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CARLINK-A SMART CARSHARING SYSTEM FIELD TEST REPORT

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Carlink- A Smart Carsharing System Field Test Report

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CARLINK—A SMART CARSHARING SYSTEM FIELD TEST REPORT

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EXECUTIVE SUMMARY

Most trips in U.S. metropolitan regions are driven alone, which is costly to individuals and society and leads to congestion and air pollution. A more efficient, but less convenient, system would allow drivers to share cars. A shared-use system aims to reduce traffic by reducing the number of cars needed by households and encouraging commuters to walk, bike, and use transit, at least for part of their trips. For commuters especially, shared-use vehicles could offer a low-cost, low-hassle alternative to private vehicles. Furthermore, carsharing could help air quality by incorporating low-emission vehicles into shared-use fleets.

Because a carsharing organization would handle maintenance and repairs, these would be completed properly and on schedule, further reducing pollution and energy waste. Carsharing could reduce government spending on arterial street systems and mass transit by increasing transit ridership through added reverse commuters and midday, evening, and weekend riders. Sharing vehicles could even free up parking space; by serving multiple users each day, vehicles would spend less time parked. Moreover, carsharing could reduce the need for additional household vehicles to support a family's travel needs. Travelers would benefit by gaining the mobility of a car without individually carrying the full ownership costs; transit operators could benefit by tapping a much larger potential market; and society might benefit by diverting travelers from single-occupancy vehicles to transit for part of their trips.

The CarLink field test combined short-term rental vehicles with communication and reservation technologies to facilitate shared-vehicle access. The ten-month demonstration was implemented and researched by two teams at the Institute of Transportation Studies at UC Davis. Project partners included American Honda Motor Company, BART, Caltrans, PATH, and LLNL. INVERS and Teletrac provided advanced carsharing and vehicle tracking technologies.

Using surveys and focus groups, researchers explored attitudes toward the carsharing concept over time. This study builds upon the work of the CarLink longitudinal survey by linking carsharing market potential data to the CarLink field test population. Although the CarLink participant sample was not statistically significant, valuable lessons may still be drawn from the results. The CarLink field test results include: operational understanding; participant profiles; behavioral findings; economic viability; and directions for future research. Operational and participant profile highlights are discussed here.

Operational Highlights

Further insight into the CarLink field test, and the future potential of commuter-based carsharing was gained through exit questionnaires, household interviews, and focus groups.

Some program feedback included:

- CarLink users were comfortable with and preferred smart technologies.
- Preferred parking was a substantial program user benefit.
- CarLink reduced commute stress, even though travel times typically increased.
- CarLink decreased Homeside User and Workside Commuter spontaneity, although this was not a daily concern.
- Environmental concern was one reason that individuals joined the CarLink program, although not the dominant one.
- Homeside Users thought having a CarLink pickup truck available would be very helpful.
- The Workside Commuter group was required to carpool as part of the program. This required most members to alter their schedules, at least occasionally. Members said they would have carpooled more frequently, if partner communication had been facilitated by a messaging system (e.g., two-way pagers).
- After joining CarLink, Homeside Users and Workside Commuters decreased their personal vehicle use. The Workside group also increased their recreational transit usage, possibly due to greater BART familiarity or ease of access.
- If CarLink became a permanent service, several Homeside Users stated they would likely sell a personal auto and greatly reduce their transportation costs. Workside Commuters were more hesitant about selling a private vehicle until transit services improved, and CarLink provided more lot locations and vehicle variety.
- The majority of Workside Commuters interviewed indicated that they would return to solo driving after CarLink ended, but carpool more frequently than they had previously. All three interviewed Homeside Users said they were considering buying a new vehicle and would continue using BART. Day Users would not change their commute modes appreciably.
- There was an average reduction of 31.8 private vehicle miles traveled per day and an increase of 13.3 CarLink miles traveled. Thus, there was a net reduction of 18.5 vehicle miles (on average). Furthermore, CarLink resulted in at least 20 new BART trips each day.

This field test focused on user response versus program optimization. Thus, the preliminary economic analysis posed many questions. To provide a more accurate picture of this program's benefits and costs, CarLink costs should be streamlined, revenues increased, and program benefits quantified (e.g., environmental, social, and hedonic).

Participant Profile Highlights

In general, CarLink members represented a more affluent, highly educated, and mature group than reflected by Bay area census data. Some other CarLink demographic trends include:

- CarLink participants were predominantly male (67%) and married (69%).
- CarLink participants were primarily homeowners (81%), and all were employed.
- Eighty-one percent of participants had an average yearly income of $50,000 or more.
- Over one third (36.4%) were between 24 and 40 years of age, and 59% were between 41 and 64 years of age.
- Seventy-five percent of participants held a bachelor's degree or higher level of education. Forty-three percent had a graduate or professional degree.

A more detailed discussion of CarLink behavioral findings, economic viability, and future research are also included in this report. While CarLink only began to judge the practicality of one carsharing model in the U.S., within the context of a limited sample population, it advanced the research understanding of carsharing response, technological limitations, and business potential from which new research efforts might build.

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CHAPTER ONE INTRODUCTION

SECTION 1.0 PROBLEM STATEMENT

The vast majority of trips in the U.S. are drive-alone car trips. Personal vehicles continue to gain market share at the expense of transit and ridesharing. Increased auto use often results in increased congestion, environmental impacts, and stress. With more vehicles on the roads, individuals are spending longer times commuting than they did in the past (Bernard and Collins, 1998). Not surprisingly, attitudes toward commuting have become more negative. Despite these trends, transit accounts for less than two percent of passenger travel, notwithstanding large subsidies (Vincent *et al.*, 1994).

A more efficient, but often less convenient, alternative to private auto use would allow drivers to share cars, linked to transit and key activity centers (e.g., airports, office parks, and college campuses). By deploying "smart" transportation technologies in concert with alternative vehicle-usage arrangements, the opportunity now exists to enhance transit services, potentially improving their competitiveness with private, individually owned cars. At present, several transportation providers are employing electronic and wireless communication systems to facilitate the use and deployment of innovative mobility services. In this study, smart technologies were linked to a shared-use vehicle system and transit (i.e., a carsharing model, called "CarLink"); this allowed researchers to perform exploratory research to better understand participant response and demand for such a service.

One of the problems motivating the CarLink field test and evaluation is the apparent inability of transit services to satisfy the presumed high value placed on instant flexibility and mobility. As expected, the success of a transportation alternative depends in part on an individual's attitude toward the traditional auto (Cullaine, 1992). The CarLink field test examined the relationships of program participants to autos, carsharing, and other transportation modes, such as transit and bicycling. This study also pursued other important questions, such as: At what cost are individuals willing to share vehicles? Are they willing to trade some of the convenience offered by a personal auto for CarLink (connected with other modes)? If so, what service features might increase the attractiveness of CarLink (e.g., preferred parking at transit stations and reduced transit fares)?

SECTION 1.1 CARLINK: A COMMUTER-BASED CARSHARING MODEL[1]

Carsharing is the use of a fleet of vehicles by a group of individuals to assist in meeting their transportation needs. Smart carsharing employs electronic and wireless technologies to organize, track, and collect data and to provide vehicle availability information to users. Through carsharing, many have access to and drive a set of shared vehicles.

While a relatively new concept in the U.S., carsharing is more widespread in Europe. CarLink also has roots in the station car concept (Bernard, 1999), which is also a shared-use vehicle model. Research is needed to evaluate carsharing and station car models to determine how to adapt, design, and implement such programs for a range of U.S markets. CarLink is one model that accomplishes this goal. CarLink integrates short-term rental vehicles and smart communication and reservation technologies to facilitate shared-vehicle access at transit stations or other activity locations. CarLink incorporates the convenience of a private automobile with the environmental and societal benefits of transit.

The CarLink project has three main research components: review of relevant literature, a longitudinal market survey, and an exploratory analysis of this carsharing model through a field test. The literature review and longitudinal survey analysis are presented in a separate Partners for Advanced Transit and Highways (PATH) report (Shaheen, 1999). See Section 1.2 below for a discussion of carsharing and station cars in North America.

The CarLink field test was a ten-month pilot program designed to investigate carsharing use and behavior primarily in the eastern portion of the San Francisco Bay Area. Launched on January 20, 1999, the CarLink field test[2] was an example of a "smart" carsharing (or station car) system designed to meet the unique travel patterns of this region. It incorporated traditional and reverse commute travel patterns and a day-use fleet application, tested at an employment center.

CarLink is based on partnership management. Partnership management is a framework in which carsharing providers partner with other agencies and businesses such as transit operators, gas stations, auto manufacturers, and local employers, to supply a shared-use vehicle service. The primary CarLink partners included the Institute of Transportation Studies at the University of California, Davis (ITS-Davis); American Honda Motor Company; the Bay Area Rapid Transit District (BART); the California Department of Transportation (Caltrans); and Lawrence

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[1] Bernard (1999) defines carsharing and station cars as separate concepts, though somewhat overlapping. Bernard characterizes carsharing as a European development that usually begins as a local cooperative (i.e., at the grass roots level) with one to two vehicles parked in several residential neighborhoods. "The station car concept (a U.S. approach) has several to many cars parked at central locations such as business and college campuses, high density residential areas, convention centers, airports, and transit stations for subscribers to make local trips, including going to work or home. Car-sharing vehicles are seldom used for commute trips. Station cars are generally small electric vehicles for environmental reasons, but other types of vehicles could and are being used to fit the situation" (Bernard, 1999). Under this definition, CarLink is a station car program. As with any developing concept, definitions are evolving. The authors of this report regard CarLink as a blend of both the station car and carsharing concepts, which are not mutually exclusive.

[2] A second smart field test, known as Intellishare, was launched in March 1999 in southern California with 15 Honda EV Plus electric vehicles, smart cards, and on-board computer technologies. The shared vehicles are available for day use by faculty, staff, and students at the University of California, Riverside campus.

Livermore National Laboratory (LLNL). These partners provided funding, technical assistance, and in-kind donations to test and evaluate this transportation alternative. Two smart technology partners also contributed to the field test: Teletrac and INVERS.

The Dublin/Pleasanton BART station was the main access point, or hub, for the CarLink vehicles (i.e., the cars were exchanged by Homeside and Workside participants at this location). This station facilitated intermodal tripmaking as well as vehicle access for several personal, commute, and work trips throughout the day. The Dublin/Pleasanton station is the terminus of the East Bay line; it attracts residents from the immediate surrounding areas as well as those living up to an hour away (e.g., Stockton and Modesto). It is also a convenient location for making connections to Oakland and San Francisco and all the East Bay.

LLNL served as the workside employment center for the field test. The Lab is a one square-mile facility, with offices scattered throughout the area. To aid in travel across the campus, LLNL provides an on-campus taxi service and bicycles for use. Employees pick bikes up and drop them off as needed, anywhere on-site. In addition, LLNL maintains a fleet of vehicles for official business use on and off the facility. Thus, vehicle sharing was already a familiar concept to many Lab employees. LLNL is located approximately 15 miles east of the Dublin/Pleasanton station. Bus connections between BART and the Lab are offered on a limited and fixed basis and require approximately 45 minutes in commute time. CarLink offered an alternative to the traditional bus linkage to and from the BART station.

During the field test, CarLink participants drove vehicles to and from the Dublin/Pleasanton BART station, LLNL, their homes, and other activity locations throughout the region. The field test enrolled 54[3] participants who shared a fleet of 12 Honda Civic compressed natural gas (CNG) vehicles.[4] Although 54 individuals were CarLink members, only 38 participants actually used the vehicles during the program. The CarLink model includes three separate user group structures: a Homeside User lease, transit links for Workside Commuters, and shared vehicle access at employment locations through a Day Use program. Each group paid a distinct fee according to the duration of car use and amount of time the vehicle was accessible. A brief description of each user group follows.

- ***Homeside Users*** drove a CarLink vehicle between home and the Dublin/Pleasanton BART station daily, keeping the car overnight and through the weekends for personal use. There was a fee of $200 per month for this package.

- ***Workside Commuters*** took BART to the Dublin/Pleasanton station and drove CarLink vehicles to and from work at LLNL. There was a fee of $60/month per car, which was shared with a co-worker by carpooling.

[3] The goal for the field test was to involve 60 participants in the CarLink program. This goal was not achieved due to a variety of reasons, including: program costs (i.e., Homeside User lease was too high for many households that already owned cars), technology issues/delays (e.g., limited CNG refueling infrastructure), limited program length, variability in employment, and lifestyle changes.

[4] All 12 CarLink vehicles were identical in model and color; by holding these variables constant, research focused on understanding participant response to the CarLink technology and usage models.

- ***Day Users*** employed CarLink vehicles for business trips or personal errands during the day. The fee was $1.50 per hour and $0.10 per mile for personal trips. Participants did not pay for work trips because LLNL donated the CNG fuel for this program.

All user fees included fuel, insurance, and maintenance costs. Roadside assistance and an emergency taxi service were also provided. Interestingly, neither of these latter options was used during the demonstration. In addition to vehicle support services, CarLink implementation staff supported the program, providing cleaning and occasional refueling services, as well as e-mail and phone contact for addressing user questions or problems.

Throughout the program, CarLink members provided data for the program evaluation (e.g., questionnaires and travel diaries). Participants were very cooperative in furnishing usage data and program feedback. CarLink members remained active in data collection, before, during, and after the field test. They completed initial- and post-program questionnaires, provided data about their travel patterns throughout operations, participated in household interviews and focus groups, and even interacted with the media.

This evaluation reviews the field test from an operational perspective, analyzes usage and questionnaire data collected throughout the program, and provides conclusions and recommendations based on these findings. Since the CarLink model is complex and incorporates advanced technologies, several logistical and technological issues were addressed during project planning and throughout the field test. This project was intended as a short-term, exploratory demonstration. Thus, findings provide insights into participant response to the CarLink concept and smart technologies and directions for future research. It would be inappropriate to generalize too broadly from such a limited and preliminary effort.

SECTION 1.2 CARSHARING AND STATION CARS IN NORTH AMERICA

Today, there are ten existing carsharing organizations in North America. They all share a similar operational model. Members access vehicles at a neighborhood lot located a short walking distance from their home or work site, and make carsharing reservations over the phone. One organization has recently implemented an automated reservation system based on a computerized, touch-tone telephone system. At present, none of these carsharing organizations (CSOs) use smart technologies to facilitate reservations, operations, and key management. Four of them are run as for-profit businesses, and the rest are run as nonprofit cooperatives. Recently, developments have been initiated to found the North American Car Sharing Association. See Table 1.1 (below) for a summary of the existing North American Carsharing Organizations.

Table 1.1: Summary of Existing North American CSOs				
Name	**Location**	**Start Date**	**Size**	**Business Strategy**
CommunAuto, Inc.	Montreal and Quebec, Canada	September 1995 & August 1997 (respectively)	1400 Members 86 Vehicles	Profit
Cooperative Auto Network	Vancouver, Canada	January 1997	450 Members 24 Vehicles	Non Profit
Victoria CarShare	Victoria, Canada	February 1997	70 Members 4 Vehicles	Non Profit
AutoShare-Car Sharing Network, Inc.	Toronto, Canada	October 1998	160 Members 13 Vehicles	Profit
BoulderCarShare Cooperative	Boulder, Colorado	May 1997	8 Members 1 Vehicle	Non Profit
Dancing Rabbit Vehicle Cooperative (DRVC)	Rutledge, Missouri	July 1997	15 Members 3 Vehicles	Non Profit
CarSharing Portland, Inc.	Portland, Oregon	February 1998	231 Members 14 Vehicles	Profit
Olympia Car Coop	Olympia, Washington	March 1998	6 Members 1 Vehicle	Non Profit
People's Car Co-op	Waterloo, Canada	June 1999	12 Members 1 Vehicle	Non Profit
Flexcar	Seattle, Washington	January 2000	150 Members 6 Vehicles	Profit

Five of the ten North American CSOs are located in Canada. The first and oldest is CommunAuto, which is located in Quebec City and Montreal. CommunAuto began operations in September 1995 in Quebec (as Auto-Com). CommunAuto launched in Montreal in 1997. CommunAuto currently has 1400 members and 86 cars. Interestingly, this organization began as a nonprofit cooperative, but changed to a for-profit business in 1997.

Less than two years later, two new Canadian CSOs emerged. In January 1997, the Cooperative Auto Network (CAN) began offering carsharing services in British Columbia. At present, CAN has 450 members and 24 vehicles. This CSO operates as a nonprofit cooperative. In February 1997, Victoria Car-Share Co-Op launched its operations in Victoria. This nonprofit cooperative currently has 70 members and four vehicles.

In October 1998, AutoShare–Car Sharing Network, Incorporated began its operations with three cars in downtown Toronto. During its first month of operation, 40 members joined, which is actually 15 members more than the CSO's initial projections. Currently, AutoShare has 13 vehicles and more than 160 members.

People's Car Co-op launched in June 1999 in Waterloo, Ontario. It currently has 12 members, utilizing one vehicle. People's Car Co-op is run as a not-for-profit venture. Five additional regions are developing carsharing plans in Calgary, Edmonton, Guelph, Kingston, and Ottawa.

Five carsharing organizations, all two years old or less, operate in the United States. Others are planned for Boston, Massachusetts; Chicago, Illinois; Corvallis, Oregon; Fort Collins, Colorado; San Francisco, California; Traverse City, Michigan; and Washington, DC.

Boulder CarShare Cooperative was launched in Boulder, Colorado, in May 1997. The Boulder CSO has eight members who share one vehicle. Members pay a modest monthly fee and mileage charges for vehicle use. This CSO also provides assistance to other neighborhood groups interested in forming a car co-op.

Dancing Rabbit Vehicle Cooperative (DRVC), located in Rutledge, Missouri, has been in operation since July 1997. This CSO currently has 15 members, three biodiesel vehicles, and supplies an average of 370 vehicle miles of travel per week to its members. DRVC operates under a nonprofit, cooperative business structure.

The Oregon Department of Environmental Quality and the U.S. Environmental Protection Agency funded a one-year carsharing pilot project in Portland, Oregon, which began operation in February 1998 with two Dodge Neons. Currently, CarSharing Portland, Inc. has 231 members, 14 vehicles, and 13 locations, and operates as a for-profit business (with government start-up subsidies). The fourth U.S. CSO, Olympia Car Coop, located in Olympia, Washington, has been in operation as a nonprofit cooperative since March 1998. Olympia has six members and one car. This operation guarantees that members use at least two weekend days per month and unlimited weekday usage. Olympia currently does not have an hourly charge nor a per mile fee. Members pay an initial and annual membership fee.

In January 2000, the city of Seattle, King County Metro, and University of Washington began the fifth U.S. CSO in Seattle's Capitol Hill region—a high-density neighborhood—with six vehicles. The University of Washington at Seattle will conduct the evaluation. Based on a contract with the City and Metro, Mobility Inc. operates the carsharing service with the goal of deploying 100 vehicles and enrolling 1,500 subscribers by the end of its first year. By the end of the second year, more than 200 vehicles are planned to serve residents and employees—the first target groups.

In part, funding for this project was secured due to the strong interest of Seattle's mayor, the King County executive, and several council members. The Seattle organizers hope to cultivate this project into a profitable private-sector venture sometime during the third year of operation. Additional partners (car rental, taxi, etc.) will also provide their services in conjunction with Mobility Inc. as part of a mobility package.

In San Francisco, a group of environmental organizations, planners, and transportation researchers, have formed a public-private partnership called City CarShare, which consists of public agencies and nonprofit organizations. City CarShare began seeking funds in late 1997. They hope to begin a three-year pilot operation in 2000, with 50 members and a minimum of eight cars, with the goal of reaching 100 vehicles by the project's end. City CarShare, a nonprofit organization, plans to locate vehicles in dense, transit-rich neighborhoods within San Francisco and will move into outlying city neighborhoods as membership grows.

In Chicago, a project called "ShareCarGo!" is also projected to begin operation in 2000, with a fleet of approximately 12 to 14 vehicles. ShareCarGo! hopes to service its anticipated membership of 100 people with five to six sites around the city.

1.2.1 Station Car Efforts

Better funded efforts to launch carsharing programs in the United States have their roots in "station cars." As mentioned earlier, the station car concept is a U.S. approach in which "…several cars are parked at central locations such as business and college campuses, high density residential areas, convention centers, airports, and transit stations for subscribers to make local trips, including going to work or home. Station cars are generally small electric vehicles for environmental reasons, but other types of vehicles could and are being used to fit the situation" (Bernard, 1999).

In several demonstrations, station cars have been deployed at transit stations in metropolitan areas and made available either near the home or work end of a commute. Station car demonstrations are at various stages of planning, funding, and implementation across the country. The largest was the BART station car demonstration program in the San Francisco area, with nearly 50 electric vehicles, including 40 PIVCO City Bees from Norway; two Toyota RAV-4s; and five Kewets from Denmark (Bernard and Collins, 1998). This project ended in the spring of 1998. Several activities are now underway to launch follow-up station car projects in the San Francisco Bay area, including CarLink II.

Several station car programs were launched in the mid 1990s by rail transit operators seeking to relieve parking shortages at stations (and desiring to avoid the high cost of building more parking infrastructure), by electric utilities eyeing a potential initial market for battery-powered electric vehicles, and by air quality regulators seeking to reduce vehicle usage and pollution. Most of these programs secured government grants to help address the high cost of first-generation electric cars. In mid-1998, the San Francisco station car program deployed two small multiple-use tests[5] (Bernard and Collins, 1998), followed by CarLink. In January 1999, BART released a proposal seeking a for-profit station car service with at least 25 cars each at four suburban BART stations. Hertz submitted a proposal in May 1999. Launch of this program is planned for early to mid-2000.

[5] These tests were deployed for periods ranging between one and two months. The projects are described briefly in (Bernard and Collins, 1998).

SECTION 1.3 REPORT OVERVIEW

This report is organized into six chapters. The second chapter analyzes the field test from an operational perspective. The third chapter, “CarLink Participant Profile,” provides an overall characterization of CarLink members and contrasts them to the longitudinal survey participants (Shaheen, 1999). The fourth chapter details CarLink “Usage Patterns” for each user group and also discusses program findings based on questionnaire data, household interviews, and focus groups. The fifth chapter provides an initial economic viability analysis for the CarLink field test, including a willingness to pay analysis and a discussion of short-term versus long-term costs. Finally, the sixth chapter provides conclusions and recommendations for future carsharing programs.

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CHAPTER TWO CARLINK: AN OPERATIONAL PERSPECTIVE

SECTION 2.0 INTRODUCTION

The CarLink field test integrated specific usage criteria (e.g., three user groups) and implementation mechanisms (e.g., technology, transit linkages, and an employment site). This section documents the field test from an operational perspective, identifying lessons learned and success factors.

As discussed in Chapter One, the purpose of the CarLink field test was to demonstrate, test, and evaluate a commuter-based carsharing model in the eastern portion of the San Francisco Bay Area. It consisted of three user groups, a fleet of 12 CNG Honda vehicles, and a project partnership among ITS-Davis, American Honda, BART, Caltrans, LLNL, Teletrac (i.e., the vehicle tracking technology vendor), and INVERS (i.e., the smart key manager technology provider). Fifty-four participants enrolled in CarLink to share a pool of vehicles in the East Bay area, beginning in January 1999. Ten vehicles were available for participant assignment at all times, and the remaining two cars were in reserve in case of participant illness, an accident, vehicle repair, or other emergency.

The CarLink demonstration provided an exploratory test bed for this shared-vehicle use model. During the deployment, many lessons were learned about consumer acceptance and adoption and several success factors were identified, many of which may be generalizable to other carsharing efforts. Evaluation topics include: partnership management, parking availability, user fee collection, technological performance, data collection, user satisfaction, and flexible services.

This chapter describes components of the CarLink field test from an operational perspective. There are three sections in this chapter, each addressing specific aspects of the field test. The first, “Key Model and Implementation Components,” discusses the major program elements and how they worked together. Primary issues arising during planning and operations are reviewed next. Finally, lessons learned and program success factors are discussed.

SECTION 2.1 KEY MODEL AND IMPLEMENTATION COMPONENTS

Significant experience and insights were gained throughout the field test. The human element of the demonstration required versatility in design (e.g., adapting user guidelines when necessary). Due to the wide range of participants and goals (e.g., those of the project partners, users, research staff, and operational staff), it was sometimes a challenge to provide program flexibility. For instance, CarLink membership was limited to a small sample of CarLink users (i.e., a maximum of 60 participants). This facilitated the authorization[1] and consistent monitoring of participants with regular vehicle access in contrast to a much larger user group. This allowed research to be conducted in a more controlled setting.

[1] Authorization included a DMV and credit check.

Major field test components included:

- Partnership management;
- Three user groups: Homeside Users, Workside Commuters, and Day Users;
- User fees determined by group;
- Smart technology: smart cards, key box manager, an Internet-based reservations system, a vehicle locator, and data collection; and
- Links to mass transit (BART).

2.1.1 Partnership Management

A unique and beneficial field test feature was project involvement by public and private organizations. CarLink partners provided crucial contributions to the design and implementation of the field test, including in-kind contributions (e.g., staff time, guaranteed parking, signs, and insurance). Each partner provided a unique perspective and contributed significantly to the program's success. The combination of their skills, insights, and commitment is realized in the understanding gained from the CarLink program. A brief description of each project partner and their contributions follows.

2.1.1.1 ITS-Davis

The Institute of Transportation Studies at UC Davis (ITS-Davis) provided program leadership and research throughout the CarLink field test. Contributions included:

- Providing a review of the literature on station cars and carsharing;
- Designing and implementing research parameters for the field test;
- Providing research expertise and project management;
- Facilitating project partner coordination; and
- Securing research and field test implementation funding.

The CarLink staff at ITS-Davis consisted of two groups: an implementation and an evaluation team. The implementation staff was overseen by the CarLink field test manager, Linda Novick. This team consisted of an administrative assistant, a graduate student, and several undergraduates who worked on day-to-day issues and operations. Much of their time was spent addressing participant questions/concerns and collecting and entering vehicle usage data. The evaluation team, led by Dr. Susan Shaheen, included a post-graduate researcher, a graduate student, and several undergraduates. ITS-Davis researchers conducted and analyzed surveys and vehicle usage data, household interviews, and a focus group, leading to this final report.

2.1.1.2 American Honda Motor Company

American Honda provided financial, in-kind support, and technical expertise throughout the field test. Specific contributions included:

- Providing and insuring twelve 1998 CNG Honda Civic vehicles;
- Conducting DMV record checks for all participants and "creating" user contracts;
- Working closely with ITS-Davis implementation staff and technology providers to ensure compatibility between the vehicles and information technologies;
- Hiring and providing operations staff to assist in cleaning and refueling the vehicles and oversee participant billing;
- Servicing the cars through a local Honda dealership; and
- Subscribing to an emergency roadside and guaranteed taxi service.

Convenient vehicle maintenance and services helped increase user confidence that the CarLink vehicles and service were reliable and safe.

2.1.1.3 BART District

The field test was designed to facilitate BART access and increase ridership. Homeside Users and Workside Commuters were required to ride BART, as part of their CarLink commute. In addition, Workside Commuters carpooled from the Dublin/Pleasanton BART station to LLNL, increasing program participation and BART ridership. BART contributions to the field test included:

- Providing 12 preferred parking spaces and signs for CarLink cars at the Dublin/Pleasanton station;
- Assisting in recruitment efforts by developing and displaying posters at the BART station and running advertisements in a local auto buyer's guide;
- Installing and providing phone lines and kiosk space for the smart key manager; and
- Offering technical expertise throughout the field test.

BART's experience with transit and station cars[2] was extremely useful in designing the system. Since transit is a key component of the CarLink model, BART's demographic and customer knowledge were essential.

2.1.1.4 California Department of Transportation (Caltrans)

Caltrans provided crucial public sector support for the field test through in-kind staffing expertise and implementation funding. Contributions included:

- Supplying operational funds for the ITS-Davis implementation team;
- Providing financial resources to purchase computers for data tracking and analysis; and
- Contributing to day-to-day program operations by developing solutions to deployment issues as they arose and working with ITS-Davis staff to develop ideas for future research.

[2] BART previously operated a station car project with 40 electric vehicles.

By supplying their knowledge and input, Caltrans helped project partners implement the system that ITS-Davis researchers evaluated in this study.

2.1.1.5 Lawrence Livermore National Laboratory (LLNL)

LLNL supported the Workside Commuter and Day Use components of the program. Furthermore, the Lab offered a unique "culture" and environment for the CarLink field test (e.g., many participants were scientists and worked flexible schedules). LLNL contributions included:

- Providing legal services to develop the project partner Memorandum of Understanding for the demonstration;
- Donating CNG fuel and staff time to train CarLink participants to refuel vehicles;
- Providing car wash facilities at no charge;
- Offering on-site tire repair; and
- Providing CarLink signs at five lots throughout the Lab.

In the future, employers may be motivated to reduce vehicular use to participate in shared-use programs to reduce fleet size and parking needs, meet air-quality guidelines, or increase the mobility options of employees. The Lab's involvement provided researchers an opportunity to evaluate use and potential benefits of the CarLink Workside Commuter and Day Use programs.

2.1.2 CarLink Users

Participant recruitment was a primary task in the demonstration. The CarLink model includes three user groups: Homeside Users, Workside Commuters, and Day Users. Overall, many participants were willing to adjust their established routines to integrate CarLink into their lifestyles. Each user group required a different recruitment strategy, detailed in the descriptions below.

All users attended an orientation to learn how to use the system, including a vehicle refueling session for the LLNL employees, and they had a DMV and credit check. Participants received documentation regarding the CarLink field test, including a Frequently Asked Questions (FAQ) factsheet and a CarLink User Manual. As the program progressed, the User Manual was revised (to address changes in the Day Use program and data collection methods). The factsheet and final User Manual are included in the Appendix to this report. In addition to these materials, verbal and e-mail exchanges played a key role in clarifying program concerns and questions throughout recruitment and the field test.

2.1.2.1 Homeside Users

All Homeside Users lived within driving distance of the Dublin/Pleasanton station and commuted using BART. Participants were recruited from the areas surrounding the Dublin/Pleasanton BART station. A number of methods were employed to attract individuals to the program. Among the most effective methods were large posters displayed at the Dublin/Pleasanton station and a CarLink information table at BART, staffed by ITS-Davis employees. In addition, local newspaper articles (e.g., *Tri Valley Herald*) about the program attracted several participants. Other methods, such as advertising in a local auto buyer's guide (i.e., the *Diablo Dealer*) were less effective.

It is not surprising that all Homeside Users were already using BART for at least part of their week, since one program requirement was regular BART use and much of the recruitment took place at BART. The program was designed to integrate new participants as the program progressed (i.e., a rolling start). Five Homeside User households joined the program in January 1999. Within two months, this group reached its maximum capacity, with ten enrolled households. Although this group filled up relatively quickly, a few recruitment issues were noted, including high program costs (i.e., $200/month) for households already owning a vehicle[3] and limited participation parameters (i.e., Homeside Users had to use BART and adhere to specified commute hours). In addition, the limited nature of the program (i.e., initially just six months) did not warrant the sale of a family vehicle. In their evaluation of the San Francisco Bay Area Station Car Demonstration project, Bernard and Collins (1998) also found that program permanence is critical to behavioral adoption and change. Despite this, one household sold a vehicle early in the CarLink program.

Initially, the program started with four Homeside Users from outlying regions (i.e., over a 45-minute drive from the Dublin/Pleasanton station), although all users were limited to a 150-mile range to restrict potential towing distances. After two months, it became apparent that long-distance vehicle use was incompatible with the limited fueling infrastructure. Vehicles were frequently returned to the BART station without enough fuel to support the travel patterns of Homeside and Workside Commuters. To ensure that Homeside Users had enough fuel for their evening and morning commutes, daily refueling by a CarLink employee was often required. This put an additional burden on program efficiency. Although several solutions were attempted, including the use of fuel cards and restricted weekend use, the heavy fueling demands of long-distance users still strained the program. In May 1999, long-distance participants were asked to leave the program. While this group was disappointed, it was evident that the combination of limited CNG infrastructure in the region and infrequent refueling at LLNL made their participation impractical. In the future, these issues could be addressed by deploying internal combustion engine vehicles in conjunction with fuel cards and by monitoring users' fuel consumption in real time.

2.1.2.2 *Workside Commuters*

[3] CarLink vehicles most often served as additional household vehicles.

Since LLNL was selected as the employment site for the field test, Workside Commuter recruitment was targeted at the Lab. Recruitment was conducted through NEWSONLINE, an internally circulated, Internet-based newsletter; a weekly LLNL bulletin (i.e., *NewsLine*); and by word of mouth. Each of these devices proved effective. After individuals decided to join the CarLink program, their schedules had to be matched because carpooling was a key component of the Workside Commuter program. Through carpooling, CarLink was able to serve more transit and carsharing customers.

Workside Commuters were phased into the program at the same time as the Homeside Users, on a limited basis. Four carpools (i.e., eight participants) started on January 20, 1999. By the following week, there were five carpools, and at the end of the first month, there were six—increasing to nine in March.[4] Since schedule coordination between these two groups was critical to program success, a phased approach was sensible.

At the beginning of the program, a few individuals missed their designated carpool partner and had to take another CarLink vehicle to LLNL (i.e., driving one of the extra, unassigned CarLink vehicles or sharing a ride in another CarLink carpool). Once the carpools were finalized, this part of the program ran more smoothly. Workside Commuters communicated with each other regarding their schedules and were contacted if changes were needed. Only one participant left the program due partly to the carpooling requirement.

There was a perception among some Workside Commuters, however, that there was more program flexibility than the CarLink guidelines specified. For instance, one individual suggested that he would like to drive and park his personal vehicle at the Dublin/Pleasanton BART station, meet other participants, and carpool to work in a CarLink vehicle. The reason for this is that his home was not located in close proximity of a BART station.

Another Workside Commuter mistakenly thought that he could occasionally drive a CarLink vehicle home rather than returning it to the BART station. This individual drove a CarLink vehicle home and returned it to LLNL the next morning. Since these trips were recorded in the CarLink vehicle trip diary,[5] researchers clarified the program guidelines to this individual, and he stopped using the vehicles in this manner. This anecdote illustrates that individuals may wish to use vehicles in this manner from time to time and that the program guidelines should be strengthened or updated.

2.1.2.3 Day Use

Day Use recruitment at LLNL took place during the early program months. Recruitment was conducted through the NEWSONLINE service at the Lab, with the goal of enrolling 30 participants (22 individuals actually enrolled and only six used the system). The objective was to provide participants with consistent vehicle access during the day for

[4] Two of the carpools contained three individuals; that is, one person carpooled both ways, while the other two drove a CarLink vehicle alone one way.
[5] This indicated that he considered this type of usage permissible.

business and personal trips. Many LLNL employees who use a range of modes to get to work, such as vanpools, carpools, bicycles, and walking expressed interest in Day Use. The carsharing fleet provided supplemental vehicles for personal trips during the day (e.g., going to lunch or running errands), particularly because LLNL is located far from restaurants, shopping, and other services. Day Users were of great assistance to the CarLink implementation staff, volunteering as vehicle monitors and developing the Internet-based reservation system.

Interestingly, only one Day User actually used the vehicles for business trips, although they were available for this purpose. Most used LLNL vehicles for business trips. Thus, the CarLink fleet was redundant for such trips. An important issue to explore is whether Day Use can prosper in a location with an existing business fleet. It appears that Day Use would be most successful in locations that want to replace, augment,[6] or create a shared-use fleet. If employees do not use carsharing vehicles for business trips the fleet may be underutilized.

Although the first Day Use orientation session was conducted in January, actual implementation was not possible until July 1999. Delays occurred for several reasons. First, a Day Use reservation system was needed to ensure cars were available for users. Second, vehicle tracking system difficulties (e.g., poor radio-frequency reception and transmission) made it impossible to locate vehicles and collect trip purpose data.[7] Because Teletrac terminated their service in the area in June, it became apparent that an alternative data collection method (i.e., vehicle trip diaries) was necessary to implement Day Use. To ensure good vehicle access, five designated parking lots were phased into the program, beginning with the CNG refueling lot.

By July, all Day Users had to attend a second orientation session to re-enroll in the Day Use program. Fewer individuals than expected participated in the program due to the late start-up, summer vacations, and the lot "phase in" approach (i.e., many individuals did not want to walk long distances to access CarLink cars). Despite the delays and other program difficulties, many participants liked the Day Use program. If started earlier, it could have served more individuals. Consequently, further Day Use testing is needed to evaluate participant demand and program use, as well as the types and frequency of midday trips.

SECTION 2.2 ISSUES AND RESOLUTIONS

While carsharing can offer the convenience of a private automobile at a reduced cost, it often involves sophisticated coordination, not required by traditional vehicle ownership. Thus, researchers expected initial concerns to focus on scheduling. However, most scheduling issues were addressed in the first few weeks of the program. More prominent

[6] It is important to note that LLNL wanted to augment their business fleet through CarLink participation, although most participants did not use the vehicles for this purpose.

[7] Trip purpose data were needed for LLNL insurance purposes. LLNL only covered "business" trips and needed to distinguish between business and personal trips at all times.

CarLink User concerns related to CNG refueling issues, safety, and maintenance. CarLink provided a test bed for addressing many of these issues.

The CarLink demonstration helped researchers identify key implementation issues relevant to a commuter-based carsharing program. The field test necessitated schedule and location coordination to ensure system reliability and on-time arrivals. Although many implementation issues were addressed during planning, several problems developed throughout the field test. Many of these issues contributed to deeper understanding.

Table 2.1 (CarLink Issues and Resolutions) below outlines key issues, disaggregated by planning and implementation, and subsequent resolutions. A detailed discussion of each item follows the table. While many issues were anticipated, many solutions required specific, situational knowledge of system use.

Table 2.1: CarLink Issues and Resolutions

Planning Issue	Resolution
Car availability at BART (i.e., cars need to be returned in time for next user group)	• Collected commute schedules of Homeside Users and Workside Commuters. • Organized carpools to accommodate schedule changes. • Specified times that cars would be available in mornings and afternoons at BART. • Provided extra vehicle(s) at BART station.
Vehicle maintenance and emergencies (i.e., plan for efficient vehicle management)	• Hired CarLink operational personnel to provide quick response. • Subscribed to a 24-hour emergency roadside assistance service. • Contracted with a local Honda dealership for expedited vehicle servicing and repairs. • Provided spare “hide-a-keys” for emergencies.
Vehicle refueling	• Established guideline that vehicles must be refueled by LLNL CarLink members, whenever possible. • Provided that vehicles must be returned to BART with no less than 1/4 tank of fuel. • Considered offering fuel cards to Homeside Users for fueling outside of LLNL, but did not implement until deemed necessary. • Required CNG fueling training of all LLNL participants.
Vehicle cleanliness (i.e., in-vehicle debris left and car washing)	• Notified users about cleaning trash from vehicles after use. • Provided CarLink operations staff to clean and drive cars through the LLNL car wash weekly or more frequently if needed.
Vehicle insurance	• Provided by Honda as an umbrella policy for all CarLink trips. • Covered by LLNL for business trips (in addition to Honda coverage).
Carpool scheduling and billing	• Communicated with participants about carpooling

	partners. • Reorganized carpools as needed, based on schedules and work sites. • Billed each user (i.e., $30/month) directly versus each car (i.e., $60/month) to simplify user fee collection.
Vehicle tracking system (i.e., needed for research and insurance liability issues)	• Purchased and installed Teletrac radio-frequency-based vehicle tracking system to collect user data and distinguish between personal and business trips by Day Users for LLNL liability issues.
Smart key manager box (i.e., to disseminate keys at central location)	• Installed at BART station. • Standing reservations for Homeside Users and Workside Commuters were made with smart key manager system.
Manual key boxes at LLNL	• Manual key boxes were installed at each LLNL CarLink lot.
Implementation Issue	**Resolution**
Parking lot assignments (i.e., more and different lot locations were required at LLNL)	• Expanded from three to five parking lots, with designated CarLink spaces, at LLNL. • Changed initially selected parking lots to new locations with input from LLNL CarLink participants.
CNG refueling (i.e., demands on fuel were greater than expected and LLNL infrastructure improvements needed)	• Asked long-distance users to leave program in April 1999. • Placed extra cars at CNG refueling station to remove refueling wait times. • Upgraded CNG infrastructure at LLNL to reduce fueling times. • Allowed Homeside Users to obtain fuel cards for fueling, if necessary, for evenings and weekends. • Instructions for refueling at LLNL were unclear (reported by participants at program end, so this issue was not addressed).
Smart vehicle tracking/data collection system (i.e., chosen system did not work effectively)	• Attempted to diagnose and repair data transmission problems. • Implemented a manual data collection method (i.e., travel diaries in CarLink vehicles) after Teletrac services were discontinued (i.e., radio frequency tower coverage was no longer available in the field test area).
Day Use reservations system (i.e., LLNL employees requested an Internet-based system, but it was not accessible to users at home)	• An LLNL employee developed an Internet-based reservations page for Day Use. • Reservations were made through the Internet page and supported by LLNL volunteer vehicle monitors.
Lost and found system developed for CarLink program	• Created a lost and found center at LLNL for retrieving items left in CarLink vehicles.

2.2.1 Car Availability at BART

CarLink cars were exchanged between the Homeside and Workside Commuter groups at the Dublin/Pleasanton BART station. The main user concern focused on vehicle availability at the BART station in the morning and afternoon. Standing reservations were established for Homeside Users and Workside Commuters, allowing the key manager to release keys to them.

