Title

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APPLYING INTEGRATED ITS TECHNOLOGIES TO CARSHARING SYSTEM MANAGEMENT
A CARLINK CASE STUDY

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SUMMARY

Carsharing is the short-term use of a shared vehicle fleet by authorized members. Since 1998, U.S. carsharing services have experienced exponential growth. At present, there are 13 carsharing organizations. Over the past three years, electronic and wireless technologies have been developed that can facilitate carsharing system management in the U.S., improve customer services, and reduce program costs. This paper examines the U.S. carsharing market; the role of advanced technology in program management, including CarLink lessons learned; and technology benefits to this nascent market.

INTRODUCTION

In the U.S., the private auto accounts for over ninety-eight percent of urban passenger miles (1). This reflects a lack of competitive options to the personal vehicle, including limited transit access. To foster and enhance the range of available travel choices, more economically sustainable transportation options must be explored. Advanced technologies can play a key role in enabling the development and management of innovative mobility services, improving customer satisfaction, and reducing overall costs. This paper examines the role of technology in supporting one such alternative, carsharing.

Carsharing enables its users to reserve a vehicle for short time periods, during which the car can be driven to any destination. Typically, vehicles (including cars, minivans, and light-duty trucks) are picked up and returned to one of several designated lots throughout a community, including neighborhoods, transit stations, and employment sites. Users gain the benefits of a private car without the costs and responsibilities of ownership (2). Since the mid-1990s, interest in carsharing as an alternative mobility solution has grown significantly throughout Europe, North America, and Asia. Increasingly, U.S. carsharing organizations are integrating advanced technologies into their services to facilitate reservations and billing, vehicle tracking, and overall system management (3).

The use of advanced technologies also creates opportunities for new carsharing applications, such as one-way rentals (i.e., users can return a vehicle to a location different from the pick-up lot). At present, carsharing technologies require high initial investment for development and remain costly at low volumes. In the future, access to affordable technologies could become less challenging as a result of increased carsharing growth. If the market continues to expand, costs could be lowered due to scale and availability of preinstalled in-vehicle components to which customized carsharing telematics could be added.

From August 2001 to July 2002, a carsharing pilot program, emphasizing transit and employer access—CarLink II—was deployed in the San Francisco Bay Area. Pilot objectives included testing an advanced carsharing system, user response to this technology, and its role in facilitating system management and cost reduction. This paper examines the CarLink technology, user response, and lessons learned from this initiative. The authors first provide a background overview of the current U.S. carsharing market. Next, the CarLink model, technologies, and findings are presented. Finally, the relationship among system management, costs, and technology is discussed in the conclusion.

U.S. CARSHARING: MARKET DEVELOPMENTS

Since the first U.S. carsharing organization was established in 1998, the carsharing industry has experienced exponential membership growth. From 2001 to 2003, the authors periodically surveyed carsharing organizations on a range of topics, including business model, size, market segmentation, insurance, and technology to assess developments. As of July 2003, 13 U.S. carsharing organizations were operational. Another nine programs were planned. Collectively, existing organizations served approximately 25,000 members and deployed more than 600 vehicles. Between August 2002 to July 2003, membership in carsharing programs grew by 110 percent; the number of vehicles increased by 35 percent. The three largest carsharing organizations: Flexcar and Zipcar—both for-profit businesses—and City Carshare, a non-profit organization, accounted for 95 percent of U.S. membership and 91 percent of the total fleet. As such, these organizations had an extensive impact on overall growth.

