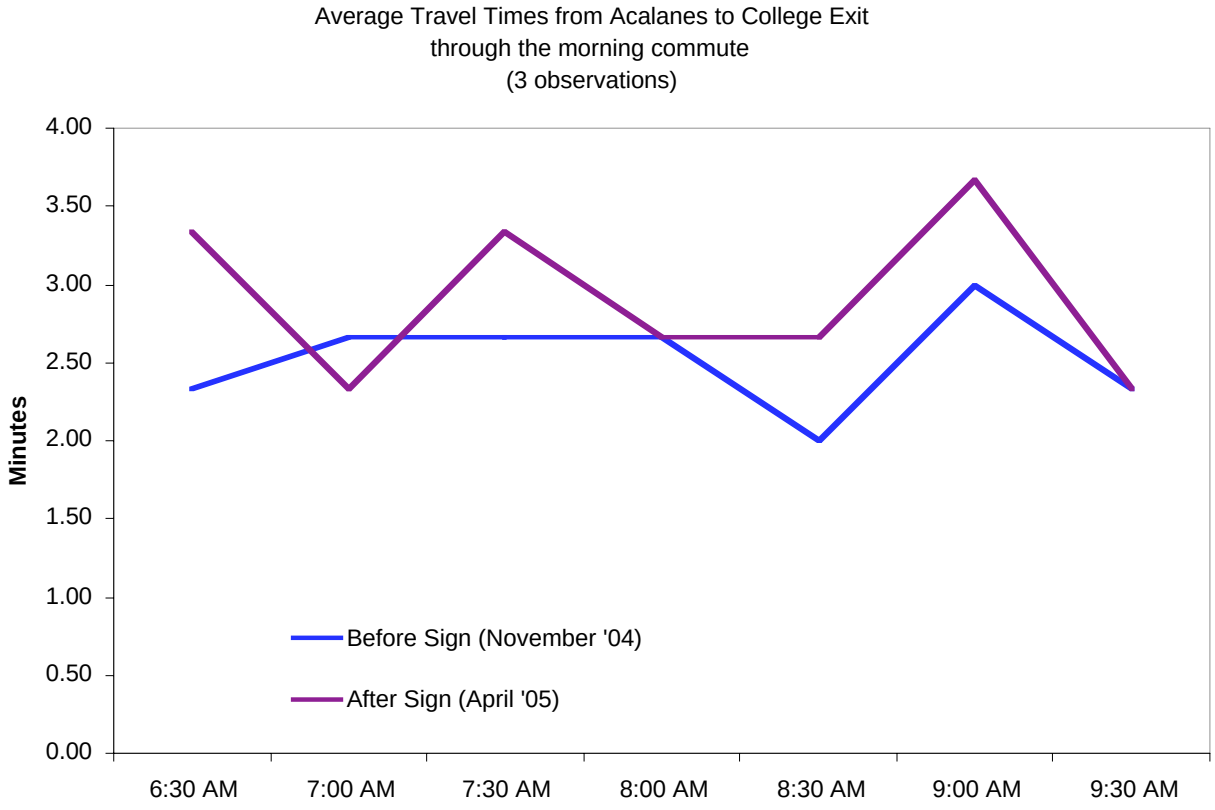
Data analysis shows some difference in the average travel time to the check points during the two trials. This difference is generally consistent across the entire morning. The table below provides a summary of the data collected at each checkpoint throughout the entire time range for both trials. The averages are reported for the trial before the sign's implementation as well as after its placement and activation. Additional data include the high and low values of time traveled to each checkpoint for both trials.

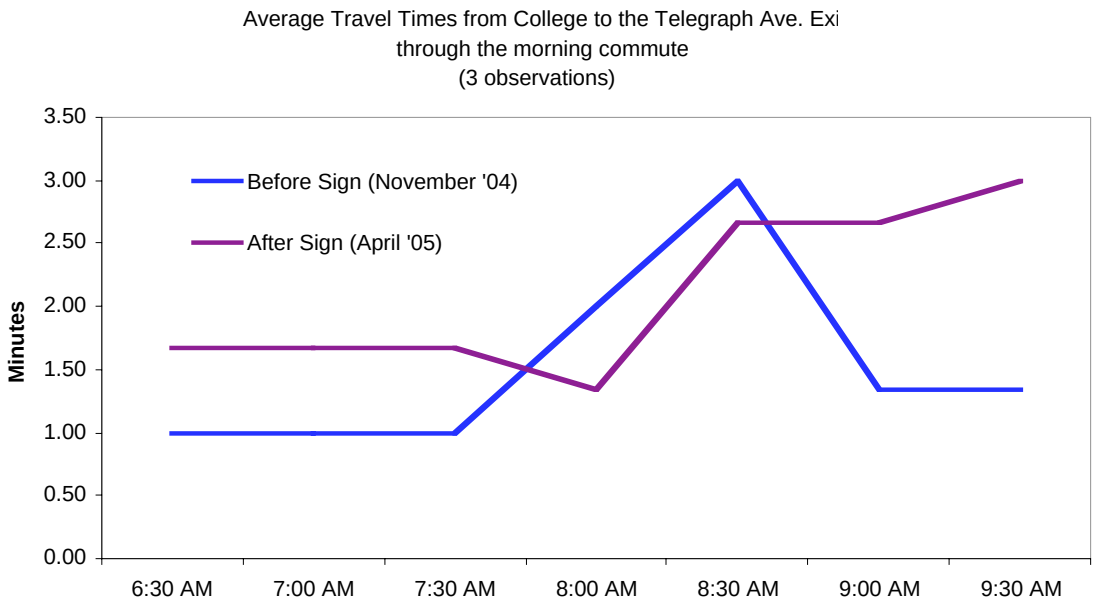
Data Summary of Each Checkpoint

Fish Ranch Road Exit	Averages		Before		After	
	Before	After	Lows	Highs	Lows	Highs
6:30 AM	4.00	4.33	3	5	4	5
7:00 AM	3.00	4.33	2	4	4	5
7:30 AM	4.00	4.67	2	5	3	6
8:00 AM	5.33	6.33	5	6	6	7
8:30 AM	4.67	7.00	4	5	6	9
9:00 AM	3.00	6.67	2	4	5	9
9:30 AM	3.00	5.00	3	3	4	6
College Exit	Averages		Before		After	
	Before	After	Lows	Highs	Lows	Highs
6:30 AM	2.33	3.33	2	3	3	4
7:00 AM	2.67	2.33	2	3	2	3
7:30 AM	2.67	3.33	2	3	2	5
8:00 AM	2.67	2.67	2	3	2	3
8:30 AM	2.00	2.67	2	2	2	3
9:00 AM	3.00	3.67	2	4	3	4
9:30 AM	2.33	2.33	2	3	2	3
Telegraph Exit (end of off ramp)	Averages		Before		After	
	Before	After	Lows	Highs	Lows	Highs
6:30 AM	1.00	1.67	1	1	1	3
7:00 AM	1.00	1.67	1	1	1	2
7:30 AM	1.00	1.67	1	1	1	2
8:00 AM	2.00	1.33	1	3	1	2
8:30 AM	3.00	2.67	3	3	2	3
9:00 AM	1.33	2.67	1	2	1	4
9:30 AM	1.33	3.00	1	2	1	5

The following graphs plot the average travel times across all hours of the experiment at each checkpoint.







The plots show that the travel times for this experiment after the sign was activated are generally higher than the travel times of the sign before the activation. However, this relationship is not consistent across checkpoints and is also not always consistent across the entire commute period. At the first checkpoint, the average travel time for the trial after the sign activation is slower throughout the entire commute. This includes the hours of 6:30 and 7:00 am, when the sign is not activated.

The other checkpoints present a less definitive relationship between trial periods and hours across the commute. At the College Exit, the trial with the greatest average travel time varies across the morning hours, and the difference between the two average travel times never differs by more than one minute. At the Telegraph exit, a similar result is found. During the trial, the difference between the two average travel times is never more than one minute, with exception of the last half hour of the test period.

The fluctuation in travel time dominance over the course of the morning and across checkpoints suggests that the CMS exhibits no significant effect on the speed of traffic in the test corridor. The data from the Fish Ranch Road checkpoint also show that other factors may have influenced the travel times between the two trials as the post-CMS activation trial is higher even when the sign is not turned on. The Fish Ranch Road checkpoint is also positioned in a location where conclusions about specific causes of slow downs are especially difficult to make. The Caldecott Tunnel, which is only a quarter mile downstream from this exit, is a major bottleneck on Highway 24 going in both directions. If on any given day, queuing from this bottleneck spills back past the checkpoint, then it would slow the researchers' advance towards the checkpoint. This slowed advance could very well be due to excess traffic flow exceeding the capacity of the tunnel, which sends queues back at least a quarter of a mile. When researchers encountered such queues, their advance to Fish Ranch Road was slowed, not as a result of the sign, but as a result of a high traffic volume trying to squeeze though the tunnel. Any slowing as caused by the sign would merely slow a vehicle's advance to an eventual halt in a traffic jam. Thus, a day with a higher level of traffic would easily cause exaggerated delays on the eastern side of the tunnel as a result of long queue formation.

Limitations of Methodology

To interpret the results of the data collection effort, it is important to understand the limitations of the methodology employed. One limitation is the difficulty of controlling for factors other than the CMSs that might influence traffic speed or the speed of the researcher's vehicle. Such factors may include, for example, weather (it rained on one collection day in April), different driver behavior (the driver in the November test was different from the driver in the April test), and general fluctuations in traffic can also occur at different times of the year, for instance, due to seasonal fluctuations in gas prices.