During the first month of the field test, a few Homeside Users reported there were no cars available when they arrived at BART. These instances occurred when several users arrived earlier or later than their scheduled times. Alternatively, there was a car available but the user felt it was insufficiently fueled. In all cases but one, a car arrived at the BART station within five to 15 minutes (there was one exception in which a participant caught a ride with a fellow user after waiting 15 minutes). Users expressed their frustration when this occurred. However, all were willing to wait for a car and did not use the guaranteed taxi service. Short of reducing the user-to-vehicle ratio,[8] one way to solve this issue might be to enforce a narrower commute window.

A few factors contributed to the initial wait times. First, some Homeside Users arrived in the afternoon before their scheduled times. Second, Workside Commuters with more flexible schedules returned to the BART station later than scheduled. Wait times were no longer than 15 minutes. (BART trains arrive at the Dublin/Pleasanton station every 15 minutes.) Therefore, participants generally planned departure and arrival times according to BART schedules and CarLink reservation times. Wait times were resolved after CarLink members became accustomed with the program parameters. After a few weeks, Homeside and Workside Commuters no longer expected cars to be available outside their standing reservation times.

Frequently throughout the program, CarLink implementation staff learned that individuals were not carpooling, reducing the number of available vehicles at the BART station. This problem was compounded by the flexible schedules of LLNL employees. Many employees arrived at variable hours and worked later in the afternoon. Initially, this problem was addressed by re-organizing carpools so individuals with similar schedules were paired. In addition, e-mail and phone reminders throughout the program helped manage this situation. Finally, one or more back-up vehicles were available at the BART station for Workside Commuter carpools.

2.2.2 Maintenance and Emergencies

Maintenance and emergency services were included in the CarLink fee for each user group. Maintenance was conducted by a local Honda dealership and coordinated by CarLink operations staff. Roadside emergency assistance and a back-up taxi service were also provided, but the guaranteed ride service was never used. Although this service was not employed, it was critical for program enrollment. Bernard and Collins (1998) also noted that technical support staff are needed to maintain a shared-use fleet. Although the station car demonstration employed prototype electric vehicles, maintenance of the CNG Honda Civics necessitated field support staff, as well.

In the case a vehicle key was lost or the smart key box malfunctioned, a spare key was placed in a hidden location for emergency use. In one instance, a participant, who was locked outside a CarLink vehicle, forgot about the spare key and tried to use the roadside assistance service. However, he was unable to obtain assistance. Soon after, CarLink

[8] The user-to-vehicle ratio is the average number of users to program vehicles.

implementation staff discovered that the service operator had not heard of the project. The field test was referred to as the "CNG program" rather than CarLink, which confused her. Once the correct program information was entered into the operator's system, participants could obtain service by providing their CarLink vehicle identification number. After this occasion, however, no one contacted the emergency service again.

2.2.3 Refueling of CNG Vehicles

As mentioned earlier, the CarLink vehicles were fueled by compressed natural gas (CNG). During the program, Workside Commuters and Day Users were responsible for vehicle fueling, with CarLink implementation staff assistance. The alternative-fuel vehicle component of the demonstration presented several obstacles to program efficiency during the early project months. CNG problems included limited infrastructure in the field test area, heavy fueling demands of long-distance commuters, inconsistent refueling by users, and needed infrastructure upgrades at the Lab.

The study area offered a limited CNG infrastructure outside of LLNL. Indeed, there were only two local sites available for CNG fueling in close proximity to the Dublin/Pleasanton station (i.e., LLNL and a Pacific Gas & Electric facility, located in San Ramon—approximately 10 miles from the BART station and 25 miles from LLNL). The principal fueling station for CarLink was located at LLNL.[9] Furthermore, LLNL's CNG infrastructure warranted upgrade because the tanks did not offer adequate fueling pressure levels. Optimal CNG fuel pressure was 3600 psi, which provides the longest range (i.e., 275-300 miles). At the beginning of the program, pressure levels were often below 3000 or the infrastructure was inoperable due to internal LLNL issues. Restrictive pressure levels often resulted in more frequent refueling and fewer miles driven per tank. Mid-way through the demonstration, LLNL provided some upgrades (to 3200 psi), but the pumps still did not operate at the highest possible level.

Due to these issues, some Workside Commuters spent an additional half-hour per day refueling cars initially,[10] and CarLink implementation staff spent three to four days per week refueling the vehicles. To help address these issues, several strategies were implemented. First, Homeside User weekend mileage was restricted (i.e., to 120 miles). Second, one of the extra CarLink vehicles was moved from the BART station to the CNG fueling lot. The extra car permitted Workside Commuters to use the refueled spare immediately and leave their vehicle to refuel each morning. Third, fuel cards were issued to long-distance Homeside Users who requested them. Fourth, long-distance commuters were asked to leave the program. Fifth, CNG infrastructure repairs and upgrades were implemented. Sixth, those LLNL participants, who were not refueling as often as required, were reminded to do so. Finally, weekend vehicle range restrictions were relaxed for households that properly refueled vehicles. Together, these solutions helped

[9] Participants, who received authorization from Honda and appropriate training, could receive a refueling card for use at other CNG stations during the program. However, the individual member paid for fuel purchased at other locations.

[10] The LLNL refueling facility was not "fast fill," which would have required no more time than fueling a gasoline vehicle at a conventional station.

to alleviate refueling demands and allowed the program to operate much more smoothly. Nevertheless, program efficiency was limited, which indirectly affected membership and use. In the future, refueling issues could be addressed by employing internal combustion engine vehicles (at least until the CNG infrastructure is expanded), issuing fuel cards, and requiring/enforcing all participants to refuel vehicles below one-quarter tank.

2.2.4 Vehicle Cleanliness

One of the obvious concerns of a carsharing program is how to maintain vehicle cleanliness (i.e., interior and exterior) among a variety of individuals and lifestyles. To address these issues, the vehicles were washed regularly by operations staff at the LLNL car wash. Staff and users worked together to keep the vehicle interiors clean. Occasionally, CarLink staff reminded participants to remove trash from the vehicles via e-mail communications. Although the weekly vehicle cleaning service provided by CarLink helped to alleviate this issue, vehicle cleanliness continued to be a chronic issue throughout the program (as it is with most fleet management).

2.2.5 Insurance

During the design phase of the test, CarLink insurance coverage for participants and vehicles was addressed. Insurance for varied vehicle use necessitated that users log their trip purpose. For instance, CarLink vehicles were used at LLNL for both business and personal use. These uses were handled differently by LLNL insurance providers (i.e., LLNL covered business uses only). Ultimately, Honda provided an umbrella policy for the entire CarLink fleet, including business Day Use.

2.2.6 Carpooling

The CarLink program required carpooling for Workside Commuters. The rationale for this is that more BART participants could be served by carpools, thereby lowering program fees and increasing the societal gains. Despite its many benefits, carpooling coordination was complicated because many LLNL employees worked flexible schedules.

At the onset of the CarLink program, a few Workside Commuters missed their carpool connections at the BART station. Carpooling worked much more smoothly after individuals began to factor BART into their CarLink commute schedules and maintain regular communications with partners. Most carpool participants developed their own communication tools, such as cell phones to communicate during morning commutes, establishing maximum wait times, and adhering to BART schedules. While many Workside Commuters adhered to the carpooling guidelines of the CarLink program, several users continued to drive to work alone from BART to LLNL throughout the program. This issue did not develop into a serious problem because participation levels fluctuated throughout the field test, resulting in additional fleet vehicles (i.e., beyond the two extra CarLink vehicles). If participation levels had reached program capacity, the solo-driving trend of several Workside Commuters would have caused a vehicle shortage

and likely triggered the guaranteed ride service. As noted earlier, the ride service was not used during the field test. In the future, carsharing technology could be developed that limits Workside Commuter access to additional program vehicles beyond a few times each month.

Another carpooling issue involved monthly billing. Initially, CarLink operations staff planned to bill each carpool rather than each individual participant. However, carpool members insisted this process be amended so each individual was billed separately and monetary arrangements did not complicate their carpool relationships. The billing issue arose during the first program month and was resolved quickly.

2.2.7 Smart Vehicle Navigation and Data Collection System (Teletrac)

The CarLink project partners selected the Teletrac vehicle locator and data collection system based on its data collection abilities, regional availability, and cost. The vehicle location system was designed to track vehicles and collect data. Specified data included: an individual's ID number, trip purpose, and vehicle miles driven.

The Teletrac radio-frequency-based tracking system was implemented to allow participants to enter data, the operations staff to track vehicles in real-time, and evaluation staff to gather automated data for research. Furthermore, it allowed CarLink implementation staff to locate vehicles (for a brief time). Participants were interested in the automated nature of the tracking device and the opportunity to use this technology. From a research perspective, this technology would have made data collection more efficient, had it worked in practice, than the manual travel diary method eventually implemented.

Despite the project goals, there were extensive, unanticipated problems associated with the Teletrac system in the Bay area.[11] The majority of problems could not be repaired for consistent data transmission; often much of the trip data were not received. During the first six months, however, the vehicle location system was operational. In June, Teletrac ceased to provide radio frequency coverage in the Bay area, and later the company declared bankruptcy. Subsequently, in-vehicle travel diaries were used to collect vehicle usage data. Although the manual data collection was not the preferred method of researchers or participants, it succeeded in providing sufficient data for the field test evaluation.

2.2.8 Key Box Manager

The smart key manager[12] was instrumental in providing car access and reservations for Homeside Users and Workside Commuters at the Dublin/Pleasanton BART station.

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[11] It is important to note that Teletrac is being used successfully by UC Riverside and Honda in their smart carsharing project, called Intellishare, in the Los Angeles area.

[12] INVERS, a private German company, provided the smart carsharing key system for the CarLink project. The smart key system is comprised of three components: a key dispenser, a reservations system called Carsharing Organization and Communication System (COCOS), and a fleet management system called COCOS Universal Communication Manager (CUCUM).

INVERS employed this system in many European locations and modified it so it could be used in the U.S. The smart key manager was installed at the Dublin/Pleasanton station close to the CarLink parking lot at the BART station.

The key manager responded to individual "smart cards" (similar to an ATM system) and recognized users by distinct ID numbers. If positively identified, the key manager randomly assigned vehicle keys to each customer. Users returned vehicle keys to the smart key box after returning CarLink vehicles to the BART station. For the majority of the program, this system worked very well. In addition to key management, the system collected, stored, and communicated data about vehicle use. Furthermore, it provided a two-way flow of information between a central control computer (i.e., located at ITS-Davis) and the key manager. In the final program month, however, a problem arose between the electronic key manager hardware and the modem that relayed user reservations. As a result, several components were returned to Germany for repair. This was necessary because of compatibility issues between U.S. and European communication standards.

The COCOS key box system was developed for a single-lot design (i.e., vehicles are rented and returned to the same lot).[13] As such, this system was not ideal for the CarLink model, which includes multiple lots from which vehicles may be rented and returned. Since the key system could not be easily and inexpensively modified for a multi-lot program, manual key boxes were used at LLNL. At the time of this demonstration, COCOS was the only smart key management system available for purchase.

2.2.9 Parking Lot Assignments

Identifying the best parking configuration at LLNL was a challenge. The LLNL campus is one square-mile in size. Participant offices were scattered throughout the Lab. At the beginning of the CarLink field test, one central parking lot was identified for program use. In theory, this strategy should have worked because the Lab provides a taxi shuttle and shared-use bicycles for all employees. However, in the first program month, it became apparent that a central parking location was inconvenient for many participants. Decentralized parking would make a big difference in many individuals' commute time, and thus increase CarLink satisfaction. Consequently, a new lot configuration was adopted early in the demonstration.

First three, and subsequently five, parking structures were identified as CarLink lots, with designated parking spaces and manual key box installations. CarLink signs were posted in each lot, and LLNL security began ticketing cars parked in CarLink spaces. Several carpools consisted of members who worked at different LLNL locations. Drivers of such vehicles would drop partners off at distant sites and park at a nearby CarLink lot. Parking modifications, made during the early program months, remained in operation throughout the field test.

[13] It is important to note that both the COCOS key manager and stand-alone smart card, keyless entry systems are currently being used successfully in Singapore and throughout Europe.

While the lots were modified with participant input, a few Workside Commuters began parking at their offices, despite designated CarLink parking. This made it difficult for CarLink operations staff to locate cars for maintenance and cleaning. This also presented a potential problem for the Day Use program, implemented in July.[14] This parking issue was resolved by identifying specific violators and explaining the necessity of assigned parking spaces. Since Day Use provided a concrete and immediate reason for restricted parking, no violations occurred after the program began.

2.2.10 Reservation System

Homeside and Workside Commuter schedules were relatively constant throughout the program. Standing reservations were made for these two user groups, using the COCOS key manager system. For the Day Use program, an LLNL participant developed the Internet-based reservation system. The LLNL reservation page was installed on the Lab's Internet system for convenience; however, due to security it was only accessible at LLNL. Furthermore, vehicle locations were not available on the Internet site because the reservation page was not integrated with Teletrac or the smart key manager.[15]

At the beginning of the Day Use program, there were a couple of instances in which participants were unable to find a vehicle at a specified lot. The problem-solving nature of LLNL participants and the backup instructions specified in the Day Use Manual (please see Appendix to this report) kept frustration to a minimum. Over the next few weeks, the reservation page was revised, more lots were opened, and the Day Use program ran more smoothly. Ultimately, an extra car was placed at LLNL as a Day Use backup vehicle.[16]

2.2.11 Lost and Found

The CarLink field test was designed to assign vehicles randomly to program participants. Consequently, if a user left a personal item (e.g., sunglasses) in a vehicle, there was a high likelihood that they would not travel in the same vehicle subsequently. In response, a lost and found was established at LLNL to address this issue.

SECTION 2.3 LESSONS LEARNED AND SUCCESS FACTORS

One of the field test goals is to identify successful program elements and recommendations. Although the CarLink field test involved several challenges, the program provided transportation services to 38 active participants. As discussed in the first chapter, the purpose of the CarLink field test was to demonstrate, test, and evaluate a commuter-based carsharing model in the eastern portion of the San Francisco Bay area. The ten-month CarLink demonstration implemented and tested three model user groups

[14] Individuals who had a CarLink reservation found it difficult to locate their reserved vehicle.
[15] It is important to note that there is no possible system that would ensure drivers return vehicles at specified times, so others with a reservation are not stranded.
[16] This was possible because the size of the Workside Commuter and Homeside User groups had fallen below the ten-vehicle capacity.

and data were collected throughout. Participants used CarLink as an alternative to their traditional commute. In addition, the field test provided an opportunity to test smart technology to facilitate carsharing.

This evaluation addresses lessons learned and factors contributing to program success. There are six key lessons learned, which are also instructive for future programs. Researchers identified these issues by evaluating the list of program issues and resolutions in the previous section. Table 2.2 below outlines these elements. They include:

- Lack of CNG infrastructure,
- Key box limitations,
- Radio frequency tracking issues,
- Reservation system limitations,
- Carpool adherence, and
- Vehicle cleanliness issues.

In particular, the CNG fuel infrastructure component of this project was a limiting factor, although not insurmountable. The other factors require modification for future success.

The CarLink program tested several systems and found that an integrated technology would best suit the needs of shared-use vehicle management. CarLink key box, vehicle tracking, and reservation limitations support the findings of the station car demonstration that untested technologies pose higher deployment risks (Bernard and Collins, 1998).

CarLink carpool results also provide support for station car findings that participants do not always use vehicles as designated. Indeed, there were several instances in both demonstrations that users took vehicles to undesignated locations (Bernard and Collins, 1998).

Table 2.2: CarLink Lessons Learned	
Key Program Factors	**Lessons Learned**
Limited CNG infrastructure (i.e., all CarLink vehicles used CNG fuel and refueled at LLNL)	• Infrastructure in Tri-Valley area did not support CNG vehicles. • Limited refueling at LLNL was frustrating to users. • CNG component restricted vehicle range and participation (e.g., long-distance commuters were asked to leave the program). • Users did not refuel the vehicles as frequently as agreed. • Use of CNG vehicles in field test distracts from carsharing evaluation; thus this model should be tested with internal combustion engine (ICE) vehicles and fuel cards. ICE vehicles would alleviate infrastructure-related refueling issues but not behavioral ones.
Multiple key box system limitations (i.e., smart system located at BART station and several key boxes at LLNL)	• The smart key manager was designed for a centralized system. It did not operate efficiently with CarLink's decentralized, commuter-based approach. • The smart key manager was manufactured in Germany, causing repair delays. • There was no integration between the smart key manager and the LLNL key boxes. • A stand alone "smart card" approach should be developed and tested in which fixed key manager lots are not needed. In contrast, participants could access vehicles with smart cards alone.
Vehicle tracking system limitations (i.e., tracking and data collection operations were not linked with billing and reservations)	• Vehicle tracking system (RF-based) did not function properly in collecting data and tracking vehicles throughout program. • A satellite-based tracking system, perhaps linked with radio-frequency communication, should be tested. • Vehicle location and usage data should be linked to a reservations and billing system to provide an integrated carsharing system.
Reservations system limitations (i.e., the LLNL reservations system was not linked to other technologies)	• System could not identify location of available vehicles. • Security issues at LLNL prevented users and CarLink implementation staff from accessing Internet reservations page offsite. • Day Use reservations required human interface and were not linked with vehicle location system.
Workside Commuter carpool adherence issues (i.e., some participants failed to carpool regularly)	• CarLink implementation staff communicated with participants about need to drive with designated carpool partners. • Several Workside Commuters continued to take additional vehicles (i.e., commuted alone) throughout the program, despite CarLink implementation staff communications.
Vehicle cleanliness issues (i.e., in-vehicle debris)	• Provided CarLink operations staff to clean and wash cars, in addition to participants. Nevertheless, vehicle cleanliness continued to be a chronic issue throughout the program.
Day Use program underutilized	• The Day Use program would work best when the carsharing fleet is used for both business and personal use. • Any delays in implementation will lead to higher attrition rates. • Parking lots should be convenient and easy to access.

Several success factors were also identified as a result of the field test. These include partnership management, preferred parking incentives, smart technology (i.e., smart card access and automated data collection methods), program flexibility and user satisfaction,

user fee collection, and media coverage. These factors are outlined in Table 2.3 below and addressed in more detail in the following text.

Table 2.3: CarLink Success Factors

Program Success Factors	Evaluation
Partnership management (i.e., coordination of multiple partners to meet individual and field test goals)	• Facilitated flexible deployment (Bernard and Collins, 1998). • Coordination of meetings and brainstorming discussions (Bernard and Collins, 1998) was time-consuming, but resulted in a better program. • Partner Memorandum of Understanding (MOU) was resource intensive to develop, but necessary to document and establish the critical partner understanding. • Continuing partnership is critical to CarLink model: communicate with regular meetings and e-mails.
Guaranteed parking (i.e., BART and LLNL)	• Guaranteed parking at BART station where CarLink cars were located was a huge program incentive. • Providing designated parking at workside location is an added convenience. • Continue guaranteed (preferred, if possible) parking and consider instituting other participant incentives (e.g., reduced transit fares, discounts at local stores, etc.).
Smart technology (i.e. smart cards, data collection, user acceptance)	• Smart cards were a program plus. • Technology assisted in recruitment. • Technology facilitated a complex shared-use design with limited staff resources for key dispersal at BART. • Smart technology can aid significantly in data collection, when functional. • Integrate smart technologies for vehicle access, tracking, emergency response, data collection, and reservations. • Test technologies before program startup (Bernard and Collins, 1998).
Program flexibility and user satisfaction	• User participation did not diminish as new issues arose. • Personal contact with users was high, which enabled rapid response to issues. • Program flexibility (Bernard and Collins, 1998) and user responsiveness are key factors for program success.
User fees	• Reasonable fees for CarLink use are critical to program acceptance/adoption. • Establish usage fees by conducting focus groups with potential users prior to project implementation.
Media (print, radio, television)	• Media interest in CarLink was unexpectedly high. • Positive media stories increased interest in CarLink and carsharing. • Market future programs to public through media coverage, if possible (i.e., reduce advertising expense).
Data collection	• Data collection (i.e., Teletrac or travel diaries) continued uninterrupted during the field test. • Smart technology (i.e., Teletrac) was designed to collect usage data and manual travel diaries were used as a backup. • Develop and test an automated vehicle tracking and data collection system to collect user data. Integrate data collection system with billing and reservations systems, if possible.

2.3.1 Partnership Management

The CarLink field test was based on a partnership of public and private organizations (also known as partnership management). This required balancing partner goals with research objectives, which was often a complex task. The process of coordinating schedules, decision making, and communications was also challenging and time consuming. For example, the CarLink Memorandum of Understanding (MOU) among the partners required over nine months to develop and finalize. Additional time was dedicated to partner meetings and weekly project partner updates (i.e., via e-mail and telephone). Frequent communication and flexibility are key to successful partnership management (Bernard and Collins, 1998).

The diversified input and contributions of each partner resulted in a unique transportation service and satisfied customers. Partner efforts resulted in a successful field test.[17] The San Francisco station car demonstration, using neighborhood electric vehicles and based at BART, also included a range of participants.[18]

Another program, CarSharing Portland also bears similarity to CarLink and the station car demonstration in their use of public institutional support to start a private carsharing venture. The idea for Carsharing Portland originated through group discussions sponsored by the City of Portland and the Oregon Department of Environmental Quality (DEQ). As the capital costs of instituting a carsharing program are high, Oregon DEQ provided funding to help start this organization (Katzev, 1999).

While CarLink did not meet its participant target goals, several smart technologies were deployed, three user groups were served, and the commuter-based carsharing service was tested. While several planning and implementation issues did arise, the partnership provided and supported a test bed for addressing program issues. To summarize, the CarLink partnership was critical to developing and implementing the field test and has proved a key element of carsharing demonstrations and programs in multiple contexts.

2.3.2 Guaranteed Parking

Guaranteed parking at BART provided convenient spaces for CarLink vehicles. At the Dublin/Pleasanton BART station, guaranteed parking, close to the station entrance, was a major incentive for participants to join the field test, since they no longer were forced to search for a parking space. At LLNL, designated parking in specified lots added to the program's convenience, and thus greater satisfaction. In addition, designated lots provided assurance that the cars were located in areas where Day Users could find them. Thus, guaranteed parking[19] is a crucial element of a carsharing program, particularly in

[17] Most program goals were achieved and program/technology experience was attained.
[18] In addition to BART, the station car demonstration involved the Bay Area Air Quality Management District, PG&E, CALSTART Green MotorWorks, Bank of America, the City of Emeryville, the City of Berkeley, and other partners (Bernard and Collins, 1998).
[19] And preferred, if possible.

areas where parking is limited. Other customer incentives, such as reduced transit fares and customer discounts, should be explored in the future.

2.3.3 Technology

The use of advanced electronic and wireless technologies is what made this carsharing demonstration 'smart.' While all of the technology in CarLink did not function optimally, its presence allowed the program to operate more efficiently, attracted users (see Chapter 4), and supported the commuter-based model. In the future, efficiency can be enhanced by developing and testing an integrated, stand-alone carsharing system (i.e., reservations, vehicle location, and billing information are linked and vehicle access is provided through smart cards and transponders rather than a dedicated key box).

Smart cards played a critical role in vehicle access (and customer tracking) at the BART station and participant satisfaction. The CarLink smart cards worked well throughout most the program and were positively accepted by users. However, CarLink experience demonstrated that an integrated technology approach would be more effective. The integration of vehicle access, tracking, emergency response, data collection, and reservation systems would greatly benefit carsharing efficiency in the future, particularly for a commuter-based model, such as CarLink.

2.3.4. Program Flexibility and User Satisfaction

Carsharing must be dependable and flexible to serve a diverse population of users throughout the day with minimal staff involvement. During the CarLink field test, participants generally communicated issues and concerns via e-mail. Consistently, they accompanied this information with CarLink program praise (e.g., how well it was working for them and how they hoped the program would be able to continue).

CarLink participants were patient, understanding, and enthusiastic about the program. In general, they became more enthusiastic as the program advanced, often providing technological and logistical input.

Workside Commuters preferred to solve commute issues as they arose, later informing CarLink implementation staff about scheduling changes. Occasionally, this approach frustrated the CarLink implementation staff, but more often than not it prevented delays. In the future, it would be helpful to test the Workside Commuter model among individuals with less flexible work schedules.

The CarLink field test aimed to provide maximum flexibility while maintaining adherence to research and model parameters (e.g., providing vehicle access to each user group during agreed upon hours). Providing customer flexibility appears to be a critical carsharing success factor, particularly in this field test. Indeed, many individuals and households participating in the demonstration were pleased and amazed that the program was as flexible in meeting their transportation needs as it was. As a matter of fact, the program was extended from a six-month to a 10-month demonstration period due to the enthusiasm of users. However, it is important to note that increased program flexibility

likely resulted from limited user group participation (and therefore additional vehicles being available for use).

2.3.5 Fees

Throughout CarLink participants were willing to pay for this service.[20] Participants thought that the CarLink billing invoices were easy to understand and simple to pay. Payment is a useful gauge of commitment and is critical to a carsharing economic viability analysis (see Chapter 5: Economic Viability of CarLink).

2.3.6 Media

One of the unanticipated results of the field test was the tremendous media interest in carsharing, particularly CarLink. Primarily, correspondents were interested in interviewing individuals from each user group involved and observing (and filming) how they used the cars in their daily lives. All types of media, including print (*Time* Magazine, *Family Circle*), radio (*Osgood Files*) and television stations (CNN, ABC World News, and local stations) wanted to report on carsharing. While they were primarily interested in research results, they also wanted to experience "A Day in the Life of a CarLink Car." For example, correspondents would meet a participant at their home (at 6:00 a.m.), drive in a CarLink car while they dropped children at day care, and then park the car at the Dublin/Pleasanton BART station before taking the train to work. Next, the correspondent would ride with Workside Commuters to LLNL. Once at Lab, they accompanied Day Users on errands or for lunch.

The enthusiasm of CarLink Users and the smooth operation of the project contributed to the positive news stories. While guiding the media, coordinating participants and locations, and arranging security clearance at the LLNL proved to be time consuming (for both the CarLink implementation staff and participants), media coverage was a strong advertising device for CarLink. Performed in conjunction with a recruitment clinic (see Shaheen, 1999), a media campaign could be very beneficial to program marketing.

Media attention also came as an unanticipated result of the San Francisco station car demonstration (Bernard and Collins, 1998). Indeed, Bernard and Collin's evaluation provides a one and a half page list of magazine articles, reports, news coverage, and papers describing the demonstration, as well as a list of prominent international, political, and business visitors.

[20] Day Users did not pay to use the CarLink service due to deployment delays. If they had paid, usage fees were set at $1.50/hour and $.10/mile.

SECTION 2.4 SUMMARY

CarLink tested a new "smart" carsharing model applicable in the San Francisco Bay area. CarLink helped provide a linkage between public transit, homes, and other activity locations. This design also incorporated a partnership management strategy to provide and support the program. Additionally, it achieved the following:

- Deployed and evaluated several smart technologies;
- Data were collected consistently throughout the program on travel patterns. These data were analyzed and provide insight into carsharing in the East Bay area (see Chapter 4);
- Guaranteed parking was available at the Dublin/Pleasanton BART, and designated parking was available at LLNL;
- CarLink User satisfaction remained high, and users accommodated their lifestyles to share vehicles (see Chapter 4);
- CarLink proved to be a flexible program; and
- CarLink attracted positive media attention and indirectly served as a CarLink marketing tool throughout the field test.

Participants continually offered that they thought CarLink was a great program, and they wished it could continue. All three user groups were easy to work with and communicated with the CarLink team to improve the field test. Even with issues to overcome, participants continued to provide solutions and recommendations for program improvement. As mentioned, many users went beyond their agreed upon participation by making time for media interviews, being patient with technology glitches, and maintaining open communication with CarLink staff.

An interesting observation is the number of changes researchers noted in participants' lifestyles during the brief study period (see Chapter 4). While CarLink accommodated many of these changes, others were inconsistent with car scheduling, so some participants had to leave the program. Reasons for this included the short program duration (Bernard and Collins, 1998), out-of-town work schedules, and changes in employment location and hours.

To summarize, the CarLink field test demonstrated a commuter-based carsharing model in the San Francisco Bay area. Not surprisingly, further study is needed to assess the market for shared-use services. A subsequent evaluation is recommended which includes a larger, more diverse group of users, a fleet of internal-combustion engine vehicles, and specialized, electronic and wireless carsharing technologies.

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CHAPTER THREE CARLINK PARTICIPANT PROFILE

SECTION 3.0 INTRODUCTION

The purpose of the CarLink field test was to understand how participants used the CarLink vehicles and reacted to the concept in practice. This chapter describes CarLink participants by sociodemographic, attitudinal, and vehicle usage trends. Although the number of participants is not statistically significant, the CarLink field test provided data for developing an anecdotal, early adopter profile.

To create this profile, researchers asked participants a series of questions to gather attitudinal and demographic data. The characteristics described here coincide with those in Shaheen's doctoral dissertation (Shaheen, 1999). Since a majority (i.e., 59%) of field test members also participated in Shaheen's longitudinal CarLink survey[1] (dissertation), results from her study are referenced throughout this chapter. Attitudinal characteristics investigated here include:

- **Congestion** – Examines attitudes towards congestion, the role of the automobile, and feelings about traffic growth.
- **Vehicle Hassle** – Investigates feelings of inconvenience regarding auto use.
- **Environmental Concern** – Measures perceptions and attitudes towards environmental degradation.
- **Experimentation** – Examines an individual's willingness to experiment with new ideas, such as computers.
- **Vehicle Enjoyment** – Identifies levels of vehicle enjoyment.
- **Satisfaction with Transportation Mode** – Investigates personal satisfaction and fulfillment with current modes.

As mentioned above, researchers also collected sociodemographic data to contrast field test participants to the larger population surveyed in Shaheen's study (n=302) and the overall population in this area (i.e., to assess generalizability of CarLink survey and field test results with others living in this region). These characteristics include community and household size, number of household members below age 18, homeowner status, income, gender, marital and employment status, education and occupation levels, and commute methods prior to CarLink membership.

Upon joining CarLink, recruited participants[2] also received similar survey instruments, including an initial questionnaire and three-day travel diary to document their mode use prior to CarLink. Eleven of the twenty-two recruited participants returned survey and travel diary information. Accordingly, summary and analysis of field test members is based upon 43 of the 54 participants.

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[1] This study investigated acceptance and viability of the CarLink concept in a four-month longitudinal survey.

[2] Recruited participants did not participate in the longitudinal survey, but rather responded to a poster or newspaper announcement.

There are seven sections in this chapter, each addressing specific aspects of participant trends. The first, "CarLink User Groups," describes the three CarLink membership groups, the number of participants that expressed interest and joined the field test from the longitudinal survey, and the number of individuals per user group. Next, participant usage trends are discussed in "Field Test Usage Rates." Third is a discussion of participant residences. Section four describes participant profiles for six attitudinal characteristics and contrasts them to the responses of longitudinal study participants from Shaheen's dissertation (Shaheen, 1999). In section five, sociodemographic characteristics of the field test participants are compared to those of the longitudinal survey and the Bay Area population. Section six discusses the commute patterns of field test prior to CarLink, and section seven concludes with a field test participant profile.

SECTION 3.1 CARLINK USER GROUPS

At the completion of the longitudinal market evaluation, participants had the option of joining the field test phase of the CarLink program. As noted in Shaheen's dissertation, 53.6% (n=111) of the experimental and 17.8% (n=17) of control participants from the longitudinal survey expressed interest in CarLink field test participation. However, much fewer joined the program due to program eligibility requirements (described below) and costs.

In the CarLink field test, there were three key user groups, categorized as follows:

- **Homeside User** – An individual who drove a CarLink vehicle from home to a transit station in the morning (i.e., Dublin/Pleasanton BART station) and used transit for the line-haul portion of their commute. Reversed at the end of the workday, the Homeside User kept the CarLink vehicle at home during evenings and weekends for personal use. Homeside Users paid a monthly fee of $200, which covered fuel, insurance, and maintenance costs.

- **Workside Commuter** – A CarLink participant employed at Lawrence Livermore National Laboratory (LLNL), who commuted to work via BART to the Dublin/Pleasanton station and drove a CarLink vehicle from the station to LLNL. There was a $60 monthly fee per vehicle, which could be shared with a co-worker by carpooling. Again, this fee included fuel, insurance, and maintenance costs.

- **Day User** – An employee of LLNL who accessed a CarLink vehicle for business or personal use during the workday. (Any use of CarLink vehicles during the workday is termed "Day Use." This includes business or personal use by a Workside Commuter, who also had access to CarLink vehicles during the day.) A fee of $1.50 per hour and $.10 per mile was assessed for personal trips; business trips were free of charge during the demonstration.

Of the longitudinal survey participants, 32 of the 111 experimental group members interested in the field test actually joined the program, and none of the 17 control group

members became participants. (See Table 3.1 below.) Outreach to recruit the additional 22 field test participants consisted of informational announcements at LLNL (i.e., Internet and newsletter), a recruitment poster at the Dublin/Pleasanton BART station, and advertisements in the *Tri-Valley Herald* and the *Diablo Dealer* (i.e., an auto buyers guide). There were a total of 54 field test participants enrolled in the program.[3]

Table 3.1: Summary of Survey Participants Who Expressed Interest and Joined Field Test

Longitudinal Survey Participants	Experimental (n=207)	Control (n=95)
Interested in CarLink field test	53.6% (n=111)	17.8% (n=17)
Joined CarLink field test	15.5% (n=32)	0.0%

Although no control participants joined the field test, it is important to note that the costs and criteria for joining one of the three user groups affected program eligibility and participation.

Fifty-four individuals, comprising fifty-three households[4], enrolled in the CarLink field test. As noted above, 15.5% of longitudinal survey participants joined the CarLink field test (see Table 3.1 above). Of the total field test participants, a maximum of 44 were authorized users at any one time. Throughout the program there were several dropouts (i.e., primarily due to lifestyle changes), and several new individuals joined the program. CarLink staff admitted new participants through August 1999. Survey respondents are disaggregated by user groups in Table 3.2 below. For a discussion of recruitment methods and issues affecting participation levels, see Section 2.1.1: CarLink Users.

Table 3.2: Field Test Participants by User Group

Field Test Participants	Homeside Users*	Workside Commuters* (LLNL employees)	Day Users** (LLNL employees)	Total
Longitudinal Survey	2	8	23	**32**
Recruited Participants	9	12	1	**22**
Total	**11**	**20**	**24**	**54**
Active Participants	11 (100%)	20 (100%)	6 (25%)	38 (69%)
Provided Baseline (Initial) Survey	6 (55% of field test participants)	15 (75% of field test participants)	23 (96% of field test participants)	44 (80% of field test participants)

*Usage commenced January 20, 1999; ** use began on June 30, 1999.

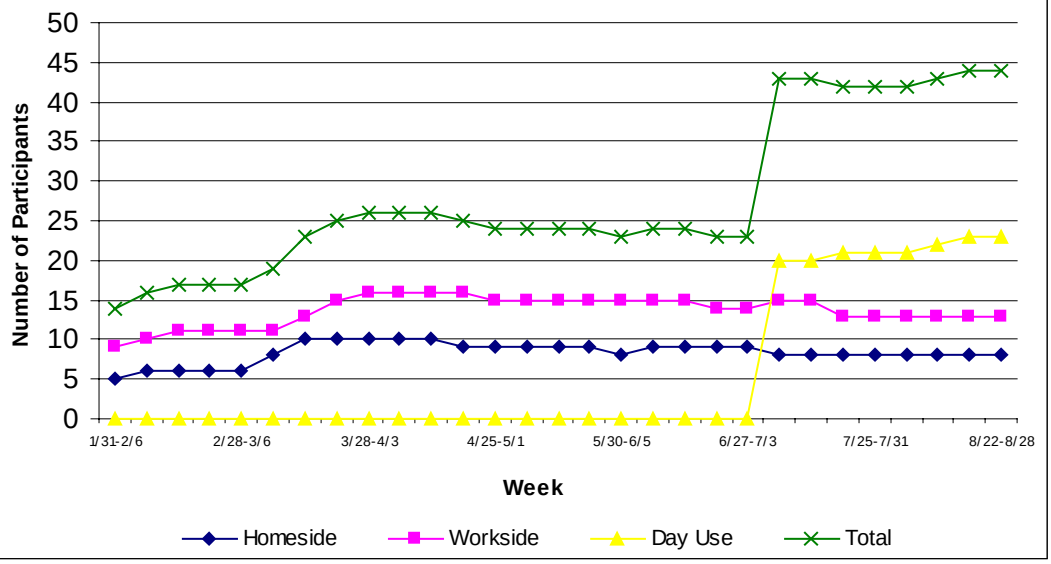
[3] It is important to note that only 38 of the 54 enrolled participants actively used the program.
[4] Two Workside Commuters were members of the same household.

The CarLink field test commenced on January 20, 1999, and ran until November 15, 1999. Usage data were collected between January 31, and August 31, 1999. While the aggregate number of authorized users is outlined in Table 3.2 above, levels of use fluctuated throughout the program.

SECTION 3.2 FIELD TEST USAGE RATES

The CarLink field test began operation with a total of five Homeside Users and nine Workside Commuters, as shown in Figure 3.1 (below). While the total number of authorized users quickly increased (n=25) by late March, the end of the data collection period (August 31, 1999) included the largest user population (n=44).

Figure 3.1: Number of Authorized CarLink Participants (February to August)



Another distinction is relevant to this user group discussion. While 54 participants were authorized CarLink users, only 70% (n=38 participants) actually drove the CarLink vehicles. Inactive members belonged to the Day User group. The Homeside User and Workside Commuter groups experienced full participation, as noted in Table 3.2 above. During July and August 1999, only six of the 23 (i.e., 26%) authorized Day Users took CarLink trips.

There were numerous contributing factors to this phenomenon, among them the late start date of the Day Use program.[5] Furthermore, many Day Users were on vacation during the months of July and August. For a more detailed discussion of the issues affecting user participation, please see Section 2.1.2.3: Day Use.

SECTION 3.3 PARTICIPANT RESIDENCES

CarLink participants' residences were spread throughout the Bay Area. Of particular note is the distribution of Homeside Users. In addition to Tri-Valley members, CarLink attracted two Homeside Users from the Stockton area (i.e., greater than 40 miles from the Dublin/Pleasanton BART station). Thus, the CarLink participant pool reflects the expanding draw of the Bay Area as a job center. (Please see Appendix V for map of the residences of all field test participants.)

The following sections describe the attitudinal and sociodemographic characteristics of field test members. The 32 longitudinal survey participants who joined the field test provided this information prior to CarLink use.

SECTION 3.4 ATTITUDINAL DATA

In this section, field test participant attitudes (or psychographics) are summarized for purposes of comparison with the longitudinal survey group (Shaheen, 1999). The CarLink longitudinal survey investigated participants' attitudes towards modal satisfaction, vehicle hassle and enjoyment, experimentation, congestion, the environment, and other issues. This was a key aspect of the initial CarLink survey, as results enabled identification of potentially critical issues to carsharing success and modal choice.

In Shaheen's dissertation and this report, responses to 41 attitudinal questions are disaggregated into six measures (or scales): congestion, vehicle hassle, environmental concern, willingness to experiment, vehicle enjoyment, and modal satisfaction.[6] Attitudinal scales provide researchers with a means of characterizing participant response to a series of related questions. The vehicle hassle scale, for example, investigates attitudes towards parking, vehicle maintenance, transit use, vehicle costs, and smog checks. Responses, which are evaluated on the five-point scale—ranging from "Strongly Agree" to "Strongly Disagree," are assigned a point value and averaged over several questions to calculate a respondent rating.

Since the sample size of field participants (n=43) is small, conclusions cannot be drawn from the field test results. The primary value of the CarLink demonstration is its exploratory nature. Again, field test results are related to Shaheen's dissertation, as those sample sizes were larger and had greater statistical relevance. It is important to note that

[5] Day Use did not commence until almost six months after the January 20, 1999, launch date due to vehicle location reception and data transmission difficulties and limited lot introduction (i.e., Day Use launched with two lots and expanded to five lots in August).

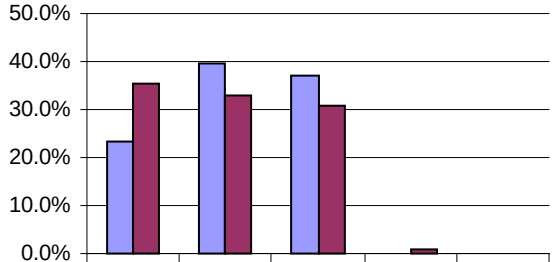
[6] Please see Appendix VI for a listing of the questions that comprise each attitudinal scale.

data from 32 individuals, who also participated in the longitudinal survey, are included in the field test analysis (n=43).

3.4.1 Congestion Scale

The congestion measure is comprised of participant opinions about the automobile's role in congestion, perception of congestion as a normal condition, and attitudes towards traffic growth. Results exhibited a neutral to strong agreement among participants that congestion is a problem. Although this population is not statistically significant, congestion recognition among field test participants suggests that CarLink early adopters may be more sensitive to congestion than the longitudinal survey group. (See Figure 3.2 below.)

Figure 3.2: Attitudes towards Congestion



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	23.3%	39.5%	37.2%	0.0%	0.0%
% Longitudinal (N=302)	35.4%	33.0%	30.7%	0.9%	0.0%

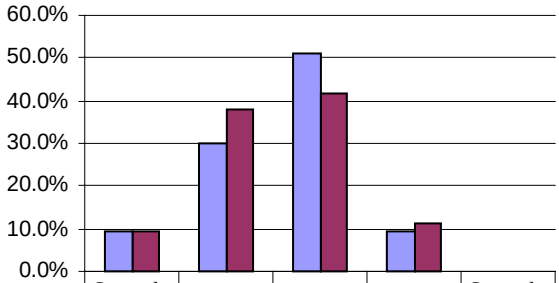
The congestion scale scores for the field test are comparable to those found in Shaheen's dissertation of a larger sample population (n=302). Only one to two percent of the longitudinal survey participants disagreed that congestion was a problem, while none of the field test participants disagreed (Shaheen, 1999). Though both field test and longitudinal survey participants agreed that congestion is a problem, a regression model developed by Shaheen for the longitudinal survey indicated that congestion response did not factor significantly into CarLink use. While congestion awareness is common among CarLink participants, awareness alone is not necessarily a significant predictor of carsharing adopters.