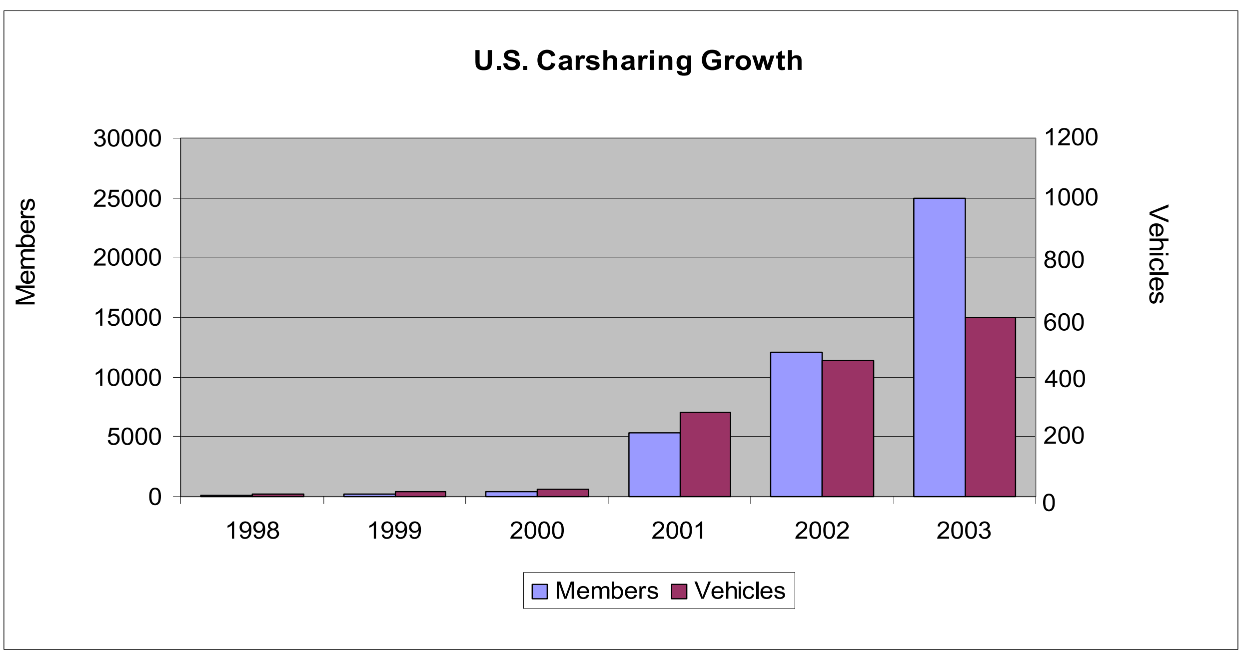

Figure 1: U.S. Carsharing Membership and Vehicle Fleet Growth

As a result of growth and regulatory incentives that award additional credits for placement of clean-fuel vehicles into carsharing programs (e.g., the California Zero Emission Vehicle Mandate, see (4) for more information), automakers and technology providers have expressed an increased interest in shared-use vehicle services. In the future, decreasing electronic and wireless technology costs could support increased market growth and the ongoing development of carsharing technologies, such as customized hardware and software systems.

During the author's latest survey of U.S. carsharing organizations (August 2002 to July 2003), several additional trends were identified. In addition to ongoing neighborhood carsharing expansion, there is an emerging trend towards the business carsharing market. At present, corporate carsharing services include: 1) the augmentation or substitution of company fleets with carsharing vehicles; and 2) fleet management services in which the carsharing organization administers an existing commercial fleet of vehicles owned or leased by a corporation.

Another trend represents a secondary market expansion (or business operation outside the core carsharing market) into what we call "carsharing support systems." At present, this includes two key areas: 1) licensing of carsharing technologies—software or hardware—to other shared-use vehicle service providers, government, or corporate fleets; and 2) contracting of back-office management support (e.g., reservations and billing) to other carsharing organizations.

Other market updates include funding, insurance, fixed program costs, and revenue generation. In the recent survey, smaller non-profit organizations identified decreased public funding opportunities as a primary obstacle to sustainability. High insurance costs continue to adversely affect market growth—posing an entry barrier to planned start-ups—across carsharing programs. While high premiums were recognized as a concern, the majority of organizations surveyed reported that securing an insurance carrier was not as significant a challenge in contrast to one year ago. A possible explanation for this is continued market growth (i.e., doubling in membership since August 2002), which might have led to increased familiarity with this innovative service among insurers. It is also interesting to note that difficulties in identifying affordable insurance can translate into a competitive advantage for organizations that obtain lower rates. High fixed costs due to vehicle leasing/purchase and program management, however, continue to mark an ongoing market barrier. Finally, difficulties in revenue generation were reported in a few cases, largely attributed to overall economic downturn. The next section includes a description of the CarLink model, technology, and lessons learned.