Another limitation of this study is measurement error. Travel times were recorded to the precision of the nearest minute, which means that there was some approximation as to whether minutes were rounded up or rounded down. As a result, any given measurement could have been as much as 30 seconds off from the actual time and any given travel time between two points could be off by as much as a minute due simply to rounding (i.e., if one checkpoint rounds down and the next one rounds up).

Caltrans is currently considering a research project that would provide a complete evaluation of the effects of CMSs on driver behaviors. Such a study would address any concerns about the traffic effects resulting from the use of CMSs for smart parking purposes.

Conclusion

The checkpoint travel time data did show that there was some slow down of traffic on the days and locations on which the data were collected. However, since factors other than the CMSs could not be controlled for, there is no evidence that the CMSs caused the documented slow down. Moreover, with the exception of the Fish Ranch Road checkpoint, differences between the two trials generally did not exceed a minute, which is well within the range of measurement errors due to rounding. More research is necessary to adequately understand the traffic effects of CMSs.

APPENDIX B: FOCUS GROUP SUMMARIES

FOCUS GROUP ONE

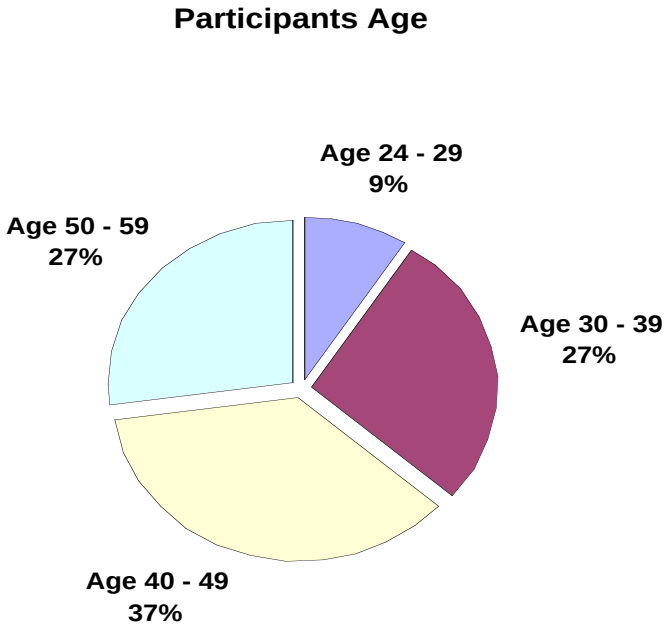
May 18, 2005
Montclair Recreational Facility, Oakland

Participants in the smart parking field test located at the Rockridge Bay Area Rapid Transit (BART) District station shared their experiences in a focus group conducted on May 18, 2005, at the Montclair Recreational Facility in Oakland, California. The participants in the focus group were recruited from a list of over 200 participants in the smart parking field test. This focus group included participants who tended to use BART less frequently (relative to the second focus group). Rachel Finson, of California PATH, facilitated the focus group with researchers assisting and taking notes. Below follows is a summary of the findings from the focus group.

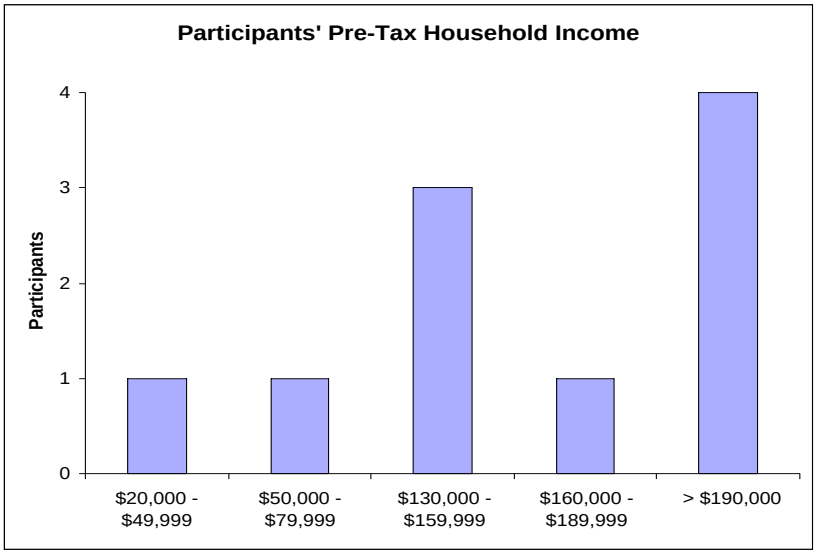
BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey to participants that explored their socio-demographic attributes, travel patterns, travel constraints, and parking options. The following were the socio-demographic attributes of the 11 focus group participants:

- Six were women, and five were men.
- One lived alone, five lived with a spouse/partner, and five lived with a spouse/partner and a child or children.
- Four had one commuter in the household, and seven had two commuters.
- One had one person in the household driving a motor vehicle, and ten had two people driving a motor vehicle in the household.
- Two had completed up to a high school education, four had completed college, and five had completed a graduate/professional degree.
- Nine were employed full-time, and two worked part-time.
- Five described their occupation as a manager/administrator, and six as professional/technical.
- Out of a choice of four technologies, six participants used all four (Internet at work, Internet at home, a cellular phone, and a PDA within the last week); three used three technologies (Internet at work, Internet at home, and a cellular phone), and one used only the Internet at home and at work within the last week.
- One was between the ages of 24 and 29; three were between the ages of 30 and 39; four were between the ages of 40 and 49; and three were between the ages of 50 and 59.



- One had two household members aged 18 and under, and four had one household member aged 18 and under.
- One reported a 2004 pre-tax household income in the $20,000 to $49,999 range; one was in the $50,000 to $79,999 range; three were in the $130,000 to $159,999 range; one was in the $160,000 to $189,999 range; and four reported more than $190,000.



In total, participants reported four different combinations of origin and destination location pairs for their commute travel:

- Eight commuted from Oakland to San Francisco,

- One from Berkeley to Oakland,
- One from Berkeley to San Francisco, and
- One from Oakland to San Mateo.

Participants' responses to questions about parking options at the workplace and BART indicated that:

- Within the last year, four participants parked at work less than one day a month; three between one and three days a month; two between one and three days a week; and two participants drove and parked near work four to five days a week.

How Often Do You Park at Work?	
Frequency	**Participants**
Less than 1 day a month	4
1-3 days a month	3
1-3 days a week	2
4-5 days a week	2

- Of those that drove and parked near work at some time in the last year, three participants had access to free parking provided by their employer, two had free parking not provided by their employer, and five used paid parking not provided by their employer.
- Those participants who drove and parked at work paid the following to park near their workplace:
  - $2 per hour
  - $15 per day
  - $5-9 per day
  - $21 per day
  - $15 per day
  - $35 per month.
- Ten people periodically chose BART's daily free parking when taking BART and one person did not.
- Only one out of the 11 participants had used BART's monthly reserved paid parking program.

LEARNING ABOUT SMART PARKING

Participants learned about the smart parking program at Rockridge BART in a variety of ways. See table below.

How Did You Know About Smart Parking?	
Method	**Participants**
Household Member	1
Called BART	1
ParkingCarma representative	1
Internet	2
Flyers and Signs Near BART	6

One person had been on a waiting list for a monthly reserved space for quite a while. Another had been talking with friends about developing a parking system program at the Rockridge BART station because he felt there was a latent demand, and then realized that the smart parking field test was already launched and ready to use. Overall, the information about the smart parking field test was conveyed most commonly to participants through flyers, signs, and the Internet.

INTRODUCTIONS AND USING SMART PARKING

Out of 11 focus group participants, two regularly commuted to work; one worked only one day a week; another worked at home, but still traveled frequently to meet customers and clients; one traveled into the city primarily for shopping trips; and two participants traveled to off-site work locations. Eight participants reported regular use of BART, two primarily drove alone to their work destination(s), and one rode the trans-bay bus. To access their home-end BART station, participants tended to drive, bike, or walk.

COMMUTE MODES

The primary commute mode of participants before and after smart parking with corresponding travel times and distance (including access to and egress from the primary mode) are provided below.

Primary Commute Mode Before Smart Parking			
	Participants	**Average Minutes**	**Average Miles**
Drive by myself	2	38	21
Bus	1	30	15
BART	8	23	12

Primary Commute Mode After Smart Parking			
	Participants	**Average Minutes**	**Average Miles**
Drive by myself	1	35	22
Bus	1	30	15
BART	9	28	13

BART

In general, participants had positive experiences commuting by BART. Eight of the 11 participants used BART as their primary commute mode before the smart parking field test began with an average travel time of 23 minutes and distance of 12 miles. After joining, nine used BART as their primary commute mode with an average (door to door) travel time of 28 minutes and distance of 13 miles.

Driving Alone

One of the 11 participants shifted from the driving alone to work to BART after the introduction of smart parking. Two used BART as their primary commute mode before the smart parking field test began with an average travel time of 37 minutes and distance of 21 miles. After joining, nine used BART as their primary commute mode with an average (door to door) travel time of 35 minutes and distance of 22 miles.

Most participants did have some experience driving from home to work, but most did not find it to be pleasant. One participant drove to work as their primary commute mode, one drove into the city on her frequent shopping runs, and three drove to work from one to two days a week to a couple times a month. One person complained that there was a dearth of FastTrak lanes on the bridge: “when I am in Chicago or New York, more than 50 percent of the lanes are “FastTrak only,” but it seems that here, only two out of 10 are equipped for “FastTrak only” travel. Another mentioned that parking was hard to find and very expensive in downtown San Francisco.