3.4.2 Vehicle Hassle Scale

The vehicle hassle scale measures attitudes towards parking availability, car maintenance and smog checks, vehicle costs, and transit use. Although this scale exhibits identification

with automobile inconvenience, neither field test nor longitudinal survey participants unilaterally identified vehicles as a source of aggravation. See Figure 3.3 below.

Figure 3.3: Vehicle Hassle Scale



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	9.3%	30.2%	51.2%	9.3%	0.0%
% Longitudinal (N=302)	9.4%	37.7%	41.5%	11.3%	0.0%

Note: Totals are within one-tenth of 100% due to rounding.

Hassle scale scores were similar between longitudinal survey and field test participants. Both groups revealed similarly low disagreement levels that vehicles are a hassle; 9% of field test and 11% of longitudinal study participants disagreed or strongly disagreed (Shaheen, 1999). In contrast, while 47% of the longitudinal study population agreed or strongly agreed that automobiles are aggravating, only 39% of the field test participants responded as such. Thus, field test participant responses are more neutral than the longitudinal survey group.

The vehicle hassle scale also played a role in Shaheen's regression models. Shaheen's "Transit Commuter Model" sought to identify characteristics of those inclined to commute by transit on a regular basis. This model found individuals who perceived vehicles as a hassle tended to be transit riders; other significant factors included mode satisfaction, transit cost, and income. Shaheen's "CarLink User" model also identified vehicle hassle as predictive of stated CarLink use.[7]

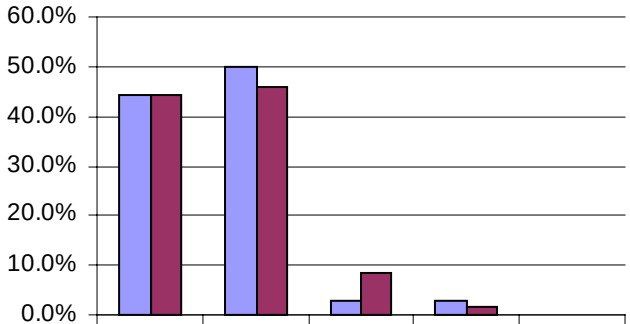
While vehicle hassle proved to be relevant to the longitudinal survey regression models, this may not have been true for field test participants. Since the field test sample is not statistically significant, it would be premature to draw conclusions regarding vehicle hassle based on their response.

[7] For a full discussion of the regression model and its results, please see Shaheen (1999), pp. 206 – 211 and pp. 255 – 257.

3.4.3 Environmental Concern

The environmental scale is a composite of seven questions. To improve transportation and air-quality conditions, participants were asked to judge their willingness to drive an alternative-fuel vehicle or reduce auto usage by using bicycles and transit. Additional questions addressed personal attitudes toward the environment, air quality solutions, lifestyle modifications to address environmental problems, and the relationship of transportation emissions to global warming and other environmental issues. As noted below, 94% of CarLink field test and 90% of longitudinal survey participants agreed or strongly agreed that the environment is a concern. See Figure 3.4 below.

Figure 3.4: Attitudes towards the Environment



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	44.1%	50.0%	2.9%	2.9%	0.0%
% Longitudinal (N=302)	44.2%	45.9%	8.3%	1.7%	0.0%

Note: Totals are within one-tenth of 100% due to rounding.

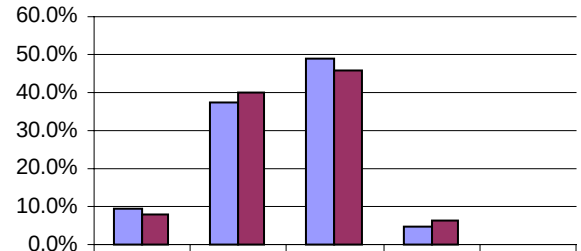
As found in Shaheen's "CarLink User" regression model, environmental concern is a key predictor in an individual's stated response regarding potential CarLink usage. As found in the regression model, those who expressed an interest in using CarLink in the future were .4 times more likely to indicate high environmental concern than those who did not express CarLink interest. In addition to environmental concern, mode satisfaction (discussed later in this section) and informational media (i.e., a brochure, video, and test clinic) played significant roles in predicting stated CarLink use.

3.4.4 Attitudes Toward Experimentation

The experimentation scale investigated individual attitudes towards adopting new ways of doing things, inclinations towards following trends, attitudes towards workplace challenges, and a propensity to follow manufacturer product instructions. A majority of field test participants (i.e., 61%) were neutral toward experimenting with new things, while 32% of those surveyed expressed a positive response. A positive scale score

implies a willingness to try new things, such as CarLink. However, Shaheen (1999) did not find the "experimenter" scale to be a significant predictor of CarLink use. See Figure 3.5 below.

Figure 3.5: Attitudes towards Experimentation



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	9.3%	37.2%	48.8%	4.7%	0.0%
% Longitudinal (N=302)	7.7%	40.1%	45.9%	6.3%	0.0%

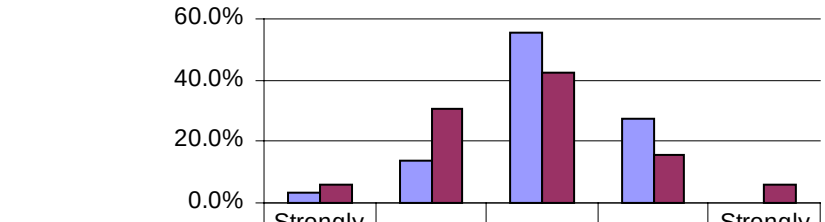
3.4.5 Vehicle Enjoyment

Vehicle enjoyment is a measure of an individual's satisfaction with personal vehicles. This scale is based on responses to driving enjoyment, vehicle identification, mode choice, personal freedom, and willingness to use alternative modes. This factor was found significant in Shaheen's "Auto Commuter" model. Those who responded affirmatively to this model (i.e., respondents who use cars to commute) were 12 times more likely to agree that vehicles are enjoyable.

Based upon the response of the field test participants (summarized below), it appears that these participants were less likely to derive enjoyment from personal vehicles than those in the longitudinal study. Only 17% of field test users agreed that vehicles are enjoyable, while 36% of longitudinal survey participants are in agreement.

It is important to note, however, that none of the field test participants strongly disagreed on the enjoyment scale, while 6% of the longitudinal study population fell into this category. Although significant conclusions cannot be drawn from these data, the field test population was considerably more moderate in their attitudes towards automobile enjoyment. (See Figure 3.6 below.)

Figure 3.6: Attitudes towards Auto Enjoyment



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	3.4%	13.8%	55.2%	27.6%	0.0%
% Longitudinal (N=302)	5.7%	30.5%	42.6%	15.6%	5.7%

Note: Totals are within one-tenth of 100% due to rounding.

3.4.6 Modal Satisfaction

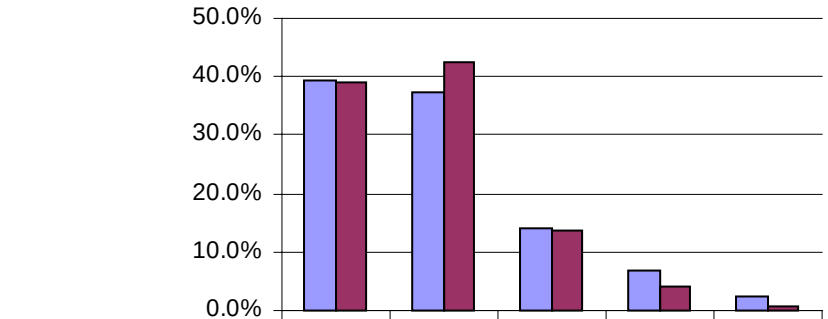
This scale consists of responses to 15 modal satisfaction questions, related to: reliability, safety, flexibility, spontaneity, emergency response, and individuality.[8] A comparison of the modal satisfaction scores between the field test and longitudinal study participants revealed a high degree of similarity. Seventy-seven percent of field test and 82% of longitudinal survey participants agreed that their current mode (i.e., before CarLink) fulfills their basic transportation needs. Thus, overall modal satisfaction is clear.

Of particular note is the relevance of modal satisfaction in the regression models, developed by Shaheen (1999). In the "Auto Use" model, a positive score on the modal satisfaction scale was a significant predictor of an auto driver. Conversely, negative modal satisfaction was predictive of "Transit Use" and "CarLink Use."

It is interesting to note that both field test and longitudinal survey participants revealed a high degree of modal satisfaction. Although this may seem counterintuitive, many CarLink members did not need to change their current modes to participate in the program.[9] (See Figure 3.7 below.)

[8] See Appendix VI for a full list of the questions comprising the attitudinal scales.
[9] A majority of Homeside and Day Users did not change their current modes. In contrast, many Workside Commuters altered their commute behavior through CarLink.

Figure 3.7: Modal Satisfaction Scale



	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
% Field Test (N=43)	39.5%	37.2%	14.0%	7.0%	2.3%
% Longitudinal (N=302)	38.9%	42.5%	13.8%	4.0%	0.7%

Note: Totals are within one-tenth of 100% due to rounding.

3.4.7 Attitudinal Characteristic Overview

To summarize, the attitudinal characteristics of field test members were relatively similar to those found among longitudinal survey participants. Responses did not differ significantly between field test and longitudinal survey populations for the environmental concern and experimentation scales. The inclination of CarLink field test participants to express environmental concern is consistent with Shaheen's (1999) "CarLink Use" model, which found that individuals who were interested in CarLink were .4 times more likely to express environmental attitudes. Experimentation scores, which tended to be neutral among study participants, were not significant predictors of "CarLink Use."

Among the congestion, vehicle hassle, and vehicle enjoyment scales, field test members' scores were slightly more neutral than those of longitudinal survey participants. Although the congestion scale was not a significant predictor in Shaheen's models,[10] the vehicle hassle and enjoyment scales were in the "Transit" and "Auto Use" models (respectively). Although less adamant than the longitudinal population, 39% of field test participants agreed that personal vehicles are a hassle.

The modal satisfaction score indicated a high degree of contentment among longitudinal (i.e., 82%) and field test participants (i.e., 77%). Positive modal satisfaction was a predictive factor in the "Auto Use" model, while a negative modal satisfaction score was predictive in the "Transit Use" and "CarLink Use" models. Thus, one might suspect that CarLink participants would be more likely to indicate a negative modal satisfaction score. However, most Homeside and Day Users did not alter their primary commute modes to

[10] Shaheen (1999) developed three models: Auto User, Transit User, and CarLink Use.

participate in CarLink. Furthermore, Homeside and Day Users comprised 65% of the field test population for whom attitudinal and psychographic data were collected.

SECTION 3.5 SOCIODEMOGRAPHICS

The CarLink sociodemographic profile consists of eleven variables, including: community type, household size, rent or own home, income, age, gender, marital status, education, employment status, occupation, and commute mode prior to CarLink. In this section, field test participant profiles are compared to those of longitudinal survey participants (as in Section 3.4 above) and to demographic data from the San Francisco/ Oakland area, as provided in the 1990 U.S. Census. The San Francisco/Oakland area was selected as a point of comparison because many field test and longitudinal survey participants were residents of this area (i.e., 89% of the 44 participants providing survey information).

Since many CarLink survey questions are different from those asked in the U.S. Census, not all sociodemographic data are directly comparable to the general population. In some instances, approximations were made to facilitate comparison among these groups. Approximations are noted as appropriate in figures and tables below. Another source of discrepancy between the U.S. Census and CarLink are the data collection timeframes. Census data were gathered in 1990, while CarLink data were collected in 1998 and 1999. Although these differences lower the accuracy of comparisons, the small size of the field test population alone necessitates an anecdotal understanding. This analysis is meant to illustrate the similarity of CarLink early adopters to the general Bay area population.

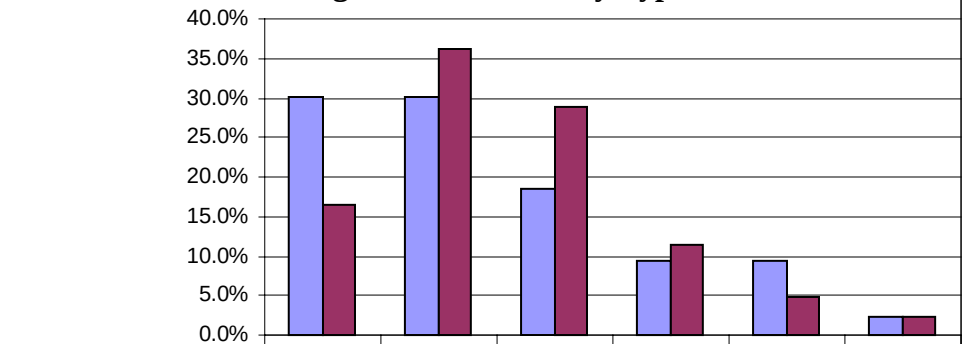
3.5.1 Community Type

Primary differences in community characteristics are attributable to the majority of Workside Commuters living in large cities[11] and Homeside participants residing in medium-sized cities in the Dublin/Pleasanton region.[12] These trends are not unexpected, since Workside participants were reverse commuters[13] and Homeside Users commuted via BART from Dublin/Pleasanton. Day Use participants were spread among different-sized communities, though many lived in a small city.[14] (See Appendix V for San Francisco Bay Area maps of Homeside, Workside, and Day Use participants by residence.)

The greatest disparity between the longitudinal and field test populations is that 30% of field test and 17% of longitudinal participants lived in large cities. This is likely due to the significant number of Workside Commuters, living in a large city. (See Figure 3.8 below.)

[11] Nine participants or 64.3% of the Workside Commuter group.
[12] Four individuals or 66.7% of the Homeside User group.
[13] Most took BART from an urban area to LLNL, a suburban job site.
[14] Seven individuals or 30% of Day Users.

Figure 3.8: Community Type



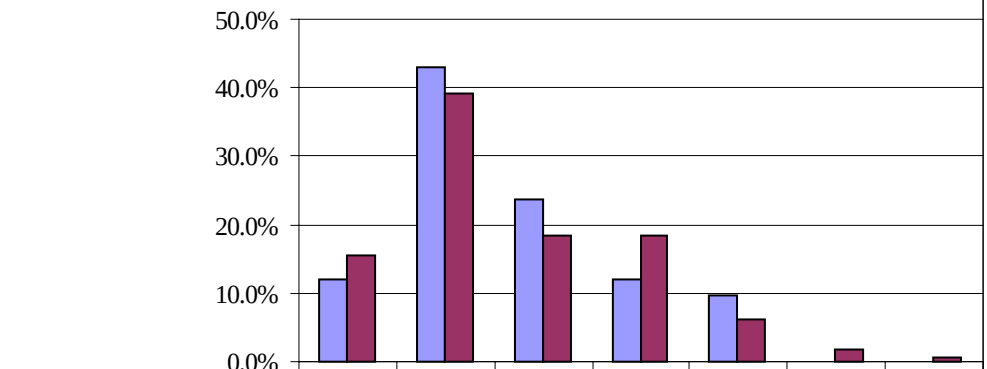
	Lg. City (>250,000)	Med. City	Sm. City (< 50,000)	Suburb of Lg. City	Suburb of Med. City	Rural Area
% Field Test (N=43)	30.2%	30.2%	18.6%	9.3%	9.3%	2.3%
% Longitudinal (N=302)	16.5%	36.3%	28.8%	11.3%	4.7%	2.4%

Note: Totals are within one-tenth of 100% due to rounding.

3.5.2 Household Size

Average household size for field test and longitudinal survey participants was 2.5, which is consistent with the San Francisco/Oakland area. In a breakdown of the field test participants by user group, Workside Commuters had the highest frequency of two-member households (i.e., 50% or nine participants). Two of the six Homeside Users were from five-member households. Although Bay Area data are not disaggregated by household size, the size distribution of field test and longitudinal study participants is similar. The average household size for each field test group follows—Homeside Users: 3.5; Workside Commuters: 2.1; and Day Users: 2.7. The average household size for field test participants was 2.64, slightly above the San Francisco/Oakland average of 2.52. (See Figure 3.9 below.)

Figure 3.9: Household Size



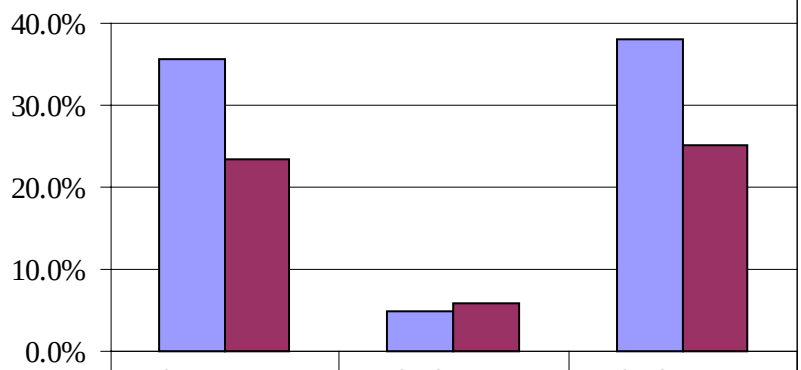
	1	2	3	4	5	6	7
% Field Test (N=43)	11.9%	42.9%	23.8%	11.9%	9.5%	0.0%	0.0%
% Longitudinal (N=302)	15.6%	39.2%	18.4%	18.4%	6.1%	1.9%	0.5%

Note: Totals are within one-tenth of 100% due to rounding.

3.5.3 Children by Household

The primary trends exhibited for this variable were the high number of Homeside Users with children under the age of 18 and the relative lack of children in Workside Commuter and Day Use households. This is consistent with Workside Commuter data (reported above), since they have smaller households. Overall, field test households have noticeably more children under the age of sixteen. Significantly more field test households have children than longitudinal respondents. (See Figure 3.10 below.)

Figure 3.10: Percentage of Households with Children 18 or Under

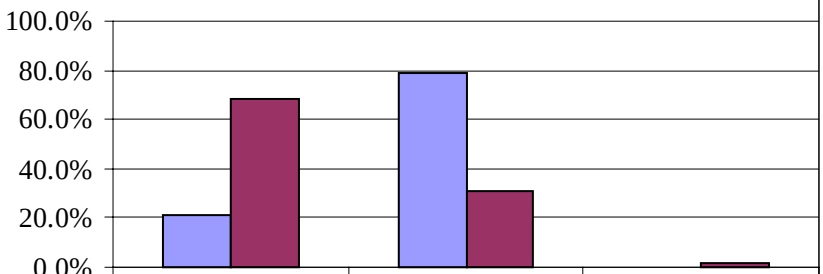


	0-15 Years	16-18 Years	0-18 Years
% Field Test (N=43)	35.7%	4.8%	38.1%
% Longitudinal (N=302)	23.5%	6.0%	25.2%

3.5.4 Home Ownership

CarLink field test participants were primarily homeowners. The high ownership rate of field test participants (i.e., 79%) was significantly greater than that of the general population (i.e., 54%) and longitudinal respondents (i.e., 31%). Along with high income and education levels, the high home ownership rate of field test participants indicates that they are not average Bay area residents. (See Figure 3.11 below, which includes 1990 Census data from the San Francisco/Oakland Area.)

Figure 3.11: Home Ownership Status



	Rent/ lease	Own	Other
% Field Test (N=43)	21.4%	78.6%	0.0%
% Longitudinal (N=302)	67.9%	30.6%	1.4%

Note: Totals are within one-tenth of 100% due to rounding.

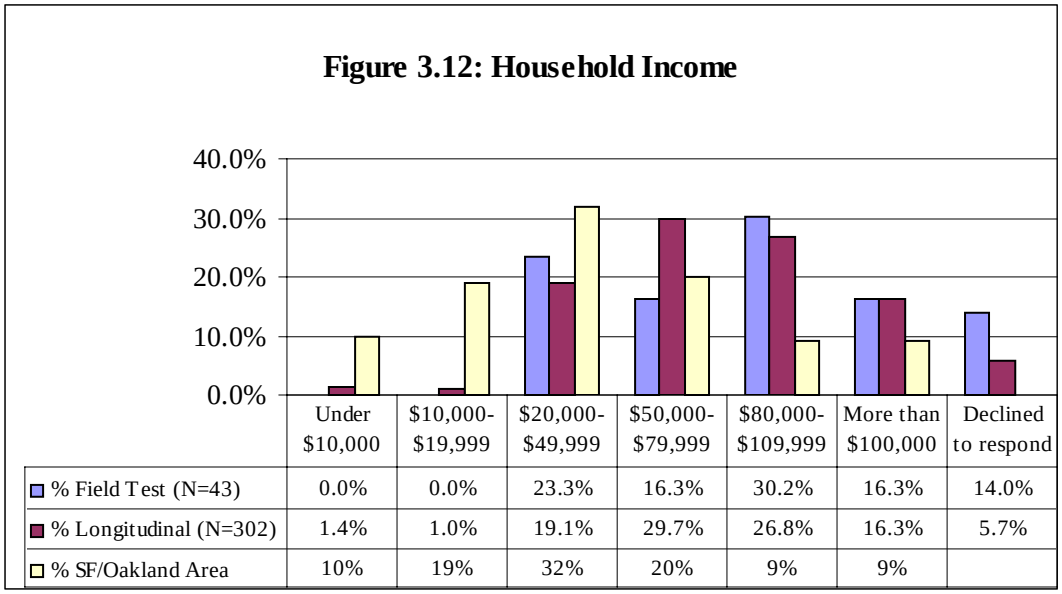
3.5.5 Income

The household incomes of CarLink field test and longitudinal survey participants were relatively high in comparison to the general population. Seventy-six percent of CarLink field test members and 79% of longitudinal survey participants had household income levels above $50,000 per year. These figures are notably above the general population, with just 38% of households with incomes above $50,000 per year. However, it is important to note that these data are from 1990, and CarLink income data are from 1997 and 1998. Furthermore, almost 15% (i.e., six participants) of field test participants declined to respond to this question.

It is interesting to note that Shaheen (1999) found the $20,000 to $50,000 household income category to be a significant predictor in her "Transit Use" model. This may reflect that the general San Francisco/Oakland population is receptive to transit use as a low-cost transportation option. (See Figure 3.12 below, which includes 1990 San Francisco/Oakland Census data.[15])

[15] San Francisco/Oakland area income information is taken from the 1990 U.S. Census. Additionally, SF/Oakland area income categories do not align exactly with CarLink income categories. The misaligned

Figure 3.12: Household Income



	Under $10,000	$10,000-$19,999	$20,000-$49,999	$50,000-$79,999	$80,000-$109,999	More than $100,000	Declined to respond
% Field Test (N=43)	0.0%	0.0%	23.3%	16.3%	30.2%	16.3%	14.0%
% Longitudinal (N=302)	1.4%	1.0%	19.1%	29.7%	26.8%	16.3%	5.7%
% SF/Oakland Area	10%	19%	32%	20%	9%	9%	

Note: Totals are within one-tenth of 100% due to rounding (1% for SF/Oakland due to different data source).

3.5.6 Age

The age profile of the field test participants was somewhat older than that of the longitudinal survey group. Although the 41- to 64-year-old age group appears higher for field test participants, employees of LLNL account for 92% of CarLink users in this category. It is not surprising that the age profiles of both groups are significantly older than those of the general population, as children participated in neither the longitudinal survey nor the field test. (See Figure 3.13 below.[16])

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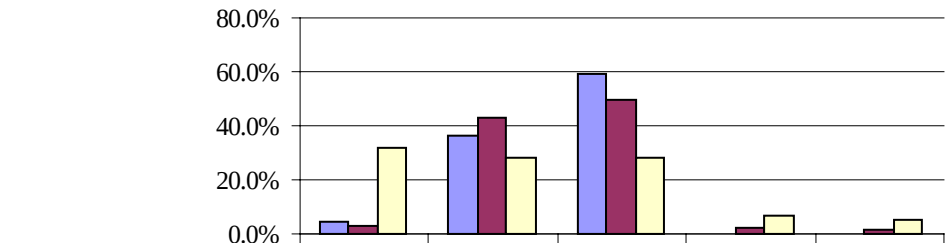
categories are as follows: 1) $10,000 - $20,000 CarLink compared to $10,000 - $24,999 Census; 2) $20,000 - $50,000 CarLink compared to $25,000 - $49,999 Census; 3) $50,000 - $80,000 CarLink compared to $50,000 - $74,999 Census; 4) $80,000 - $100,000 CarLink compared to $75,000 - $99,999; and 8) $110,000 + CarLink compared to $100,000 + Census data. Because of these different categories

[16] To accommodate different age categories between 1990 U.S. Census and CarLink, Census data are approximated as follows: 1) Census, 0 – 24 years of age compared to CarLink, 0 – 23 years of age; 2) Census, 25 – 39 compared to CarLink, 24 – 40; 3) Census, 40 – 64 compared to CarLink, 41 – 64; and 4) the remaining categories are the same.

Figure 3.13: Age

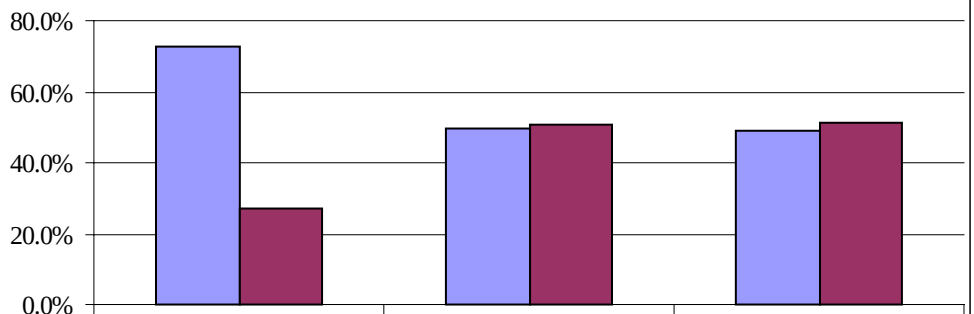


	<23	24-40	41-64	65-74	>75
% Field Test (N=43)	4.5%	36.4%	59.1%	0.0%	0.0%
% Longitudinal (N=302)	3.3%	43.0%	49.7%	2.3%	1.7%
% SF/Oakland Area	32%	28%	28%	7%	5%

3.5.7 Gender

Although not representative of the longitudinal survey and general population, men were a significant majority in all three CarLink user groups. Two-thirds of the Workside Commuter group, 72.7% of Day Users, and 83.3% of Homeside Users are male. Furthermore, this finding is consistent with trends in European carsharing (Shaheen, 1999). This trend, however, is not reflective of the general population for this area in which there is an equal percentage of men and women. (See Figure 3.14 below.)

Figure 3.14: Gender

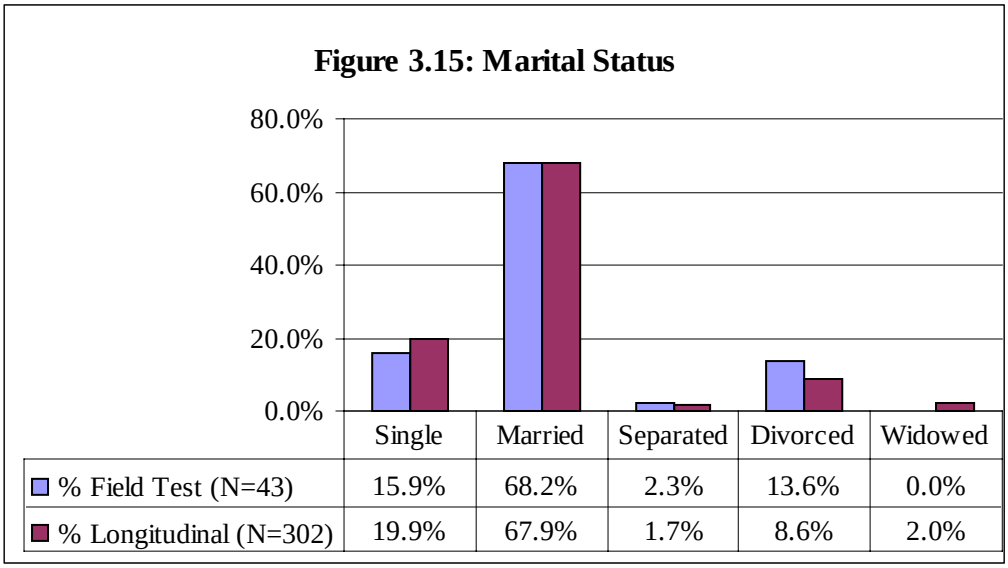


	% Field Test (N=43)	% Longitudinal (N=302)	% SF/Oakland Area
Male	72.7%	49.3%	49%
Female	27.3%	50.7%	51%

3.5.8 Marital Status

The majority of field test and longitudinal study participants were married. Day Users had the largest percentage of married participants among the CarLink user groups (i.e., 70% of Day Users). Approximately 33% of Workside Commuters were single, with the remaining respondents scattered among the single, divorced, and separated categories. (See Figure 3.15 below.)

Figure 3.15: Marital Status



	Single	Married	Separated	Divorced	Widowed
% Field Test (N=43)	15.9%	68.2%	2.3%	13.6%	0.0%
% Longitudinal (N=302)	19.9%	67.9%	1.7%	8.6%	2.0%

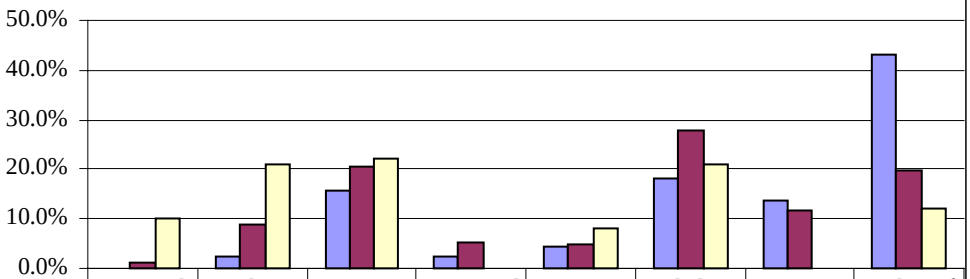
Note: Totals are within one-tenth of 100% due to rounding.

3.5.9 Education

Overall, CarLink field test users had high education levels, much higher than the general population. Approximately 75% of CarLink members and 60% of longitudinal survey participants possessed a Bachelor's degree or higher. These data are skewed from the general population. (See Figure 3.16 below.[17])

[17] The 1990 Census files have slightly different categories (i.e., no "Vocational School" nor "Some Graduate" categories), so totals for SF/Oakland do not equal 100%.

Figure 3.16: Education



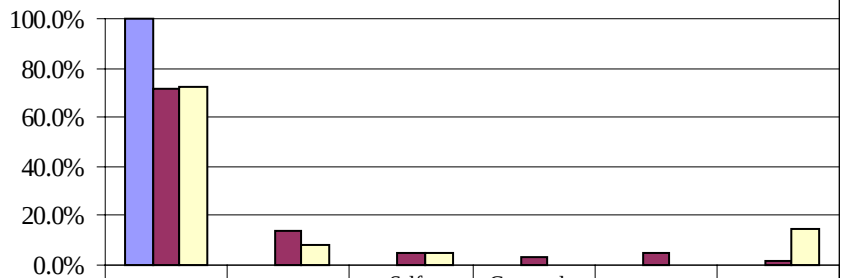
	Some High School	Graduate from High	Some College	Vocational School	Associate's Degree	Bachelor's Degree	Some Graduate	Grad./Prof Degree
% Field Test (N=43)	0.0%	2.3%	15.9%	2.3%	4.5%	18.2%	13.6%	43.2%
% Longitudinal (N=302)	1.3%	8.7%	20.7%	5.4%	4.7%	27.8%	11.7%	19.7%
% SF/Oakland Area	10%	21%	22%		8%	21%		12%

Note: Totals are within one-tenth of 100% due to rounding.

3.5.10 Employment Status

All CarLink field test participants were fully employed. Longitudinal participants were more similar to the general population than the field test group, though their employment rate (i.e., 85%) is higher than population average of 72%. The full employment effect of field test participants likely manifests itself in income and home ownership. (See Figure 3.17 below.[18])

Figure 3.17: Employment Status



	Full-time	Part-time	Self-employed	Currently unemployed	Retired	Other
% Field Test (N=43)	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
% Longitudinal (N=302)	71.9%	13.6%	4.6%	3.3%	5.0%	1.7%
% SF/Oakland Area	72%	8%	5%			15%

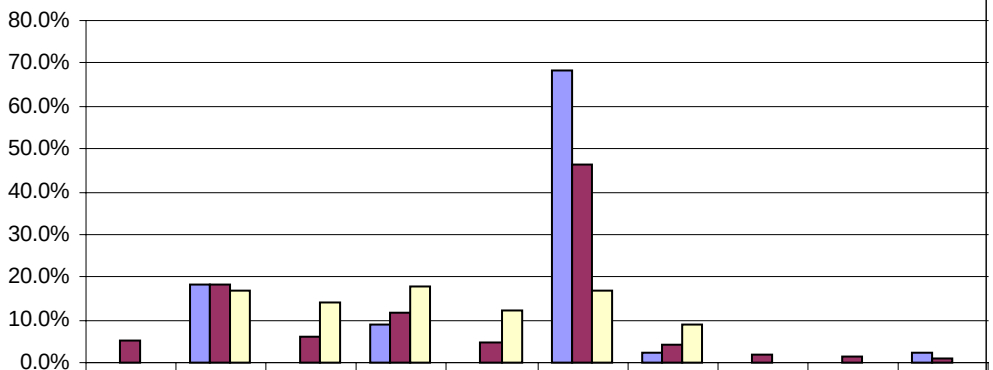
Note: Totals are within one-tenth of 100% due to rounding.

[18] San Francisco/Oakland employment data are based upon civilian labor force data from the 1990 U.S. Census. Retirement is not a category in the U.S. Census source table used for this graph.

3.5.11 Occupation

CarLink participants were spread across several occupational categories. Seventy-four percent of the 38 total employees of LLNL fell into the "Professional/technical" category. The occupation of many field test participants is consistent with the high level of employment, education, and income at LLNL. While the longitudinal survey population was comprised of many "Professional/technical" workers, this group was more widely spread among occupational categories than field test group. (See Figure 3.18 below.[19])

Figure 3.18: Occupation



	Home maker	Mgr./ Admin.	Service/ repair	Clerical	Sales	Prof./ tech.	Prod./ const.	Educatio nal	Student	Other
% Field Test (N=43)	0.0%	18.2%	0.0%	9.1%	0.0%	68.2%	2.3%	0.0%	0.0%	2.3%
% Longitudinal (N=302)	5.4%	18.1%	6.0%	11.7%	4.7%	46.2%	4.0%	1.7%	1.3%	1.0%
% SF/Oakland Area		17%	14%	18%	12%	17%	9%			

Note: Totals are within one-tenth of 100% due to rounding.

SECTION 3.6 COMMUTE PRIOR TO CARLINK

Commute data prior to field test participation revealed some interesting results. All Homeside participants used BART at least three days per week for their commute. Thus, CarLink fits into the pre-existing commute pattern of these participants. This is particularly notable given the high modal satisfaction scores of field test participants, as discussed in Section 3.4 above.

As previously mentioned, Shaheen (1999) found in her "CarLink Use" model that low levels of modal satisfaction corresponded to CarLink interest. However, field test participants' modal satisfaction scores corresponded to high levels of modal satisfaction. Homeside Users shifted from personal vehicles to CarLink cars to commute to and from

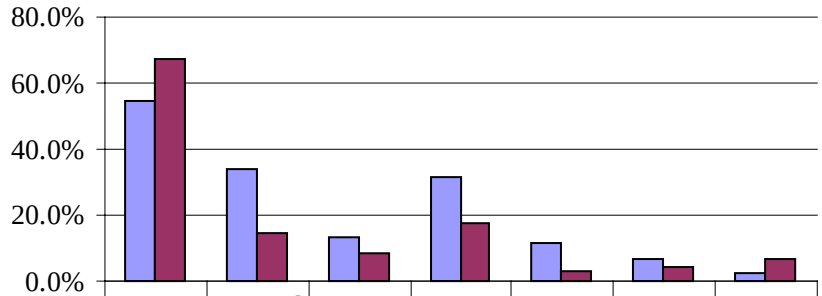
[19] SF/Oakland U.S. Census categories do not correspond exactly to CarLink occupation categories, so Census data does not sum to 100%. The following CarLink categories do not have comparable analogs with the 1990 U.S. Census data: Homemaker, Educational, Student, Other.

the Dublin/Pleasanton station, likely maintaining a high level of modal satisfaction. Thus, a great deal of behavioral change was not necessary for many CarLink participants.

Among other groups, many Day Use participants carpooled, biked, or bused to work prior to CarLink, limiting their vehicle access during the day. This made these individuals prime candidates for the CarLink Day Use program. Of the three user groups, Workside Commuters were the most varied, with a mixture of drive alone (60%); BART (53.3%) and bus riders (20%); Carpool/Vanpoolers (13%); Walkers (13%) and other options.[20] These trends indicate that CarLink complemented the existing transportation needs of each user group, particularly Homeside and Day Users. This is not unexpected.

In comparison to general population commute characteristics, the CarLink field test appeared to attract fewer drive alone commuters and a significantly higher portion of Carpool/Vanpoolers and Transit riders. (See Figure 3.19 below.[21])

Figure 3.19: Usual Commute to Work Prior to Joining CarLink



	Drive Alone	Carpool Vanpool	Bus	BART	Bike	Walk	Other
% Field Test (N=43)	54.5%	34.1%	13.6%	31.8%	11.4%	6.8%	2.3%
% Longitudinal (N=302)	67.5%	14.6%	8.6%	17.5%	3.0%	4.0%	6.6%

[20] Percentages add up to more than 100%, since respondents may have used multiple modes for a single commute.

[21] Please note that the "Public Transit Total" category includes BART usage data for the CarLink field test and the longitudinal survey participants.

SECTION 3.7 SUMMARY

The initial survey responses, though not reflective of the entire field test population, indicate some general trends. Homeside Users tended to live in medium-sized, suburban areas in the vicinity of the Dublin/Pleasanton BART station. They were predominantly married, with children. All primary Homeside Users commuted by BART prior to joining the field test. Homeside Users also had a high average income in comparison to the general population, with half of the respondents earning between $80,000 and $109,999 per year. As with all groups, users were primarily male.

Workside Commuters, in contrast, were more likely to live in a large urban area, and about half used BART to commute on a regular basis prior to joining CarLink. Workside Commuters had the highest level of education among the three user groups, though their median income level was between $50,000 to $79,999 per year range (below both Homeside and Day Users).

Day Users were the most diverse among CarLink groups. They were likely to live in small cities or suburbs, with various education levels, and use a variety of commute modes prior to CarLink. Taken as a whole, however, CarLink users were predominantly male (67%); homeowners (81%); married (69%); employed (100%), with yearly incomes of $50,000 or above (81%); and at least 24 years of age (97%).

The CarLink user profile that emerged from the field test is similar to that developed by Shaheen (1999) in the longitudinal survey. This is not surprising as longitudinal survey participants comprised 75% of the field test population from which these data were collected (i.e., 33 of the 44 participants) and 60% of total CarLink participant population (i.e., 33 of the 54 CarLink field test members). In general, CarLink users represented more affluent, highly educated, and older individuals than reflected in the Bay area.

Although it is not possible to compare attitudinal characteristics of field test participants to the general population, they were relatively similar to those found in the longitudinal survey group. A particularly notable result from the field test is environmental concern, where the two groups differed only slightly. In Shaheen's dissertation, those interested in "CarLink Use" were .4 times as likely to express environmental concern. CarLink field test participants were slightly more neutral towards congestion, vehicle hassle, and vehicle enjoyment than longitudinal survey participants.

While attitudes toward congestion were not found as significant "CarLink Use" predictors, field test members did indicate that congestion was a problem (i.e., 63% agreement for the congestion score). Field test participants also agreed that vehicles are a hassle. This result is notable, since Shaheen (1999) found vehicle hassle as a significant predictor in her "Transit Use" and "CarLink Use" models, reinforcing that individuals who perceive vehicles as a hassle are more likely to use transit and potentially CarLink.

The one anomaly in the attitudinal response results is the finding that field test participants exhibited a high degree of modal satisfaction prior to CarLink use. These

results are counterintuitive and contrary to the findings of Shaheen's dissertation. One might have expected transit riders and those frustrated by auto driving to be those most interested in the field test. However, CarLink attracted a majority of participants (i.e., approximately 60%) who did not significantly alter their current modes (e.g., Homeside and Day Users).

As noted earlier, the CarLink survey population is too small (n=44) to draw significant conclusions regarding attitudinal and sociodemographic characteristics. Nevertheless, trends identified here are useful in guiding future research, market analyses, and the implementation of future carsharing programs.

REFERENCE

Shaheen, S.A. (1999). *Dynamics in Behavioral Adaptation in Response to a Transportation Innovation: A Case Study of CarLink--A Smart Carsharing System*. Ecology Graduate Group. Davis, University of California: 449.