CARLINK II: BUSINESS MODEL, TECHNOLOGY, AND FINDINGS

Between 1998 and 2003, researchers deployed a three-phase carsharing research program in the San Francisco Bay Area, called CarLink, in conjunction with the California Department of Transportation (Caltrans), California's Partners for Advanced Transit and Highways (PATH), the Institute of Transportation Studies-Davis (ITS-Davis), Honda Motor Company, the Bay Area Rapid Transit (BART) District, Caltrain, and Lawrence Livermore National Laboratory (LLNL). During the first phase, researchers conducted a longitudinal survey that examined CarLink concept response (for more information, see (5)). During the second phase, researchers assessed CarLink I—a field test that examined user response and operations in a controlled setting. CarLink I was based at the Dublin/Pleasanton BART station and operated for ten months during 1999 (6). In the final phase, researchers evaluated the CarLink II pilot program, which ran from July 2001 through June 2002, and was based at the California Avenue Caltrain station in Palo Alto. The research goals of this pilot project included testing advanced carsharing technologies, overall user response, and system economics.

The most common shared-use vehicle model is known as neighborhood carsharing, where vehicles are deployed at many different locations in several neighborhoods for easy member access; these vehicles are accessed from and returned to the same lot. CarLink tested a commuter carsharing model that provides vehicle access at home and work, as well as a transit linkage on either commute end. The following discussion provides an overview of the CarLink model.

CARLINK MODEL: A BRIEF OVERVIEW

Both CarLink I and II were based on the same commuter carsharing structure, involving three sets of members: Homebased Users, Workbased Commuters, and Workbased Day Users. Both CarLink programs included a single, primary transit station that served as a vehicle transfer point for Workbased Commuters and Homebased Users who commuted via transit. CarLink provided a convenient transit linkage to and from home/work via a shared-use vehicle fleet. This same fleet was also shared by households and employers for tripmaking on evenings and weekends and throughout the workday.

Each morning, Homebased Users would drive their CarLink vehicles to a selected transit station, park the car in a designated CarLink space, and ride transit to work. Next, a Workbased Commuter would arrive at the same station via train in the morning; pick up a CarLink car; and drive it to work, parking in a designated CarLink space at their work location. Throughout the day, Workbased Day Users could reserve CarLink vehicles for business and personal errands, returning the cars to a designated work lot after each trip. At the end of the workday, Workbased Commuters drove the CarLink vehicles back to the transit station and would take the train for the remainder of their trip home. After returning Homebased Users—riding the train for the majority of their commute home—arrived at the transit station, they would pick up a CarLink vehicle and drive it home for personal use on evenings and weekends. See Figure 2, below, for a graphic representation of the CarLink model.