Bus

One of the 11 participants traveled to work regularly by trans-bay bus. He expressed frustration about limited commute options and bus service that ends too early in the morning and too early in the evening. Another person mentioned that he formerly took the Montclair 59 bus, which had been cancelled.

Carpooling

Two of the 11 participants occasionally carpooled to work but were not fully satisfied with this option. One suggested that the carpool lane should start earlier in "the maze" on 580. Another person commented that there was no carpool benefit on the return trip home.

Access to Primary Commute Mode

The participant who switched from driving alone to work, before smart parking, to BART, after the smart parking project started, drove alone to the station. One switched from walking to the station to carpooling for reasons unrelated to the field test.

Primary BART Access Mode		
Mode	**Before**	**After**
Drive myself and park at or near the station	4	5
Dropped off by someone	1	1
Walk	2	1
Bicycle	2	2
Carpool	0	1

Two participants stated that they arrived at BART about three to four times a week by bicycle. One of these two participants stated that she disliked biking in the rain. When it rained, she chose to take the bus. Smart parking actually prompted her to try driving a few times to the BART station, but she has realized that it is not much better than the bus.

BEFORE SMART PARKING

In general, participants expressed dissatisfaction about parking near the Rockridge BART and other BART stations, especially before the smart parking field test, citing issues related to uncertainty, inconvenience, and lack of safety.

Uncertainty

Lack of certainty surrounding station parking was high on the list of participant concerns; six participants voted it the part of their commute they disliked the most. For example, one stated: "You don't know how early you have to leave in order to catch the BART." Another person felt that BART was inconsistent in its decision to allocate parking at their stations. She felt frustrated that at the Rockridge station parking lot demand always exceeded capacity, and paid five to six dollars to park in the West Oakland station instead.

Inconvenience

A few participants stated that finding parking was a big inconvenience in their lives. One person did not like that he had to get up early to get a space because the Rockridge BART parking lot normally fills up at around 7:15 am. Another person did not like the distance she had to walk when the lot was full. She had to park about one mile away to find available street parking. A third mentioned that even when there were spaces remaining during busy days, the only ones left were the "bird spaces."

Lack of Safety

Safety was also a big concern for participants in this focus group. They did not appreciate walking in the dark, walking for long periods in the rain, or walking on broken glass in more dangerous neighborhoods for street parking surrounding the BART station. One person had concern for the safety of his vehicle; he had witnessed cars being broken into regularly, either by homeless people in the area, or rowdy high school students under the overpass. A second person agreed and noted that some other stations were even worse than Rockridge: "There was a stabbing at Macarthur station, and West Oakland is sketchy." She stated that she did not feel safe parking further down the BART line and that the Rockridge station was the only safe, local option.

IMPRESSIONS AFTER JOINING SMART PARKING

After the smart parking field test was implemented, many participants who used the smart parking lot facilities regularly had much higher confidence in their ability to secure a spot in a safe, convenient location. Three people stated that they took BART more frequently than they previously did, and nearly everyone had positive comments about lower stress levels and better quality of life.

Taking BART More

Because he knows there will be a guaranteed spot, one person said he takes BART more. Another person added that safe, dry, and close parking that is not on the street helps encourage her to ride BART more frequently.

Lower Stress and Better Quality of Life

Everyone agreed that their stress levels have "gone way down" since the launch of the smart parking field test. Two people were happy about the more flexible schedule it offered them, and two loved that they did not have to circle around the parking lot looking for parking, and one stated that "Before, I used to circle for ten minutes to find parking…'the how much time do you have to struggle before giving up' factor has been eliminated in my life." Another person loved that he could bring a laptop and avoid having to drag it through a torrential downpour to get from the street parking to the BART station. One woman found it very freeing: "I was able to sleep in past 7:15 am during the day after Cinco de Mayo by using smart parking!"

SYSTEM FEATURES

Changeable Message Signs on Highway 24

Eight of the 11 participants had seen the changeable message signs (CMSs) on Highway 24, and one person used the signs regularly to make a decision about whether to use smart parking. There were two primary complaints about the CMSs. The first complaint was that the CMS swere not on participants' travel paths and thus not on their decision-making radar. One person stated that "the signs are targeted toward Walnut Creek commuters who have already struggled through the tunnel; the signs would be better placed on Highway 12 to serve Oakland commuters." Another mentioned he would have to drive far out of his way to see the CMSs. Another suggested that signs should be placed on the College exit and one near the College Avenue exit. Several other participants agreed with this placement strategy. The second complaint was that participants were confused about what information the signs were trying to convey. Three participants thought that the message made no sense and felt that only users of the program really had any idea of what it meant. One person thought that people would generally be risk averse: "If you see 12 spots left on the sign, people don't believe that they will still be there upon arrival." Two people suggested putting a banner on the bridge and having more overall publicity about the program, akin to the marketing strategy of 511.org; this would bolster the understanding of the CMSs. One person was perfectly happy about the lack of clarity in the CMSs, preferring that less people know about the program so he could "keep it all to myself!"

Signs to the Smart Parking Lot at BART

There was an overall sense of confusion and initial frustration with the signage leading toward the BART smart parking lot. Nearly everyone mentioned that it was very confusing the first time. People could find the general lot at BART, but they did not know which area was designated for smart parking. A few people felt the signs on the road outside of BART were satisfactory, but the signage in the lot itself was very confusing. One person described her first experience: "It was all uncertain. I saw yellow lines and thought it might be a sensor, so I tried it out. However, there was no one around to ask, and so I felt like I was taking a big risk."

Advanced Reservation System

In this focus group, six participants used only the advanced reservation, and five participants had also tried the same day call-in reservation system. Most people felt the advanced reservation system was extremely useful. Pointing to the success of the system, several people felt that the maximum limit for advanced reservation capped at three times every two weeks was very restrictive (which was a constraint placed specifically for the smart parking field test); many people wanted to use smart parking even more frequently. Two people even admitted to "overusing the system beyond its limits and restrictions." Two people liked that the advanced reservation allowed them to plan ahead and thus added an element of predictability into their travel patterns. Another said it helped to mitigate his typical "scrambling to catch BART where parking is the last thing you want to think about." People preferred the online system, although participants used both reservations by Internet and phone. One person was frustrated that after purchasing a new car, he could not change the primary car listing, which was awkward to update on the reservation system.

Reservation by Internet

There were mixed reviews about the website reservation process. One person really enjoyed having the print-out and history function, but another thought it was annoying and would have preferred a reminder on his PDA. Two people stressed that they disliked the website and thought it was not user-friendly: "Every time I visit the site, I have to re-teach myself and seem to have to re-register again." One felt that the distinction between spots kept for call-in reservations and advanced reservations was unclear. A few mentioned that the website was not intuitive to first-time users, but it was very useful once they were used to it.

Reservation by Phone

The phone system was a source frustration for many participants, in particular, the voice recognition system and the registration process. One person felt that "Kate," the voice recognition system, was "the worst I ever dealt with; I received two parking tickets because she doesn't repeat back to you or acknowledge what you say. I wanted to reserve spot 76 and she said 96." Another tried to make an advanced call-in reservation but failed, and thus resorted to the same day call-in reservation, which he found much easier.

Same Day Call-in Reservation

At least five participants used the call-in reservation service and found it to be a good feature of smart parking. Many participants noted areas that could be improved. One person did not like the fact that same day call-in reservations effectively required a cell phone because the pay phone at BART is quite far from the smart parking lot. Another found it frustrating that the call-in system required a license plate number while the website required a registration number; it seemed that the identification codes for both systems were not well coordinated and thus made effective use of both systems difficult.

System Abusers

Many participants complained about people who use the smart parking lots without being BART users. Participants observed that there were people who worked down the street at coffee shops, shoppers who come back late in the day, and carpoolers using the smart parking spots. These non-BART users were obviously abusing the system, and without parking validation, it would continue.

SMART PARKING LIKES AND DISLIKES

Participants were asked to discuss and rank their smart parking likes and dislikes. Participants mentioned a number of smart parking likes, for example: (1) the general concept, (2) encouraged people to use BART, (3) the quality of the lot (i.e., conveniently located, covered, safe, well lit, and dry); and (3) the individual registration ID that made for an easy reservation process (although, it was suggested people should choose their own ID code in the future). The five highest ranking of smart parking likes are listed below.

What People Like Most About Smart Parking	
	Number of Participants
Smart Parking is currently free of charge	4
Same-day reservations	3
Advanced reservations	1
General concept	2
Reduced air pollution and traffic	1

Many participants, however, also said that the smart parking system could use improvement and most of these participants wanted less restrictive limitations on smart parking use. In addition, participants did not like (1) the yellow barriers at the entrance of the smart parking lot and (2) the confined parking lot space which makes it difficult to maneuver. The five highest ranking of smart parking dislikes are listed below.

What People Dislike Most About Smart Parking	
	Number of Participants
Restricted use	4
The reservations time ends at 10 am	2
The lot is not big enough	1
Smart Parking is limited to Rockridge BART	1
System is not more automated	1
System requires one to have a cell phone	1

MOST ESSENTIAL FEATURES FOR PARKING

Participants were also asked to rank what features they thought were most essential in parking. The answers were diverse and covered issues, such as ease of use, safety and security, and guaranteed spots. Quality and accuracy of information was also very important. One person felt that extra benefits in a parking system could include having a car washed and more attendant-based parking. Another felt that parking should be a system-wide service, where people could find out where the closest parking garage or lot is in a city or region by calling just one centralized phone number; this would help to take circling drivers off the street and decrease air pollution in certain crowded areas. The ranking for most essential features is summarized below:

Most Essential Parking Features	
	Number of Participants
Guarantee enough space	5
Safety	1
Proximity	2
Easy to Use	2
Free/Affordable	1

SUGGESTED IMPROVEMENTS

Participants made numerous suggestions for improving the smart parking system and parking in general in the Bay Area.