CHAPTER FOUR: USAGE DATA AND PARTICIPANT FEEDBACK

SECTION 4.0 INTRODUCTION

The CarLink program provided a test bed for demonstrating a shared-use vehicle service, as well as an opportunity to collect a variety of participant data. Researchers collected data before, during, and after the field test to help analyze and describe program use and to make recommendations. Several data collection methods were employed, including trip diaries, automated vehicle location (AVL) records, questionnaires, household interviews, and focus groups. Although valuable information was gathered by all these means, the data are mostly useful for exploratory purposes. Due to the small sample size, short project duration, and Day Use program delays, data should be used to suggest trends and areas for future research. It would not be appropriate to generalize to larger populations, without further research. As discussed in Chapter 3: CarLink Participant Profile, the field test population is not representative of the general United States or East Bay area population. This small sample size motivated CarLink researchers to probe deeper into members' experiences through household interviews and a focus group.

This chapter presents data on CarLink vehicle use. Researchers collected usage data through "smart" systems (i.e., AVL) and trip diaries during the field test. Usage data included: vehicle miles traveled (VMT), travel time and date, trip purpose, and user identification.

This chapter includes five sections. The first section is based primarily on CarLink usage data and quantifies how the vehicles were utilized during the program's duration. Next is a description of the data collection methodologies, employed at the conclusion of the field test: questionnaires, household interviews, and focus groups. Section three includes a discussion of key field test issues and findings. The fourth section analyzes commute mode changes by user group. Finally, there is a chapter summary with conclusions.

SECTION 4.1 CARLINK USAGE DATA

Researchers collected CarLink usage data throughout the field test, including: vehicle identification (ID) number, mileage, trip purpose, date and time of use, and participant ID number. Two collection methods were used: an AVL/data collection system (i.e., Teletrac) and in-vehicle trip diaries. Although the project was designed to automatically collect all vehicle usage data, a manual trip diary system was implemented in June 1999, because the AVL service was malfunctioning and radio-frequency (RF) coverage was no longer available in the field test region.

The Teletrac system was designed to collect data each time a CarLink member logged into (i.e., at the beginning of a trip) and out of (i.e., at the end of a trip) a CarLink vehicle. The Teletrac units were programmed to transmit usage data via RF towers to a central computer where they were downloaded. Users entered their ID, odometer reading at trip start and trip end, and a trip purpose code (i.e., from a menu with ten selections). Trip time, date, and origin/destination location (i.e., street address) were automatically sent

with each transmission. The CarLink user manual, which includes an explanation of the data entry protocol, can be found in Appendix I: CarLink Member Manual.

Despite its design, the CarLink program regularly experienced two data transmission errors. First, there were omissions when the system failed to transmit any data due to poor or limited RF reception in the Livermore Valley and the Stockton, Turlock, and Brentwood areas, where four Homeside Users lived. The second type of error involved transmission difficulties in which data strings were received with incomplete or unintelligible information. CarLink researchers recovered as much data as possible and were able to reconstruct many trips. Another possible problem, though difficult to isolate, involved users neglecting to enter trip data.

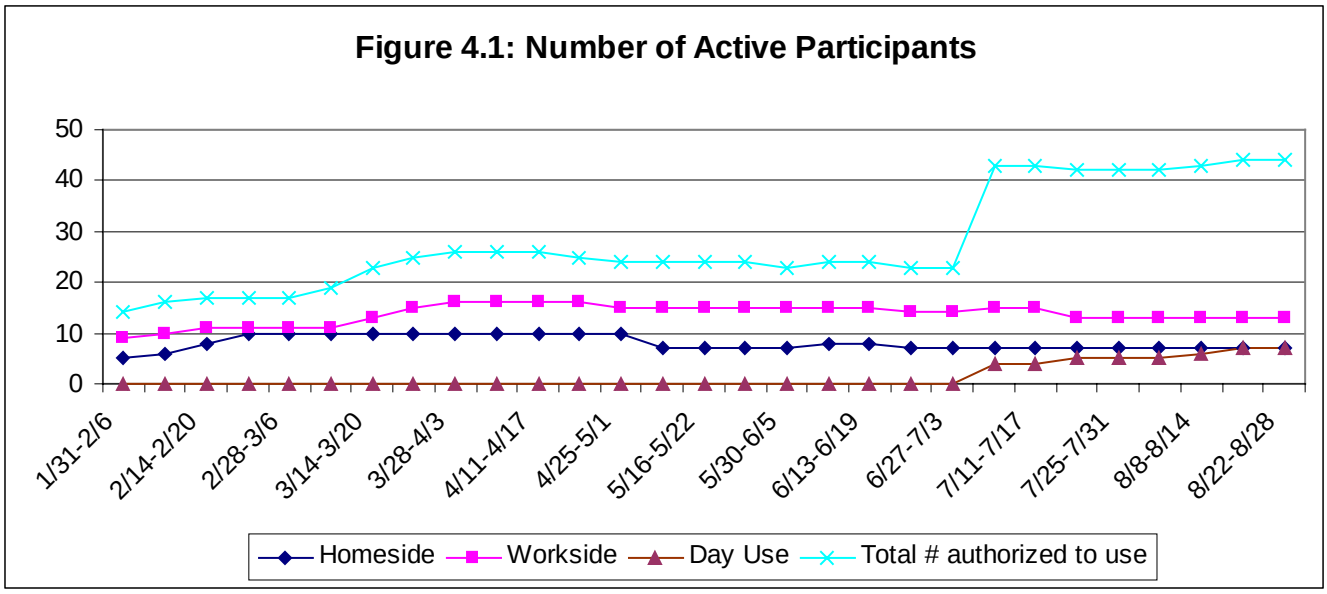
In June, researchers replaced Teletrac with in-vehicle trip diaries. The diaries were employed throughout the remainder of the demonstration. Although the diaries were more reliable, participants preferred the AVL system. Furthermore, manual data entry was inefficient for the CarLink staff.

4.1.1 Authorized and Active Participants

Figure 4.1 (below) illustrates the total number of members by user group who participated in the field test.[1] The top line of the histogram shows the level of authorized CarLink participants, including all registered Homeside Users. The Homeside User group reached the targeted participation level of ten households in March 1999. This number fell in May when three long-distance commuters were asked to leave the program due to high vehicle refueling demands (see Chapter 2 for a discussion of long-distance Homeside User issues). Soon after, a new Homeside User joined and another left the program in June due to a change in travel schedule. Throughout the program, and especially after the initial media launch, newspaper and television stories on CarLink continued to attract new individuals. On average, two individuals per week contacted the CarLink offices during the first few months, slowing down to one every few weeks by the program's end. Most recruits who actually enrolled mid-program learned about CarLink through word-of-mouth, either conversing on BART or at their workplace.

Meanwhile, new Workside Commuters continued to join the program until mid-summer. A total of six Workside Commuters left the program, mostly due to moves, job changes, and travel schedules. The Day Use program officially commenced at the beginning of July, with a total of 24 authorized members and six active participants.

[1] Although the field test operated for ten months, data in this report only reflect the first eight months of the program. To prepare the draft final report by the end of December 1999, the final two months of data were not included in this analysis. Final program usage data were collected, nevertheless.

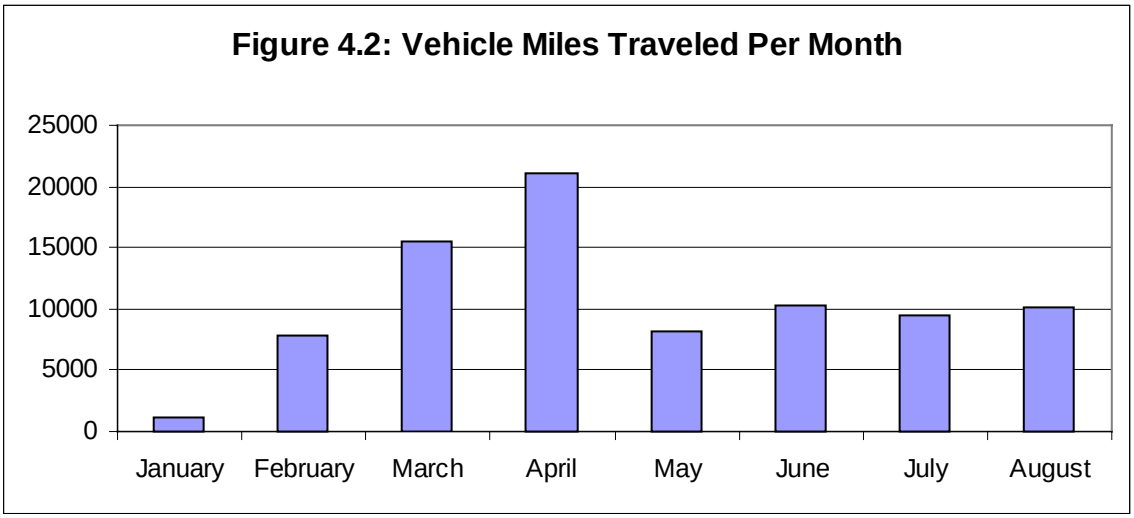


The Workside Commuter group exhibited the most usage variation throughout the program. From household interviews and personal communication, researchers learned that this fluctuation reflected variability in these individuals' work and travel schedules. This resulted in some participants driving their own personal vehicles to work some days (e.g., so they could leave work earlier or later than their CarLink carpool).

4.1.2 Vehicle Miles Traveled

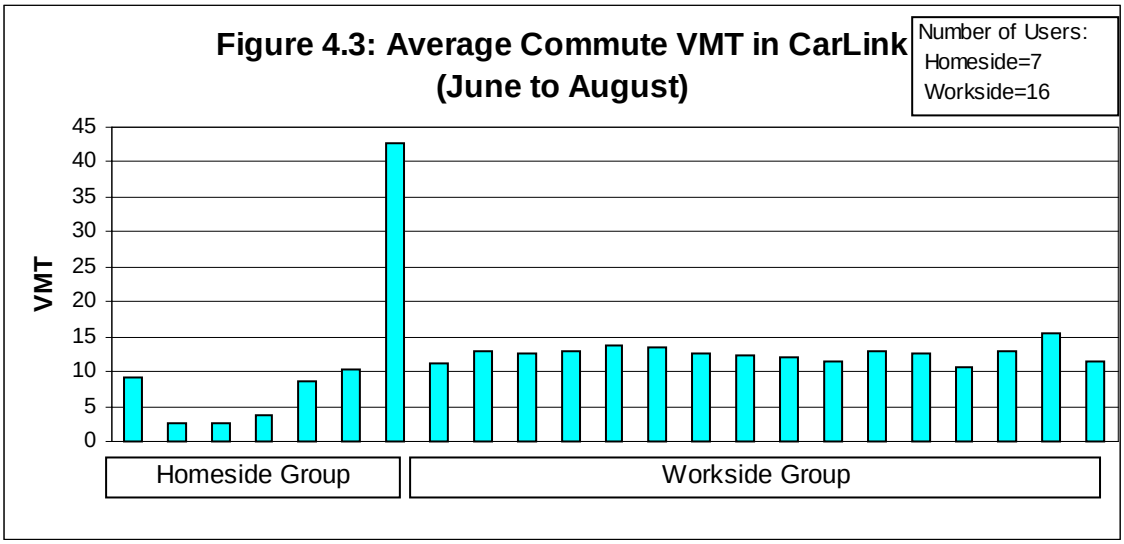
Figure 4.2 (below) shows the total number of vehicle miles traveled for the CarLink fleet (i.e., 12 cars).[2] Odometer readings were collected at the end of each month. The histogram below reflects a large increase in monthly VMT as new users joined the program. In May 1999, three long-distance users left the program, which resulted in significant VMT drop. Together long-distance users were commuting over 250 miles per day. Subsequently, VMT was approximately 10,000 miles per month (on average). Although many participants traveled out of town during July and August, the vehicles were driven approximately the same amount. For example, several Workside Commuters drove to work alone when their carpool partner was out of town. This meant that the CarLink vehicle was still being used, but by one person rather than two.

[2] Again, data included in this analysis only reflect the first eight program months.



4.1.3 Trip Length

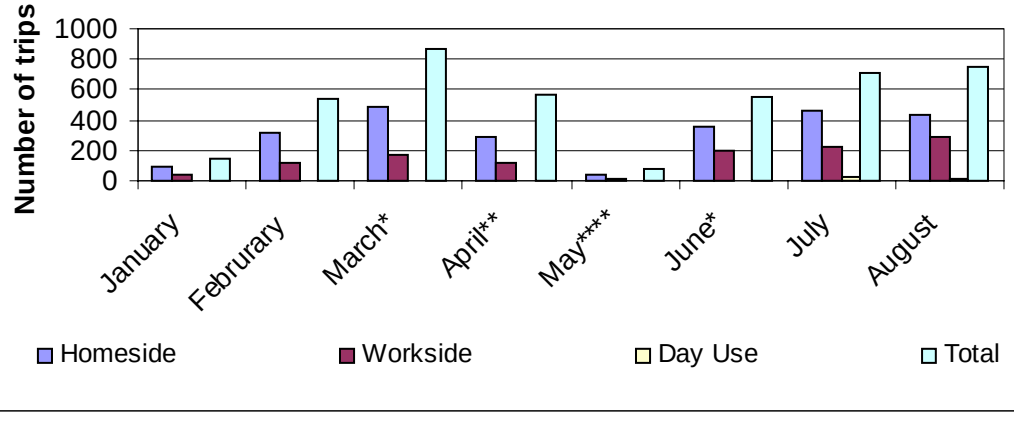
Due to problems with the Teletrac system, it is impossible to accurately compute the average trip length for the first few project months. Based on the manual trip diaries, average trip length was calculated to be 11.5 miles per trip in June, 12.5 miles per trip in July, and 11.7 miles in August. Figure 4.3 below shows the average commute distance for each user from June to August. Workside Commuters had an average trip length just under 15 miles, which corresponds to the distance between Dublin/Pleasanton BART and LLNL. Most Homeside Users commuted 10 miles or less to the BART station, except for one member who drove 43 miles each way.



4.1.4 Number of Trips

Figure 4.4 (below) illustrates the number of trips taken by each user group throughout the field test. As shown in this graph, March through June are missing several weeks of data. Total columns include trips taken by unidentified users[3] and CarLink staff; thus, they exceed the sum of the other columns. These data parallel the VMT data above. During the first few months, there was a general rise in trip number, which accompanied increased enrollment. Trip number reached a plateau during the last three program months.[4] Although there were half as many Homeside Users as Workside Commuters, these participants accounted for half the total trips. This is not surprising since a Workside carpool typically took two trips per day, and Homeside Users drove the vehicles on evenings and weekends.

Figure 4.4: Total Number of Trips Per User Group



Note: An * means that one entire week of Teletrac data is missing for that month.

Figure 4.5 (below) contrasts the number of weekend and weekday trips[5] for weeks during June to August. The number of weekday trips ranged between 100 and 150 throughout most of this three-month period and peaked a few weeks in August. This peak was primarily due to Workside Users. In designing a carsharing system, it is important to account for possible demand spikes. The field test accounted for such spikes by including two unassigned CarLink vehicles in the fleet.

[3] Due to data transmission errors.
[4] Please note that June is missing one week of data.
[5] These counts do not include trips made by unidentified users.

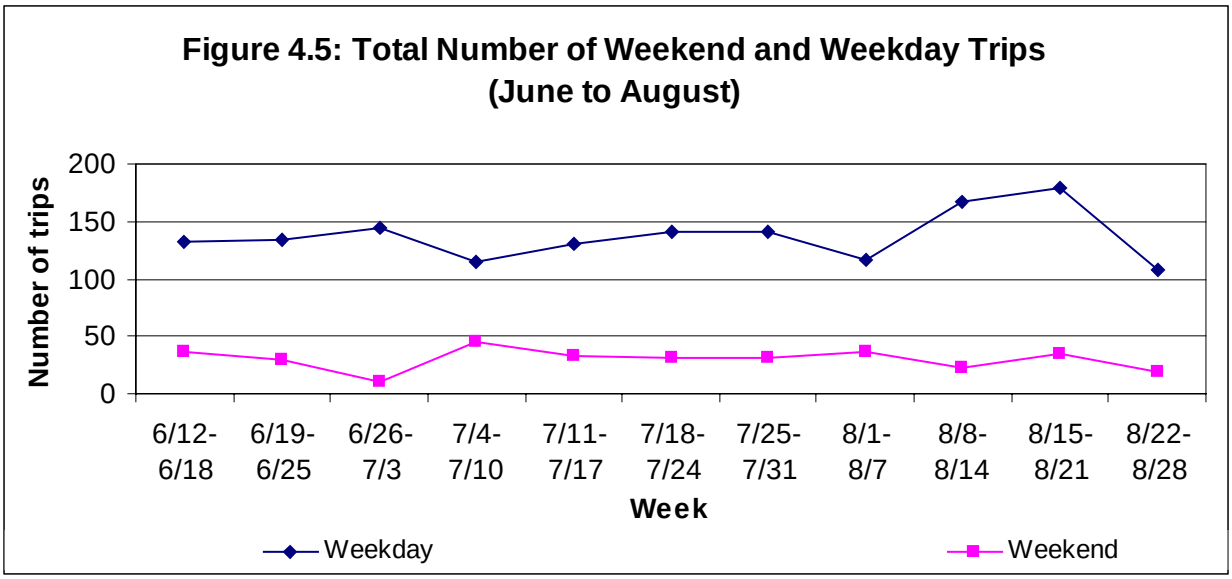
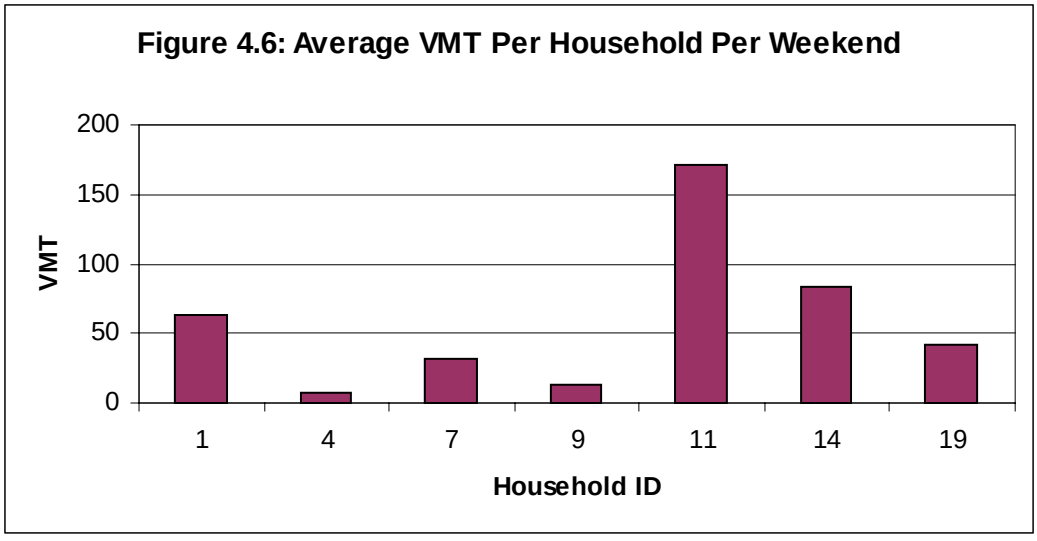
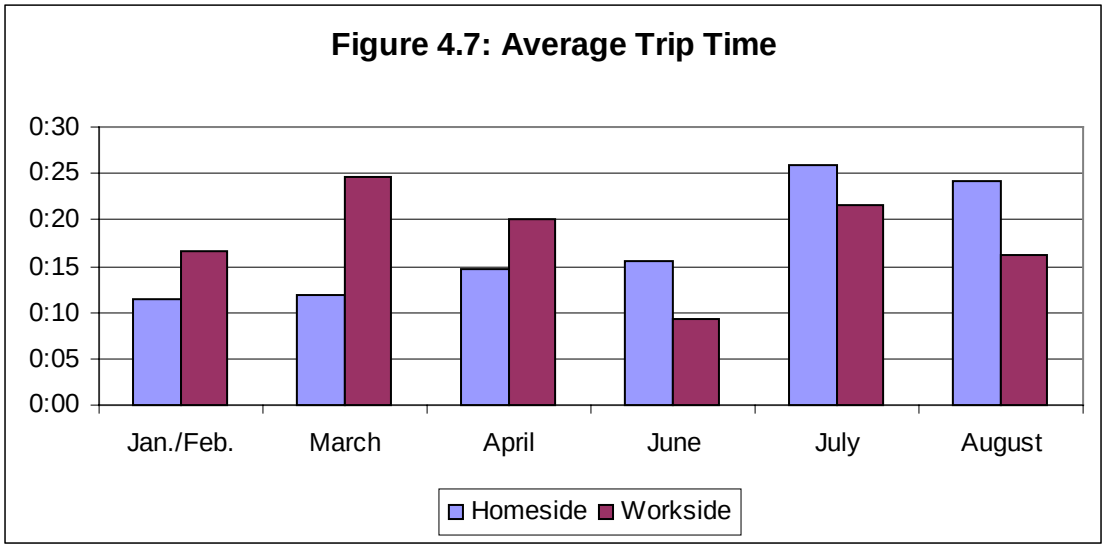


Figure 4.6 (below) examines weekend demand, specifically the average mileage driven by Homeside Users throughout June, July, and August. This mileage reflects the average amount driven during the period extending from Friday evening through Monday morning. These figures may be lower than those expected from conventional gasoline vehicles due to the limited CNG refueling infrastructure in the study region. While many Homeside members refueled CarLink vehicles, long distance trips were sometimes still impractical. With traditional vehicles, these figures would likely increase.



4.1.5 Average Trip Travel Time

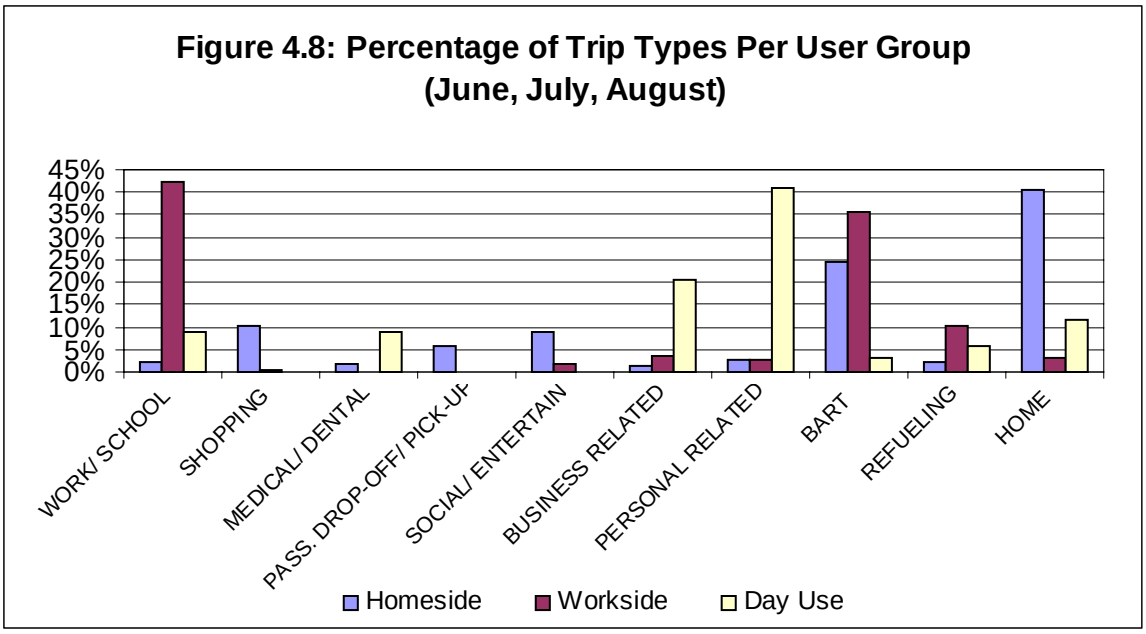
Figure 4.7 shows the average trip travel times for Workside Commuters and Homeside Users, from the last week of January through August 1999. The Homeside User average for the months of February through April are likely to be lower than those reported, because the AVL system failed to track the travel times of long-distance commuters. Homeside User travel time averages increased during July and August because travel diaries captured long-distance trips and three of the seven Homeside Users began to refuel their vehicles, allowing them to drive further.



4.1.6 Trip Purpose

Figure 4.8 (below) summarizes trip type by user group during June, July, and August.[6] As expected, the majority of Homeside User trips were between BART and home, and most Workside Commuter trips were to BART and work. Nearly half of Homeside Users' travel focused on commuting; this is significantly higher than national statistics where 27.3% of trips are for "earning a living" (NPTS, 1995). This implies that Homeside Users continued to use other household vehicles for tripmaking. However, when interviewed most households said they used CarLink vehicles whenever possible. It is also interesting that 12% of Day Use trips were to individuals' homes because many participants lived near LLNL. Many of these trips were for lunch or to pick up an item.

[6] Gathering trip purpose data was particularly problematic before June, due to difficulties with Teletrac reception and decipherment.



4.1.7 CarLink Scheduling and Vehicle Sharing

One of the key questions analyzed in this study is whether or not enough vehicles were available for each user group at the times they were reserved. Since participation levels did not reach maximum capacity at any one time, it is difficult to determine how usage behavior and fleet capacity would have interfaced in a program of 60 active users. Vehicle location depended upon how Homeside and Workside Users commuted with CarLink vehicles each day. In the final CarLink questionnaires, all Homeside Users claimed to be commuting with CarLink 100% of the time. However, from interviews and other communications, researchers learned that at least one Homeside User drove his CarLink vehicle all the way to work approximately one or two days a week throughout most of the program; two others did this less frequently. Consequently, program participants over-reported their CarLink usage in the exit surveys, perhaps reporting a "typical" week, rather than an "average" one.

Since Homeside Users generally contacted the CarLink staff regarding their vacation schedules,[7] the staff was able to ensure that a sufficient number of vehicles were available at BART for Workside Commuters. Typically, there were more than enough vehicles so CarLink management did not require that cars always be returned to the BART station during vacation times. If Homeside and Workside Commuter participation had reached capacity, this would not have been the case. Based on interviews, researchers estimate that one vehicle (on average) would not be returned to BART by a Homeside User each day[8] under full program participation. Thus, the two extra CarLink fleet vehicles would have been critical to providing enough cars daily.

[7] During which time they would leave their CarLink vehicle at BART.
[8] This might be due to an illness, change in schedule, or other unexpected circumstance.

Most Workside Users tended to commute with CarLink less frequently than Homeside Users. If a Workside Commuter planned to work late, he or she usually drove to work in a personal vehicle. While this helped ensure sufficient vehicles at BART for Homeside Users, this resulted in fewer CarLink vehicles at LLNL for Day Use and refueling. Workside Commuters, who drove a CarLink vehicle from BART to LLNL without their carpool partner, counteracted this potential problem to some degree. Below, Table 4.1 illustrates the number of days per week Workside Users reported commuting to and from the Lab and how often they carpooled in the final CarLink questionnaire.[9] As expected, a majority of Workside Users commuted via CarLink four or more days per week. Surprisingly, none of the questionnaire respondents reported carpooling every day—a program requirement. Although carpooling increases the number of Workside Commuters per vehicle, more vehicles may be needed to accommodate commute schedule variability (e.g., when carpool partners each use a CarLink vehicle).

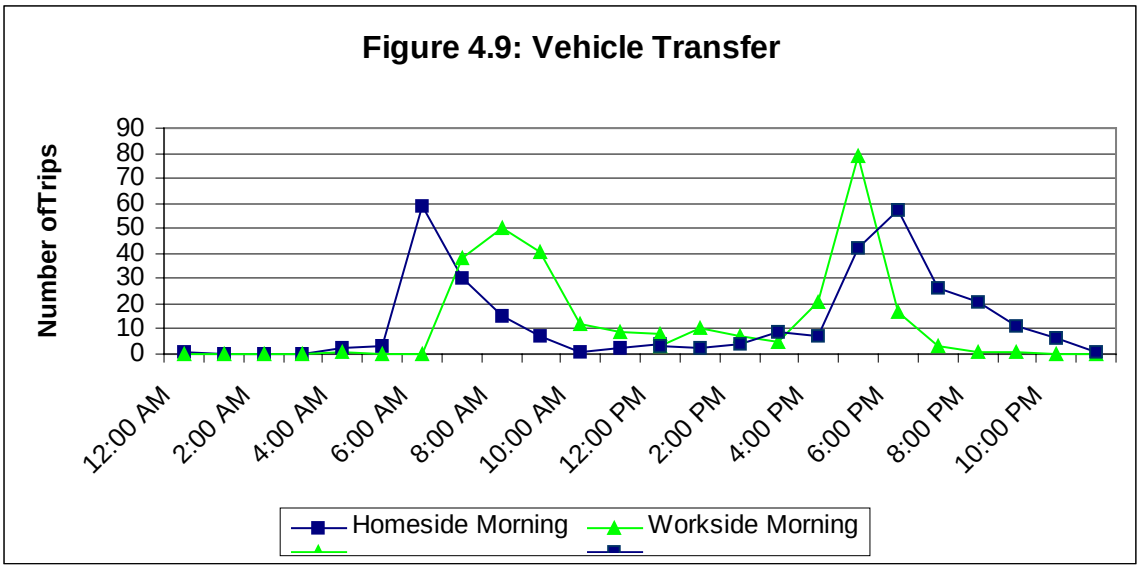
Table 4.1: CarLink Commute and Carpool Frequency

Days per Week	Percent Commuting with CarLink (n=13)	Percent Carpooling with CarLink (n=13)
1	0%	15%
2	8%	23%
3	0%	38%
4	54%	23%
5	38%	0%

During the household interviews, several Workside Commuters reported that when one partner did not use CarLink, the other generally did. Indeed, researchers observed that more CarLink vehicles were actually driven to LLNL than anticipated because many users drove alone. This trend would have definitely affected program effectiveness, had all ten carpools been operational at one time. Hence, a stricter carpool policy or more unassigned vehicles may be needed in a larger program. Throughout the project, there were only a handful of occasions when users were forced to wait for a vehicle; in these cases, wait times were almost always less than ten minutes. For the most part, Homeside Users and Workside Commuters generally adhered to their specified commute schedules.

Figure 4.9 below provides an estimate of the number of arrivals and departures per hour. These data reflect weekdays during August. The figure shows Homeside User trip end times (i.e., when they arrived at the Dublin/Pleasanton BART station) and Workside Commuter start times (i.e., when they left the station). Afternoon Homeside User start times (i.e., when they left the BART station) and Workside Commuter trip end times (i.e., when they arrived at the BART station) are also provided. These data reflect all weekday trips, so not all of them are BART-based commute trips.

[9] Please note an expanded discussion of user carpool reactions is included in Section 4.3.7: Carpool Concerns.



The above figure illustrates how the two groups' schedules worked together. Most Homeside Users parked CarLink vehicles at BART in the morning before the majority of Workside Commuters arrived at the station. In the evening the opposite occurred. However, there was less flexibility in the evening since members of both groups arrived at BART at 5pm.

4.1.8 Day Use

As discussed in Chapter 2: CarLink: An Operational Perspective, the Day Use program began later than originally planned with fewer members.[10] Furthermore, Day Users were only allowed to access two of the five (designated) CarLink lots during the first month of the three and one-half-month program. This resulted in limited usage throughout most of July.[11] Although the field test did not provide a clear picture of active Day Use, researchers developed ideas for how to improve this service.

Both Workside Commuters and Day Users could participate in the Day Use program. Figure 4.10 below shows the number of Day Use trips taken per week. Day Use is defined as any excursion, originating from LLNL during the day, that is not a commute trip. A Day Use trip is also defined here as a round trip rather than a one-way trip. This facilitates carsharing billing, which is typically calculated as the total time and mileage accumulated away from a shared-use lot. Please note that the Day Use program did not begin officially until July 6, 1999; thus, Day Use trips taken before this period were made exclusively by Workside Commuters.

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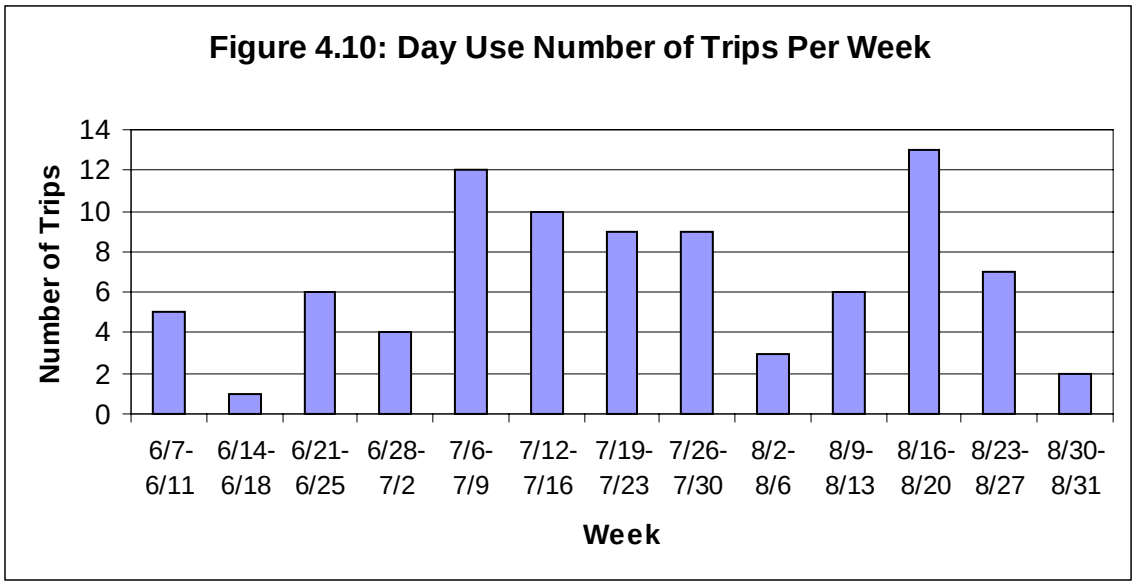
[10] Eleven individuals went through all Day Use training sessions; of the 11, only six accessed vehicles during the data-gathering portion of the field test. In addition to these 11 individuals, active Workside Commuters were also eligible to participate in Day Use.

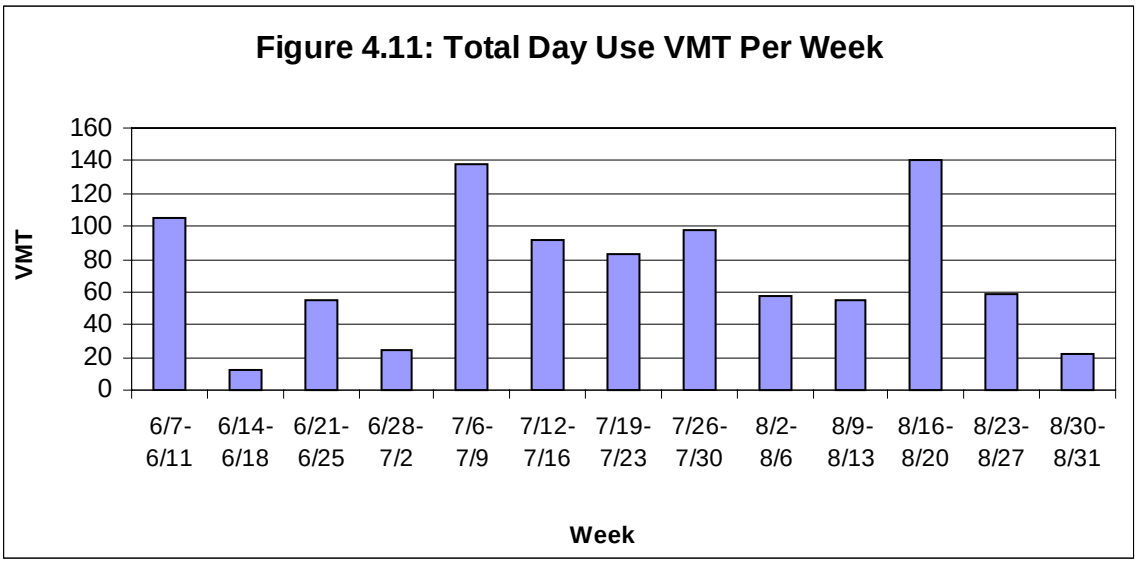
[11] Please note that this report only accounts for the months of July and August 1999. Although the CarLink program continued throughout November 15, 1999, the data analyzed for this study are only reported through August 31, 1999.



From July to August, the number of trips varied greatly from a low of two to a high of 13. During this same period, there was an average of approximately eight trips taken per week by active Workside and Day Use members. Researchers also noted that there were only three days when more than two vehicles were used for Day Use. Thus, there was an excess Day Use capacity. If Day Use members worked in a more centralized location than the Lab,[12] these numbers could be tripled or quadrupled before vehicle demand exceeded supply.

Figures 4.11 illustrates the total weekly Day Use VMT. While the weekly VMT loosely correspond to the number of weekly trips (Figure 4.10), differences in average VMT per trip do arise (see Figure 4.12). As shown, the average of most trips were within a five to ten mile range, indicating trips to downtown Livermore or to participants' homes. The two weeks (i.e., 6/7-6/11 and 8/2-8/6) with the highest average trip VMT included fewer trips, some of which were to the Dublin/Pleasanton area.

[12] Please note that Lab participants requested five CarLink lot locations to meet their Day Use demand. LLNL has work buildings spread throughout its one-square-mile campus.



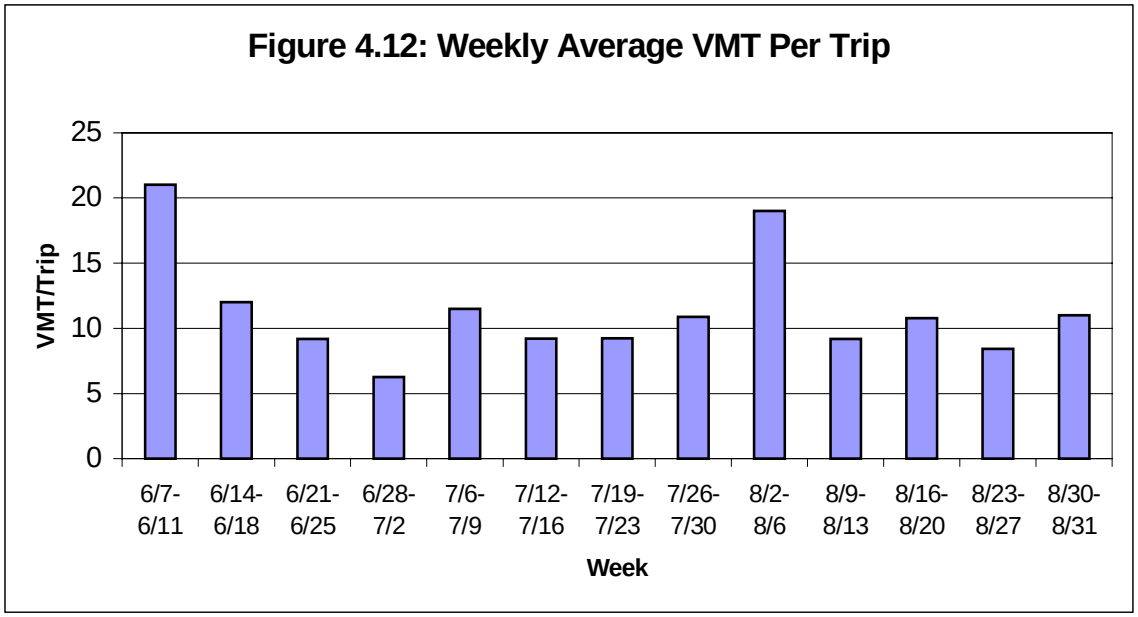
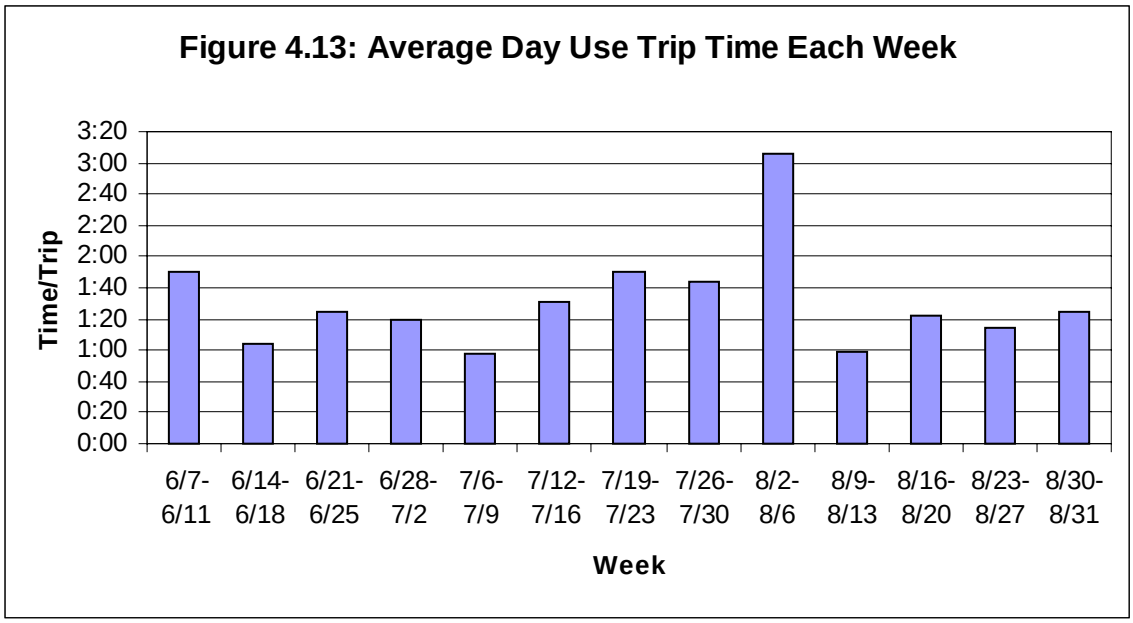


Figure 4.13 below reflects the average time of a Day Use trip per week. The average trip during most weeks was between one to two hours in length with a maximum of three hours. Researchers learned that very few trips were scheduled for the same time period. During household interviews, most users reported that if they had been charged for their trip time,[13] they might shorten some trips (although they said many trip times were inflexible).