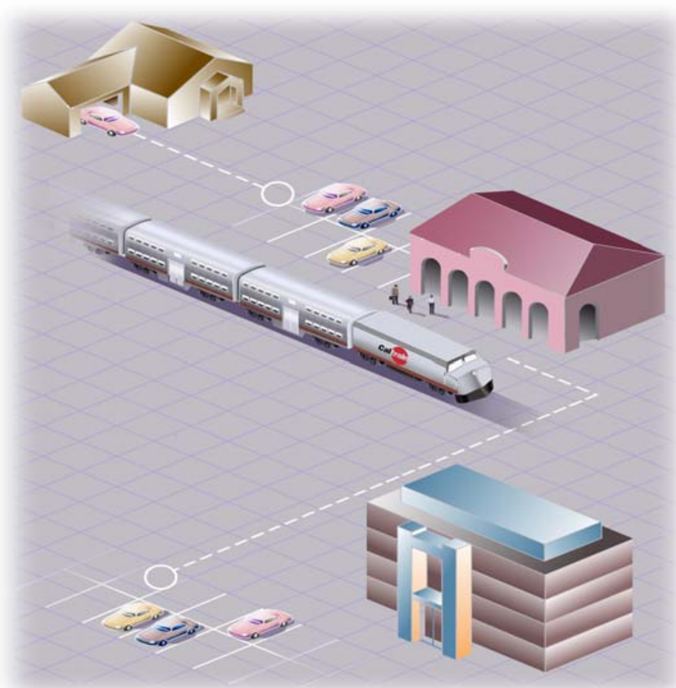

Figure 2: The CarLink Model (Consisting of Three User Groups: Homebased Users, Workbased Commuters, and Workbased Day Users)

As mentioned above, the CarLink II pilot program is based on the same general model as CarLink I. However, lessons gleaned from user feedback and recommendations from the CarLink I staff and project partners (i.e., Honda, Caltrans, BART District, and LLNL) suggested several changes to improve the model and research focus. Overall, it was decided that more could be learned by adapting the model to a new setting and attempting to create a permanent enterprise. This section describes the CarLink II project components and how they differ from CarLink I. Table 1, below, summarizes the major differences between CarLink I and II.

STUDY CHARACTERISTICS	CARLINK I	CARLINK II
Number of Vehicles	12 Vehicles	19 Vehicles
Primary Transit Partner	BART	Caltrain
Transit Station Location	Dublin/Pleasanton	Palo Alto
Vehicle Type	Compressed natural gas Honda Civics	Ultra-low emission Honda Civics
Homebased Users	Up to 10 households, pay $200 per month.	Up to 18 households, pay $300 per month.
Workbased Commuters	Up to 20 LLNL employees pay $60 per carpool ($30 each).	Up to 45 employees of businesses at Stanford Research Park (primarily), share CarLink vehicles to carpool to/from work. Businesses pay $350 per month per vehicle (a combined fee) for Workbased Commuter and Day Use services (in contrast to employees paying for this service independently as in CarLink I).
Workbased Day Users	Employees of LLNL pay $1.50 per hour and $.10 per mile.	Employees of Stanford Research Park companies and other nearby businesses have access to vehicles for business and personal use. Employers pay $350 per vehicle per month to subscribe to the combined Workbased Commuter and Day Use services.
Total Users	54	94
Employer	One: LLNL	Six: Several private companies at/nearby Stanford Research Park
Technology	In-vehicle tracking, smart key kiosk at transit station, smart cards, manual key boxes at LLNL, and on-line scheduling system at LLNL	In-vehicle tracking, automated data collection, smart key fob entry, PIN-based vehicle login, on-line reservations, and in-vehicle navigation system
Program Length	Field test designed for limited 10-month duration	Pilot program with planned transition to on-going carsharing service
Research Goals	Document demand for commuter carsharing service and gauge user satisfaction and needs	Continued analysis of commuter carsharing (in a new setting) with greater statistical confidence (i.e., a greater sample size) and new emphasis on technology testing, its impact on cost reduction, and longer-term program sustainability

Table 1: Differences Between CarLink I and II

CARLINK TECHNOLOGY

The CarLink I and II carsharing programs both employed advanced technologies that offered operations staff the ability to access and track vehicles. In CarLink I, however, the two main technologies employed were not integrated: 1) the Car-sharing Organization and Communication System (COCOS) vehicle reservation and access technology, and 2) the radio-frequency based vehicle tracking system, Teletrac. Several CarLink I technology shortcomings contributed to delays and necessitated program modifications (e.g., some Teletrac functions could not be performed as originally envisioned, such as user data transmission). Recommendations included that technology should be integrated (e.g., tracking, reservations, and billing), customized to facilitate vehicle access, and designed to serve multiple lot designs. Furthermore, the Day Use reservation system was not integrated with the vehicle tracking system. As a result, vehicle availability could not be guaranteed.