- Restrictions and limits for smart parking users should be removed. To balance risks and rewards, the limits should be maintained for advanced registration, but limits should not be placed on the same day call-in registration. In addition, more spots should be made available for advanced reservation; it would be easier to encourage people to use BART with advanced parking spots.
- Smart parking should employ transponder technology. It would be helpful to integrate smart parking with a FasTrak type device, where registration could be immediate, signaled with a 'beep' when entering the lots, and allow you to run for your BART train.
- Changes to the parking payment structure should be made. For example, the first few times parking each month should be free, but frequent use should be more expensive (as it is closer to using monthly reserved parking). Additionally, smart parking should never be more expensive than monthly parking. Students should be given discounts.
- Better signage and information is needed. A CMS sign to attract Oakland users would be helpful, as well as educational handouts around the smart parking lot. One person felt that information about casual carpooling should be given at the smart parking lots for those who were not able to get a reserved spot that day.
- The voice recognition system needs to be improved.
- The smart parking system should be applied at each BART station. Parking management should be employed to ensure that there are no unused BART parking spaces. In addition, off-site BART parking should be provided at a satellite lot with a shuttle to take people to a BART station.
- BART and the city should work together to create more parking spaces, take away parking restrictions, create more on-street parking, and better allocate parking near BART stations.

FOCUS GROUP TWO

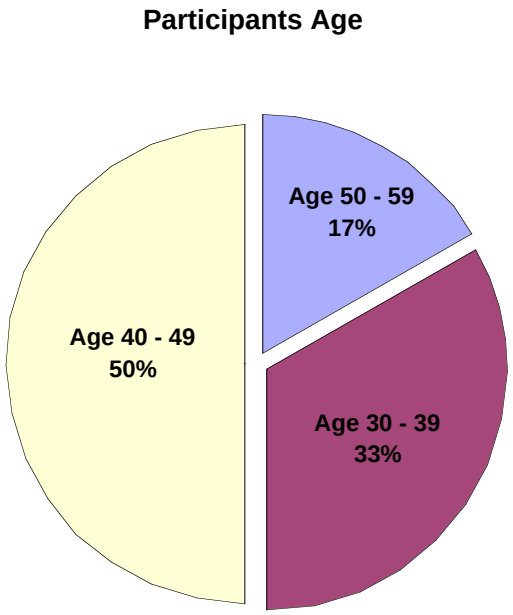
May 25, 2005
Montclair Recreational Facility, Oakland

Participants in the smart parking field test located at the Rockridge Bay Area Rapid Transit (BART) District station shared their experiences in a focus group conducted on May 18, 2005 at the Montclair Recreational Facility in Oakland, California. The participants in the focus group were recruited from a list of over 200 participants in the smart parking field test. This focus group included more frequent BART users (relative to focus group one). Rachel Finson, of California PATH, facilitated the focus group with researchers assisting and taking notes. Below follows is a summary of the findings from the focus group.

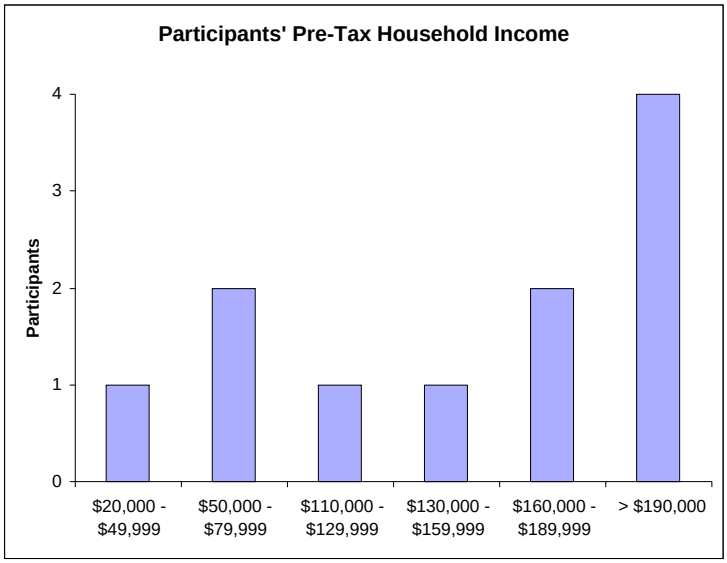
BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey to participants that explored their socio-demographic attributes, travel patterns, travel constraints, and parking options. The following were the socio-demographic attributes of the 12 focus group participants:

- Seven were women, and five were men.
- Three lived alone, three lived with a spouse/partner, and six lived with a spouse/partner and a child or children.
- One had zero commuters in the household; three had one commuter; one had one regular and one fluctuating commuter; six had two commuters; and one had four commuters.
- One had zero people in the household driving a motor vehicle; one had one regular and one fluctuating driver in the household; two had one person driving a motor vehicle; and eight had two people driving a motor vehicle in the household.
- Six had completed college, and six had completed a graduate/professional degree.
- Eleven were employed full-time, and one person was unemployed.
- One described their occupation as a manager/administrator; two as clerical/administrative support; eight as professional/technical; and one as a social worker.s
- Out of a choice of four technologies (Internet at work, Internet at home, a cellular phone, and a PDA); six participants used all four within the last week; two used only the Internet at work and a cellular phone; one used a combination of three (Internet at work, a cellular phone, and a PDA), one used Internet at home and at work and a cellular phone, one used Internet at home and at work only, and one used the Internet at home and a cellular phone.
- Four were between the ages of 30 and 39, six were between the ages of 40 and 49, and two were between the ages of 50 and 59.



- Three had two household members under the age of 16, and two had one household member under the age of 16.
- One reported a 2004 pre-tax household income in the $20,000 to $49,999 range; two were in the $50,000 to $79,999 range; one was in the $110,000 to $129,999 range; one was in the $130,000 to $159,999 range; two were in the $160,000 to $189,999 range; and four reported a household income of more than $190,000.



Participants' indicated that half of the participants had parked at work in the past, and half of them used only BART or other public transport options. More detailed results are described below.

- Within the last year, six participants stated that they never drove and parked at work; three parked at work less than one day a month; one between one and three days a month; and two participants drove to and parked near work between one and three days a week.

How Often Do You Park At Work	
	Number of Participants
Never	6
Less than 1 day a month	3
1-3 days a month	1
1-3 days a week	2

- All of the six participants that drove and parked near work at some time in the last year used paid parking not provided by their employer. These participants paid the following amounts for parking near their workplace:
    - $1.00-$1.50 per hour
    - $6 per day
    - $10 per day
    - $12 per day
    - $15 per day
    - $23 per day.

- Ten people periodically choose BART's daily free parking when taking BART, but one did not.
- All twelve participants had never used BART's monthly reserved paid parking program.

Participant reported six different combinations of origin and destination locations for their commute travel:

- Six from Oakland/Piedmont to San Francisco,
- One from Benicia to Oakland,
- One from Oakland to Berkeley,
- One from Lafayette to San Francisco,
- One from Berkeley to San Francisco, and
- One from Castro Valley to San Francisco.

Three participants had moved residences, and one had changed work location since the start of the smart parking program.

LEARNING ABOUT SMART PARKING

Participants learned about the smart parking program at Rockridge BART in a variety of ways. See table below.

How Did You Know About Smart Parking?	
	Number of Participants
Friend or Colleague	3
Newspaper or TV News	3
Roadside Changeable Message Sign	1
Internet	1
Flyers and Signs Near BART	4

One person saw a CMS on the highway, pulled into a spot that was not for smart parking, and received a parking ticket before learning about the correct location. Another person also received a ticket after pulling into the wrong location. Overall, the information about the smart parking field test was conveyed through flyers, friends, and media.

REASONS FOR JOINING SMART PARKING

Participants joined smart parking for a number of reasons. Many stated that they appreciated the certainty and reliability of parking with the program. Some participants stated that the program allowed them to sleep later on some days before going to work. One participant reserved smart parking in advance (which is in a covered lot) based on the weather forecast so that he would not have to walk in the rain.

Reason for Joining Smart Parking	
	Number of Participants
Reliable and Guaranteed Parking Spot	5
Gives Flexibility and Options	3
Covered Parking	1
Safety	2
Free Service – Avoiding Paid Parking	1

INTRODUCTIONS & USING SMART PARKING

Eleven of the 12 focus group participants regularly commuted to work. One participant was unemployed and commuted to San Francisco only for job interviews and personal business. One participant mentioned using casual carpooling as an alternative commute method. Two participants stated that they alternated between taking BART and driving alone to work. Participants used a variety of modes to access their home-end BART station including: biking, walking, driving, riding the bus, and being dropped off.

COMMUTE MODES

The primary commute mode of participants before and after smart parking test was implemented (with corresponding travel times and distance, including access to and egress from the primary mode) are provided below.

Primary Commute Before Smart Parking			
	Participants	Average Minutes	Average Miles
Drive by myself	1	23	28
Carpool	1	60	N/A
BART	9	30	16
Dropped off at Work	1	20	3

Primary Commute After Smart Parking			
	Participants	Average Minutes	Average Miles
Drive by myself	1	23	57
Carpool	1	60	N/A
BART	10	31	14

Commuting by BART

Nine of the 11 regular commuters used BART as their primary commute mode before the smart parking field test began with an average travel time of 30 minutes and distance of 16 miles. After smart parking, ten used BART as their primary commute mode with an average travel time of 31 minutes and distance of 14 miles.