[13] Day Users were not charged for their personal trips (as planned) due to program delays.



Most Day Use trips were taken during the late morning and lunchtime. Some participants were hesitant to make trips in the late afternoon for fear that the Workside Commuters would need the vehicles for their commute. Providing users with a better understanding of when vehicles are needed (e.g., through an Internet-based reservation system) would likely encourage more afternoon tripmaking. Nevertheless, it is likely that a majority of personal trips will be linked to an individual's lunch hour. In the future, it would be useful to analyze the midday travel patterns of all workers in an employment center.

It might be safe to assume that each vehicle could accommodate up to two lunchtime trips and two additional trips per day. Assuming three round trips per vehicle each day, the number of active users could increase up to 75 to 150 users. This assumes that all authorized Day Users will exhibit similar needs to those in the field test (i.e., taking one to two trips per week).

SECTION 4.2 PARTICIPANT FEEDBACK METHODS

In this study, several participant feedback tools were employed, including questionnaires (Section 4.2.1), household interviews (Section 4.2.2), and focus groups (Section 4.2.3). Each tool was designed to solicit specific information. Although participation in this study phase was voluntary, it was described as a program responsibility. Incentives were provided to encourage participation (i.e., $25 for questionnaires, $150 for household interviews, and $50 for attending the focus group). A high percentage of users agreed to participate in the evaluation. Participant response is discussed in each section below.

4.2.1 Questionnaires

The exit questionnaire was an efficient tool for collecting a broad range of information from field test participants. It allowed researchers to ask a diverse set of questions and build upon the questionnaires completed at the beginning of the field test (see Chapter 3: CarLink Participant Profile). Anonymity provided respondents with an opportunity to more freely answer questions.

The final CarLink questionnaire was mailed to all field test participants. Incentives, reminder calls, and e-mails helped promote a 73% response rate (See Table 4.2). Researchers mailed the exit questionnaire to participants on September 17, 1999, after the completion of the data collection phase[14] of the field test (i.e., in-vehicle trip diaries). The final questionnaire is included in Appendix II: CarLink Questionnaire.

Table 4.2: Response Rate for Exit Survey

Group	Questionnaires Mailed	Questionnaires Returned	Response Rate
Homeside	11	6	55%
Workside	18	13	72%
Day Use	12	11	92%
Total	**41**	**30**	**73%**

4.2.2 Household Interviews

Household interviews provided participants with an opportunity to discuss specific program issues and elaborate on their experiences in their own homes. Other household members, in addition to the primary participant, were encouraged to share their perspectives. During the interview, researchers asked questions to direct and foster the discussion.

Researchers also used Interactive Stated Response (ISR) techniques to deepen the consideration of CarLink and willingness to pay for this system. ISR interviews, which are grounded in the actual behavior of participants, ensure that households explore the impacts of new travel options on their lifestyle, activity, and travel choices.

The principal interview goal was to ensure researchers perceived CarLink through the eyes of users and understand how they valued this service. Households completed travel diaries prior to the field test. The interviews employed data from before and during the field test to explore differences in travel and activity choices, as recorded in the diaries. The interview protocol is included in Appendix III: Household Interview Protocol.

[14] Please note that in-vehicle trip diary data were collected throughout the field test (i.e., November 15, 1999). Analysis only includes data collected from January through August 1999.

To summarize, each interview began with a short introduction, followed by a few questions about how the household learned about CarLink and their initial impressions. The interviewer then showed the participants a poster-sized timeline of their travel, constructed from pre-field test travel diaries. The household discussed how typical the travel was and what other trips they make regularly. Next, the interviewer took the same days (with variations based upon the discussion) and asked how they accomplished their travel using CarLink. Finally, different CarLink scenarios were presented (e.g., CarLink lots at more and different locations at a range of cost structures), during which the household's interest in each and willingness to pay for them were discussed.

CarLink household interviews were conducted with representatives from all three user groups. The sample included six Workside Commuters, three Homeside Users, and two Day Users. This distribution of users was selected to represent the ratio of authorized users. The response rate was 100%. A total of ten interviews were conducted by CarLink staff, between October 21 and November 15, 1999.

Through this process, several new issues and ideas were identified. While it is not possible to generalize from a small sample of household interviews, this survey tool provided detailed, personal perspectives that are difficult to collect through questionnaires and focus groups. For instance, the one household with a newborn baby was able to share their unique perspectives more readily than they could have in a questionnaire. Despite their research value, household interviews are resource intense, including preparation time, the interview (i.e., two hours), travel, incentives, and transcription time.

Data gathered from these interviews contributed significantly to field test understanding, as discussed in Section 4.3. In particular, researchers were able to focus on atypical travel. Due to variable schedules, many participants had as many atypical days as typical ones.

4.2.3 Focus Group

In this study, the focus group was designed to provide a setting in which several individuals who participated in the study came together to explore the CarLink service and larger visions of smart carsharing in the San Francisco Bay Area. This larger image was intended to be a larger carsharing service, as users envisioned it in the San Francisco region.

Focus groups are designed to encourage individual involvement and group interaction. Generally, focus groups are comprised of individuals with similar experiences or backgrounds related to the study. Focus groups are a cost-effective tool to solicit ideas and information in a group setting. The moderator presented specific topics related to the CarLink field test and broader carsharing applications and facilitated participant response. A primary disadvantage of focus groups is that some individuals may not express their own views and are lead by other participants.

During the focus group, the group built carsharing images through a discussion of their CarLink experiences. Through the process of building these images, participants revealed what they considered to be the essential features of these systems. These included important system design elements, suc h as what types of vehicles should be available, where they are available, how they are accessed, and how use is billed. By constructing this image, people revealed how much they valued this new transportation service, how that value was constructed, and whether this new transportation mode complements (e.g., adds riders to transit) conventional transit services. The final images produced were less important than what was revealed in the process of building the images.

Although two focus groups were planned, researchers only conducted one focus group, consisting of 11 Day Users, at the end of the program. The second group was not held because many individuals already participated in a household interview and completed an exit questionnaire. The purpose was to discuss the CarLink Day Use program, improve Day Use, and design a broader carsharing service that might address their needs more closely. Susan Shaheen moderated the session on November 17, 1999, at LLNL.

Data gathered from the focus group contributed significantly to Day Use program understanding. In particular, many participants discussed the reasons they used the program only sporadically. For further detail on focus group results, please see Section 4.3: Issue Analyses. The focus group protocol is included in Appendix IV: Focus Group Protocol.

SECTION 4.3 ISSUE ANALYSES

This section includes a discussion of key field test issues and findings, including: smart technologies, parking issues, productivity and enjoyment of commute time, spontaneity and ability to respond to an emergency, perceived environmental impacts, vehicle variety, carpools, modal shifts, personal vehicle sale, travel behavior after CarLink, and miscellaneous issues. Each topic is introduced and findings from the three evaluation methods (i.e., questionnaires, household interviews, and focus groups) are provided.

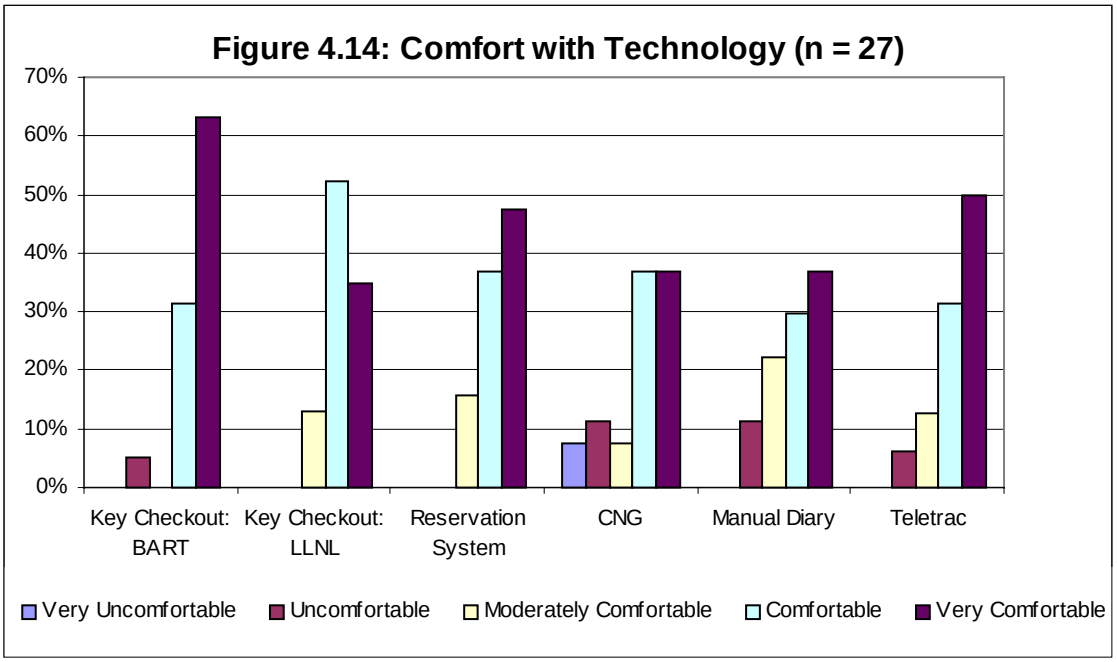
4.3.1 Smart Technologies

A primary component of the CarLink demonstration was the advanced technology employed to operate the field test. Users were exposed to four specific technologies, including: an electronic key manager and smart cards at the Dublin/Pleasanton BART station,[15] an Internet-based reservation system for Day Use at LLNL, CNG vehicle refueling, and AVL and trip data collection devices (i.e., Teletrac system). In general, all participants viewed the technology favorably. Although participants had concerns about reliability, they preferred an automated service overall.

[15] Manual key boxes were employed at each of the five LLNL lots due to program budget and logistical limitations.

4.3.1.1 Questionnaires

Questionnaire responses demonstrated a high user comfort level with all four CarLink technologies (see Figure 4.14 below). Respondents tended to prefer automated systems to manual methods (i.e., the electronic key manager to the manual key boxes and the "smart" data collection system over manual trip diaries). Since approximately 20% of respondents were "Uncomfortable" to "Moderately Comfortable" with the Teletrac data collection method, further improvements could be made to increase user satisfaction. Such improvements might include increasing the level of automation to eliminate the need for drivers to enter data (e.g., data are automatically collected and sent to a traffic management center), such as VMT, fuel level, and number of passengers.



Of the CarLink technologies, only CNG refueling made some respondents "Very Uncomfortable" (i.e., less than 10%). Indeed, none of the smart technologies[16] made more than 6% of respondents feel "Uncomfortable." With members being exposed to so many novel items (e.g., alternative-fuel vehicles, smart technologies, as well as the carsharing concept), it is interesting to note that participants were not overwhelmed by the new technologies nor found them objectionable. Nevertheless, this may be reflective of the high education and income level of most participants.

4.3.1.2 Household Interviews

Household interviews validated questionnaire findings regarding participant perception of the CarLink smart technologies. Participants reported that each device was

[16] Smart technologies included the BART key manager, the AVL system (Teletrac), and the Internet-based reservation system at LLNL.

straightforward to use. Many stated that they needed a couple of days to familiarize themselves with Teletrac and the CNG refueling systems. When problems arose, participants were willing to adapt or, if necessary, circumvent the system in accordance with CarLink staff direction. For example, participants were asked to employ manual trip diaries when the Teletrac system was disabled.

Suggestions for improving the CarLink smart technologies include providing real-time access to the booking schedule and location of CarLink vehicles (e.g., on a web page accessible from home or work, at the key manager, or inside the CarLink vehicles). This would facilitate vehicle use and access, as well as user confidence in system reliability. The main suggestion for improving CNG refueling was better training, particularly because the equipment was updated mid-project.

4.3.1.3 Day User Focus Group

The CarLink Day Use program only incorporated two smart technologies (i.e., the CNG vehicles and the reservation system). Several participants were concerned about the process and time needed for refueling the vehicles. Not surprisingly, the more frequent a Day User employed the system, the more familiar and comfortable they became with refueling.

The reservation system was positively received. While a couple of participants said that they would prefer human contact, most were comfortable using this system. It should be noted that LLNL participants requested and designed the reservations web page for this program. Suggestions for improving the web site included choosing their own passwords and including real-time vehicle location information. Furthermore, several expressed interest in spontaneous rentals (i.e., without reservations) in which a vehicle light bulb would indicate each car's rental status (i.e., reserved or open).

4.3.2 CarLink Vehicle Parking

The location of CarLink parking is a carsharing success factor. Focus groups, completed as part of the initial CarLink longitudinal study (Shaheen, 1999), found that participants were interested in lots that were simple to access, secure, and well maintained. In establishing the CarLink lots, project partners kept these points in mind. Overall, members were pleased with the CarLink lots, except several Day Users who were frustrated by limited lot openings at the beginning of the Day Use program (see Chapter 2).

4.3.2.1 Questionnaires

On a scale of zero to five, participants were asked to rate lot location, the benefits of reserved parking, and lot convenience. Mean scores for the three groups are listed in Table 4.3 below; five indicates the highest positive rating. Homeside Users, who only used the Dublin/Pleasanton BART station lot, were extremely positive in each of the questions. While six of the 13 Workside Commuters recorded a five for all three

questions, varying amounts of dissatisfaction among the others participants lowered the mean scores, slightly. In contrast, only one Day User provided a score of five for all three questions. Researchers expected a range in response among Workside Commuters and Day Users because the distribution of work sites at LLNL meant that lots were much closer for some individuals than others.

Table 4.3: CarLink Lots

Issue	Homeside (n=6)	Workside (n=13)	Day Use (n=11)
Lot Placement	4.81	4.43	3.16
Reserved Spaces	4.98	4.56	4.43
Lot Convenience	4.76	4.46	3.12

Note: A score of zero indicates the most negative response and a score of five indicates the highest positive response.

4.3.2.2 Household Interviews

As expected, Homeside Users were pleased with the location of the CarLink lot at the BART station. Since the Dublin/Pleasanton BART lot fills up very quickly on weekdays, transit riders must arrive at the station early to avoid a long walk. In fact, many BART riders drive to work when they are unable to find a parking spot at the BART station. Thus, Homeside Users expressed great satisfaction with the reserved parking near the BART entrance. Several stated that they were able to leave their houses later in the morning due to CarLink. One Homeside User, who still took BART before the morning rush, was still pleased because his personal vehicle was a large truck that he was only permitted to park a long distance from the BART entrance.

Although many Workside Commuters had never parked at the Dublin/Pleasanton BART station before (10 of the 14 responding Workside Commuters did not use BART on a regular basis), they still found it convenient. Workside Commuters who boarded BART at popular stations expressed dissatisfaction with long walks on their home end. Workside Commuters were also satisfied with the final lot structure at LLNL (i.e., lots were moved and added during the program at the request of participants). Some Workside Commuters and Day Users were willing to walk or bike several blocks to access a vehicle. Most said that they would be willing to park in a different lot on most days, if the CarLink system needed the vehicles in a particular lot. Nevertheless, some were adamant that CarLink lots had to be located within two or three blocks of their office. Nearly everyone said that they would prefer lots nearby (e.g., during inclement weather, when dressed more formally, or transporting items). Since the LLNL workforce is spread over a one-square-mile facility, it was difficult to reach everyone with only five lots.[17] Rather than increase the number of lots (at least until there are more vehicles), it might be advisable to recruit members working near the most popular lots.

[17] Although the Day Use focus group suggested a set of lots that were even more accessible than those selected for the field test. These suggestions may have resulted from Day Use experience.

All three groups said that designated parking spaces were not necessary for each vehicle. In other words, if Car A was not parked in Space A, participants thought they would have little difficulty locating the assigned vehicle, assuming it is in an assigned lot. This is an important finding since this would allow designers to reduce the number of parking spaces required for CarLink vehicles, generating substantial gains for BART, other transit agencies, employers, property management agencies, and retailers.

4.3.2.3 Day Use Focus Group

Many participants stated that lot location was important and some cited that inconvenience was a primary reason they seldom or never used CarLink. Many thought that the lots should be dispersed as widely as possible to provide vehicle access to more workers. Participants stated that a minimum of three lots would be necessary at the Lab and five would be ideal (i.e., with a fleet of 10 to 12 vehicles), with one in the center of campus and one near each corner of the facility.

4.3.3 Commute Enjoyment

One question of significant interest to researchers is how enjoyable or productive an individual's commute was with CarLink. In instances when CarLink use carried additional costs or time penalties, it was hypothesized that other benefits might emerge (e.g., reduced stress). Researchers expected this finding among participants who commuted through highly congested areas.

4.3.3.1 Questionnaires

Homeside Users and Workside Commuters were asked how CarLink affected their commute stress level and personal time.[18] Their mean scores are shown in Table 4.4 below, where a score of five indicates lower stress and enhanced personal time during the commute. All but one Homeside User indicated reduced stress levels, and only one respondent recorded a score over a four, which indicated that stress level was significantly lower. This result is expected because CarLink did not radically alter the commute patterns of participants (i.e., most were commuting with BART to varying degrees previously), but CarLink did reduce parking and walking hassles. All respondents indicated that it was very important that their commute time was available for personal use. For example, each Homeside User spent a minimum of 25 minutes on BART each way, which allowed them to use this time for other activities than driving.

[18] Most Day Users did not have sufficient time in the program for CarLink to alter their commute behavior, such as shifting from cars to bicycles.

Table 4.4: Time During Commute		
Question	**Homeside (n=6)**	**Workside (n=13)**
Stress level during commute	3.65	4.00
Availability of commute time for personal use	4.65	3.74

Note: A score of zero indicates higher stress and personal time during commute is not important, and a score of five indicates lower stress and personal time during commute is important.

All but one Workside Commuter indicated that commute stress was lowered with CarLink, and six of the 13 respondents provided a score of four or higher. The higher stress reduction among this group is likely due to a more drastic modal shift from driving alone to the BART/CarLink carpool.[19] Workside Commuters varied more than Homeside Users in their response to a second question (i.e., availability of commute time for personal use). While six of the 13 respondents provided a score of five, three individuals indicated a score below 1.5. Two of these individuals lived within one stop of the BART station and did not have sufficient time on the train.

4.3.3.2 Household Interviews

During the household interviews, each participant was asked about their commute stress and whether they arrived at work in a better disposition due to CarLink. Most Homeside Users claimed a slight stress reduction, primarily because of BART parking convenience. However, some of this benefit may have been offset by concern about getting vehicles to BART in time for Workside Commuters.

All of the Workside Commuters said they arrived at work more relaxed, although a few experienced some added stress from juggling their own schedules with a carpool partner and the BART train. Not surprisingly, those who took BART further than one stop enjoyed working or relaxing on the train. For some, this was a very important CarLink feature. One individual said he was able to work "very productively" on BART; another said it was her only opportunity to pleasure read. Another participant said it gave her a chance to "catch her breath" before arriving at work. For two participants who took BART only one stop, the added hassle and transit commute time were significant drawbacks. This led both to leave the program, although one later returned due to concept interest. Furthermore, a third Workside Commuter—living one stop away—was satisfied taking BART for only one segment.

Many respondents indicated that they had not consciously factored "commute well being" into their decision to join or remain in CarLink. Initially, they calculated the time and cost differential of CarLink in contrast to their current modes. Most also gave CarLink a few extra points for its environmental benefits (e.g., CNG vehicles and transit linkage). Although several users stated that CarLink—in its present form—was costly and time-consuming, these same individuals gave the program excellent reviews. This

[19] Ten of the fourteen responding Workside Commuters did not use BART on a regular basis before CarLink.

implies that even these individuals had a positive commute experience, otherwise they would have left the program. Another household stated that while they included the cost of oil changes into their calculations, they did not factor in reduced hassle benefits—even though they considered them significant. In the future, increased personal time and reduced stress should be emphasized in marketing carsharing services, linked to transit.

4.3.3.3 Day Use Focus Group

Although few were able to modify their commutes because of CarLink, most participants thought that carpooling, busing, and biking were preferable to driving alone. Many identified the same advantages as Workside Commuters: They were able to rest or work while commuting and put fewer miles on their personal vehicles.

4.3.4 Spontaneity and Emergency Response with CarLink

CarLink flexibility is also an important issue to program success. As expected, many individuals prefer transportation modes that allow them to act spontaneously or respond quickly to an emergency. In fact, CarLink longitudinal survey participants identified these attributes as potential CarLink limitations (Shaheen, 1999). Thus, it is interesting to review the exit perceptions of participants to these variables.

Ideally, CarLink should provide transit users with a level of spontaneity similar to that of a personal vehicle, but in practice it may fall short. Many individuals select their modes on the basis of occasional versus daily needs. A short-term field test, like CarLink, allowed researchers to analyze users' perceptions of such issues, but only document actual response (e.g., to an emergency) on rare occasions. During the program, three different users (one Homeside and two Workside) reported that they had returned home mid-day when their children's school/day care called. All said that they were able to do so adequately with CarLink.

4.3.4.1 Questionnaires

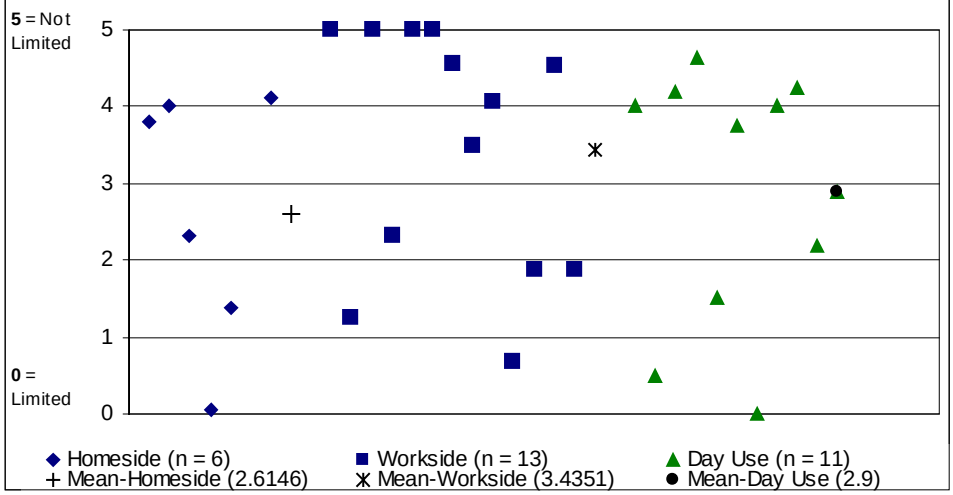
Figures 4.15 and 4.16 below illustrate how the three groups evaluated CarLink spontaneity and emergency response. For spontaneity, there was a tremendous range in response among user groups. For Homeside Users, weekday spontaneity was perceived neutrally. This is probably because these individuals already commuted via BART on a regular basis prior to CarLink; therefore, their commute modes were very similar. Those Homeside individuals who provided low scores for spontaneity may have felt restricted by the limited fuel range of the CNG vehicles.[20]

Most Workside Commuters did not think that CarLink limited their spontaneity. This is more surprising because for ten of these participants BART was a new commute mode. They enjoyed the flexibility that CarLink offered for driving to and from BART and performing errands during the day. They were less concerned about any lost spontaneity. Day Users responded similarly to Workside Commuters, although lot access concerns

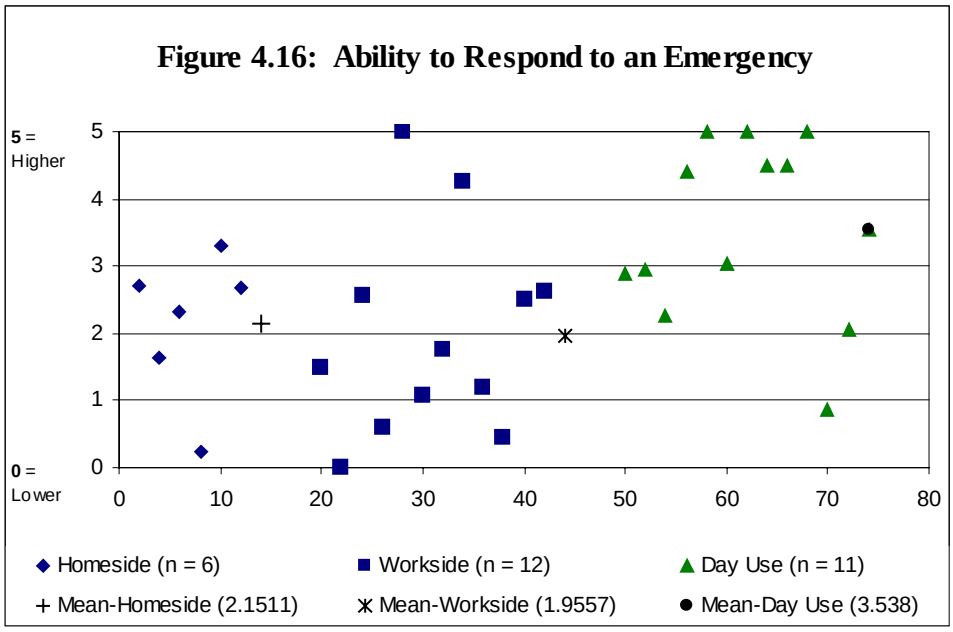
[20] The CNG vehicles were limited in range because of the limited CNG infrastructure in this area.

likely lowered this group's mean. Since many Day Users carpooled, biked, bused, or walked to work, CarLink should have only increased their mobility options and spontaneity.

Figure 4.15: Ability to take Spontaneous Trips



On emergency response, most Homeside Users felt that CarLink did little to lessen their quick response. The one individual, who commuted the farthest from home to BART, may have reported this due to limited CNG infrastructure concerns. It is interesting to note that only five Workside Commuters provided scores below 1.5 (i.e., one point lower than neutral), since CarLink appears to be stricter than driving alone. Two Workside Commuters, who scored CarLink high on emergency response, might have been contrasting it to carpooling or bussing. Finally, Day Users also responded positively regarding emergency response. This is quite logical since CarLink would increase their options. These results indicate that while this issue is a concern for some, it is not universal. It is interesting that for most participants neither of these factors was a significant limitation. This is likely due to their commute modes prior to CarLink (i.e., primarily transit and carpooling).



4.3.4.2 Household Interviews

During the household interviews, very few users stated that CarLink would seriously restrict them in an emergency. Most felt that for "minor" emergencies they could use CarLink and BART. For "major" emergencies, they could borrow a vehicle or arrange to take a CarLink vehicle home. Only three respondents said they had to leave work early due to an emergency. All had prepared for such a contingency and were able to use a CarLink vehicle, although they did have some concerns about accessing an adequately fueled vehicle.

Overall, Homeside Users felt that CarLink had little impact on their spontaneity, since they used BART prior to CarLink. After individuals were authorized to fuel at local CNG stations, they no longer felt limited by range. Most Workside Commuters said they took very few day trips, and CarLink did little to reduce their midday tripmaking ability. Finally, Day Users thought that CarLink enhanced their ability to be spontaneous.

In contrast, commute scheduling limited users' spontaneity. Homeside Users were concerned about getting cars to BART in time for Workside Commuters, especially early in the program. Similarly, Workside Commuters were worried about getting cars back to BART in time for their counterparts. Sometimes individuals would drive their personal vehicles to avoid scheduling problems. Thus, it appears that these concerns led Homeside Users to use BART more consistently and a few Workside Commuters to take BART less frequently.

4.3.4.3 Day Use Focus Group

Focus group participants agreed that CarLink increased their overall spontaneity and flexibility. Several said they were able to bike or carpool more frequently with CarLink, knowing that vehicles were available for their personal use at work. A couple of individuals mentioned, however, that a lack of spontaneity was good because they were less likely to stay at work late when they carpooled. All members believed CarLink increased their mobility and would have used it more, if afternoon hours were extended or vehicles could be driven home occasionally.

4.3.5 Perceived CarLink Environmental Benefits

One environmental benefit of transit-linked carsharing is increased transit ridership. Furthermore, by serving multiple users each day, vehicles would spend less time parked and reduce parking demand. Use of natural gas vehicles in this study also provided additional air-quality benefits. While the environment was a factor in many individual's decision to join CarLink, it was seldom the principal factor.

4.3.5.1 Questionnaires

All Homeside Users rated CarLink very positively for its environmental benefits (i.e., a mean score of 4.7 on a continuous scale, ranging from zero to five). Workside Commuters provided a slightly lower mean score (i.e., 4.5). The Day User group's score was slightly lower still (i.e., 4.2).

4.3.5.2 Household Interviews

Three of the interview participants (all Workside Commuters) stated the main reason they joined CarLink were the environmental benefits. In particular, one of these individuals was motivated to participate because of his personal and academic curiosity with alternative fuel vehicles. Moreover, two Workside Commuters and a Day User reported that the environment factored into their decision to join CarLink.

In contrast, one Homeside User and Workside Commuter said the environmental benefits of CarLink did not influence their membership decision; however, they now thought that this was an important program attribute. For the remaining respondents, CarLink's environmental benefits were unimportant. To summarize, one-half of the interview participants stated that CarLink's potential environmental contributed to their decision to participate.

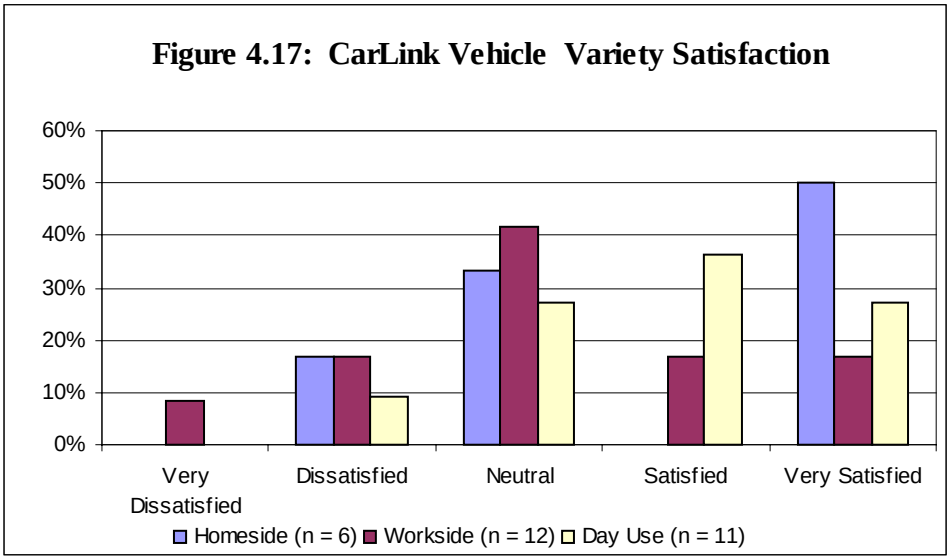
4.3.6 Vehicle Variety

The CarLink field test included a fleet of twelve identical, four-door CNG sedan vehicles. While these vehicles satisfied most users' needs, many thought a pickup truck would add significantly to the system benefits. Slightly fewer requested a minivan for carrying several passengers.

4.3.6.1 Questionnaires

Figure 4.17 below shows how users rated their satisfaction with CarLink's limited vehicle variety. Few members were dissatisfied with it, and the remainder thought sedans met most needs and was not an issue.

Figure 4.17: CarLink Vehicle Variety Satisfaction



4.3.6.2 Household Interviews

All Homeside Users reported that a truck would be a useful addition to the CarLink fleet. One individual even stated that CarLink truck rentals would enable him to sell his own pickup. Workside Commuters and Day Users stated they did not require special vehicles on weekdays, but several were interested in specialty vehicle rentals on weekends. All user groups thought that the CarLink vehicles handled well and the Honda Civics were good for commuting and in-town driving. All participants said that they would be comfortable driving a truck, if no sedans were available.

4.3.7 Carpool Concerns

Although carsharing does not require the use of carpooling, project implementers asked the Workside Commuters to do so. Carpooling increases the environmental benefits of transit ridership and can lower program costs for members. The carpooling requirement was a significant one for many Workside Users, since it increased the complexity of their commutes. Initially, participants were hesitant about carpooling, but most were comfortable with this by the program's end.

4.3.7.1 Questionnaires

Table 4.5 below shows the number of days per week Workside Commuters reported carpooling in CarLink vehicles. Due to travel schedules and assignment logistics, there were times when users did not have a partner. Interestingly, no one reported carpooling everyday, and two of the 13 respondents said that they carpooled once a week or less. While this often resulted in each "partner" driving a CarLink vehicle, it also meant that individuals drove their own vehicles to LLNL (to work early or late).

Table 4.5: Average Number of Days Per Week Workside Commuters Carpool (n=11)

Number of Days	Number of Users
1	2
2	3
3	3
4	3
5	0

Workside Commuters were asked to report the reasons they did not carpool everyday. Respondents were provided with seven explanatory statements. For each response, participants could select one of the following choices: "Never," "Infrequently," "Sometimes," "Often," or "Always." Researchers assigned a point value, ranging from one to five, for each reason and summed the total responses (see Table 4.6 below). One particular response did not emerge. Three of the top four choices, however, did address partner communication. These data suggest that communication mechanisms could be developed to improve carpooling logistics.

Table 4.6: Reasons Workside Commuters Did Not Carpool (n=11)

Reason	Score
Partner tells me they won't be there.	24
It's hard to schedule with my partner.	24
I work early and/or stay late.	23
Carpool partner(s) doesn't show up.	23
I do not have an assigned partner.	20
I like driving alone.	14
High availability of cars that day.	11

Note: The possible scores ranged from 11 (all respondents stating "Never") to 55 (all respondents responding "Always").

4.3.7.2 Household Interviews

All Workside Commuters reported that they were comfortable communicating with their partner. Half said that they were unaware of the carpooling requirement when they joined the program. Nevertheless, carpooling was only a significant problem for one individual. This individual altered his schedule two to three times per week and brought work home so he could participate; eventually, he dropped out of the program.

Two participants altered their schedules slightly, regularly leaving home 10 to 15 minutes earlier or later, to accommodate their partner. Occasionally, most worked a half-hour to an hour later to oblige a carpool partner's schedule. A few Workside Commuters mentioned that they would have been willing to change partners daily (i.e., casual carpools) to reduce costs or increase program efficiency.

4.3.8 Overall Trip Modal Shift

An interesting research question is whether CarLink usage altered the travel modes and behavior of program participants for commute and non-commute trips (e.g., errands). Did CarLink constrain members and force them to make trips at inconvenient times or did it provide new options? Did CarLink encourage BART use for non-commute trips? How did CarLink affect overall carpooling, walking, and bussing?

4.3.8.1 Questionnaires

In the exit questionnaire, respondents were asked how their travel shifted among travel modes after CarLink use. These data are presented in Table 4.7 and reflect average mode change for commute and non-commute trips (by user group). Before CarLink use, participants completed a three-day travel diary. Researchers calculated CarLink modal shifts using these baseline data, CarLink vehicle logs, and the exit questionnaire, which captured non-CarLink trips.

Table 4.7: CarLink Modal Percentage Point Shifts

Mode	Homeside (n=6)	Workside (n=13)	Day Use (n=11)
Household Vehicle	-53.7	-49.7	N/A
Carpool	-3.9	+17.2	+4.6
Bus	-8.3	-25.8	-5.4
Bike	-14.3	+1.7	+10.8
Walk	-16.3	+12.7	+5.6
Recreational Public Transit	-24.0	+21.8	N/A
Drive Alone	-13.2	-25.6	-6.5

Note: Questions about "Recreational Public Transit" and "Drive Alone" modes were asked separately. Thus, "Recreational Public Transit" is a subset of "Bus" and "Drive Alone" is a subset of "Household Vehicle" use.

As expected, the most significant change occurred in household vehicle use. Interestingly, the modal shift for Homeside Users was only slightly more (i.e., four

percentage points) than Workside Commuters, despite greater vehicle access (i.e., on evenings and weekends). This likely resulted from many Homeside Users[21] shifting from a personal vehicle to a CarLink car for their short commute to BART, while Workside Commuters (all of whom lived at least 30 miles away from work and previously drove the entire way[22]) greatly reduced their personal vehicle use. Workside Commuters reported a sizable reduction in household VMT due to modal shift, while Homeside Users reported a minimal commute change. However, they did perceive a household vehicle usage reduction due to evening and weekend CarLink trips.

An increase in recreational trips via public transit by Workside Commuters is logical, since they became more familiar with BART and had easy access to it. In contrast, Homeside Users showed a negative change, perhaps because they used the CarLink vehicle on evenings and weekends for trips previously performed using transit.

The general shift in Workside Commuter trips from drive alone to carpool is a defining CarLink model feature. The decrease in single-occupancy trips by Homeside Users is likely due to more frequent BART use. Furthermore, one Homeside User started carpooling with another BART commuter using CarLink (partially encouraged by his CarLink participation).

It is notable that Homeside Users carpooled, bussed, biked, and walked less after CarLink. This likely reflects CarLink vehicle access on evenings and weekends.

Interestingly, Workside Commuters significantly decreased bus use and increased walking trips. Of the 13 Workside respondents, three reduced their bus use to zero percent. Although these users did not previously bus each day, several shifted their bus use to CarLink. Increased walking among Workside Commuters was primarily due to walking trips to and from CarLink lots at BART and LLNL.

4.3.8.2 Household Interviews

In two of the three Homeside User interviews, members said that CarLink affected their non-commute tripmaking. However, CarLink data indicate that Homeside Users did not make more BART non-commute trips than previously (i.e., seldom). Finally, an interesting anecdote was discovered. One Homeside User frequently visited the gym after work. Prior to CarLink, he would drive directly to the gym from BART. However, during CarLink, he was unable to store his workout clothes in the CarLink vehicles, so he would drive home, change, and then go to the gym. Thus, this user recommended supplying lockers at the BART stations to reduce tripmaking.

During the interviews, three Workside Commuters reported that CarLink had little to no impact on non-commute tripmaking. These individuals perform most of their errands near home. Prior to CarLink, two said they occasionally ran errands on their way home from

[21] Again, please note that all commuted via BART on a regular basis before CarLink.
[22] During CarLink, Workside Commuters traveled using BART and their personal vehicles.

work; during the field test, they shifted these occasional trips to weekends.[23] Half of the interviewees reported the same frequency of BART use for non-commute trips during CarLink, while the other half did increase their BART usage for non-commute trips.

The two Day Users reported a change in their non-commute travel, although they did not use BART more often. One formerly ran errands on weekends or after work, via bus. With CarLink, this individual could now run errands during lunch. Prior to CarLink, the second Day User drove to work, rather than vanpooling, when he had to go off-site for an appointment. During CarLink, he was able to vanpool and use a CarLink vehicle when he wanted to take a personal trip.

The following sections describe issues that were only raised during the household interviews.

4.3.9 CarLink Changes Needed for Vehicle Sale?

During the household interviews, researchers asked participants what program alterations would be necessary to encourage them to sell a personal vehicle. Most respondents thought that they would remain in their present user group (i.e., Workside Commuters would not become Homeside Users), even in an expanded system. Everyone believed that CarLink would be much more cost-effective, if they were able to sell a car and avoid its fixed costs. All three Homeside Users (interviewed) said that they would sell a vehicle, if CarLink became a permanent service. In fact, one participant sold a vehicle during the field test. He also reported that he would likely sell his truck, especially if CarLink offered pickups for hauling cargo. The Homeside User group is perhaps the most logical one to encourage personal vehicle sale, since CarLink provides nearly all the convenience of a traditional car on the home end.

Workside Commuters were more hesitant about selling a vehicle. They requested that more CarLink lots be provided at additional BART stations. Several individuals also requested that BART trains run later at night and CarLink provide greater vehicle variety.

One Day User did not own a car and supplemented his travel modes with CarLink. Before the field test, a second Day User sold one of his vehicles and found his remaining vehicle was adequate for his household's needs, while he traveled to work via a combination CarLink and vanpool.

4.3.10 What Will Participants Do After CarLink?

Since the program continued through November 15, 1999, and interviews were conducted before the program's end,[24] researchers asked participants how their travel and vehicle use would likely change after CarLink. At the time of the interviews, all Homeside Users were thinking about buying a new car to replace their CarLink vehicle.

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[23] This resulted in only one shifted trip per month (i.e., from a weekday to weekend).

[24] Exit questionnaires, focus groups, and household interviews were conducted prior to November 15, 1999, due to research contract requirements.

Indeed, one participant had recently visited a dealership to shop for a car with better mileage than his truck. Another household was considering the purchase of a small used vehicle or motorcycle[25] to drive to and from BART. Finally, another household was debating the purchase of an additional vehicle because one of their children began to drive during the field test.

After the field test, all Workside Commuters said they would return to solo driving as their principal mode, with some carpooling. One married couple discussed buying a used vehicle to park at the Dublin/Pleasanton BART station. Finally, Day Users planned to return to pre-CarLink travel patterns (i.e., meaning biking, busing, and vanpooling), with a bit more solo driving to undertake midday trips.

4.3.11 Miscellaneous Comments

Other issues discussed during the household interviews included:

- Participants were positive about the CarLink program and wanted to see it work. This meant that they generally took very good care of the vehicles and usually strived to reduce inconvenience for fellow members. They would try to return vehicles in plenty of time for the next user, either at LLNL or BART. As individuals became habituated to the system, some would stretch this, especially when they thought a sufficient number of vehicles were available.

- One Homeside User household, who had an infant, felt constrained because they needed a carseat. They did not think that offering car seats in CarLink vehicles or at BART would help, because car seats require some personalization. Since traveling with a baby requires a lot of gear, CarLink was not practical for a large portion of their trips.

- Several individuals said that broken radio antennas were a major program flaw. One participant thought a cassette or compact disc player would greatly improve vehicle enjoyment.

- Not surprisingly, individuals who frequently traveled out of town were interested in paying only for the days they used CarLink, rather than for an entire month (i.e., Homeside Users and Workside Commuters).

- One Homeside User household thought CarLink was very useful in freeing up a personal vehicle for their newly licensed son.

- Two Workside Commuters emphasized that they tend to buy vehicles and use them until they need to be replaced. These individuals said they were hesitant about becoming Homeside Users, since they felt this program was too similar to a

[25] To take advantage of special parking at the Dublin/Pleasanton BART station.

lease. They did not want to pay the same or more for a vehicle a couple of years in the future.

- Almost everyone thought that cell phones were unnecessary, since most individuals have them. A few interviewees were also interested in mapping devices, but felt they would use them infrequently. If CarLink became more widespread, many thought they would be used more often (e.g., in unknown areas).

SECTION 4.4 COMMUTE MODAL SHIFT

A primary CarLink goal—one of many carsharing programs—is to shift individuals away from single occupancy vehicles (SOVs) toward a combination of transit and shared vehicles. Although a CarLink commute may still involve SOV trips, CarLink should reduce VMT (i.e., through transit ridership, carpooling, vanpooling, biking, and walking). How much reduction does carsharing promote? Overall carsharing benefits would be lower if CarLink caused a shift away from modes, such as buses and biking. All of these impacts need to be analyzed. Due to the short time frame of the project and the limited sample size, a definitive answer to these questions cannot be realized through this exploratory program. An expanded demonstration, with more reliable automated data collection methods, would provide better information.

The data for this section are partially from questionnaires, but primarily trip diaries; only those participants for whom researchers had pre-CarLink and CarLink data were analyzed. The pre-CarLink information is taken from initial questionnaires and a three-day trip diary that participants completed before using CarLink.

Commute modes prior to CarLink are discussed below. The discussion focuses on Homeside Users and Workside Commuters only. These data include four Homeside Users and eight Workside Commuters. Although Day Users may have changed, since they no longer needed to drive to work to access a vehicle during the day, the program was operational for too short a period to effect a significant change.[26] Table 4.8 summarizes user commute modes by percentage prior to CarLink. All Homeside Users regularly commuted via BART before CarLink, as did two Workside Commuters.

[26] At least one Day User switched some drive alone commute trips to a vanpool because he could access a CarLink vehicle.

Table 4.8 Commute Modes Prior to CarLink (n=12)				
Mode	**Percentage**	**Average Miles Per Commute**	**Average Miles Per Day**	**Total Miles Per Week**
Personal Vehicle	41.2%	16.9	33.8	2030
BART	46.0%	18.9	37.8	2270
Bus	3.4%	1.4	2.8	170
Walk	0.5%	0.2	0.4	22.5
Borrowed Vehicle	2.2%	0.9	1.8	110
Carpool	6.7%	2.8	5.6	330
Total	**100.0%**	**41.1**	**82.2**	**4932.5**

Table 4.9 below shows the commute modes of 12 CarLink users. As expected, the largest change is from drive-alone car trips to CarLink and BART. During CarLink, personal vehicle trips accounted for only 2.5% of all commute trips, with an average of 2.0 miles per day. Miles traveled on BART increased by over 50%. With CarLink, there was no longer a bus component to the commute, a 3.4 percentage point decrease. With CarLink carpooling, some vehicle trips were counted twice in Table 4.9.[27] The numbers in parentheses report total *vehicle* miles traveled versus *passenger* miles traveled.

Table 4.9 Commute Modes with CarLink (n=12)				
Mode	**Percentage**	**Average Miles Per Commute**	**Average Miles Per Person/ Day**	**Total Miles Per Week**
CarLink	26.9%	10.9	21.8 (13.3)	1310 (800)
Personal Vehicle	2.5%	1.0	2.0	120
BART	69.2%	28.1	56.2	3370
Bus	0%	0.0	0.0	0
Walk	0.6%	0.3	0.6	30
Carpool	11.3%	4.6	9.2	552
Total		**44.9**	**89.8 (81.3)**	**5382 (4872)**

Note: The carpooling component assumes that Workside Commuters carpool half the time (i.e., as reported in exit questionnaire). Most carpool trips were in a CarLink vehicle, which is why the percentages do not sum to 100 percent. Due to carpooling, there were more "passenger" miles reported than "vehicle" miles traveled. The numbers in parentheses reflect actual VMT.

For the sample of 12, CarLink resulted in an average reduction in personal vehicle use of 31.8 miles per day. At the same time, there was an increase of 13.3 CarLink miles, with a net vehicle reduction of 18.5 miles. Furthermore, these miles were also shifted from conventional vehicles to low-emission vehicles.

Additionally, BART ridership increased due to the program. For the 14 Workside Commuters who responded to this question, 10 did not use BART prior to CarLink.

[27] For instance, consider a scenario in which two individuals each commute 50 miles, 20 of which is spent carpooling together in a CarLink vehicle. The total passenger miles traveled equal 100 miles, with 40% in a CarLink vehicle. However, the CarLink vehicle was actually driven only 20 miles.

CarLink also increased the frequency of BART travel for Homeside Users. Thus, CarLink added a minimum of 20 new BART trips each day it was fully used (i.e., by the new riders). Since veteran BART riders used it more frequently and some responses were missing, this number could be higher.

SECTION 4.5 SUMMARY

This section summarizes the field test usage trends and participant program reactions. Due to the short-term duration of the project, it was difficult to attract new Homeside Users.[28] Because of this, the Homeside User group reached and maintained its maximum membership (i.e., 10 households) in March and April. Meanwhile, the Workside Commuter group reached its peak of 17 members in April. Due to logistical difficulties, the Day Use Program did not begin until July, and reached a membership of 12 in August. VMT peaked in April, with over 20,000 miles; after several long-distance Homeside Users left the program, VMT dropped appreciably.

The average length of CarLink trips was between 11.5 and 12.5 miles. Typical commute trip length was less than 10 miles for Homeside Users and approximately 13 miles for the Workside Commuters (i.e., the distance between the Dublin/Pleasanton BART station and LLNL). Monthly average trip times varied between 10 to 25 minutes. Although Workside Commuter trips were longer on average than Homeside Users' (during the first three months), the opposite was true for the last three program months. This is probably due to the manual diaries employed during the last three months, which were a more reliable data-gathering tool than Teletrac. As expected, the most common trips were work trips.

There were very few instances when members were forced to wait for a vehicle. The majority of instances occurred during the first program months and were due to vehicles being returned with inadequate fuel levels. As Workside Commuters began to refuel more frequently and long-distance Homeside Users left the program, these instances became much less frequent.

Various logistical problems delayed the Day Use component of the field test, which began in July. Furthermore, it was not until August that all five CarLink lots at LLNL were opened to Day Use members. As discussed in Section 4.1.7, the Day Use component was greatly underutilized. In fact, it might be possible to enroll 7 to 15 Day Users per vehicle, although it would be advisable to build slowly to these numbers.

Section 4.3 of this chapter discusses participant reaction to various program issues. These data were gathered using questionnaires, household interviews, and a focus group. The chief areas covered are:

- ***Smart technologies.*** One of CarLink's primary goals was to investigate the ability of smart technologies to facilitate carsharing. CarLink used three smart technologies: a

[28] It was much easier to attract Workside Commuters and Day Users, since the financial commitment was less significant.

smart card key manager system, a radio frequency-based automatic vehicle location system, and an Internet-based Day Use reservation system at LLNL. CNG vehicles also presented CarLink users with a fourth innovation. CarLink provided a range of advanced systems versus lower-tech systems (e.g., manual key boxes at LLNL). CarLink users were more comfortable with the smart card key manager at BART than with manual key boxes. In addition, they were more comfortable with the Teletrac automated vehicle tracking system than they were with the manual trip diaries used for the last three program months. User response to CNG fueling was more mixed, with responses ranging from "Very Comfortable" (~38%) to "Very Uncomfortable" (~8%). Response to the Internet-based Day Use reservation system was generally positive, with users providing comments on how to improve this system. Suggestions included customizing participant passwords and adding real-time vehicle location information.

- ***Vehicle parking.*** Response to LLNL parking varied significantly based upon location. Guaranteed parking at the Dublin/Pleasanton BART station received overwhelming feedback and was identified as a key success factor. Parking at LLNL received a more mixed response. Choosing appropriate lots among the (~30) possible locations required user feedback and flexibility from LLNL participants. The Day Use program had low levels of satisfaction for vehicle location, as cars were available at only two lots early in the program. Day User feedback indicated that vehicle usage and lot location satisfaction would have increased if all five LLNL lots were made available. Day User suggestions included providing one central carsharing lot and satellite lots in each corner of the facility.

- ***Commute enjoyment.*** Workside Commuter response indicated that commute stress was reduced during CarLink. Workside Commuters stated that being able to relax during their BART commute and reduced personal vehicle mileage were significant program benefits. Since most Homeside Users employed BART to commute prior to CarLink, they did not generally experience stress reduction. Homeside Users perceived great additional benefit from guaranteed parking at the Dublin/Pleasanton BART station; this provided more flexibility in their morning arrival.

- ***Spontaneity and emergency response***. Homeside Users did not think that CarLink limited their ability to respond to an emergency or take spontaneous trips. Getting vehicles to BART in time for Workside Commuters caused some Homeside Users concern; otherwise their travel patterns varied little from before entering CarLink. Homeside Users felt somewhat constrained by limited CNG infrastructure, though later authorized to refuel away from LLNL, which dissipated this concern. Workside Commuters did not think that CarLink limited their spontaneity, and some even felt their ability to respond to an emergency was increased with CarLink. Day Users reported their spontaneity and ability to respond to emergencies were increased through CarLink. Since CarLink provided vehicles to individuals who may not have had access to a car during the day, this result is not surprising.

- ***Perceived environmental benefits***. Increased transit use, reduced emissions from CNG vehicles, carpooling, and more efficient parking use are the basis for potential CarLink environmental benefits. Based upon household interviews, the perceived environmental benefits of carsharing played a role in participants' decisions to join the program for all but two individuals—a Homeside User and Workside Commuter. Though the magnitude of environmental benefits is difficult to calculate and was not the primary reason for joining CarLink, the environmental benefit appeal is a potential carsharing asset.

- ***Vehicle variety.*** The CarLink vehicle fleet was made up of 12 identical CNG-powered Honda Civic sedans. Questionnaire results exhibited high levels of vehicle satisfaction for the three user groups. All Homeside Users involved in household interviews unanimously stated that a pickup truck would be a useful addition to a carsharing fleet, while Workside Commuters and Day Users did not express special commute-vehicle needs. Workside Commuters and Day Users, however, were interested in specialty vehicles, if carsharing were available to them on weekends.

- ***Carpooling concerns.*** One of CarLink's participation requirements was that Workside Commuters carpool between the Dublin/Pleasanton BART station and LLNL. The number of Workside Commuters using CarLink on a given day precluded the need for many participants to carpool regularly, although this was not known by all members. The carpooling component was a significant problem for just one individual. Carpooling did necessitate slight alterations to Workside Commuters' schedules. Three of the top four reasons Workside Commuters did not carpool everyday related to personal scheduling and communication with carpool partners, indicating that better communication mechanisms might facilitate carpooling.

- ***Overall modal shift.*** In the exit questionnaire and household interviews, CarLink participants were asked how their travel shifted among transportation modes while they were in the CarLink program. Homeside Users perceived a significant drop in personal vehicle use, since they shifted a portion of their personal vehicle use to CarLink. Interestingly, Homeside Users also perceived a decrease in recreational public transit use. This may have resulted from Homeside Users using CarLink vehicles for trips previously made by transit. Workside Commuters also experienced a significant decrease in personal vehicle use because they shifted much of their commute to BART, using CarLink. Increased familiarity with BART and public transit may have also led to Workside Commuters' perceived increase in recreational transit use (+21.8 percent). Though Day Users did not experience large modal shifts, they did report biking and walking increases, due to the need to access CarLink lots.

- ***Personal vehicle sale.*** One of the long-term benefits of carsharing is the potential to avoid a vehicle purchase or vehicle sale. All three Homeside Users (interviewed) reported if the program were permanent, they would be willing to sell a personal vehicle. Workside Commuters indicated if they were provided with CarLink services at additional BART stations, expanded BART service, and greater vehicle variety, they would consider selling a vehicle. Even with the short field test duration, a

Homeside User sold a vehicle. This individual even debated selling his remaining vehicle since he felt CarLink (especially if pickup trucks were available) adequately met his household's travel needs.

- ***Travel behavior after CarLink.*** Interestingly, all interviewed Homeside Users were thinking about buying a new car after CarLink. One participant had recently visited a dealership to shop for a car with better mileage than his truck. Another household was considering a small used vehicle or motorcycle purchased for driving to and from BART. Finally, one household was debating the purchase of an additional vehicle because one of their children began driving during the field test. Although all interviewed Workside Commuters indicated they would return to driving alone as their principal commute mode, they indicated that they would now carpool a little more as well. Day Users would return to their pre-CarLink travel patterns, which involved a higher frequency of solo driving to support midday trips.

- ***Commute modal shift.*** A primary goal of many carsharing organizations is to shift individuals away from SOVs and toward a combination of transit and shared vehicles. Although a CarLink commute may still involve SOV trips, it should reduce VMT (e.g., through transit ridership, carpooling, vanpooling, biking, and walking). The short project time frame and the limited sample size do not allow definitive conclusions to be drawn regarding modal shifts and VMT reduction, though anecdotal lessons can.

The sample size for this analysis consisted of only 12 participants, since these were the only individuals who provided information about pre-CarLink travel, and responded to the exit questionnaire. For these individuals, CarLink resulted in an average personal vehicle reduction of 31.8 miles per day. At the same time, there was a 13.3 CarLink mileage increase, with a net personal vehicle reduction of 18.5 miles. Furthermore, these miles were also shifted from conventional vehicles to low-emission vehicles. As participant travel shifted from personal vehicles, BART ridership increased. Ten of the 14 Workside Commuters did not use BART prior to CarLink. CarLink also increased BART travel frequency for Homeside Users. Thus, CarLink added a minimum of 20 new BART trips each day it was fully used (i.e., from the new riders). Since veteran BART riders used it more frequently and responses were missing, this number could be higher.

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CHAPTER FIVE: PRELIMINARY ECONOMIC VIABILITY ANALYSIS

SECTION 5.0 INTRODUCTION

In addition to the field test and user evaluations, researchers also conducted a preliminary economic viability study of the CarLink demonstration. This analysis is based on usage fees, willingness-to-pay estimates (for the field test and expanded CarLink services), user demand, and supply costs. As a research project, field test operations were handled differently than they would be in a commercial venture. Indeed, the primary research objective was to investigate participant response rather than to optimize costs and revenues. Consequently, user costs were set low enough to guarantee a sufficient number of users, while high enough to be considered serious by participants. During the field test, participation and usage were limited by Day Use program delays, CNG fueling infrastructure restrictions, and the short-term project duration—a typical limitation of innovative demonstrations (Bernard and Collins, 1998). Thus, program revenues were less than start-up and operating costs. This chapter examines the economic viability of the CarLink field test, as well more commercial scenarios.

Social benefits and costs are also important to a complete economic analysis. Although these factors are only briefly mentioned in this chapter, congestion, air pollution, and energy-use reductions are often carsharing motivations. Given the limited size and duration of the CarLink field test, the magnitude of social benefits would likely have been small. With expanded use, however, such benefits could increase significantly.

For this analysis, researchers separated costs into fixed, or startup, and monthly operational costs. Startup costs are those that are paid once at the beginning of the program, some of which would be renewed yearly. Operational costs are those that are paid monthly, whether the figure varies or not. While it is possible to compare total CarLink field test costs and revenues, as outlined in Sections 5.1 and 5.2, the short program duration reduces the usefulness of this comparison. Section 5.3 discusses willingness-to-pay (WTP) estimates and relates these figures to actual user fees. To explore how CarLink might differ if costs and revenues were the principal objective, Section 5.4 presents five scenarios for lowering costs in the long term. Section 5.5 describes some potential CarLink benefits and costs for the BART District, although a full examination is not included in this analysis. Section 5.6 summarizes the economic viability results.

SECTION 5.1 COSTS

The principal CarLink program costs include the vehicle fleet, fuel, insurance, maintenance and administration, and the COCOS and Teletrac technologies. Program costs are presented in Table 5.1 below. The bold numbers reflect the costs of the field test's eight-month data collection period. The final column projects a full year's costs, using the same monthly costs. This is a reasonable projection, since CarLink could have

continued for the year without incurring additional license, advertising, or technology hardware costs.

The costs outlined address those associated with a carsharing program; they do not include research expenses. Accordingly, program sponsor research support is not included in this analysis.[1] Furthermore, BART parking costs (approximately $100 per space per month for the 12 spaces they donated) are not included, since they may theoretically be considered a cost of increased BART ridership and may also be offset by decreased parking demands (see Section 5.5.2. for a discussion of BART parking costs). Although Lawrence Livermore National Laboratory (LLNL) donated fuel to this program, it is less likely that fuel would be donated or subsidized in future programs. Thus, these costs are included in this analysis. These figures should only be used as a guide. Other programs will reflect a unique combination of vehicles, tracking/billing technologies, and personnel needs.

Table 5.1: CarLink Program Costs

CarLink Costs	Startup Costs	Monthly Costs	Field Test (Eight Months)	Total (One Year Projection)
Vehicles and Licensing Fees*	$64,800		**$64,800**	$64,800
Vehicle Maintenance and Insurance		$1,250	**$10,000**	$15,000
Advertising	$1,000		**$1,000**	$1,000
Fuel		$189	**$1,512**	$2,268
Management and Support Staff**		$4,750	**$23,000**	$57,000
Cross-Country Emergency Service	$600		**$600**	$600
Teletrac***	$4,500	$468	**$6,840**	$6,840
COCOS	$16,633		**$16,633**	$16,633
Total	**$87,533**	**$6,657**	**$124,385**	**$164,141**

Note: *Vehicle costs are based upon a 12-month period, including mileage and depreciation. Vehicle costs include a 25% loss in value due to depreciation. **During the field test, the CarLink implementation team was sometimes understaffed and the 8-month total reflects this. However, the one-year total assumes full staffing for a year. ***Teletrac total costs reflect the five-month period that the system was used (i.e., January through May 31, 1999).

American Honda provided the vehicle fleet, operational support staff (i.e., CNG refueling assistance when necessary, vehicle maintenance, and cleaning), the 24-hour emergency

[1] Caltrans, PATH, BART, Honda, the University of California Transportation Center (UCTC), the National Science Foundation (NSF), and the Dwight David Eisenhower Transportation Fellowship Program supported CarLink field test research.

service, and vehicle insurance. The BART District provided parking spaces and signs at the Dublin/Pleasanton station, a key manager kiosk with electricity and telephone service,[2] an advertising poster at the BART station, and advertisements in the *Tri-Valley Times* and the *Diablo Dealer*. LLNL provided CNG for vehicle refueling and CarLink parking signs. Caltrans provided support for the field test manager and the implementation team.

SECTION 5.2 REVENUE

As discussed in Chapter Three, the number of active CarLink users fluctuated between 15 and 44 users during the eight-month field test. Homeside Users and Workside Commuters paid fixed monthly rates, while Day Users paid variable rates based on trip duration and distance.[3] Workside Commuters also incurred Day Use charges, in addition to their monthly fees, for personal day trips.

Table 5.2 displays the monthly and total revenue data for the first eight months of the field test. Revenues appear to be less than needed to maintain the program, but this is partly due to the nature of a field test. First, the Day Use program was only in use for the last nine weeks, giving members insufficient time to adapt. Second, the Day Use program was introduced incrementally, with a lot "phase-in" approach (see Section 2.1.2.3 for a Day Use discussion). By the time data collection ended (in September 1999), less than half of all CarLink vehicles were available for Day Use each day. Third, LLNL maintained its own vehicle fleet, which most members still used for business trips. Thus, there was excess Day Use capacity. Finally, Homeside User and Workside Commuter levels were lower than expected. Several members left the program midway, making it difficult to enroll new recruits due to the short project duration (i.e., four months or less). Consequently, many were unwilling to join.

Table 5.2: CarLink Average Monthly and Total Revenue*

	Homeside Users	Workside Users	Day Use**	Total
Base Rates	$200 per household per month (or $200 per car/month)	$30 per user per month (or $60 per car/month)	$1.50 per hour and $.10 per mile	
Average Monthly Revenue	$1,625	$409	$133	$2,167
Total Revenue	$13,000	$3,272	$266	$16,538

Note: * Taxes of 8.25% were added to members' bills; Homeside Users therefore paid $216.50 and Workside Users paid $32.48 per month. Since every locality will have its own tax structure concerning carsharing and because only one household was sufficiently concerned to broach the subject, taxes are not dealt with in this chapter. **Day Use total revenue is based on trips taken during the Day Use program for July and August 1999.

[2] Electricity, telephone, and key manager operations costs are not included in project costs, since BART donated them to this project. Such costs might be covered by a transit authority, particularly when carsharing equipment is deployed from a lot located on their site. Advertising costs, however, are included in costs because they are more likely to be covered by a carsharing organization.

[3] Day Users would have paid $1.50/hour and $.10/mile, if the Day Use program had not been delayed. Due to the late deployment (i.e., July 1999), Day Users were not charged for their personal vehicle use. Furthermore, no fee was assessed for business trips, since LLNL supplied the CNG fuel for the program.

The low number of Day Use business trips is discussed in Section 2.1.2.3. Because LLNL already operated a vehicle fleet for business trips, CarLink vehicles were underutilized. Although LLNL intended the CarLink fleet to augment its existing one, only one participant used CarLink vehicles for business trips.

Section 5.4.2 below explores several alternative "commercial" scenarios, including a few in which employers lease a CarLink fleet for Day Use and pay a flat monthly fee. This would make CarLink less dependent on personal trips. Moreover, Day Use revenues might be further increased with personal trips and with fees either paid to CarLink or an employer leasing the shared-use fleet.

SECTION 5.3 WILLINGNESS-TO-PAY ANALYSES

In the final questionnaires and household interviews, researchers investigated users' willingness-to-pay (WTP) for different CarLink services.[4] A common problem of many WTP studies is that it is difficult for individuals to separate current and future service fees. To confound matters further, most users (especially Homeside participants) considered two distinct cost structures: CarLink on a trial basis and as a permanent service (i.e., one that allowed households to sell a vehicle and reduce transportation costs). Although this issue was explored in limited detail during the household interviews, it was difficult to differentiate response perspectives in the questionnaire data.

Finally, there is a risk that respondents will attempt to influence future fees. Although the interviews and exit questionnaires were conducted at the end of the field test, many were hopeful that the program would be continued and may have stated lower values. The household interviews were designed to circumvent this problem by presenting users with new usage scenarios; however, many responses may still have been lower than actual WTP.

5.3.1 Willingness-to-Pay for Homeside Use

Six Homeside respondents reported they were willing to pay an average of $239 per month to receive an identical CarLink service in the future in their exit questionnaires. The highest WTP response was $280 per month, and two reported $200 per month (i.e., the actual field test fee).

During the household interviews, participants were asked whether they would sell a vehicle, if a permanent CarLink program were available, and how much would they be willing to pay. One individual offered $300 as an upper limit, while two others reported $300 to $350 per month would be reasonable. Two interviewed Workside Commuters said they would be willing to pay up to $250 and $400 for Homeside Use.

[4] Questionnaires and interviews were designed to probe how much each user group was willing to pay for their service package (e.g., WTP of Homeside Users for Homeside Use).

5.3.2 Willingness-to-Pay for Workside Commuter Use

Average Workside Commuter WTP was $52 per month to receive the same service (i.e., compared to the $30 per month actual field test fee). Many respondents contrasted CarLink to driving alone and vanpooling to calculate their WTP. Several stated that high BART costs lowered their WTP for carsharing, a finding noted by other studies (Bernard and Collins, 1998; Shaheen, 1999). During the interviews, many users said that they would be willing to pay more for CarLink, if they lived further away and were forced to drive through congested areas. Because the drive to LLNL is relatively uncongested, most users were not willing to pay significantly higher CarLink fees.

Carsharing organizations should target markets in areas where individuals have the most to gain from carsharing, at the least cost. By taking BART, all Homeside Users avoided at least 22 miles of congested driving. In contrast, prior to CarLink many Workside Commuters drove a significant portion of their commutes through uncongested areas. Thus, a CarLink commute often proved longer due to time lost in modal transfers. This was particularly true for participants who lived just one to two stations away from the Dublin/Pleasanton BART station. Consequently, carsharing programs should target members who have longer, congested commutes.

5.3.3 Willingness-to-Pay for Day Use

In the questionnaires, Day Users were asked what they would be willing to pay for Day Use on a per hour and per mile basis. Two of the seven individuals responding to this question said they would be willing to pay $5 per hour, while the rest said $1 or $1.50 per hour, for an average of $2.32 per hour. Three individuals said that $.50 per mile would be fair, and four offered $.10 to $.20 per mile. Many respondents commented that the current rate was reasonable (i.e., $1.50/hour and $.10/mile).

During the household interviews, researchers asked how much members would be willing to pay for a two-hour trip of 10 to 15 miles. Most respondents tried to visualize a typical trip, convert it into miles and minutes, determine how much the trip was worth to them, and then computed WTP on a time and distance scale. Most users thought that they would be willing to pay up to $5 for a two-hour trip, and both interviewed Day Users thought that $7 would be reasonable. If costs were raised above this level, participants thought they would rather drive and use their personal vehicle during the day.

Most said they might reduce trip time and distance, if it lowered costs. However, respondents said that many trip locations could not be changed, and that their tripmaking is often already constrained by their work schedules.

As discussed in the previous section, targeted marketing is an important tool for recruiting new users. Day Use target markets include employment centers (e.g., CarLink as fleet vehicles) and individuals who can commute via transit or carpool. Not surprisingly, the most “captive” personal trip markets include individuals who walk,

bicycle, or take transit to work and do not have access to a personal vehicle during the day. At many work sites, however, this is likely to reflect a small portion of employees.

SECTION 5.4 LONG-TERM REVENUES AND COSTS

For a variety of reasons, a carsharing business has different costs and revenues than those of a short-term demonstration, such as CarLink. Field test goals included examining consumer and institutional reactions to carsharing, not minimizing costs. Bernard and Collins (1998) found that program permanence is critical to behavioral adoption and change. Thus, CarLink use and perception might have changed appreciably if the program had continued.

During household interviews, many participants said if CarLink had been extended, they would be more likely to sell a personal vehicle and pay higher service fees. In a longer running program, more members could have been recruited to increase revenues, and many costs could have been amortized over longer periods. Finally, more aggressive strategies for expanding the number of users per vehicle, without increasing staff and infrastructure costs, would be employed.

This section explores the effects of various CarLink commercialization scenarios on costs and revenues.

5.4.1 Long-Term Program Costs

To gain more insights into CarLink economic viability, this section presents several scenarios for exploring long-term revenues and costs. *Long-term* is defined as three years or greater. This should be a sufficient period for members to make more significant behavioral changes, such as selling a household vehicle. Likewise, institutions (e.g., large employers, transit agencies, and activity centers) also need time to adapt to a carsharing system. This time frame was also used because many European carsharing organizations replace vehicles in three-year increments (Shaheen, 1999).

Table 5.3 summarizes monthly costs from Table 5.1. Although the depreciation costs cannot be estimated precisely, the figures used in Section 5.1 and in Table 5.3 are best approximations. Monthly operating costs combined with startup costs provide a benchmark for break-even revenue generation. Except where indicated, all scenarios assume program parameters similar to the CarLink field test (i.e., 12 CNG vehicles, a transit port, and a work-side port).

Table 5.3: CarLink One Year Program Costs

	Startup Costs Per Month	Monthly Operating Costs	Total Monthly Costs
One Year	$7,294	$6,657	$13,678

The "Total Monthly Costs" reflect that Teletrac was only used for five months and the implementation team was under staffed during the first few months. Thus, the total category is slightly smaller than the sum of startup and monthly operating costs.

Based on these projections, the revenue needed per car would be approximately $1,140 per month to achieve a breakeven point. However, if the program costs are amortized over a three-year period, vehicle purchase costs could be spread over a longer time frame. Table 5.4 shows CarLink program costs over a three-year period, with an average monthly cost between $10,616 and $11,656, depending on the type of vehicle used (i.e., conventional fuel versus CNG). Based on these projections, revenue generation per car each month would need to be approximately $885 to $971.

Table 5.4: CarLink Three-Year Cost Projections

CarLink Costs	Year One Costs	Average Yearly Costs	Average Monthly Costs*	Three Year Total
Vehicles and Licensing Fees	$64,800	$49,950	$4,163	$149,850
Vehicle Maintenance and Insurance	$15,000	$15,000	$1,250	$45,000
Advertising	$1,000	$1,000	$83	$3,000
Fuel	$2,268	$2,756	$230	$8,268
Management and Support staff	$57,000	$58,727	$4,894	$176,181
Cross-Country Emergency Service	$600	$600	$50	$1,800
RF-Tracking System	$6,840	$6,025	$468	$18,075
COCOS	$16,633	$6,211	$518	$18,633
Total	**$164,141**	**$140,269**	**$11,656**	**$420,807**

Note: * It is assumed that Teletrac is only in use for part of Year One. Average and yearly costs reflect a fully operational tracking system over a three-year period.

- ***Vehicles and Vehicle Licensing Fees:*** The majority of these costs accrue for vehicle depreciation. Since vehicles depreciate a smaller amount each year and because licensing fees are based on the vehicle value, CarLink would only pay $48,600 for Year Two and $36,450 for Year Three.

  The vehicles used in the field test were 1998 Honda Civics, fueled by compressed natural gas. The natural gas fueling component raised the vehicle price by approximately $5,000 per car contrasted to a conventionally fueled Honda Civic LX. While there are other vehicles that could further reduce costs, this analysis considers Civics, to keep the vehicle-model variable constant. Changing to gasoline vehicles would reduce the total three-year amount paid for this category from $149,850 to $112,375. Average monthly costs would be $1,040 less if conventional vehicles were used.

- ***Vehicle Maintenance and Insurance:*** Over a three-year period, maintenance and insurance costs are estimated to average $1,250 per vehicle per year. For the 12 vehicles this comes to a total of $45,000.

- ***Advertising:*** During the CarLink field test, advertising proved to be less fruitful than press coverage and word-of-mouth. However, some advertising in Years Two and Three may be necessary, so $1,000 was assigned to this category for the final two calendar years.

- ***Fuel:*** During the CarLink field test, fuel was assumed approximately $189 per month on average. With increased CarLink usage and inflation, this figure would likely be higher. A rate of $250 per month was assigned for the final two calendar years.

- ***Support Staff:*** Support staff salaries reflect a three percent cost of living increase each year, assuming a Year One level of $4,750 per month.

- ***Emergency Service:*** For the 12-vehicle fleet, emergency service costs are approximately $600 per year.

- ***RF-Tracking System****:* During the field test, the Teletrac system failed after five months. Table 5.4 assumes start up and airtime costs for the first five months. In Year Two, it was assumed that a similar service is available at the same costs. Because hardware capital costs were invested in Year One, RF-tracking costs would be less in Years Two and Three, where $468 is paid for air time each month.

- ***COCOS:*** The majority of COCOS system costs include hardware, software, and installation. However, due to possible maintenance needs, $1,000 was assigned to COCOS in Years Two and Three for upkeep.

Another way for CarLink to reduce costs would involve adding vehicles and increasing membership, since each additional car costs less to operate up to a certain level. For instance, the majority of COCOS system costs supported hardware (i.e., key box and on-board computers) and software. These components would require minimal changes to accommodate more vehicles. Furthermore, it might be possible to obtain volume discounts for costs such as insurance.

5.4.2 Long-Term Program Revenues

This section explores several CarLink scenarios where revenues might be increased. These scenarios all assume a fleet of twelve vehicles. The first few presume a fully operational program (i.e., membership levels above those of the field test) and incorporate higher fees based upon the WTP analyses discussed in Section 5.3. The final scenarios introduce a new business model, where an employer or employment center pays a monthly fee to lease vehicles throughout the workday.

Table 5.5 below presents projected monthly revenues for five different scenarios, compared to actual field test revenues. Although the revenue estimates are hypothetical, they are based on empirical data from the demonstration. In all scenarios, user groups are assumed to be at full capacity, with at least 10 Homeside Users, 20 Workside Commuters, and a sufficient number of Day Users to meet usage goals.[5]

Table 5.5: Monthly CarLink and Scenario Revenues

	Homeside Users	Workside Commuter	Day Use	Total
CarLink Field Test	$1,625	$409	$133	**$2,167**
Scenario One	$2,000	$600	$2,363	**$4,963**
Scenario Two	$2,390	$1,040	$2,363	**$5,793**
Scenario Three	$3,000	$1,040	$3,150	**$7,190**
Scenario Four	$3,500	$1,040	$6,000	**$10,540**
Scenario Five	$3,500	$1,560	$8,000	**$13,060**

The revenue generation rate for Day Use trips is based upon data collected during the Day Use portion of the field test. The average Day Use trip would have generated $3.75 (i.e., $2.70 based on time and $1.05 from mileage). Total Day Use revenues are based on three round trips per vehicle per day (equivalent to 30 Day Use trips per workday, estimates discussed in Section 4.1.7) for each scenario. This trip rate is applied to 21 workdays per month. The following subsections describe each scenario.

5.4.2.1 Scenario One

Scenario One reflects the actual field test rate structure (i.e., $200 per month for Homeside Users, $30 per month for Workside Commuters, and $1.50/hour and $.10/mile for personal Day Use). This scenario assumes full user group membership (i.e., 10 Homeside Users, 20 Workside Commuters, and 30 Day Use trips per day).

This scenario yields $4,963 in monthly revenues, over twice that of the field test. Much of this increase is a result of expanded Day Use participation. As discussed in Section 4.1.8, it should be possible to increase Day Use to at least three round trips per vehicle per day. Although Scenario One revenues greatly exceed those of the field test, a permanent enterprise would have time to expand Day Use.

5.4.2.2 Scenario Two

Scenario Two assumes the same membership and usage as Scenario One. However, this scenario includes increased Homeside User and Workside Commuter user fees, as discussed in Section 5.3. By the increasing Homeside User rates to $239 per month, this results in an additional $390 in revenues. Similarly, raising Workside Commuter fees to

[5] Day Use membership may be increased above the 30-person field test target to address excess capacity issues discussed in Chapter Four.

$52 per month increases revenues by $440 per month. These changes result in an $830 per month revenue increase, up to $5,793.

5.4.2.3 Scenario Three

Scenario Three reflects the same membership numbers, usage levels, and Workside Commuter fees of Scenario Two. However, Day Use trips are increased to $5, as discussed in the Day Use WTP analysis in Section 5.3.3. In addition to increased revenues, this base fee would simplify the billing process and reduce administrative costs.[6]

Second, in this scenario Homeside Users are assessed $300 per month. While this fee was above surveyed users' WTP, it assumes that households would be able to sell a personal vehicle in a permanent CarLink program and be willing to pay more.[7] This scenario would increase total revenues by $1,397 to a total of $7,190.

5.4.2.4 Scenario Four

Scenario Four represents a significant departure from the existing CarLink Day Use model. An alternative to the existing Day Use model is to provide employers with access to the carsharing fleet during the workday. With this system, a business could obtain access to a vehicle fleet without having to purchase, insure, or maintain the cars directly. Vehicles would be maintained and managed by CarLink, at a potential cost of $600 per vehicle per month. This is a rate of less than $29 per business day per car and would include all vehicle costs.

In this scenario, Homeside Users would continue to follow the basic CarLink model, dropping vehicles off at a transit station or other CarLink lot in the morning and retrieving them in the evening. Workside Commuters would also behave similarly, driving vehicles between the CarLink lot and their work site.[8] However, a business would now control the vehicles during the day, until the Workside Commuters returned them to the main CarLink lot in the evening. While each contract would be different, agreements could also be developed to allow personal Day Usage, at least for Workside Commuters. In such a case, fees paid either to the employment center or CarLink, depending on the contract. During times when a business might not need all of the vehicles (e.g., 11:00 AM to 2:00 PM), additional revenues could be realized (e.g., $200 per vehicle or $2,000 for a fleet of ten vehicles).

Scenario Four is similar to Scenario Three, except it includes the Day Use business model. It does not reflect any revenues from personal Day Use trips, however.

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[6] To prevent users from abusing this system, further analyses should be performed to set a maximum allowable distance and time (e.g., up to 25 miles and two hours, with an additional dollar charged for every 15 minutes over two hours).

[7] When a similar scenario was presented to Homeside Users, their WTP rose to over $300.

[8] If insufficient carpools are commuting to work on a given day (e.g., all members of a carpool are out of town), then some might be broken up to ensure that all vehicles travel to the worksite that day.

Furthermore, it reflects an increase in Homeside User fees to $350 per month. This fee was considered reasonable by CarLink members, if they were able to sell a personal vehicle. The additional $2,850 generated from the business model and $500 from Homeside User fees raises revenues to $10,540.

5.4.2.5 Scenario Five

Scenario Five is the most optimistic presented. It is similar to Scenario Four with two differences. First, it assumes a personal Day Use market. Revenues are assumed to be $200 per vehicle per month or $2,000 for the fleet, resulting from an average of two trips per vehicle per day. Second, it assumes 30 Workside Commuters rather than the baseline of 20. In work environments where employees arrive and leave at the same time, carpools could include more than two people. While this may not be applicable for all work sites, it could be for institutions in which carpooling is more popular.

These two changes produce an increase of $2,520, raising total revenues to $13,060.

5.4.2.6 Scenario Summary

A longer-term program results in costs of $11,656 per month (or $10,616 with conventionally fueled Honda Civics) and best-case revenues of $13,060 per month (Scenario Five). The only scenario exhibiting positive revenues is the final one, involving the CarLink business-lease model, with personal Day Use. Using conventional vehicles would almost make Scenario Four (the business-lease model without personal Day Use) economically viable as well.

The primary reason that scenario revenues might fall below estimates would be insufficient usage levels. Homeside Users levels should be straightforward, given a large population and adequate recruitment. Problems could potentially develop with the other two user groups due to logistical difficulties. For instance, the CarLink field test did not reach the target goal of 20 Workside Commuters, and carpooling might put a significant strain on the system. Carpools could also result in too many or too few vehicles being taken to and from the work site. Likewise, Day Use personal revenues are based on projections that may fall short when tested.

One way for revenues to exceed these projections would be if each group's WTP has been underestimated. If CarLink was permanent, the ability for Homeside Users (and perhaps some Workside Commuters) to sell a personal vehicle might increase customers' WTP beyond those discussed.

Finally, revenues collected through fees or business leases are not the only benefits of a carsharing program. Although it is exceedingly difficult to place a dollar amount on societal benefits of reduced congestion and pollution, employers seeking to lower the number of employees driving to work to comply with clean air regulations or reduce parking burdens may be willing to partially subsidize carsharing. Furthermore, transit partners may benefit from increased ridership and more efficient parking space usage

(i.e., a CarLink space could serve up to three or more transit customers per day). Thus, social benefits may increase overall program value, beyond revenues. In the next section, several CarLink effects on the BART system are discussed.

SECTION 5.5 CARLINK REVENUES AND COSTS FOR BART

While it is difficult to estimate the monetary potential of CarLink to reduce congestion and emissions or improve quality of life, several BART District revenues and costs can be estimated. BART (and other transit agencies) could potentially benefit in two ways: 1) increased ridership and 2) decreased parking demand at stations. BART field test costs included advertisements, signs, smart key manager installation, and telephone/modem and electricity supply to the key box.[9]

5.5.1 BART Fare Box Revenues

All Homeside Users responding to the initial CarLink questionnaire used BART at least three days per week prior to the field test. Although they took BART every day throughout the field test, Homeside Users only generated a limited number of new transit trips. In contrast, 10 of the 14 Workside Commuters, responding to the initial questionnaire, did not use BART on a regular basis prior to CarLink. Thus, the Workside Commuter group generated many new BART riders. Furthermore, as new riders become more familiar with BART, they may have used it more frequently for non-commute trips, although these revenues are not estimated here (see Section 4.3.8 for a discussion of how field test members used BART).

Table 5.6 presents the monthly roundtrip fare revenues of 8 Homeside Users and 16 Workside Commuters, who supplied this questionnaire data. The second two rows of this table present fare box revenues for full CarLink membership (i.e., 10 Homeside Users and 20 Workside Commuters), with individuals paying the same average fares as respondents.

In the final questionnaire, CarLink members claimed to use BART an average of 4.4 days per week, while trip diaries for June through August indicated average BART usage of 2.5 days per week. Researchers averaged both estimates and calculated revenues for 3.5 days per week or 14 days each month.

[9] It is estimated that these costs totaled between $2,500 and $3,000 for the field test.

Table 5.6: Fare Box Revenues from BART/CarLink Commuters		
Daily and Monthly BART Revenues for CarLink Commuters	Homeside Users	Workside Commuters*
Daily BART Revenues (n=8 and n=16, respectively)	$55	$86
Monthly BART Revenues (n=8 and n=16, respectively)	$770	$1,204
Daily BART Revenues (n=10 and n=20, respectively)	$69	$108
Monthly BART Revenues (n=10 and n=20, respectively)	$966	$1,512

*New BART revenues may be more simply captured by Workside Commuter trips, although both groups would generate new transit trips. A majority of them would likely be made by Workside Commuters (i.e., based on empirical data).