In general, participants stated that they enjoyed commuting by BART. Several participants liked to relax, do work, read, or "zone out" during their BART commute. They also felt that BART's regular trains during rush hour are frequent, reliable, convenient, and on-time. One person liked taking BART to avoid sitting in traffic. However, one participant disliked the lack of seating on morning BART trains, and another disliked the Rockridge BART station's chaotic and congested atmosphere.

Casual Carpool

One participant stated that she uses casual carpooling as her primary mode of commute and really enjoys it. However, when she needs to take her kids to preschool in the morning, she arrives too late for casual carpooling. During these times, smart parking has allowed her to take BART instead and has filled an important gap for her as a working mom.

ACCESS TO PRIMARY COMMUTE MODE

Driving and Parking at the Station

Even before the smart parking field test began, nine of the 12 participants used parking facilities at or near a BART station, making it the most popular BART access mode. Still, participants indicated that parking near the Rockridge BART station was rife with problems. One person felt flustered by the lack of parking during street cleaning on the second and fourth

Monday or Tuesday of every month. Another was bothered and frustrated by the seasonal variation in parking and the general lack of reliable parking spaces. The BART monthly reserved parking program irritated one person, who stated that: "It is almost impossible to get a reserved spot, but those who have the reserved spots don't use them. I hate seeing unused parking spots."

After the implementation of the field test, ten of the 12 participants used smart parking lot facilities. Many participants indicated that they liked that smart parking provided certainty in securing a spot, a safe parking location, and convenience. One felt that parking close to the BART station in a smart parking lot was safer than parking on a neighboring street at night. Another person noted that smart parking helped her avoid circling the neighborhood to look for a parking spot when she was running late. Several people noted that "quality of life is better in general" after the smart parking program began.

Bus

Five participants used the bus to access BART and commented that they did not like doing so. One person said that buses are difficult to use. Another commented that the bus ride does not make for a good return trip. A third said that she disliked the bus part of her commute and enjoys the smart parking program because it allows her to avoid the bus completely.

Bicycle

One participant stated that he rode a bike to BART about once a week and that he very much enjoyed doing so (it is "the best part of my day"). He also appreciated having a bike locker at the Rockridge BART station, which costs thirty dollars annually.

AFTER SMART PARKING

Overall, most participants did not report drastic changes in their travel patterns and mode choice after smart parking was implemented; however, some did find that its availability frequently encouraged them to take BART rather than driving to work. In sum, four participants took BART more frequently than previously; four changed their home-end BART station; three enjoyed quality of life changes; and two had no change at all in their commute.

Taking BART Mores

One participant stated that she rode BART more frequently because smart parking provided a guaranteed parking spot. Two people said that they definitely took BART more and drove less. Another said that smart parking brought her back to BART after three years of carpooling. She had commuted by BART for 25 years but switched to carpooling because she felt that parking was unsafe at the West Oakland station. She indicated that smart parking provides safe, convenient, and flexible parking.

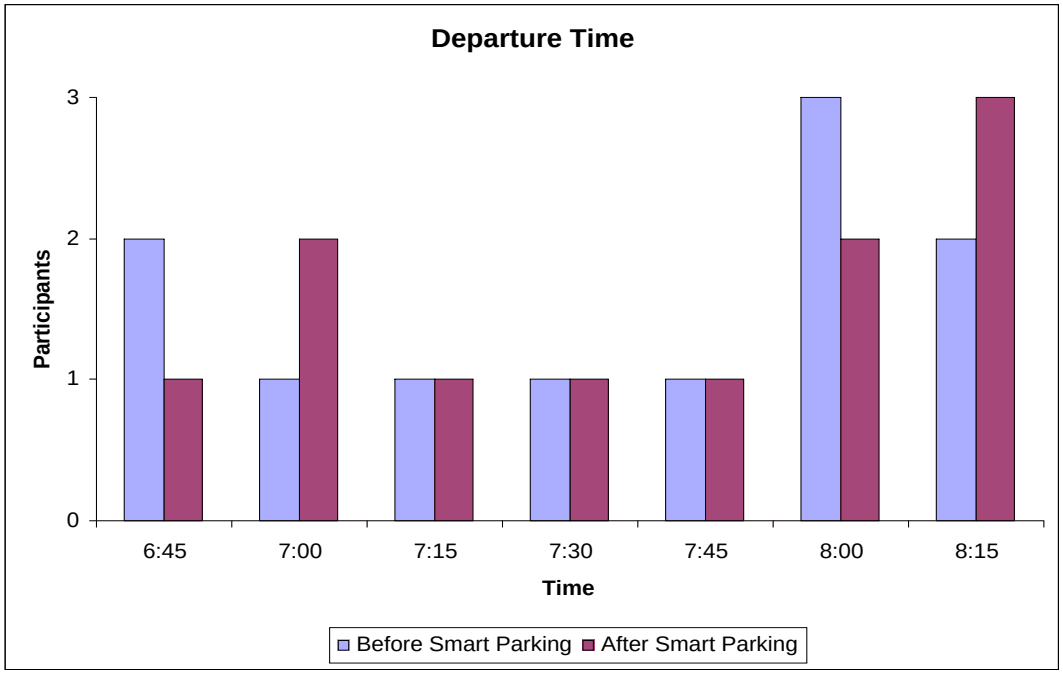
Changing Home-End BART Stations

Two people lengthened their driving distances to use smart parking at Rockridge BART, and two people shortened their driving distances because they lived near Rockridge but had been

parking further down the line to secure an available spot. One participant, who increased their driving distance to BART, still used BART at the same level, but now had a shorter BART commute. One, who had a shorted driving commute, using Rockridge instead of the Macarthur Station.

Quality of Life

Generally, participants indicated that smart parking increased their quality of life for the following reasons: the convenience of reserving in advance, the availability and reliability of having a parking spot, reducing stress, the ability to sleep in, and free cost. One person stated that although her commute pattern had not changed, she did not feel stressed about running late and not being able to find parking at the BART station. Another person said that her commute was shortened by 15 to 20 minutes because she did not have to wait for the bus and take it to the BART station. A third person walked less because he now had the option of driving to the BART station.



SYSTEM FEATURES

Parking Lot at the Rockridge Station

A large number of participants felt that there were not enough spots designated for smart parking; they wanted there to be a bigger lot assigned for advanced and call-in reservations. On the other hand, one participant expressed concern about underutilization; he felt that there always seemed to be empty spaces.

Changeable Message Signs on Highway 24

Six participants had seen the CMSs on Highway 24. Two used smart parking because they saw the CMSs and pulled into the lot out of curiosity. Participants had mixed reactions about the

CMSs, but in general, the participants indicted that the signs were not critical to their decision making. One felt that the signs were misplaced and only useful for people coming through the tunnel. Another participant indicated that he did not trust the signs because he observed that the number of parking spaces displayed on the sign never changed much. However, one participant indicated that the CMS was reassuring, and another thought the location of the CMS sign made sense given the goal of the program was to attract typical drivers going into the city to BART.

Signs to the Smart Parking Lot at BART

Participants expressed an overall sense of confusion and initial frustration with the signage leading toward the BART smart parking lot. Nearly everyone mentioned that it was very confusing to use the system the first time. People could find the general lot at BART, but they did not know which area was designated for smart parking. In addition, people did not understand the relationship between smart parking and ParkingCarma™ and did not realize that ParkingCarma™ was involved in the same field test. One participant felt that the large yellow barriers in front of the lot were a helpful clue, but she still had to ask the program people to guide her in the right direction. In fact, one person received a ticket for not having parked in the right place, and another was lucky to solicit advice from a police officer that would have ticketed him.

Advanced Reservation System

Participants indicated that the advanced reservation system was generally an important feature of the smart parking system. Pointing to the success of the system, several people felt that the maximum limit for advanced reservations capped at three times every two weeks (which was a constraint placed specifically for the smart parking field test) was very restrictive; many people wanted to use it even more frequently. Additionally, some did not like the fact that parking spaces could only be reserved prior to 10:00 am and wanted the time extended.

Although most participants expressed more satisfaction with the web-based reservation system compared to the telephone reservation system, they felt that both could be made more user-friendly. Two people noted that there was little coordination between the phone and web system, and the code used on the phone was not the same as the one needed to enter the system on the computer, which was confusing. One person did not like the fact that each car needed to be registered separately; she wanted to be able to register two vehicles that belong to the same family under one ID code.

Reservation by Internet

One person felt that the website was baffling at the outset because he was not sure if the system locked out registrants the day before or if all the advanced reservation spots were always already taken. Another person felt confused on two occasions when the web noted that there were no spots remaining, but there were empty spots on the chart that did not seem possible to reserve. Another person felt that there were too many steps in the online system; he needed to constantly log on for availability, and there was no automatic calculation of space availability. On the other hand, participants indicated that they enjoyed various features of the web system including the print-out with the date to put in the windshield and their reservation history.

Reservation by Phone

Participants indicated that the phone system was confusing because of the lack of confirmation. Only one participant attempted to use this system more than once. She stated that she went to the parking lot but was not sure if she was required to call again to note the number of her parking space. Intuitively, she thought it might be necessary to avoid double parking, but the phone system did not mention any details.