New monthly BART revenues could range between $1,204 and $1,512. In the future, increased transit ridership and revenues should be factored into an evaluation of CarLink benefits and costs.

5.5.2 BART/CarLink Parking—Benefits and Costs

Parking is a critical issue for both BART and its riders (please see Section 4.3.2 for a discussion on CarLink users' reactions to BART). Each parking space at a BART station, such as the Dublin/Pleasanton, costs approximately $100 per month. Lack of adequate BART parking can greatly affect costs in terms of lost ridership. Indeed, if a potential BART rider drives to a station and is unable to find a convenient parking space, he or she is more likely to drive to work.

BART donated 12 spaces to the CarLink project; due to factors discussed in this section parking costs were not factored into over program costs. The monthly value of these spaces is $1,200. At the peak of the field test, there were ten Homeside Users who parked CarLink vehicles in spaces each morning. Since each parked personal vehicles at BART prior to CarLink, these ten spaces were now available for use by other BART/CarLink customers each day (e.g., two individuals comprising a Workside Commuter carpool). In theory, three customers could use one space to complete a total of six distinct transit trips each day.

Since Homeside and Workside groups were well balanced, seldom were more than half of the CarLink vehicles awaiting pick up by commuters at the BART station. Thus, CarLink could possibly reduce the number of parking spaces by 50%. This might mean that ten Homeside Users could be accommodated by six parking spaces each morning. This is possible because not all Homeside Users arrive at BART before Workside Commuters begin picking up vehicles. In this scenario, CarLink could save BART $400 per month in parking costs because Homeside Users now share six spaces that would have been previously occupied by ten personal vehicles.

While all the Homeside Users walked to their work sites, some Workside Commuters accessed BART with a personal vehicle (i.e., some members drove from their homes to a nearby BART station). As reported in the final questionnaire, Workside Commuters drove a vehicle (either alone or in a carpool) to their home-end BART station 43.5% of the time; other modes included buses, walking, biking, and rollerblading. With a maximum of 20 Workside Commuters this would necessitate nine parking spaces at other BART stations. As long as parking is available at these stations, each additional rider is presumably advantageous. Ideally, CarLink could develop into a system where members could share vehicles on both ends of their commutes.

5.5.3 Summary of BART/CarLink Benefits and Costs

Combining these elements together, CarLink had a limited, yet positive affect on the BART system. Based on empirical CarLink data, new BART riders generated a minimum of $1,204 and potentially $1,512 in new revenues per month. Additionally, CarLink could reduce the Dublin/Pleasanton station's parking demand by four spaces or $400 per month.[10] Finally, CarLink generated ten new BART riders, approximately half of whom did not require parking.[11] If it is assumed that every BART/CarLink user, who did not park a personal vehicle at BART, reduces parking costs by approximately $100 per month, an additional $500 in reduced parking demand would be attributable to Workside Commuters.

In summary, a CarLink program with full membership could generate approximately $1,512 in new fares per month, while reducing parking costs by $900, totaling $2,412. Since the field test also included advertisement, sign, and key management costs, these should be deducted from the total benefits.[12] Subtracting $300 per month in costs, net gains are estimated at $2,112 per month. By incorporating these numbers into a partial benefit-cost analysis,[13] Scenario Four joins Five in breaking even with either CNG or conventional vehicles.

SECTION 5.6 SUMMARY

One of the main findings of this analysis is that more research is needed to explore a CarLink commercial venture, particularly the Day Use business-lease model. Since the goal of the field test was to investigate user response, not to maximize revenues, the actual financial numbers are less promising. The scenario analyses including higher willingness-to-pay estimates and advanced business models (see Scenarios Four and Five) were more favorable. The best-case scenario results in a net profit of approximately

[10] Although empty CarLink spaces were not available to the general public, some might be in a commercial program.
[11] Only 43.5% of Workside Commuters parked at home-end stations.
[12] BART field test costs included advertisements, signs, smart key manager installation, and telephone/modem and electricity supply to the key box, which totaled $2,500 to $3,000. Monthly costs for the ten-month demonstration were $250 to $300.
[13] In this case, revenues would reflect BART benefits and costs.

$3,516 to $4,405 per month for the 12 vehicles. However, less aggressive scenarios show shortfalls of $2,354 to $4,581 per month.

As a research project, many potential carsharing cost reductions were not fully explored. A carsharing project could seek to cut costs in many different ways including:

- ***Streamlining technology.*** One of the primary CarLink goals was to investigate the viability of advanced technologies to facilitate carsharing. It is unlikely that carsharing systems would invest in more than one smart system. Therefore, carsharing organizations should seek technologies that could cost-effectively integrate key management and vehicle tracking technologies, for instance.

- ***Operations personnel.*** A chief advantage of a smart system is program expansion without the need for increased operational personnel. While the implementation staff was very busy during the field test, much of their time was focused on partnership management and program development. Furthermore, integrated technology advances may help reduce personnel costs/needs. A certain number of vehicles could be added without increasing staff demands unrealistically. Since CarLink did not expand beyond 12 vehicles, economies of scale were not realized.

- ***More efficient use of parking spaces.*** Parking is another instance where potential economies of scale were not realized. By encouraging carpooling, a successful carsharing program would reduce an employer's need for parking, while potentially helping meet air quality control requirements. At the BART station, six, or possibly more, parking spaces could be opened to the public. This could help BART reduce costs considerably.

- ***Increased membership.*** Enlarging Workside Commuter carpools, or even developing Homeside carpools among neighbors, could increase CarLink revenues. Larger Day User groups could also increase revenues generated.

- ***Fleet management Day Use package.*** Under a business-lease model, CarLink vehicles could be leased to an employer or institution during business hours for a set fee each month. This would help increase revenues and lower administrative costs, while reducing uncertainty.

- ***Increased user fees.*** It is likely that the most significant revenue increase would result from higher user fees. As noted in Section 5.3, all user groups appear to be willing-to-pay more for the system than they paid to participate in the CarLink field test. Further investigations are needed to estimate accurately market rates.

This preliminary economic viability analysis poses many questions and requires further investigation. Different commercial ventures should be examined, such as the business-lease model. Research should also examine non-monetary carsharing benefits, including pollution reduction, congestion relief, and reduced land-use impacts. Transportation policy analysis should also investigate tax incentives for carsharing organizations and government subsidies. Finally, more willingness-to-pay experiments should be conducted.

The CarLink field test provides a starting point for a benefit-cost analysis of a commuter-based carsharing model. Many societal benefits and costs were not estimated and economies of scale could not be calculated, the CarLink program was not large enough from which to extrapolate. To summarize, further study is needed to better understand the long-term viability and societal benefits of various carsharing models in North America.

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CHAPTER SIX: CONCLUSIONS

SECTION 6.0 INTRODUCTION

Most trips in U.S. metropolitan regions are driven alone, which is costly to individuals and society and leads to congestion and air pollution. A more efficient, but less convenient, system would allow drivers to share cars. A shared-use system aims to reduce traffic by reducing the number of cars needed by households and encouraging commuters to walk, bike, and use transit, at least for part of their trips. For commuters especially, shared-use vehicles could offer a low-cost, low-hassle alternative to private vehicles. Furthermore, carsharing could help air quality by incorporating low-emission vehicles into shared-use fleets.

Because a carsharing organization would handle maintenance and repairs, these would be completed properly and on schedule, further reducing pollution and energy waste. Carsharing could reduce government spending on arterial street systems and mass transit by increasing transit ridership through added reverse commuters and midday, evening, and weekend riders. Sharing vehicles could even free up parking space; by serving multiple users each day, vehicles would spend less time parked. Moreover, carsharing could reduce the need for additional household vehicles to support a family's travel needs. Travelers would benefit by gaining the mobility of a car without individually carrying the full ownership costs; transit operators could benefit by tapping a much larger potential market; and society might benefit by diverting travelers from single-occupancy vehicles to transit for part of their trips.

The CarLink field test combined short-term rental vehicles with communication and reservation technologies to facilitate shared-vehicle access. The ten-month demonstration was implemented and researched by two teams at the Institute of Transportation Studies at UC Davis. Project partners included American Honda Motor Company, BART, Caltrans, PATH, and LLNL. INVERS and Teletrac provided advanced carsharing and vehicle tracking technologies.

Using surveys and focus groups, researchers explored attitudes toward the carsharing concept over time. This study builds upon the work of Shaheen's (1999) dissertation by linking carsharing market potential data to the CarLink field test population. Although the CarLink participant sample was not statistically significant, valuable lessons may still be drawn from the results. This chapter provides an overview of the lessons learned and success factors that may apply to carsharing in North America. The CarLink field test results include: operational understanding; participant profiles; behavioral findings; economic viability; and directions for future research.

SECTION 6.1 OPERATIONAL FACTORS

The CarLink field test investigated carsharing deployment challenges. In addition to studying participant behavior, CarLink employed a partnership management strategy as a means of supplying an integrated carsharing service (e.g., linked to transit and employers). CarLink also employed alternative fuel vehicles and tested smart key management and data collection technologies. The results of the ten-month field test (including eight months of data gathering) provided lessons learned and success factors for a commuter-based carsharing model. Following are the program parameters, which guided deployment and research methodologies.

- ***Three user groups*.** Two CarLink user groups exchanged vehicles and commuted via BART (i.e., Homeside User and Workside Commuter), while the third group accessed vehicles only during the workday at LLNL (i.e., Day User). Two of three groups paid user fees.[1] CarLink usage data were collected throughout the field test.

- ***Participation level*.** The program enrolled 54 participants throughout the ten-month field test, nearing the targeted 60 members.

- ***Smart technologies.*** CarLink tested two smart carsharing technologies: the COCOS smart key box manager and the Teletrac vehicle locator and data collection system.

- ***Partnership management.*** CarLink employed a partnership management organizational strategy (i.e., participation from government, a transit agency, employment center, and private industry).

- ***CarLink user satisfaction*.** Participants provided feedback through surveys, household interviews, focus groups, and problem resolution before, during, and after the field test.

- ***Economic data.*** Data were collected throughout field test for a preliminary economic viability analysis of commuter-based carsharing, including start-up and operational costs, as well as revenues from fees.

The program parameters listed above are evaluated throughout this report and in subsequent sections of this final chapter.

6.1.1 Lessons Learned

The following lessons were learned from the operation and evaluation of the CarLink field test. As with most demonstrations, new questions arose and solutions were developed for the design, operation, and study of future projects.

- ***Participation.*** Fifty-four participants enrolled in the ten-month CarLink field test—six members short of the targeted membership. CarLink reached a maximum of

[1] Day Users did not pay usage fees, as planned, due to program delays.

44 participants at any one time. The participant pool was limited due to the short project duration (Bernard and Collins, 1998), program delays (i.e., the Day Use program), and limited CNG infrastructure. The Day Use program included 24 participants, but only six used the vehicles during the data collection period. Although the Day Use program operated for only eight weeks, these results suggest that LLNL Day Use membership could have sustained a much higher membership level before excess demands were placed on the carsharing fleet.

- ***Smart technologies.*** Several technology shortcomings contributed to delays and necessitated program modifications. Technology should be customized to facilitate vehicle access and a multiple lot design. Technologies should be tested before program launch (Bernard and Collins, 1998). Deployment issues were not identified until the program was underway due to technology customization delays (i.e., CarLink data transmissions via Teletrac system).

- ***Internet-based reservation system.*** The Day Use reservations system was not integrated with the vehicle location system. As a result, vehicle availability could not be guaranteed.

- ***CNG infrastructure.*** Limited CNG infrastructure was identified as restrictive of the field test design and implementation. Participant response to a conventionally fueled shared-use vehicle program may vary.

- ***Partnership management.*** There were many challenges in bringing private industry, public agencies, a transit operator, an employment center, and university researchers together to design and implement CarLink. However, this diversity of partners facilitated the testing and development of this integrated carsharing service (Bernard and Collins, 1998).

- ***User satisfaction.*** CarLink members provided positive feedback on carsharing and guaranteed parking at BART, enjoyed driving the Honda CNG Civics, and reported having positive experiences with the COCOS key manager and the Teletrac vehicle tracking system.

- ***Vehicle cleanliness.*** Maintaining vehicle cleanliness, inside and out, was an ongoing CarLink concern.

- ***Carpool adherence.*** Consistent carpooling of Workside Commuters was difficult to achieve. Carpool matching required coordination of individuals' schedules. At times, user levels did not necessitate consistent Workside Commuter carpooling (i.e., often enough vehicles were available for several participants to drive their own vehicles). This confounded a carpool feasibility assessment.

- ***Lot selection.*** Planned carsharing lots at LLNL did not meet the needs of Workside Commuters initially. Input from participants facilitated lot placement resolution.

6.1.2 Success Factors

Results of the CarLink field test led to the identification of the following success factors.

- ***Smart technologies.*** Participants had positive experiences with the COCOS key manager, Teletrac vehicle tracking system, and the Internet-based reservation system. When properly functional, smart technologies can greatly facilitate data collection for managing reservations, billing, and research. Technology testing prior to program startup would be very beneficial, as noted earlier.

- ***Program flexibility and user satisfaction.*** Contact with users was high, enabling rapid issue resolution. While user levels fluctuated throughout the program, they were not generally related to program issues, but rather lifestyle changes that CarLink could not accommodate (e.g., changing jobs). Flexibility and responsiveness are key aspects in providing a successful carsharing service (Bernard and Collins, 1998).

- ***User fees.*** Reasonable rates are essential for program acceptance and adoption. Focus groups prior to marketing and recruitment facilitated identification of initial user fees.

- ***Guaranteed/designated parking at BART and LLNL.*** Guaranteed parking at the BART station was a significant program incentive. Designated Workside User parking (i.e., for Workside Commuters and Day Users) provided an additional participant convenience.

- ***Data collection.*** Data collection continued throughout the CarLink field test. Smart technologies were used for data collection, with manual trip diaries serving as a backup. Data collection, vehicle tracking, billing, reservations, and key management should be integrated, when possible.

- ***Media interest.*** Attention from the press was positive and prolific throughout the CarLink field test. Although previous programs had received substantial publicity, this was an unexpected program consequence and resulted in higher levels of program interest (Bernard and Collins, 1998).

SECTION 6.2 PARTICIPANT PROFILES

Developing characteristic profiles of CarLink participants, including their attitudes and program experiences, were among the primary CarLink goals. Field-test participant profiles compared similarly to the longitudinal carsharing survey results (Shaheen, 1999). This is not surprising since 75% of the CarLink population participated in the longitudinal study. Although the CarLink field test population was not statistically significant, 73% of participants receiving questionnaires provided survey data.

6.2.1 Demographic Trends

The following demographic trends emerged from the CarLink population:

- CarLink participants were predominantly male (67%) and married (69%).
- CarLink participants were primarily homeowners (81%), and all were employed.
- Eighty-one percent of participants had an average yearly income of $50,000 or more.
- Over one third (36.4%) were between 24 and 40 years of age and 59% were between 41 and 64 years of age.
- Seventy-five percent of participants held a bachelor's degree or higher level of education. Forty-three percent had a graduate or professional degree.

In general, CarLink members represented a more affluent, highly educated, and mature group than reflected by Bay area census data.

6.2.1.1 CarLink User Group Differences

Several differences did emerge among the Homeside User, Workside Commuter, and Day User populations.

- ***Homeside Users*** tended to live in medium-sized, suburban areas in the vicinity of the Dublin/Pleasanton BART station (64%), were married (67%), and had children (67%). All primary Homeside Users commuted by BART at least three days per week prior to joining the field test. The Homeside User group had the highest average yearly household income of all field test participant groups, with 67% of respondents reporting incomes above $80,000 per year.
- ***Workside Commuters*** were more likely to live in large, urban areas with populations greater than 250,000 (64%), were married (67%), and without children (79%). The Workside Commuter group's education level was the highest of the three user groups (60% had graduate or professional degrees). Their household income level, in contrast, was the lowest of the three user groups. Indeed, 50% of Workside Commuters, who provided a response, had household incomes below $80,000 per year. It is important to note that 29% of respondents declined to provide income-related data.
- ***Day Users*** were the most diverse CarLink group. Day Users lived in a wider range of locations: small cities (30%), medium-size cities (26%), and suburbs (21%). Most were married (80%), and 39% had children. Education levels ranged from "Some College" to "Graduate/Professional." Day User income levels were almost evenly spread: 43% of household income levels were below $80,000, and 48% were above $80,000 per year, and 9% declined to respond. Day Users used a variety of commute

modes prior to (and during) CarLink: drive alone, carpool/vanpool, bus, and bicycle. This was the only user group that did not include any regular BART riders (i.e., taking transit at least three times per week) prior to CarLink.

6.2.2 Psychographic (Attitudinal) Characteristics

Although it is not possible to compare attitudinal characteristics of field test participants to the general population, they were relatively similar to those of longitudinal survey participants. Notable attitudinal results from the field test include:

- ***Environmental concern*.** In Shaheen's dissertation (1999), those interested in "CarLink Use" were .4 times more likely to express environmental concern. CarLink field test participants were slightly more neutral than those of longitudinal respondents regarding congestion, vehicle hassle, and vehicle enjoyment perception.

- ***Congestion concern*.** Congestion attitudes were not found useful as "CarLink Use" predictors (Shaheen, 1999), although a majority of field-test members thought congestion was a problem (i.e., 63% agreement on congestion).

- ***Vehicle hassle*.** Field test participants agreed that vehicles are a hassle. This result is notable, since hassle perception was a predictor in Shaheen's "Transit" and "CarLink Use" models, reinforcing that individuals who perceive vehicles as a hassle are more likely to use transit and potentially CarLink.

- ***Modal satisfaction*.** The one anomaly in the attitudinal response results is the finding that CarLink users exhibited a high degree of modal satisfaction (i.e., before CarLink). These results are counter to Shaheen's dissertation findings. In the "Auto User" model, a positive modal satisfaction score was a significant predictor of an auto driver. Conversely, negative modal satisfaction was predictive of "Transit" and "CarLink Use." Field test participants, however, revealed a high degree of modal satisfaction. Although this may seem counterintuitive, a majority of CarLink members did not change their current modes to participate in the program (e.g., Homeside and Day Users). Thus, modal dissatisfaction was not a principal motivating factor for participation.

SECTION 6.3 PROGRAM FINDINGS AND RESULTS

Further insight into the CarLink field test, and the future potential of commuter-based carsharing was gained through exit questionnaires, household interviews, and focus groups. The following program feedback was provided.

- CarLink users were comfortable with and preferred smart technologies. Specifically, they were more at ease with the COCOS key manager system at the Dublin/Pleasanton BART station than they were with the LLNL manual key boxes. They also preferred the Teletrac automatic vehicle location system in contrast to completing manual trip diaries. LLNL employees were comfortable with the

reservation system, but they would have liked to access it off site and preferred that it provided real-time car location information.

- Preferred parking was a substantial program user benefit. This was especially true at the Dublin/Pleasanton BART station, where guaranteed spaces offered Homeside Users greater flexibility with their morning departure times. Designated spaces at LLNL provided additional convenience.

- CarLink reduced commute stress, even though travel times typically increased. Workside Commuters, in particular, enjoyed shifting their solo auto trips to BART, especially those living farther from Dublin/Pleasanton.

- CarLink decreased Homeside User and Workside Commuter spontaneity, although this was not a daily concern. Homeside Users sometimes worried about returning cars in time for Workside participants. Workside Commuters had some concerns about using CarLink in an emergency due to the necessary BART link. Day Users did not have access to a car at work before CarLink, so the program enhanced their spontaneity.

- Environmental concern was one reason that individuals joined the CarLink program (Shaheen, 1999), although not the dominant one.[2]

- Homeside Users thought having a CarLink pickup truck available would be very helpful. Workside Commuters and Day Users agreed that a truck would be very useful for Homeside use, but it would be less so for them.

- The Workside Commuter group was required to carpool as part of the program. This required most members to alter their schedules, at least occasionally. Interestingly, this was only a significant issue for one member, who later left the program. Due to a high degree of schedule variability, on many days carpool members drove separately—either in CarLink vehicles or one driving a private vehicle. Members said they would have carpooled more frequently, if partner communication had been facilitated by a messaging system (e.g., two-way pagers).

- After joining CarLink, Homeside Users and Workside Commuters decreased their personal vehicle use. The Workside group also increased their recreational transit usage, possibly due to greater BART familiarity or ease of access.

- If CarLink became a permanent service, several Homeside Users stated they would likely sell a personal auto and greatly reduce their transportation costs. Workside Commuters were more hesitant about selling a private vehicle until transit services improved (Bernard and Collins, 1998) and CarLink provided more lot locations and vehicle variety.

[2] Bernard and Collins (1998) found that environmental concern and interest in electric vehicles were key reasons that individuals joined the San Francisco Station Car Demonstration.

- The majority of Workside Commuters interviewed indicated that they would return to solo driving after CarLink ended, but carpool more frequently than they had previously. All three interviewed Homeside Users said they were considering buying a new vehicle and would continue using BART. Day Users would not change their commute modes appreciably.

- There was an average reduction of 31.8 private vehicle miles traveled per day and an increase of 13.3 CarLink miles traveled. Thus, there was a net reduction of 18.5 vehicle miles (on average). Furthermore, CarLink resulted in at least 20 new BART trips each day.

SECTION 6.4 ECONOMIC VIABILITY

The principal CarLink study goal was to study behavioral response rather than to maximize participation and profits. Thus, it is not surprising that costs exceeded revenues. Scenario analyses in Section 5.4 present more aggressive CarLink deployment strategies and results. The best-case scenario demonstrates a net profit of approximately $3,349 to $4,389 per month for the twelve vehicles, which does not reflect environmental and social benefits (e.g., increased transit ridership and reduced parking demand).[3] However, less aggressive scenarios demonstrate shortfalls of $2,500 to $4,750 per month.

During the field test, revenue-expansion and cost-reduction strategies were not explored. CarLink economic viability might be improved in many ways including:

- ***Streamlining technology.*** Another CarLink objective focused on investigating off-the-shelf technologies to facilitate carsharing. This resulted in some COCOS and Teletrac overlap, as both systems had vehicle-tracking capabilities. If an integrated system were developed, technology and system deployment costs could be reduced.

- ***Operations personnel.*** A chief advantage of smart technologies is program facilitation, particularly expansion, without significant personnel requirements. Since CarLink did not expand beyond 12 vehicles and 44 participants at one time, economies of scale were not realized.

- ***More efficient parking use.*** Parking is another instance where potential economies of scale were not realized. In the field test, parking was provided for all 12 vehicles at the BART station. In practice, fewer parking spaces were needed because vehicles spent a limited time at BART. This might facilitate transit access for new customers, since reduced parking demand (resulting from CarLink use) would free up parking for other customers. Furthermore, CarLink could reduce an employment center's parking demand, while potentially helping to meet air quality control requirements.

[3] A benefit-cost analysis would incorporate social, environmental, and other non-monetary benefits (e.g., reduced commute stress and vehicle hassle).

- ***Increased use by employers and commuters.*** Larger Day User and Workside Commuter groups would increase system revenues. Moreover, business fleets could be started, augmented, or replaced with a CarLink service and guaranteed monthly revenues might be generated. See Scenarios Four and Five in Chapter Five for further discussion.

- ***Increased usage rates.*** Charging higher user fees could also increase revenues. As noted in Section 5.3, all user groups appeared to be willing to pay more than they paid during the CarLink field test. Although CarLink participants provided an estimate of their willingness to pay for the program, it is difficult to estimate the true potential for rate increases.

This field test focused on user response versus program optimization. Thus, the preliminary economic analysis poses many questions. To provide a more accurate picture of this program's benefits and costs, CarLink costs should be streamlined, revenues increased, and program benefits quantified (e.g., environmental, social, and hedonic).

SECTION 6.5 FUTURE RESEARCH

Recommendations for future carsharing research include:

- Expand the CarLink program in vehicle number and duration. This would attract more users and support behavioral change (e.g., selling a personal vehicle).

- Change the employment center to an office park to investigate a more typical employee population. Results would likely be more generalizable to other programs and might reduce difficulties of high schedule variability.

- Further investigate willingness to pay and users' motivations to participate long term in a carsharing program. This would best be done by charging users different rates in practice, as opposed to discussing them in focus groups, interviews, or questionnaires.

- Deploy integrated technologies designed for a commuter-based carsharing model.

- Test technology in the field before the program starts.

- Use conventional internal combustion engine (ICE) vehicles to concentrate on carsharing issues. It would be easier to use conventional vehicles than to rely upon limited infrastructure (e.g., natural gas or electric recharging stations).

- Continue to address car cleanliness issues (e.g., place trash receptacles in cars).

- Develop systems to increase carpool participation, where requested. This might involve facilitating communication between members with advanced technology (e.g., two-way pagers).

The future of carsharing in North America can be influenced by empirical research results. CarLink assessed user response and off-the-shelf technologies in a commuter-based carsharing test. While CarLink only began to judge the practicality of one carsharing model in the U.S., within the context of a limited sample population, it advanced our understanding of consumer response, technological limitations, and business potential from which new research efforts might build.

REFERENCES

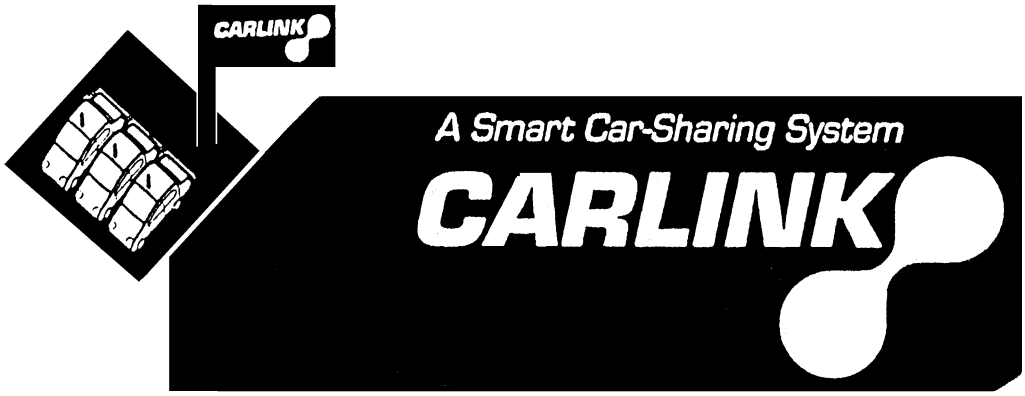
Bernard, M.J. and N.E. Collins (1998). San Francisco Bay Area Station Car Demonstration Evaluation. Oakland, CA, Bay Area Rapid Transit District**:** 71 pages.

Shaheen, S.A. (1999). *Dynamics in Behavioral Adaptation in Response to a Transportation Innovation: A Case Study of CarLink--A Smart Carsharing System*. Graduate Group in Ecology. Davis, University of California**:** 449.

APPENDIX I

CARLINK MEMBER MANUAL

CarLink Member Manual



SECTION 1:

CarLink Responsibilities

&

Usage Procedures

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CarLink Smart Car Sharing Project
Membership Manual

1. Introduction

Welcome to the CarLink Smart Car Sharing Demonstration Project. This Manual will explain the operating rules and requirements for participation in this project. The terms and conditions described in this Manual will insure that each member is fully aware of the responsibilities he or she incurs in agreeing to share a fleet of vehicles with other CarLink members. It will also explain how you can take advantage of the CarLink Program to achieve maximum benefit from the mobility services it provides.

The vehicles in the fleet are available for three different groups of individuals—Homeside Users in the Dublin/Pleasanton area, Workside Commuters to the Lawrence Livermore National Laboratory (LLNL), and Day Users at the Lab. While the Manual describes the rules and procedures for each of these groups, it should be understood that each member will only be obligated to follow those applicable to the group(s) to which he or she may belong.

2. The Vehicles

Twelve (12) new Honda 4-door low-emission Civics will be employed in the CarLink Project. Ten (10) will be available for use at all times, while the remaining two (2) will be kept in reserve as back-up vehicles at the D/P BART Station. They will be available when a regularly reserved vehicle is unavailable (e.g., a user is ill and does not bring the vehicle into the station that day or a vehicle is disabled).

The vehicles will be fueled with compressed natural gas (CNG). They have a range of approximately 150 miles, although, except by permission, members will agree not to drive more than 150 miles during each rental period. Workside Commuters and Day Users will be responsible for refueling the vehicles, and they will be trained and certified to perform this task at the CNG fueling station near the Fleet Management Center at the Lab.

The vehicle-operating manual is located in the glove compartment of each Honda. Please read this manual carefully to familiarize yourself with the operational characteristics of the Hondas. In addition, the vehicle manual should be consulted in the event of a mechanical failure or other breakdown, such as a flat tire or dead battery.

3. Reservations

Standing Reservations
Homeside Users and Workside Commuters will have a standing reservation that is booked at the start of the project. Members of these two groups must return the vehicle to the D/P BART Station on a regular schedule during each workday.

1. A Homeside User must return the vehicle to the D/P BART Station at the start of each workday for use by an arriving Workside Commuter.

2. A Workside Commuter must return the vehicle to the D/P BART Station at the end of each workday for use by a returning Homeside User. Workside Commuters carpool to and from the D/P BART Station.

The CarLink Staff was informed of each member's schedule at the time he or she joined the Project. Any change in this schedule must be immediately communicated to the Bob Reese.

Day Use Reservations
A booking for day use at the Lab will be required for each separate trip. To insure the availability of a vehicle, it is advisable that these reservations be made as far in advance as possible.

Vehicle Monitor: Lee Anne Mila
Telephone: 423-0974
E-mail: mila1@llnl.gov

Backup Monitor: Norman Samuelson
Telephone: 422-0661
E-mail: nhs@llnl.gov

Timeliness of returns is especially important at the end of the day when a Workside Commuter will return the car to the D/P BART Station. The penalty for failing to return a vehicle on time is listed in Section 9.

Please see the section on Day Use for specific instructions.

4. Key Access

Dublin/Pleasanton BART Station (For Homeside Users and BART/LLNL Commuters)
Homeside Users and Workside Commuters will use a smart Key Manager system consisting of a steel, safe box located on the side of the kiosk on the south side of the D/P BART Station, close to the CarLink vehicle parking area. To pick up your keys for the CarLink vehicle:

- Go to the Electronic Key Manager. The Key Manager is located on the side of a large kiosk building. It has a blue door with a stainless steel casing.

- Place the CarLink Smart Card in front of the screen (within a half inch) depicting a miniature version of your orange card.

- Within a few seconds of holding the card in front of the screen, the Key Manager will ask for your PIN number. Type in your four-digit PIN number on the keypad.

- If you correctly type your PIN number, the screen will prompt you to open the door. Typically this door needs a good tug to open it. The screen will then tell you what key/vehicle you are registered to take. If you do not take the authorized key, you will be unable to start the vehicle corresponding to this key. Your reservation only corresponds to the key designated by a green light near the key hanger.

- Please remove the key at this time. The letter on each key chain corresponds to the letter displayed on the vehicle it operates.

- Please make sure to **close the door** to the Key Manager.

LLNL (For Day Users)
A manual Key Box will be located attached to a building adjacent to each lot where the vehicles are parked. Each Workside Commuter and Day User will be issued a key to these boxes.

- After opening the Key Box, please remove the key chain with the letter corresponding to the letter displayed on the vehicle you have reserved.

- Be sure to lock the Key Box once you have removed the vehicle key.

- Workside Commuters and Day Users must always return the keys to the inside manual Key Box at the conclusion of their trips.

Five parking lots will be used at the Lab. Each lot will typically have one to two vehicles. On any given day, the cars available in each lot will be a different mix of vehicles (i.e., each vehicle is assigned a letter and cars are randomly assigned to users each day). These lots—along with the number of CarLink vehicles assigned to these locations—are listed below (buildings where Key Boxes are located are listed first and in bold face):

- **Port 1 Lot A4** by Buildings **132N**, 141, 1449, and 131—two vehicles
- **Port 2 Lot D7** by Buildings **3724,** 4729, 482 and 481—one vehicle
- **Port 3 Lot A7** by Buildings 170 and 1736—two vehicles
- **Port 4 Lot C-5W** by Buildings 362 and 254—two vehicles
- **CNG Refueling Station** -- two vehicles

5. Before Driving

- After picking up your keys from the Key Manager or manual Key Box proceed to your designated vehicle. The letter of the vehicle should be clearly marked on the front windshield on the passenger's side and on the back windshield on the driver's side.

- Please look around the vehicle to make sure that no prior theft or damage was done to the vehicle. If theft or damage has occurred prior to your use of the vehicle, please report these damages immediately to Bob Reese.

- Unlock the vehicle with the flat ignition key.

- Before starting the vehicle with the flat ignition key, insert the cylindrical Relox (Data) Key in the slot located to the left of the steering wheel in front of your left knee. You should see a red light turn off and a green light turn on.

- Remove the cylindrical Relox Key and put the ignition key into the ignition on the right side of the steering wheel. You have approximately 1 minute to start the vehicle after the red light turns to green. During this minute the green light will be blinking to let you know to turn on the vehicle.

- Teletrac System: Before driving away you must press the "Form Fill" button on the Teletrac unit. Then follow the on-screen instructions which will ask you to enter in your two digit user ID as well as the last three digits on the odometer. Please note that your user ID is different than your PIN number.

  Finally press the "Message" button and select your trip purpose. You can do this by scrolling through the preprogrammed messages using the up and down arrow keys or by entering in the corresponding trip purpose number.

  Trip Diary System: Fill out the Trip Diary. Record your user I.D., date, time and current odometer reading and trip purpose. Record the beginning and end odometer readings and time for each trip[1].

- Homeside and Day Users should be sure to enter a new trip purpose each time it changes while on the road. For example, if you are running errands in the morning and then go to a doctor's appointment, you will want to enter both of these trip purposes when you begin each part of your journey.

[1] CarLink is a research project, thus data collection is a vital part of the program. Homeside Users and Workside Commuters collected data regarding their usage in two different ways: an automated system, called Teletrac, was used from January 20, 1999 to June 4, 1999. A manual system, called a Trip Diary, was used from June 7, 1999 until the end of the data collection phase on August 31, 1999. Day Users used the Trip Diary System as their form of data collection throughout the entire project.

6. On the Road

All CarLink members share in the responsibility of keeping the vehicles in good condition at all times. At the outset of the Project, please take a few moments to familiarize yourself with the vehicle controls. If you are uncertain about the operation of any vehicle system, refer to the manual in the glove compartment.

Once you are on the road, please adhere to the following safety and maintenance procedures:

- All passengers must fasten their seatbelts.
- Smoking is prohibited in the CarLink vehicles.
- Please do not leave trash or personal items in the vehicles.
- The doors must always be locked when you leave the vehicle.
- Members are responsible for paying traffic or parking tickets while using a CarLink vehicle.

7. Returning the Vehicle

Late Returns/Schedule Changes

- It is essential to contact CarLink whenever you are unable to return the vehicle on time. To change a booking at the Lab, members should call the Vehicle Monitor at either 423-0974 or 422-0661. If you cannot reach the Vehicle Monitor, please call Sal Ruiz at Fleet Management at 422-7474. Homeside Users and BART/LLNL Commuters should call Green MotorWorks at (510) 521-4300 (e.g., if you are a Homeside User and you are ill and will not be taking the vehicle to BART in the morning).

CarLink Parking

- Please return the CarLink vehicle to the lot where it was picked up and park it in a designated CarLink parking spot. This makes it possible for the next user to not have to search for the vehicle.
- If an unmarked vehicle is parked in the designated CarLink spot at the Lab, please notify the Fleet Management office at 422-7474.
- If an unmarked vehicle is parked in the designated CarLink spot at the Dublin/Pleasanton BART Station, please call the BART Police Department at (510) 464-7000.

Leaving/Locking Procedures

- Teletrac System: Before removing the keys, be sure to log off the Teletrac system by pressing the "Form Fill" button. Then enter your 2-digit ID number, the last 3 digits of the odometer and press send.

  Trip Diary System: Before leaving the vehicle, record ending odometer and ending time for the current trip purpose in the Trip Diary. Be sure that your user I.D. is entered, and the date.

- Then remove the flat ignition key and use the cylindrical Relox key to log out of the COCOS-on-board computer. Insert the Relox key into the slot to the left of the steering wheel. Hold it in this slot until the green light shuts off and the red light comes on.

- Don't forget to lock the vehicle when you leave. You can lock the vehicle by inserting the flat ignition key into the door lock and turning the key until you see all four door locks go down.

8. Emergencies

Vehicle Damage

Please treat the CarLink vehicles as you would your own and be careful to avoid damaging them. If a vehicle is damaged while you are using it, please contact Green MotorWorks at (510) 521-4300 so that it can be repaired as soon as possible.

Vehicle Breakdown

If you are unable to operate the vehicle due to a flat tire, dead battery, or a mechanical problem *at a location other than the Lab*, please contact Cross Country Motor Club at (800) 864-8336. Be sure to provide them with 1) The fact that you are driving a Natural Gas vehicle and 2) The vehicle identification numbers from the drivers' side dashboard. If one of these problems occurs at the Lab, please contact Sal Ruiz at Fleet Management at 422-7474.

Accident

If you have an accident, be sure to stop, note the time and location of the incident, and obtain the name, phone number, and insurance agent of the driver of the other vehicle. Call 911 if there are any life-threatening injuries. Members must report accidents, damages, or vandalism to SALEX. Instructions on how to file a claim with SALEX are included in the insurance packet in the glove compartment of the vehicle. Complete all the applicable spaces on this form, including witness information. Be sure to also notify Green MotorWorks at (510) 521-4300, once you are able.

9. Ground Rules

The following section highlights the most important rules governing your membership in the CarLink Demonstration Project.

Vehicle Usage

- The car must be picked up and returned to the designated lot on or before the end of each reservation period.

- Teletrac System: At the start of each trip members must log on to the Teletrac System by entering their ID Number, odometer reading and trip purpose by code.

  Trip Diary System: Members must fill out the Trip Diary for each trip.

- The vehicles must not be driven more than 150 miles during any single reservation period.

- The vehicles may not be driven by anyone not authorized by Honda.

Unforeseen Events

If members are unable to return the vehicle to the designated lot on or before the end of their reservation period, they must contact CarLink. For a *booking at the Lab*, members should call the Vehicle Monitor at one of the following numbers: 423-0974 or 422-0661 or Sal Ruiz at Fleet Management at 422-7474. Under all other conditions, members should call Green MotorWorks at 1-510-521-4300.

Accidents, thefts, or other damage to the vehicle must be reported immediately to Green MotorWorks at (510) 521-4300.

CarLink Vehicle Maintenance

The driver and all passengers must use safety belts and, when required by law, child restraint devices.

Smoking is not permitted in the vehicles.

Permanent marks (stickers or decals) or installation of an accessory or piece of equipment is not permitted in the vehicles.

Towing vehicles is not permitted, nor is the transport of hitchhikers permitted in any vehicle.

Member Accounts
Within five days of the monthly invoice due date, members must pay to Green MotorWorks the fees specified in their Membership Agreement as follows:

Group	**Monthly Fee**	**Usage Fee**
Homeside User	$200.00	None
Workside Commuter	$ 60.00 /vehicle	None
Day User	None	$1.50 /hour. $ .10 /mile

All fines or tickets must be paid promptly to the appropriate authorities.

Penalties
Members will be obligated to pay the penalties assessed for the following violations of the terms of their Membership Agreement:

- Late fee for monthly invoice $ 1.00 /day
- Each hour the vehicle is not returned at the end of the rental period $ 5.00
- Each mile the vehicle is driven in excess of the l50 miles $ 1.00
- Each failure to deposit car keys at the designated key drop off location $ 25.00
- Each occasion vehicle is returned with less than required amount of fuel $ 10.00

10. Essential Contact Information

Emergency Numbers

Cross Country Motor Club	(800) 864 8336
Green MotorWorks (GMW)	
Office Number	(510) 521-4300
Pager (24 hrs)	(800) 304-1508
LLNL Fleet Management	(925) 422-7474
LLNL Vehicle Monitor	
Primary Lee Anne Mila	(925) 423-0974 mila1@llnl.gov
Back-up Norm Samuelson	(925) 422-0661 nhs@llnl.gov
CarLink office	(530) 752-1934
CarLink Field Test Manager -pager	(510) 666-1844

Glossary

COCOS System
The COCOS system incorporates the Electronic Key Manager at the D/P BART Station, the Relox Key, and the on-board computer in the vehicle that releases the immobilizer. This system authorizes use of a particular vehicle by individuals who belong to the system, and, in the case of the Smart Key Manager at BART, hold a reservation.

Electronic Key Manager
The Key Manager at the D/P BART Station has a stainless steel casing and a blue door. The screen in the left top corner is where you put your card to enter the Key Manager. It will ask you for your four-digit PIN code. Only Homeside Users and Workside Commuters will be able to access the Key Manager at the D/P BART Station. There are slots inside the Key Manager for keys. Please take only the key that is assigned to you. The screen will instruct you of the key number slot of the vehicle that has been assigned to you and a green light will appear above that key inside the box as well.

ID Number
Each CarLink member will receive an ID number when they join CarLink. This number is associated with the Teletrac System. The ID number is a two-digit number and each user will have his or her own number.

Ignition Key
The Ignition Key is the flat key that is attached to the key chain. It is used to start and turn off the vehicle. To start the vehicle, place this key into the ignition on the right side of the steering wheel.

Key Box
The Key Box at the LLNL will be operated on a manual basis.

Message Display Terminal (MDT)
The MDT is located in front of the gear shifter. When entering the vehicle you must log on to the MDT made by Teletrac. First press the *Form Fill* button. You will then enter in your two-digit ID number. This number is different from your PIN number that you use at the D/P Bart Station Key Manager. You will then enter in the last three digits of the odometer. Make sure it is the last three digits of the odometer and not the trip meter number. Then Press send. Press Message button and select a trip purpose. You can select the trip purpose by using the cheat sheet and pushing in the code or by scrolling down the list using the arrow keys.

PIN Number
This number is associated with your Smart Card and the COCOS System. This number is different than your ID number used with Teletrac. Your PIN number has four digits. Homeside Users and Workside Commuters will be the only members who have a COCOS PIN number.

Relox Key
The Relox Key is a cylindrical key with a black plastic box on the end. This is used to release the immobilizer in the vehicle. When entering the vehicle, place the Relox Key into the slot on the left side of the steering wheel and in front of your left knee. To start the vehicle you must first put the key in and watch for the red light to turn off and the green light to flash. If the green light is flashing, you have used the key for your specified assigned vehicle and reservation. Then you can use your ignition key to start the vehicle. This must be done every time you enter a CarLink vehicle.

Smart Card
The Smart Card is an orange credit card-like key that has a computer chip inside that identifies you as a CarLink member and allows you to access the Key Manager at the D/P BART Station. It holds all your personal information and when it is held up to the screen on the Key Manager the Key Manager will ask for your PIN number. The card allows you to check out only one vehicle at a time from the D/P BART Station.

Teletrac System
The Teletrac system incorporates the Message Display Terminal (MDT) and Vehicle Locator Unit (VLU). It tracks the position of the vehicle and provides communication with Fleet Manager. Users must follow the instructions for logging onto this system every time your start the vehicle for a trip. Instructions can be read in this manual or on the cheat sheet that is on the dash next to the Teletrac System. (The cheat sheet is a description of how to use the vehicle and log on. It is a step by step listing of what to do before driving away.)

Vehicle Locator Unit (VLU)
The VLU allows the vehicle to be monitored. There is no interaction with the user.

SECTION 2:

CarLink

Day Use

CARLINK DAY USE AT LLNL
Usage Guidelines

Welcome to the CarLink Day Use Program!

Thanks for participating in the Day Use carsharing program at LLNL. The CarLink program is composed of two groups of participants at LLNL. The first group drives the cars from the Dublin/Pleasanton BART Station to work in addition to having access to them during the day. (They are Workside Commuters and many also participate in Day Use.) The second group, or Day Users, only uses the cars while at work. Both groups will use an Internet-based reservations system to reserve cars for use (the reservation system is described below). Further, both groups will assist in refueling the vehicles.

The CarLink project is a field test. Not surprisingly, we are collecting data to monitor use and system logistics. To collect these data, we are requesting that participants complete trip logs, detailing their trip purpose and mileage, for each trip. To facilitate use and ensure vehicle access, we have developed this user protocol, as well as contingency plans (e.g., in case you're running late on a vehicle reservation) so that the program will work smoothly for all participants.

The Day Use guidelines follow. Please note that this document will be incorporated into an updated User's Manual, which you will receive a copy of shortly.

Day Users Groups at LLNL

- Workside Commuters (and Day Users)
- Day Users—Group 2 (Day Use only)
- Day Users—Group 3 (selected LLNL fleet users). This group will not be involved in the first phase of the project. When they are incorporated into the program, they will become members of the CarLink Day Use program.

Participant Requirements

All Day Users must attend an Orientation session (which includes instructions on refueling, logs, reservations, contingency plans, and key system usage) and complete a CarLink membership application (including a DMV and credit check.) Please contact Linda Novick (lnovick@ucdavis.edu), if you know anyone that would like a membership application.

Day Use is available for all qualified participants, but only at approved lots. Workside Commuters, who are also Day Users, access CarLink vehicles from the lots in which they leave a CarLink vehicle--driven from the BART Station--each morning.

For the second group of Day Users (i.e., Group 2), the first phase of the Day Use program is deployed from the CNG lot. This is the only lot that can be used by this group during our testing phase (i.e., probably between 2 to 4 weeks).

Parking Lots for Day Use Group 2

Day Use, Group 2 participants will begin the program by accessing and returning cars to the CNG lot. This lot is located at the SE corner of Ave. J and the South Outer Loop. We have chosen this location for the test because it is where the refueling station is located and will facilitate vehicle refueling for the Day Use program. It is also near to Building 611, the Fleet Maintenance center for LLNL.

Our goal is to expand from this lot as soon as possible. We will be able to proceed once we have demonstrated that this phase of the program is running smoothly. Three CarLink vehicles will be located at this lot for Day Use (i.e., for Group 2 participants), although only two vehicles can be reserved at any one time. The reason for this is that is critical to have a back-up vehicle in reserve each day.

There are four additional lots where other CarLink cars are parked during the day (in part due to the Workside Commuter program). These are lots A-4, A-7, C-5, and D-7. One of these will be used as a backup lot (i.e., C-5) for the Day Use, Group 2 program in case an individual has a reservation and the reserved vehicle is not available in time.

CarLink Reservation System

The CarLink reservation's web site at LLNL is:

http://www.llnl.gov/llnl_only/tsmp/carlink/carlink.html

All Day Users must use this system to reserve CarLink vehicles. Furthermore, all CarLink cars must be reserved in advance. More detailed instructions for accessing this site will be provided separately. Each user will be given their own ID number to access the system. No one else can access a user's reservation, except the system administrator.

The system works as follows:

- Day User accesses the system per the instructions on the Web site. Click on the reservations icon.

- Day User reviews the calendar to determine available vehicles at the CNG lot (or other lots in the case of Day Use, Group 1 (i.e., the Workside Commuters)).

- Day User reserves a car for the desired time slot.

- One half hour “dead time “ is required between reservations to allow time for refueling and late arrivals.

- Day Users will check reservations before entering their preferred reservation time to prevent an overlapping reservation problem. Basically, an overlapping reservation is one that would start in the middle of the previous reservation. This means that two individuals might try to reserve a car for the same time period without realizing it. For example, if a car is reserved from 1:00-3:00pm and another user wants to use the car from 2:30-4:00pm, the system would no longer recognize the first user. If each user checks the monthly calendar, he or she can easily determine when the cars are available for Day Use. The reservation system does check if there are more reservations than cars available; however, it cannot currently account for the time overlap.

- Be conservative with your time when you make the reservation. If there is a strong likelihood of running into heavy 580 traffic, please provide extra time in your reservation.

- If a Day User reserves a car a few days in advance, he or she must check the reservation system on the morning of this reservation to be sure that a car is available. (Please see the section on contingency plans, below, for cases when a car does not appear to be available for a reservation.)

- If a Day User returns early, they can delete the record and re-enter it to reflect the trip time more accurately. This may seem like an extra step, but there is not currently a method for modifying reservations once they are made. Although this step is not required, it is a courtesy to others who may need the car during the time that you thought you needed it but did not.

Refueling

The CarLink cars are compressed natural gas (CNG) vehicles. There is one location at LLNL for CNG vehicle refueling; the location is the lot in which the Day User, Group 2 cars are deployed. At the end of each trip, Day Use participants will refuel vehicles at the CNG tanks to ensure that the vehicles are refueled for each new user.

This step is extremely important since other LLNL CarLink members (i.e., Workside Commuters) use these vehicles to return to the D/P BART Station at the end of the workday. In addition, it ensures that cars will consistently have enough fuel throughout the day for each reservation.

Trip Diaries – Data Collection

Collecting the Trip Diary information is important for Day Use billing (i.e., personal use only) and the research component of the CarLink program. Below is a summary of the Trip Diary Instructions, a copy of which will soon be placed in each CarLink vehicle.

CarLink Trip Diary Instructions:

When you enter the CarLink Vehicle

- Record the following information:

Date
Start Time (AM/PM)
Start Odometer Reading
Trip Purpose
Your User ID #
Additional Occupant(s) in Vehicle
Additional Occupant(s) User ID# (if applicable)

When you leave the CarLink Vehicle

- Record the following information:

End Time (AM/PM)
End Odometer Reading

Day Users: For billing purposes, please note "Day Use" in the "Comments" section.

For the purpose of accurate data collection, it is important that all trips are recorded in the Trip Diary. This includes evening and weekend trips made by Homeside Users in addition to Workside Commuters and Day User trips.

Billing

During the initial phase of the program, when Day Use, Group 2 usage is only conducted from the CNG parking lot, there will be no charge for vehicle use (i.e., business trips or personal). After the program expands, personal Day Use trips will be charged at $1.50 per hour and $.10 per mile.

Billing reports will be generated monthly. In the initial phase of the program, reports will be informational, demonstrating the cost that would be incurred if personal Day Use trips were not free of charge.

Contingency Plan

Although we do not anticipate any problems with the system, we are providing instructions in the case of an occasional emergency. The telephone numbers of our LLNL CarLink vehicle monitors, the CarLink UC Davis Field Test Manager, and the UC Davis CarLink office will be left in the cars for emergency purposes.

A Few Questions and Answers:

What Do I Do If a Reserved Vehicle is Not Available?

Q: What if a CarLink vehicle is reserved, but it is not in the lot at the reserved time?

A: Here's What to Do:

- First check the CarLink web page before your reservation.
  If you check the system in the morning to ensure your car is available, and determine that not enough vehicles are there, please contact a vehicle monitor (please see contact information, below).

- Next, contact a Vehicle Monitor.
  The vehicle monitor will locate an available car at another lot for your time slot.
  One backup lot has been designated for this purpose.

- Vehicle Monitor is not available when you call, next contact the Field Test Manager
  If the vehicle monitor is not available, page Linda Novick.
  Linda will make appropriate contacts and inform the next user.

What if I Am Running Late on My Reservation?

Q: What if I am on a trip with a vehicle, and I am running late (i.e., more than 15 minutes)?

A: Here's What to Do:

- First, contact a Vehicle Monitor.
  Contact a vehicle monitor. The vehicle monitor will check to see if anyone else needs your car for another reservation and adjusts the reservation system. If there is a reservation, the vehicle monitor will contact the person with this reservation and assign another vehicle.

- Next, contact the Field Test Manager.
  If the vehicle monitor is not available, page Linda Novick.
  Linda will make appropriate contacts and inform the next user.

Contact Information

Vehicle Monitors:

1. Norman Samuelson
   Telephone: 422-0661
   Email: nhs@llnl.gov

2. Lee Anne Mila
   Email: mila1@llnl.gov

Field Test Manager:

Linda Novick
Pager: 510-666-1844 (numeric only)
Enter phone number or user identification number
Telephone: 530-752-1934 (not often in office)
E-mail: lnovick@ucdavis.edu

SECTION 3:

Frequently

Asked

Questions

CarLink Smart Car Sharing Demonstration Project
Frequently Asked Questions

Contents

- **When did the project begin?**
- **What types of vehicles will be available?**
- **What types of trips can I take?**
- **Where will the CarLink vehicles be located?**
- **How can a vehicle be reserved?**
- **How do I obtain the key to the vehicle?**
- **What are my responsibilities when I enter the vehicle?**
- **What are my responsibilities when I leave the vehicle?**
- **How much does it cost to use a CarLink Vehicle?**
- **What are the membership requirements?**
- **What are my principal obligations as member of the CarLink Project?**
- **What do I do in the event of unforeseen difficulties?**

When did the project begin?

The Project was launched January 20, 1999 and Members began using the vehicles that day. The project was formally announced to the public at a widely attended Media Presentation on February 2, 1999. Descriptions of the CarLink Project appeared in all the local papers that day, as well as the day after. The web archives of such papers as the San Francisco Chronicle, the Examiner, the Tri-Valley Herald, the Contra Costa Times, Sacramento Bee, as well as the Los Angeles Times provide online versions of these articles.

What types of vehicles will available?
Twelve (12) new Honda 4-door low-emission Civics are employed in the project. Ten (10) will be available at all times for member usage, while the remaining two (2) will be kept in reserve at the D/P BART Station. They serve as back-up vehicles in the event of an emergency or unavailability of a regularly reserved vehicle (e.g., A user is ill and does not bring the vehicle into the station that day.).

The vehicles are fueled by compressed natural gas (CNG). They have a range of approximately 200 miles, although members will agree not to drive more than 150 miles during each rental period. Workside Commuters and Day Users are responsible for refueling the vehicles, and receive training to perform this task. Except on a case-by-case basis, refueling will be undertaken at the CNG fueling station near the Fleet Management Center at the Lawrence Livermore National Lab. (LLNL).

What types of trips can I take?
CarLink Members share these vehicles depending upon the nature of their commute to work:

Homeside User: Those who live in the D/P area and commute to work on BART five days a week drive the vehicles from their home to the D/P BART Station. When they return at the end of the day, they take the Civic back home for use on evenings and weekends. In addition, other authorized members in their household can drive the CarLink vehicle.

Workside Commuter: Individuals who commute to the Lab by taking BART to the D/P station have access to the vehicles for the last leg of the trip to the Lab. The CarLink Members in this group are asked to carpool to the lab with at least one other member during this portion of their commute. The fee for individuals in this group is shared equally by the individuals in each carpool. At the end of the workday, Workside Commuters drive the vehicles back to the D/P BART Station to continue their home-end commute on BART.

Day User: Other employees at the Lab, who qualify for membership in the CarLink Project, as well as those in the Workside Commuter group, share the use of these vehicles for personal or government trips during the day. They are charged only for personal use (i.e. $1.50/hr and 10 cents/mile).

Where are the CarLink vehicles be located?
At the D/P BART Station the vehicles are located in 12 reserved parking spaces near the Key Manager Kiosk on the south side of the BART Parking Lot. It is important for members to return the vehicles to these designated spaces at the end of their trip.

Five parking lots will be used at the Lab. The cars are distributed among these lots to provide convenient access to the greatest number of people.

How can a vehicle be reserved?
Homeside Users and Workside Commuters have a standing reservation to pick up and return a CarLink vehicle to the D/P BART Station at a fixed time during each workday. During the evenings and weekends, Homeside Users have access to the car at any time.

In contrast, a booking for Day Use at the Lab for Workside Commuters and Day Users is required for each separate trip. To insure the availability of a vehicle, it is advisable that these reservations be made as far ahead as possible.

The Day Use reservation system is detailed in Section 2.

How do I obtain the key to the vehicle?

Homeside Users and Workside Commuters: CarLink Members in these two groups will use a smart Key Manger system consisting of a steel, safe box located inside the exit/entry area of the D/P BART Station, close to the CarLink vehicle parking area. To access the vehicle key from this Key Manager, the user holds their smart card (A smart car and PIN number will be issued to all members of these two groups) close to the display of the Key Manager. The Key Manager then checks to confirm the standing reservation of the user and asks for his or her personal identification number (PIN). When the correct number is entered, the electronic door lock is released. After opening the door, a flashing light above a key socket indicates to the user which key should be taken.

Day User: A manual Key Box will be located inside buildings at the Lab adjacent to the three lots where the cars are parked. Each CarLink member is issued a key to these boxes, which provides access to the keys required to operate the car.

What are my responsibilities when I enter the vehicle?
Once the user in each of the three groups has an ignition key, he or she can open the car door. A red warning light inside the car reminds the user that the car is still being blocked. In order to "unblock" the vehicle, the small cylinder shaped key must be inserted into the smart reader on the dashboard. If the red light turns green, this step was completed successfully and the car is no longer being blocked.

Before beginning their trip, users are required to enter the following items of information in the trip diary log.

1. Date
2. User ID number
3. Time of day
4. Trip purpose
5. Odometer reading

What are my responsibilities when I leave the vehicle?
When returning the car, the user must complete the Trip Diary, including the purpose of the trip, number of miles traveled and time of day.

To return the vehicle key, Day Users simply return it to the Key Box inside the same building where they picked it up. Home Side and Workside Commuters must return the key to the Key Manager which can be opened with their assigned Smart card and PIN. The user is prompted to return the vehicle key and Relox Key (attached on a key chain) back into the vacant socket.

How much does it cost to use a CarLink Vehicle?
Table 1 indicates the fees to the users in each of the three Groups. It is important to note that these rates include full insurance, registration, cleaning, maintenance, and repair or fuel costs.

Table 1:

Group	**Monthly Fee**	**Usage Fee**
Homeside User	$200.00	None
Workside Commuter	$ 60.00 /vehicle	None
Day User	None	$1.50 /hour. $ .10 /mile

Homeside Users and Workside Commuters are only required to pay a monthly fee. In the latter group this fee is shared by those who carpool to and from the Lab in the CarLink vehicle. There are no usage fees to the members of both these groups for their commuting trips.

Day Users, including those in the Workside Commuter Group, who use the car during the day at the Lab, will incur a usage fee of $1.50/hr and $ .10/mile.

How much do Day Use trips cost? We have estimated in Table 2, below, the cost of three-day trips from the Lab and compared them to other forms of transport.

Table 2

Destination	Hours	Miles	CarLink	Personal Vehicle*	Taxi#
Stone Ridge Mall	2	24	$ 5.40	$ 10.80	$ 50.00
Livermore Tennis Club	2	12	4.20	5.40	26.00
COSTCO	2	14	4.40	6.30	30.00

* Based on AAA based operating and maintenance cost of 45 cents p/mile of new compact size car. The true cost of car ownership adds up when calculating the cost per mile of monthly payments (if car purchase is financed), insurance, registration, depreciation (the money being saved up for the next car purchase), as well as repairs, maintenance, and cleaning.

Round trip between Lab and destination

What are the membership requirements?
Each CarLink Member will be asked to complete a formal application to the program. It authorizes Honda to conduct a check of your DMV driving and credit record. Other licensed drivers who are household members of a Homeside User will be able to drive the CarLink vehicles, but they must also complete the formal application process. An applicant who has been cited for Driving Under the Influence (DUI) will be excluded from the Project.

What are my principal obligations as a member of the CarLink Project?

- The car must be returned to the designated lot.
- Enter your user ID number, trip purpose, and odometer reading at the beginning of each rental period.
- Return the car to the designated lot before or by the end of your rental period.
- Do not drive the vehicle more that 150 miles during a rental period.
- Return the keys to the designated key drop-off location at the end the rental period.
- Refuel the vehicle once the level reaches the 3/4 or below mark on the fuel gauge (Workside Commuters and Day Users only).
- Do not smoke inside the car.

What do I do in the event of unforeseen difficulties?
CarLink members must immediately telephone the toll free help and emergency/repair telephone number if the user is unable to return a car to the designated lot on or before the end of the rental period or if roadside assistance is required. The same is true if the user, because of illness, family emergency or change of plans, must cancel a Day Use or standing reservation. If the car becomes inoperable during a rental period for reasons not attributable to user misuse, Honda will provide an alternative means to transportation, such as taxi, another car, or rental.

APPENDIX II

CARLINK QUESTIONNAIRE

CarLink Questionnaire

Thank you for your continued enthusiasm and participation in the CarLink Smart Carsharing Program. As you know, a key aspect of the project is our research on carsharing usage and the viability of the CarLink system. Your feedback will allow us to understand how the service is used, identify its strengths and weaknesses, and prioritize improvements for future carsharing programs. In this research phase, we focus on your CarLink experiences. We greatly appreciate your time in completing this questionnaire and thank you in advance for your help.

For the purposes of this questionnaire, please identify yourself with the user group that best describes your CarLink usage and mark the appropriate box below:

- **Homeside Users:** CarLink participants that use the CarLink vehicle at home in the evenings and on weekends and use CarLink to travel between home and BART during their weekday commute.

- **Workside Commuters:** Individuals that use the CarLink vehicle to travel between BART and Lawrence Livermore National Laboratory (LLNL) during their weekday commute. Workside Commuters also have access to CarLink vehicles during the day at LLNL, what we call "Day Use".

- **Day Users:** Participants who only have access to CarLink vehicles during the day at LLNL (i.e., Day Use) for personal or business related trips. Day Users do not employ CarLink vehicles in conjunction with their commute.

Terms:

LLNL: Lawrence Livermore National Laboratory
CNG: Compressed natural gas

STRENGTHS AND WEAKNESSES

Please help us to identify the strengths and weaknesses of the program, allowing us to improve future carsharing services.

1. Please rate the following aspects of CarLink based on your level of comfort using each part indicated.

	Very uncomfortable	Uncomfortable	Moderately comfortable	Comfortable	Very comfortable
a. Car key checkout:					
i. At BART	1	2	3	4	5
ii. At LLNL (see first page)	1	2	3	4	5
b. CNG refueling (see first page)	1	2	3	4	5
c. Use of reservation system for day use at LLNL (see first page)	1	2	3	4	5
d. Other	1	2	3	4	5
please specify: _____					
e. Recording vehicle use: i. Manual trip diaries	1	2	3	4	5

If you have not used the Teletrac system, please proceed to question 2 on the next page

ii. Teletrac messaging system	1	2	3	4	5

Error!

Error! Unknown switch argument.

2. Please rate the following aspects of the CarLink program.
   (Please indicate your response with an χ on the scale below.)

   (For example: "Color of the CarLink vehicle.")

   |----------
   |
   Poor Good

a. Lots <u>are</u>/<u>are not</u> placed where I need them.

   |----------|
   Not where I need them Where I need them

b. I <u>do</u>/<u>do not</u> have to wait for a vehicle.

   |----------|
   Have to wait No wait

c. CarLink costs are <u>expensive</u>/<u>inexpensive</u>.

   |----------|
   Expensive Inexpensive

d. My commute time is <u>longer</u>/<u>shorter.</u>

   |----------|
   Longer Shorter

e. Stress during my commute is <u>higher</u>/<u>lower.</u>

|----------|
Higher Lower

f. Reserved CarLink parking spaces are/are not beneficial.

|----------|
Not beneficial Beneficial

g. Car keys are/are not quick and easy to access.

|----------|
Not easy to access Easy to access

h. Car entry and ignition are/are not simple.

|----------|
Not simple Simple

i. My ability to take spontaneous trips is/is not limited by CarLink.

|----------|
Limited Not limited

j. CarLink parking lot(s) are/are not in convenient locations.

|----------|
Lots are not located conveniently Lots are located conveniently

k. My ability to respond to an emergency is higher/lower with Carlink.

|----------|
Lower Higher

l. Having commute time available for personal use, such as working, reading or napping, is important/not important to me.

|----------|

Not important Important

m. The environmental impact of CarLink is negative/positive.

|----------|

Large negative impact Large positive impact

n. Other:

|----------|

_____ _____

please specify: _____

COMMUTING AND CARPOOLING

1. How many days per week do you commute with the CarLink system? _____ days per week

2. ***<u>On days you do NOT use CarLink:</u>*** Please indicate the percent of **commute** time you spend traveling by the following transportation options (**Please provide percentages for all options you use; totals must add up to 100%.)**

   a. Drive alone _____%
   b. Carpool _____%
   c. Bus _____%
   d. Bike _____%
   e. Walk _____%
   f. BART _____%
   g. Other _____%
   please specify:_____

3. ***<u>When you DO use CarLink:</u>*** How do you typically travel to BART during your morning commute? (**Please provide percentages for all options you use; totals must add up to 100%.)**

   a. Drive alone _____%
   b. Carpool _____%
   c. Bus _____%
   d. Bike _____%
   e. Walk _____%
   f. BART _____%
   g. Other _____%
   please specify:_____

4. What is the approximate **length** of your morning commute to BART(in miles)?
   _____ miles

5. During your morning commute, at which station do you board BART ?
   _____ BART station

6. How many days per week do you have an additional occupant (i.e., carpool) for the CarLink portion of your commute (between Dublin/Pleasanton BART and LLNL)?
   _____ days per week

7. If there are days you do ***NOT*** carpool in a CarLink car, how often do the following reasons apply? (Please check the best response for each item.)

	Never	Infrequently	Sometimes	Often	Always
a. Carpool partner(s) doesn't show up	1	2	3	4	5
b. Partner tells me they won't be there	1	2	3	4	5
c. High availability of cars that day	1	2	3	4	5
d. I like driving alone	1	2	3	4	5
e. I work early and/or stay late	1	2	3	4	5
f. It's hard to schedule with my carpool partner	1	2	3	4	5
g. I do not have an assigned partner	1	2	3	4	5

h. Other

please specify: _____

VEHICLES AND TRIPS

1a. How much has your household vehicle use changed since participating in CarLink?
(Please indicate your response with an χ on the scale below.)

Level of use: 100% 0% 100%
|----------|----------|----------|
Decrease No Change Increase

1b. If your household vehicle use has changed, please briefly describe how and why it has changed:

_____

_____

_____

_____

2. How many times do you refuel the CarLink vehicle per week? ____ times per week

3. How much has your personal or recreational travel on public transit changed since you began participating in CarLink?
(Please indicate your response with an χ on the scale below.)

Level of use: 100% 0% 100%
|----------|----------|----------|
Decrease No Change Increase

4. For each of the following, please indicate how much your travel has changed since you began participating in CarLink.

   (Please indicate your response with an χ on the scale below.)

(Level of use: -100% 0% +100%)

|----------|----------|

Decrease No Change Increase

a. Drive alone -100% 0% +100%

|----------|----------|

Decrease No Change Increase

b. Carpool -100% 0% +100%

|----------|----------|

Decrease No Change Increase

c. Bus -100% 0% +100%

|----------|----------|

Decrease No Change Increase

d. Bike -100% 0% +100%

|----------|----------|

Decrease No Change Increase

e. Walk -100% 0% +100%

|----------|----------|

Decrease No Change Increase

f. Other: -100% 0% +100%

|----------|----------|

Decrease No Change Increase

please specify: _____

5. Considering that fuel, insurance, and repair and maintenance costs are included in your total CarLink payment, how do CarLink travel costs compare to the total costs of personal vehicle ownership?

(Indicate your response with an χ on the scale below.)

|----------|

CarLink costs significantly more — CarLink costs significantly less

6. How satisfied are you with CarLink vehicle variety? (Please check one response below.)

Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
1		3	4	5

7a. CarLink is a research demonstration project. As such, many operating costs of the system are subsidized by the project partners (e.g., LLNL, CalTrans, Honda, etc.). Assuming the CarLink service did not change, how much would you be willing to pay to participate in CarLink in a non-research setting?

$_____ per month

7b. Please briefly describe how you calculated your response for question 7a above.

_____

_____

_____

_____

HELP US DESIGN A BETTER CARLINK SERVICE FOR THE FUTURE

Do you have any comments or suggestions for improving CarLink?

_____

_____

_____

_____

_____

_____

_____

_____

Thank you!

APPENDIX III

HOUSEHOLD INTERVIEW PROTOCOL

Household Interview Protocol

Each of the household interviews began with a short round of introductions and an explanation of the design. Following this, the researchers would begin a discussion of how the members heard about the project, how it was first introduced to them, and how the recruitment and explanation processes can be improved. Then, using timelines of a typical day of their pre-CarLink travel (created from their trip diaries by the CarLink staff), we discussed what their travel had been like. The timeline was then used as an interactive tool to explore what their typical travel with CarLink was.

Following the timeline of a typical day, each successive aspect of the CarLink system was discussed. For example, a Workside commuter would be asked questions about his or her travel to their local BART station, then about their travel on BART, then about the Key Manager, etc. After and during these questions, various different problems that they might face were presented and discussed. Scenarios involving the present as well as potential carsharing programs were outlined and discussed. These topics included exploring what CarLink would have to become before the interviewees sold a personal vehicle and what costs they would be willing to pay. Finally, the participants were prompted to ask any remaining questions they had.

The question checklist given the interviewers is on the next page. This checklist was intended for use as an overall guide and not an exact script. The tone of the interviews was conversational and often tangents would prove more illustratory than planned topics.

Question/Issue Checklist

For all issues: How has this changed over the course of the program? How has this been different from what you thought it would be?

Introduction

- ❑ What first interested you? How can we improve recruitment, orientation?
- ❑ How easy is the system to understand?

Timelines

- ❑ Let's go over your schedule before and with CarLink
- ❑ How many days a week do you use CarLink?
- ❑ Key Manager (How do you like it and how well does it work?)
- ❑ Parking at BART
- ❑ Carpool
- ❑ Problems with vehicle?
- ❑ Dirty, cluttered vehicles?
- ❑ Teletrac/manual trip diaries (privacy concerns?)
- ❑ Refueling
- ❑ Reservation system
- ❑ Wait time for appropriate vehicle (i.e., one with adequate fuel)
- ❑ How much interaction do you have with the other members?
- ❑ Getting car back in time for next user
- ❑ How do you like the lot placements? Would different ones work?

Gaming

- ❑ Range of trips
- ❑ Emergencies
- ❑ Getting rid of current vehicles
- ❑ Different infrastructures: How about if there was a lot near your house?
- ❑ How much of your activity is BART accessible?
- ❑ How much would be BART/CarLink accessible if there was CarLink at the appropriate BART station?

Afterwards

- ❑ Costs-compared to without CarLink, how would you like to pay, etc.
- ❑ Costs vs. time vs. convenience vs. environment
- ❑ Would you like cell phones, mapping devices, etc.?
- ❑ Do you walk/bike/BART/bus more or less often?
- ❑ How spontaneous can you be with CarLink? Are you spontaneous enough?
- ❑ How do you feel about sharing vehicles?
- ❑ What is different than you thought it would be?

APPENDIX IV

FOCUS GROUP PROTOCOL

Focus Group Protocol

Wednesday 11/17/99

Focus Group (n=12)
All trained (July '99)
Day Users: 4 consistent CarLink users
6 attempted CarLink
2 never tried CarLink

Introduction
(5 min.)

I. (20 min.)

(10 min.) •**What do you like about your current commute mode?**
(BART, auto, carpool/vanpool, biking)

(10 min.) •**Why did you join Day Use?**

- Stress levels, commute length?
- Did your mode shift?

II. (20 min.)

•**Why didn't you join Day Use?**

- *Bigger Issues*
  - spontaneity & emergency (how
  - might be convinced or shown this?)
  - (linked to CNG)
- *Smaller Issues*
  - lots
  - scheduling
  - Day Use behavior

{15 minute break}

III. (25 min.)

•**How to improve Day Use? (CarLink)**

- *Bigger Issues*
  - scheduling (reservations)
  - costs (3 packages)
  - invoice feedback
- *Smaller Issues*
  - lots
  - bikes? (did they help?)
  - multiple vs. few lots?
  - lot aesthetics/signage

IV. (35 min.)

- **Design a new Day Use program**
  - *Bigger Issue*
    - technology
    - willingness to pay
    - marketing (what are most relevant & telling features)
    - cell phones
    - Internet access
    - Concierge"
  - *Smaller Issues*
    - non alternative fuel vehicles?
    - restricting use?
    - environmental motivation

APPENDIX V

MAPS OF THE FIELD TEST REGION

Home Locations of Day Users of Dublin/Pleasanton BART Station Cars

LEGEND

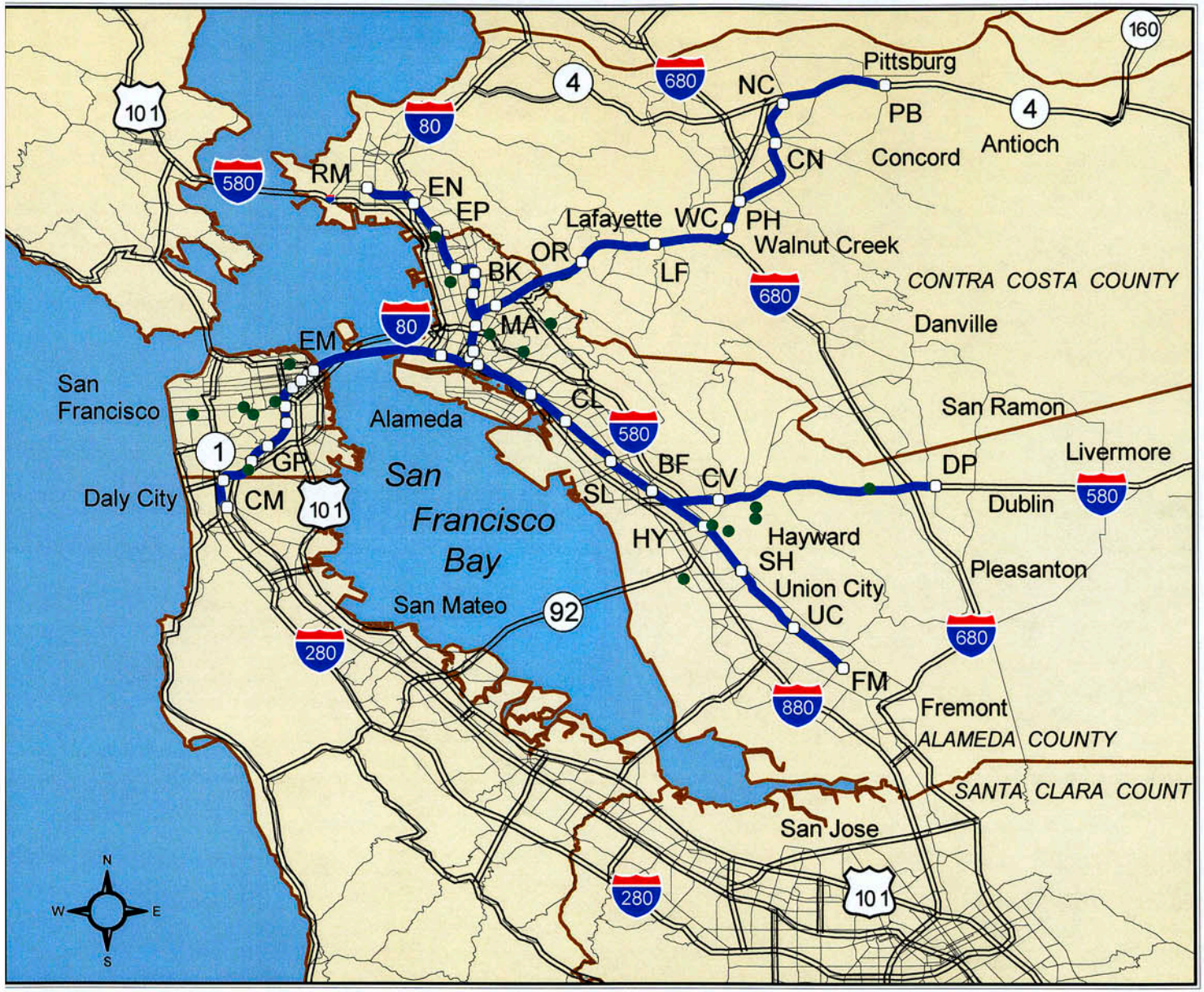
- BART Stations
- BART Line
- Origin Points
- County Line
- Highways
- Arterial Roads

Prepared:
December 6, 1999

0 4 8 12 16 Miles

BART Customer and Performance Research

Home Locations of Dublin/Pleasanton BART Workside Station Car Users



LEGEND

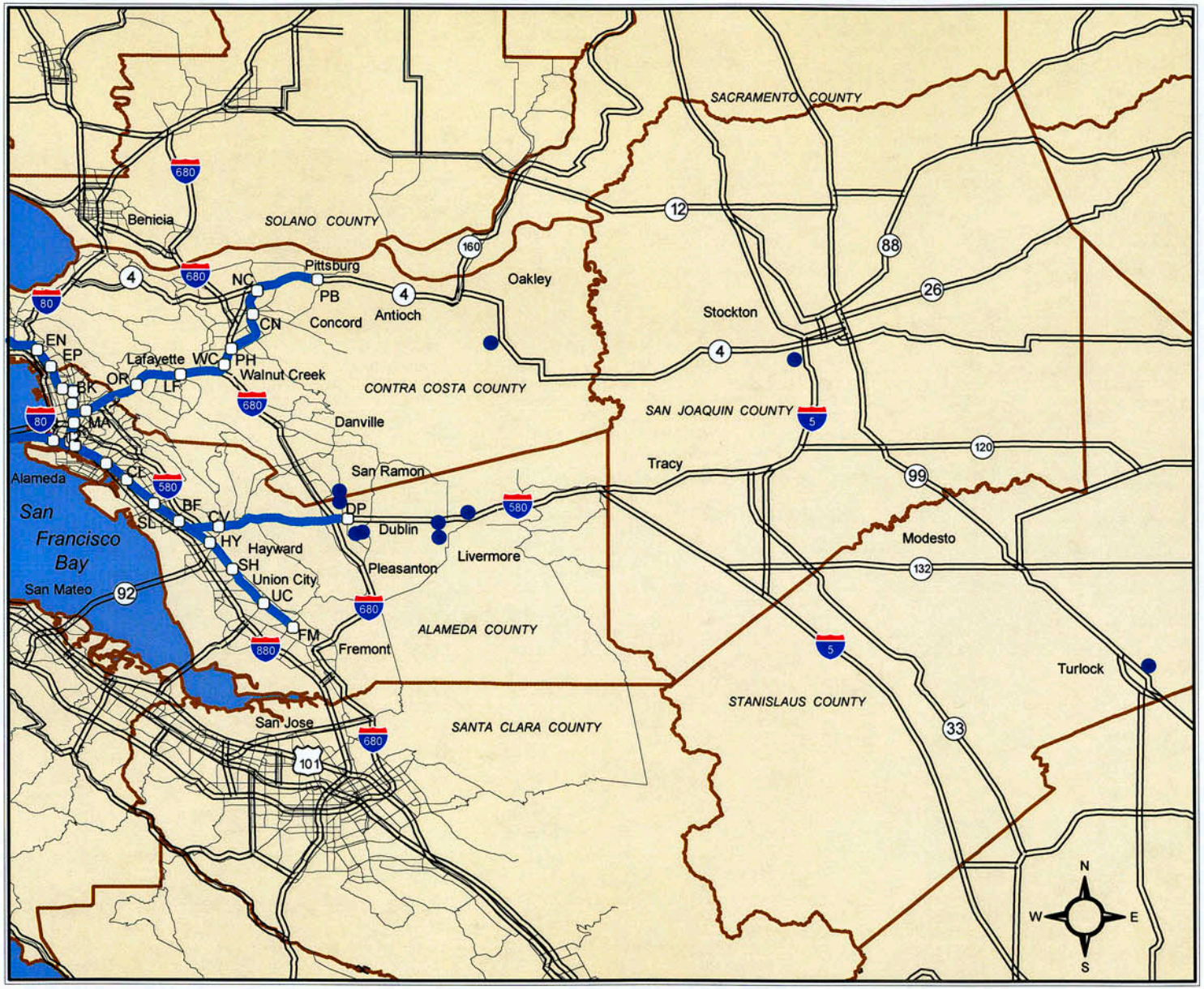
- BART Stations
- BART Line
- Origin Points
- County Line
- Highways
- Arterial Roads

Prepared:
November 16, 1999

0 3 6 9 12 Miles

BART Customer and Performance Research

Home Locations of Homeside Users of Dublin/Pleasanton BART Station Cars



LEGEND

- BART Stations
- BART Line
- Origin Points
- County Line
- Highways
- Arterial Roads

Prepared:
November 16, 1999

0 4 8 12 16 Miles

BART Customer and Performance Research

APPENDIX VI

ATTITUDINAL SCALE QUESTIONS

These scales were created by developing a list of attitudinal questions that were later combined into a single measure for each scale. All scales were based on participants' responses to questions on a five-point Likert-type scale, ranging from "Strongly Agree" to "Strongly Disagree." For a full discussion, please see *Dynamics in Behavioral Adaptation to a Transportation Innovation: A Case Study of CarLink—A Smart Carsharing System* (Shaheen, 1999).

The ***mode satisfaction score*** is comprised of responses to the following question: "My current ways of getting around…":

- Get me to work on time;
- Allow me to store important items (e.g., clothes, shopping bags);
- Fit my budget;
- Allow me to be spontaneous;
- Help me go everywhere;
- Allow me to visit friends when I want;
- Give me a sense of freedom;
- Help me to do my shopping;
- Make me feel safe;
- Give me a sense of independence;
- Say a lot about who I am;
- Are great for my lifestyle needs;
- Allow me to quickly respond to an emergency; and
- Are comfortable.

The ***vehicle hassle score*** is comprised of the following responses:

- Finding a parking space is a real hassle;
- I use transit when it goes where I want it to go;
- Car maintenance is a hassle;
- A smog check is a real hassle; and
- The costs of owning a car are higher than the benefits.

The ***congestion score*** consists of responses to the following:

- Congestion on the road is something one has to live with;
- Traffic growth is a serious problem; and
- The roadways are congested due to too many vehicles on the road.

The ***vehicle enjoyment score*** is comprised of the following responses:

- I like driving alone;
- I have to admit the type of car I own says a lot about who I am;
- I prefer to drive my personal vehicle to places I need to go;

- To me, a car is nothing more than a convenient way to get around (Likert-type score reversed);
- If possible, I would like to change from driving to work to some other transportation mode (Likert score reversed);
- Automobiles mean personal freedom; and
- I wouldn't give up my own vehicle(s) even if there is a feasible alternative.

The ***environmental score*** is comprised of the following responses:

- I am willing to reduce my auto use to improve transportation and air quality;
- I am willing to drive an electric or other clean-fuel vehicle to improve air quality;
- We can find cost-effective technological solutions to the problem of air pollution;
- Environmental problems are the biggest crisis and challenge of our times;
- It is time to change the way we live in order to solve environmental problems;
- Traffic fumes are a major contributor to global warming, smog, and other environmental problems; and
- I'd be willing to ride a bike or take transit to work in order to reduce air pollution.

The ***experimenter score*** consists of responses to the following:

- I like to experiment with new ways of doing things;
- If friends and neighbors reduced their driving, I would follow their example;
- I would like a job that doesn't require that I keep learning new skills; and
- I always follow a manufacturer's warnings regarding how to use a product.

REFERENCES

Shaheen, S.A. (1999). *Dynamics in Behavioral Adaptation in Response to a Transportation Innovation: A Case Study of CarLink--A Smart Carsharing System*. Graduate Group in Ecology. Davis, University of California**:** 449.