Same Day Call-in Reservation

Despite a few comments on the lack of initial ease of use, the four people who frequently used the call-in reservation service found it to be a great feature of smart parking. One person mentioned that he was able to get the spot that he called in to reserve all but one time. On the other hand, one woman did not like the system because she did not have a cell phone and thus it was very difficult to make a same day call-in reservation.

One person had some very exasperating conversations with the voice recognition system, "Kate," and has now mastered the strategy of "speaking softly and keying in…Kate does not like to be yelled at." The main complaint was that if the user makes a mistake, such as forgetting or entering the wrong account number, there is no recourse, and no way to access a live person on the phone to answer more complex questions.

WILLINGNESS TO PAY

Several people commented on their willingness to pay for parking service. Although no one said they would be willing to pay over ten dollars for the service, four people said that they would be willing to pay up to four dollars to park at the Rockridge smart parking lot. One person said she would be willing to pay but not more than the cost of the monthly reserved spaces at BART. Another said he would be willing to pay but not more than the cost of parking at a commercial lot adjacent to the station. A third person stressed that he would pay "whatever it took for the program to break even but not for BART to balance its budget." He felt that smart parking is good and gets people onto the BART system and off the freeway, but that BART should not be using it as a revenue source.

IMPROVEMENTS AND SUGGESTIONS

Several suggestions came out of the focus group session:

- Smart parking should be tied to a FasTrak device. This dynamic management automated reader could monitor and manage the number of vehicles entering and exiting the lot all day long and would be able to charge a minimal amount very easily.
- The system should use a cellular phone browser. The suggestion came from someone who wanted the whole reservation process to be done via cell phone button activation, without needing to speak though a voice recognition system.
- A touch pad should be installed on site. The improvement would be to have a courtesy phone or an electronic touch pad at the smart parking lot to make reservations at the last minute without having a cellular phone.
- Smart parking should be a program implemented more broadly at other BART stations.

- Smart parking should be available elsewhere like shopping complexes. This idea was to broaden the range of smart parking facilities, to integrate them into other areas within and outside of BART.

APPENDIX C: FOCUS GROUP INSTRUMENTS

TELEPHONE SCREENING SCRIPT

Smart Parking Focus Groups Telephone Screening Script
April 2005

Is [name] there?

Hello. My name is _____ , and I'm calling from the Innovative Mobility Research Group on behalf of the University of California. Do you have about 10 minutes right now?

I've received an email from you about your interest to participate in a focus group at the Montclair Recreational Facility based on your participation in the smart parking management field test at the Rockridge BART station.

I'm calling to follow up and confirm your interest and ask you a few questions to make sure you are qualified for these focus groups.

1) Do you have a child or children between the ages of 0-15?

Yes (1)
No (0)

2) Before the smart parking program field test, how often did you use BART in the past to commute to work?

Every day (1)
3-4 times per week (2)
1-2 times per week (3)
Several times a month (4)
I never used it (5)

3) After the smart parking program field test, how often did you use BART to commute to work?

Every day (1)
3-4 times per week (2)
1-2 times per week (3)
Several times a month (4)
I never used it (5)

Thanks.

I also want to make sure that you know that your participation, of course, would be completely voluntary. You would only have to respond to the questions that you felt comfortable with and could withdraw from the focus group at any time. Any information that we obtain from the focus group will remain confidential. The information that we collect will only be reported as a product of the focus group and not of any individual attending the meeting.

We are also planning to videotape this event. Your identity would remain confidential for this videotape. Would you be willing to be videotaped? (YES-1/NO-0)

There will be 10 to 14 other people participating and, if you stay until the end of the focus group, you would receive $75 as a token of our appreciation.

Depending on your answers, we will decide if you are qualified for the focus group and get back to you. If we do not get back to you, I want you to know that we are likely to be planning more focus groups in early June. Would you be interested in participating then, if you do not get selected for this round of focus groups? (YES-1/NO-0)

I will call you back and give you more details on location and time if we select you for this focus group. If you have any concerns, please contact Wendy Tao at 510-231-5659 or wendytao@path.berkeley.edu. Thanks for your time and for your help in this project.

FOCUS GROUP PROTOCOL

6:15 pm to 6:30 pm – Introductions and Preliminary Forms
6:30 pm to 8:30 pm – Focus Group on Smart Parking

6:15-6:30 pm Pre-Focus Group Information

- Sign-in sheet
- Permission to record (i.e., video and/or audio)
- Consent to participate (focus group participation waiver) – 2 copies
- Questionnaire
- Table Tents

6:30-6:35 pm Introductions

- Moderator introductions and focus group purpose
  - Thank you for coming…
  - Rachel Finson….
  - Sponsored by Caltrans, with project partners BART, ParkingCarma, Quixote Corporation. They will have access to data from the focus groups as well.
  - This focus group is part of the research evaluation of the smart parking field test at the Rockridge BART station that is being conducted by UC Berkeley researchers. We have invited you to participate in this focus group today to better understand your experiences with the smart parking system and to understand how this system may have affected your travel patterns.

- Overview of the focus group process
  - Want your opinions/feedback. It's okay to disagree
  - 1. Introductions
  - 2. Commute likes and dislikes before and after smart parking use
  - 3. Break
  - 4. Smart parking
  - 5. Wrap up/distribute incentives

6:35-6:45 pm Participant Introductions/Warm-Up

- Participant introductions
  - Ask each participant to introduce him or herself and to briefly describe how and why they use the smart parking system
    - En-route and/or reservation system
    - How long they have used the service
    - Frequency of use
    - Reason for use (commuting, shopping?)
    - Days of week used/variable?
    - Times of day (arrival and departure times at BART)

6:45-7:10 pm Commute Travel Before & After Smart Parking Use

- Before joining smart parking, what aspects of your commute did you **like** and what aspects did you **dislike**?

- Since joining smart parking, what aspects of your commute do you **like** and what aspects do you **dislike**?

- Note: Make sure we understand what prompted them to join smart parking, and why or why not they continued to use it frequently or infrequently (*you may do this on an individual, one by one questioning technique*).
  - What prompted them to use the service? What made them decide to use it at all?
  - How did they hear about it (flyers, website)?

- How has your commute travel changed after joining smart parking?
  - Frequency of BART travel?
  - How has access mode to BART changed?

7:10-7:20 pm Break

7:20-7:50 pm Smart Parking Likes and Dislikes

- How do you feel about having a changeable message signs on the roadway?
  - CMS message sign on Highway 24

- How do you feel about the signage and directions once you get off the freeway and into the Smart Parking lots?
  - Signage directing to smart parking lots

- How has the advanced reservation service worked for you?
  - Web
  - Phone

- How has the call-in service right before parking worked for you?

- What do you like most about the smart parking system? And/or why do you use the system? *Rank the preferences.*
  - Easy to use aspects of service, including technology (reservation system via web, PDA, phone & electronic message sign)
  - Lifestyle--less stress, sleep in
  - Save money
  - Take kids to school and still take BART
  - Parking enforcement

- What do you like the least about the smart parking system? And/or why don't you use the system and say drive to work? *Rank dislikes.*
  - Hard to use aspects of service, including technology (specify if possible)
  - Reduces after-10 am parking

- Not enough spaces
- Reservations are booked quickly
- Limits on frequency of use
- Parking enforcement

- How do you think the existing smart parking service could be improved? (*both positive and negative features mentioned earlier*)

7:50–8:15 pm Essential Parking Service Features

- In general, what parking features are most important to you?
  - Proximity of parking to destination
  - Guaranteed parking
  - Parking guidance (i.e., signs guiding to a specific space)
  - Access to information (advance or en-route; on-line, cell phone, PDA, phone)
  - Quality of information (real-time, accuracy, easy-to-read, relevance)
  - Access to reservations (on-line, cell phone, PDA, phone)
  - Method of billing (cash, credit, debit, monthly; weekly, daily, hourly; over the phone, web, mail)

- Please rank the features identified in order of importance.

- How much would you pay for the service if the smart parking system started charging for use?
  - Over $10
  - $7.50 to $10
  - $5 to $7.50
  - $2.50 to $5
  - $.01 to $2.50
  - Nothing – I would never use this service if it cost money

- Additional comments and feedback?

8:15-8:30 pm Closing Topics and Administrative Details

- Final report availability – December 2006
- Incentives

FOCUS GROUP QUESTIONNAIRE

Thank you for participating in the California PATH smart parking research program. This survey asks you questions about your commute travel before and after joining the smart parking program to understand how your commute travel may have changed. Please bear with us: some questions may seem repetitious, but your answers to these questions are very important!

*First, we begin by asking you some questions about your commute travel **before you began using the smart parking** program at the Rockridge BART station.*

1. For your most frequent commute method to your primary work location, please provide the amount of time and number of miles you typically spent on each mode of travel for your one-way door-to-door commute trip. It is important to separately include all the distinct modes that made up your total commute; for example, 20 minutes and 10 miles for BART and 10 minutes and 0.5 miles to walk to BART and to the office. Include any waiting times in your estimate; for example, my total BART travel time is 20 minutes (15 minutes riding time and 5 minutes waiting time). Estimate all distances to the best of your ability.

Transportation Modes for Primary Commute	Minutes	Miles
Drive by myself		
Carpool		
Vanpool		
Bus		
BART		
Amtrak		
MUNI		
Caltrain		
Taxi		
Walk		
Bicycle		
Dropped off to ride Transit/Vanpool/Carpool		
Other, please specify:		

2. How many days a week did you use your primary commute method?
   ____ Less than 1 day ____ 1 to 2 days ____ 3 to 4 days ____ 5 or more days

3. At what time did you typically *leave home to go to work*? _____AM/PM

4. At what time did you typically *arrive at work*? _____AM/PM

5. Did you sometimes commute to work by a different method? ____ Yes ____ No

If you used BART as part of your commute and answered NO to Question 5, please SKIP to Question 8 on page 2.

If you did NOT use BART as part of your commute and answered NO to Question 5, please SKIP to Question 11 on page 3.

6. For your second most frequent commute mode to your primary work location, please provide the amount of time and number of miles you typically spent on a one-way commute trip.

Transportation Modes for Secondary Commute	Minutes	Miles
Drive by myself		
Carpool		
Vanpool		
Bus		
BART		
Amtrak		
MUNI		
Caltrain		
Taxi		
Walk		
Bicycle		
Dropped off to ride Transit/Vanpool/Carpool		
Other, please specify:		

7. How often do you use your secondary commute method?
   ____ Less than once a month
   ____ 1 to 3 days a month
   ____ 1 day a week
   ____ 2 days a week
   ____ 3 or more days a week

8. How do you typically get from your home to your most frequently used BART station?
   ____ Drive myself and park at or near the station
   ____ Dropped off by someone
   ____ Carpool
   ____ Walk
   ____ Bus
   ____ Bicycle
   ____ Other, please specify: _____

9. What was your most frequently used home-end BART station? _____

10. What was your most frequently used destination-end BART station? _____

Next, we ask you some questions about your commute travel ***after you began using the smart parking*** *program at the Rockridge BART station.*

11. For your most frequent commute method to your primary work location, please provide the amount of time and number of miles you typically spend on each mode of travel for your one-way door-to-door commute trip.

Transportation Modes for Primary Commute	Minutes	Miles
Drive by myself		
Carpool		
Vanpool		
Bus		
BART		
Amtrak		
MUNI		
Caltrain		
Taxi		
Walk		
Bicycle		
Dropped off to ride Transit/Vanpool/Carpool		
Other, please specify:		

12. How many days a week do you use your primary commute method?
    ____ Less than 1 day ____ 1 to 2 days ____ 3 to 4 days ____ 5 or more days

13. At what time do you typically *leave home to go to work*? _____AM/PM

14. At what time do you typically *arrive at work*? _____AM/PM

15. Do you sometimes commute to work by a different method? ____ Yes ____ No

If you use BART as part of your commute and answered NO to Question 15, please SKIP to Question 18 on page 4.

If you do NOT use BART as part of your commute and answered NO to Question 15, please SKIP to Question 21 on page 5.

16. For your second most frequent commute mode to your primary work location, please provide the amount of time and number of miles you typically spend on a one-way commute trip.

Transportation Modes for Secondary Commute	Minutes	Miles
Drive by myself		
Carpool		
Vanpool		
Bus		
BART		
Amtrak		
MUNI		
Caltrain		
Taxi		
Walk		
Bicycle		
Dropped off to ride Transit/Vanpool/Carpool		
Other, please specify:		

17. How often do you use your secondary commute method?
    ____ Less than once a month
    ____ 1 to 3 days a month
    ____ 1 day a week
    ____ 2 days a week
    ____ 3 or more days a week

18. How do you typically get from your home to your most frequently used BART station?
    ____ Drive myself and park at or near the station
    ____ Dropped off by someone
    ____ Carpool
    ____ Walk
    ____ Bus
    ____ Bicycle
    ____ Other, please specify: _____

19. What is your most frequently used home-end BART station? _____

20. What is your most frequently used destination-end BART station? _____

Now, we ask you some questions about ***parking at your workplace and BART****.*

21. Within the last year, how often have you driven to and parked at or near your workplace?
    ____ Never
    ____ Less than 1 day a month
    ____ 1 to 3 days a month
    ____ 1 to 3 days a week
    ____ 4 to 5 days a week
    ____ More than 5 days a week

If you have not parked at or near your work within the past year, please SKIP to Question 24.

22. Please indicate which of the following best represents the type of parking you typically use at or near your workplace.
    ____ Free parking provided by my employer
    ____ Parking provided by my employer that I pay for
    ____ Free parking not provided by my employer
    ____ Paid parking not provided by my employer

If you typically park for FREE at or near your work, please SKIP to Question 24.

23. Please provide the typical cost of parking for whichever ONE of the time periods below is most familiar to you.
    $ _____ per hour
    $ _____ per day
    $ _____ per week
    $ _____ per month
    $ _____ per year

24. At present, do you sometimes choose to use BART's daily free parking when you take BART to work?
    ❑ Yes
    ❑ No

25. Have you ever used BART's monthly reserved paid parking program?
    ❑ Yes
    ❑ No

*Finally, we have some **demographic questions** that help us categorize our data. The information you provide will remain completely confidential.*

26. How did you hear about the smart parking program at the Rockridge BART station?

- ❑ Friend or colleague
- ❑ Newspaper, magazine, or other print media
- ❑ TV/radio spot
- ❑ Internet
- ❑ Household member
- ❑ Flyers
- ❑ Signs posted around BART
- ❑ Other, please specify:_____

27. In the table below, please provide the following information on your **current** work and home location:

Location	City	Zip Code	Nearest Cross Streets
Home			
Primary work			

If your home or workplace was different from those listed above one year before joining the smart parking program, please indicate in the table below.

Location	City	Zip Code	Nearest Cross Streets
Home			
Primary work			

28. Gender: ____ Female ____ Male

29. Please check the category below that best describes your household.

- ____ Self only
- ____ Self with spouse/partner
- ____ Self with spouse/partner and child(ren)
- ____ Self with child(ren)
- ____ Self with roommate(s)
- ____ Other, please specify: _____

30. How many commuters, including yourself, are in your household? (A commuter is an adult who travels three or more days per week to and from work or school.) _____

31. How many people in your household drive a motor vehicle? _____

32. What is the highest level of school that you have completed?
    - ____ Grade School
    - ____ High School
    - ____ Trade School
    - ____ College
    - ____ Graduate/Professional
    - ____ Other, please specify: _____

33. What is your employment status?
    - ____ Employed full-time
    - ____ Employed part-time
    - ____ Student
    - ____ Other, please specify: _____

34. What category best describes your occupation?
    - ____ Manager/administrator
    - ____ Service/repair
    - ____ Clerical/administrative support
    - ____ Sales
    - ____ Professional/technical
    - ____ Production/construction/crafts
    - ____ Other, please specify: _____

35. Please indicate if you have used any of the following technologies **within the last week**. Check all that apply.
    - ____ Internet at work
    - ____ Internet at home
    - ____ Mobile telephone
    - ____ PDA (hand-held electronic organizer)

36. What is your age?
    - ____ up to 18 years old
    - ____ 19 to 23 years old
    - ____ 24 to 29 years old
    - ____ 30 to 39 years old
    - ____ 40 to 49 years old
    - ____ 50 to 59 years old
    - ____ 60 to 69 years old
    - ____ 70 years old or older

37. How many individuals in your household are in each of the following age groups below, including yourself? In the spaces below, please indicate the number of people in each age group.
    - ____ 0 to 5 years old
    - ____ 6 to 15 years old
    - ____ 16 to 18 years old
    - ____ 19 to 23 years old
    - ____ 24 to 29 years old
    - ____ 30 to 39 years old
    - ____ 40 to 49 years old
    - ____ 50 to 59 years old
    - ____ 60 to 69 years old
    - ____ 70 years old or older

38. What was your household's 2004 gross (before taxes) income?

____ Under $10,000
____ $10,000 to $19,999
____ $20,000 to $49,999
____ $50,000 to $79,999
____ $80,000 to $109,999
____ $110,000 to $129,999
____ $130,000 to $159,999
____ $160,000 to $189,999
____ More than $190,000

APPENDIX D: ON-LINE PARTICIPANT SURVEY

NSurvey

new survey | settings | stats | survey builder | type builder | results report | export | mailing | mailing status | asp.net code

Survey builder

Smart Parking Initial Survey

Page 1

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SMART PARKING RESEARCH PROGRAM QUESTIONNAIRE

Thank you for participating in the Smart Parking project, a collaboration between California Partners for Advanced Transit and Highways, the California Department of Transportation and the Bay Area Rapid Transit District. We hope that you enjoyed using the Smart Parking service. Your answers to this questionnaire will help us evaluate the potential of Smart Parking to improve parking shortages, traffic congestion and access to transit in the San Francisco Bay Area. Thank you again for your participation!

Instructions: Please read and answer each question. Unless otherwise noted, all questions refer to your travel before you started using the smart parking system. The questionnaire should take about 10 minutes to complete. Your responses will remain completely confidential. There is no way to connect you to your answers. If you have any questions, please contact the Project Coordinator at smartparking@path.berkeley.edu.

One word of Advice! If you want to change a response, you can use your browser's back button to go back one page, but any answers you have completed on subsequent pages will be lost. Please be sure that you have completed answers to your liking before clicking "Next page" to avoid frustration.

First, we'd like to ask you some questions about how you travel.

Page 2

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For your most frequent commute method to your primary work location, please provide the amount of time and number of miles you typically spend on each mode of travel for your one-way door-to-door commute trip. It is important to separately include all the distinct modes that make up your total commute: for example, 10 min and 5 miles to drive to BART; 25 min and 15 miles on BART; and 10 min and 0.5 miles to walk from BART to the office. Include any waiting times in your estimate: for example, a total BART travel time of 25 min could be 20 min riding time and 5 min waiting time. Estimate all distances to the best of your ability.

	Minutes	Miles
BART		
Drive by myself		
Carpool		
Vanpool		
Shuttle		

Bus		
Bike		
Walk		
Muni		
Train		
Driven to Transit/Carpool		
Taxi		
Other		

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many days a week do you typically use your most frequent commute method?*

Less than 1 day 1-2 days 3-4 days 5 or more days

Page 3

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Voters who did answer to **Do you sometimes commute to work or school by a different method?** with **No** are redirected to page **page 5** (Delete rule)

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Do you sometimes commute to work or school by a different method?

*

Yes No

Page 4

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Edit | Delete | Clone | Insert question | Insert page break | Insert line break

For your second most frequent commute method to your primary work location, please provide the amount of time and the number of miles you typically spend on a one-way commute trip.

	Minutes	Miles
BART		
Drive by myself		
Carpool		
Vanpool		
Shuttle		
Bus		
Bike		
Walk		
Muni		
Train		
Driven to Transit/Carpool		

Taxi

Other

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many days a week do you typically use your secondary commute method? *

- Less than 1 day per month
- 1-3 days per month
- 1 day per week
- 2 days per week
- 3 or more days per week

Page 5

Delete | Insert question | Insert line break | Edit branching

Voters who did answer to **Do you ever ride BART to commute to work or school?** with **No** are redirected to page **page 7** (Delete rule)

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Do you ever ride BART to commute to work or school?*

Yes No

Page 6

Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How frequently do you use BART to commute to work or school?*

- Only occasionally
- 1 - 3 days per month
- 1 - 3 days per week
- 4 - 5 days per week
- More than 5 days a week

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How do you typically get from your home to your most frequently used BART station?*

- Drive myself and park at or near the station
- Dropped off by someone
- Carpool
- Walk
- Bus
- Bike
- Other, please specify:

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is your most frequently used destination-end BART station?

*

[Select an answer]

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is your most frequently used home-end BART station?

*

[Select an answer]

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Overall, how satisfied are you with the services provided by BART?

Very unsatisfied

Somewhat unsatisfied

Neutral

Somewhat satisfied

Very satisfied

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please select the one response that represents your primary reason for using BART:

*

Reduces the time I sit in traffic.

Fits with my schedule better than buses/shuttles.

Gives me time to work or relax during my commute.

Saves me money.

Means I will not have to buy another car.

Helps me do my part to reduce congestion and air pollution.

Parking at BART is easier than parking at my workplace.

Parking at BART is less expensive than parking at my workplace.

No opinion

Other, please specify:

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please indicate how frequently you have used any type of public transit (e.g., bus, BART, MUNI, AMTRAK, etc.) for non-work travel (e.g., shopping, recreation, etc.) within the past year?*

Never

Less than 1 day per month

1 to 3 days per month

1 to 3 days per week

4 to 5 days per week

More than 5 days per week

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please select the one response that represents what you like least about using BART for your commute trip:
*

- The fares are too high.
- It takes me more time to go places.
- I'm unfamiliar with the transit systems.
- I can't easily transport personal items (e.g., gym bag, groceries, etc.).
- I'm not able to be as spontaneous as I might like.
- I have concerns about station area safety at night.
- The trains don't run on time.
- The trains don't run frequently enough.
- I can't get a seat.
- No opinion
- Other, please specify:

Page 7 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Next, we have some questions about your travel needs and constraints.

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many days a week do you typically commute to the same work location?*

Less than 1 day 1-2 days 1-3 days 4-5 days More than 5 days

Page 8 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

On average, within the last year, how frequently did you commute directly from home to an alternative location for work related purposes?*

- Never
- Only occasionally
- 1 - 2 days per month
- 1 - 3 days per week
- 4 - 5 days per week
- More than 5 days per week

Page 9 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many hours per week do you typically work?
*

0

1 - 10

11 - 20

21 - 30

31 - 40

41 or more

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many days per week do you typically work?*

0 1 2 3 4 5 6 7

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Are you required to arrive at work by a certain time?*

Yes No

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

When do you typically arrive at work? (Please specify am/pm)

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

When do you typically leave work? (Please specify am/pm)

Page 10

Delete | Insert question | Insert line break | Edit branching

Voters who did answer to **On average, within the last year, how often did you park when you arrived at your place of work?** with **Never** are redirected to page **page 14** (Delete rule)

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

On average, within the last year, how often did you park when you arrived at your place of work?

*

Never

Only occasionally

2 - 3 days per month

1 - 3 days per week

4 - 5 days per week

5 or more days per week

Page 11

Delete | Insert question | Insert line break | Edit branching

Voters who did answer to **Where do you typically park at work?** with **Free parking provided by my employer** are redirected to page **page 13** (Delete rule)

Voters who did answer to **Where do you typically park at work?** with **Free parking not provided by my employer** are redirected to page **page 13** (Delete rule)

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Where do you typically park at work?*

- Free parking provided by my employer
- Parking provided by my employer that I pay for
- Free parking not provided by my employer
- Paid parking not provided by my employer

Page 12 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please provide the cost for whichever ONE of the time periods below is most familiar to you.*

$ per hour

$ per day

$ per week

$ per month

$ per year

Page 13 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How long does it typically take you to find parking when you first arrive at your workplace?

*

0-5 minutes 6-10 minutes 11-15 minutes 16-20 minutes 21 or more minutes

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How long does it typically take you to walk from your parking space to your workplace?

*

0-5 minutes 6-10 minutes 11-15 minutes 16-20 minutes 21 or more minutes

Page 14 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Next, we have some questions about your travel related attitudes and opinions.

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

For each of the following statements, please check the one response that best expresses how strongly you disagree or agree. "My primary commute method (that is, the transportation mode(s) I typically use to get to work or school)...

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
...is enjoyable to me."					
...allows me to visit friends when I want."					
...fits my budget."					
...allows me to be spontaneous."					
...helps me go everywhere."					
...says a lot about who I am."					
...does not make me feel safe."					
...gives me a sense of independence."					
...is great for my lifestyle needs."					
...allows me to quickly respond in an emergency."					
...is comfortable."					
...gives me a sense of freedom."					

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please check the one response that best represents what you like least about your current commute method.*

- It's too expensive.
- Parking is a hassle.
- I waste too much time in traffic.
- Vehicle maintenance is a hassle.
- It's not reliable enough.
- It takes too long to get places.
- It's not environmentally-friendly.
- It's not flexible enough.
- Other, please specify:

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

For each of the following statements, please check the one response that best represents how strongly you disagree or agree.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Does not apply
I like to experiment with new ways of doing things.						
I sometimes don't drive because finding a parking space is difficult and frustrating.						
Transit is too expensive, so I don't use it much.						
I would like to reduce my auto use to reduce congestion and improve air quality.						
Once I am happy with something, I don't want to change it.						
I spend too much time dealing with car maintenance.						
Keeping licenses and smog checks current is relatively easy.						
I usually do not wait too long for buses and trains.						
I am willing to drive an electric or other clean-fuel vehicle to improve air quality if I can afford it.						

I use transit when it goes where I want to go.

I'd be willing to ride a bike or take transit to help improve air quality.

If friends and neighbors reduced their driving, I would follow their example.

I know transit schedules and routes relatively well.

It is time to change the way we live to help address environmental problems.

The benefits of owning a car are higher than the costs.

Traffic fumes are a major contribuor to global warming, smog and other environmental problems.

I sometimes do not feel safe while using public transportation.

Page 15 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Next, we have some demographic questions that will be used to categorize our data. All responses are completely confidential.

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is your gender?*

Female Male

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please select the category below that best describes your household.

*

Self only

Self with spouse/partner

Self with spouse/partner and child(ren)

Self with child(ren)

Self with roommate(s)

Other, please specify:

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is the highest level of school that you have completed? (Please select one)

*

Grade School High School College Graduate/Professional Trade School

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is your employment status? (Please select one)

*

Employed full-time

Homemaker

Employed part-time

Retired

Currently unemployed

Student

Other, please specify:

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is your age?

Under 18

18-23

24-30

31-40

41-50

51-60

61-70

71 or older

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

How many individuals in your household are in each of the age groups below, including yourself? Please type in the number of people for each age category.

	Number of people in household in each age category
0-5 years old	
6-15 years old	
16-18 years old	
19-23 years old	
24-30	
31-40	
41-50	
51-60	
61-70	
71 and over	

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Which category best describes your occupation (even if you are unemployed or retired)? (Please select one) *

Homemaker

Manager/administrator

Service/repair

Clerical/administrative support

Professional/technical

Production/construction/crafts

Sales

Other, please specify:

Page 16 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is the zipcode at your home location?

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is a street intersection near your home location? (Format: Grant & Virginia)

Street Intersection

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What is a street intersection near your place of employment? (Please provide a town as well. For example, "Grant & Virginia" in box 1 and "Berkeley" in box 2)

Street Intersection Town

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

What was your household's 2003 gross income (please include all sources of income, not just personal salaries)?

Under $10,000
$10,000 - $19,999
$20,000 - $49,999
$50,000 - $79,999
$80,000 - $109,999
$110,000 or more

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Please check all of the devices/services that you have used within the past week:

☐ mobile phone ☐ Internet at work ☐ Internet at home ☐ handheld device or Personal Digital Assistant

Page 17 Delete | Insert question | Insert line break | Edit branching

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Finally, we have a couple of questions related to your experience with the Smart Parking program at the Rockridge BART station. In your response, please consider your use of the online reservation system, the telephone reservation system, the changeable message signs on the Highway, and the directions to the smart parking area.

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Do you have any comments about what you like about the Smart Parking system?

Edit | Delete | Clone | Insert question | Insert page break | Insert line break

Do you have any comments about areas in which the Smart Parking system might be improved?