For CarLink II, Honda R&D, Americas developed an integrated carsharing system that included: 1) vehicle access (smart key fobs); 2) a reservation system (internet-based web site); and 3) vehicle use and tracking (car location, vehicle miles traveled, fuel levels, user ID number, and time). CarLink II also included a navigational system to direct users to a destination.

Members accessed vehicles using an electronic key fob, which was held above the key reader or transponder mounted in the back windshield of a CarLink vehicle, to release the door lock. Homebased Users and Workbased Commuters each had their own key fob. Workbased Day Users, at selected employment sites, obtained a key fob at the front desk of their office, prior to and after vehicle use.

The CarLink reservation system was web-based and accessible by a personal computer. CarLink II operations staff was able to monitor the reservation system remotely. The system allowed for reservations to be made in advance (e.g., one month) or at the last minute. The system was designed with a cushion of 15 minutes between reservations.

The vehicle tracking system employed a combination of cellular and Global Positioning System (GPS) technologies. Vehicle tracking enabled CarLink II staff to monitor car location and availability, time of use, user ID, VMT, and fuel levels. Cars were tracked consistently throughout the pilot program. In addition, CarLink II operations staff could remotely monitor real-time vehicle data. Table 2, below, offers a comparison between the CarLink I and II technologies.

TECHNOLOGY FEATURES	**CARLINK I**	**CARLINK II**
Vehicle Access and Ignition	• Smart key box at train station • In-vehicle immobilizer that required an initialized key to start car • Manual lock boxes at employment location	• Smart key fob for instant vehicle access • In-vehicle immobilizer that required a personal identification number (PIN) code to start vehicle
Vehicle Tracking	• Teletrac system using Radio Frequency (RF) technology	• Cellular and GPS technology • Ability to locate vehicle and transmit vehicle usage data, including user ID
Data Collection	• RF technology, which did not function reliably in terms of data transmission • Manual trip diary collection was implemented	• User ID • Time in and out of vehicle • VMT • Trip purpose • Fuel level
Reservation System & Billing	• On-line reservation system available only for LLNL employees • Phone call necessary to make reservation changes • Limited reservation system access by CarLink I staff • Billing conducted manually	• Real-time and advanced reservations • Online access from any location • Fully accessible to CarLink II staff • Automated billing
In-Vehicle Navigation	• Not included	• GPS-based navigation system

Table 2: Comparison of CarLink I and II Technology

The next section provides an overview of technology lessons learned from the CarLink II pilot.

CARLINK II: TECHNOLOGY LESSONS LEARNED

One of the many benefits of demonstration/pilot programs is the opportunity to test new technologies in a "controlled" environment. Since participants know that they are engaging in a study, they are often open to collaborating with researchers and program operators in understanding and modifying technology/service features prior to widespread deployment. For instance, the CarLink II reservation system underwent several revisions. Throughout the CarLink II technology testing, program participants identified practical technology issues, and operations staff worked with technology developers to address them, if at all possible during the pilot phase.

Because the technology was straightforward to operate, the operations staff incorporated training into the initial CarLink II orientation sessions. This proved to be sufficient for most members. A membership manual provided additional details on the reservation system. Not surprisingly, employees from various member companies reacted differently to the technology. More technologically advanced member companies (e.g., software and biotech) were more comfortable with the CarLink II technology and asked more questions, often offering recommendations for improvement. Employees from other member companies (e.g., a foundation) required more upfront training and were more likely to ask for assistance immediately after a problem occurred, rather than attempting to solve the difficulty themselves. The following sections provide feedback from interim user interviews (six months into the CarLink II program) and final program focus groups and interviews at the end of the 12-month pilot.

CarLink II User Feedback: Interim Interviews

After the first six months of the program, PATH researchers conducted 25 personal interviews with CarLink II participants. Interviewees included Homebased Users, Workbased Commuters, and Workbased Day Users from four participating employment sites (two additional companies joined during the second half of the pilot program). During the interviews, researchers addressed the following CarLink II components: in-vehicle navigation system, vehicle access, and reservation system. Findings are presented in Figure 3, below. User satisfaction is measured employing a five-point Likert scale (ranging from very satisfied to very dissatisfied).

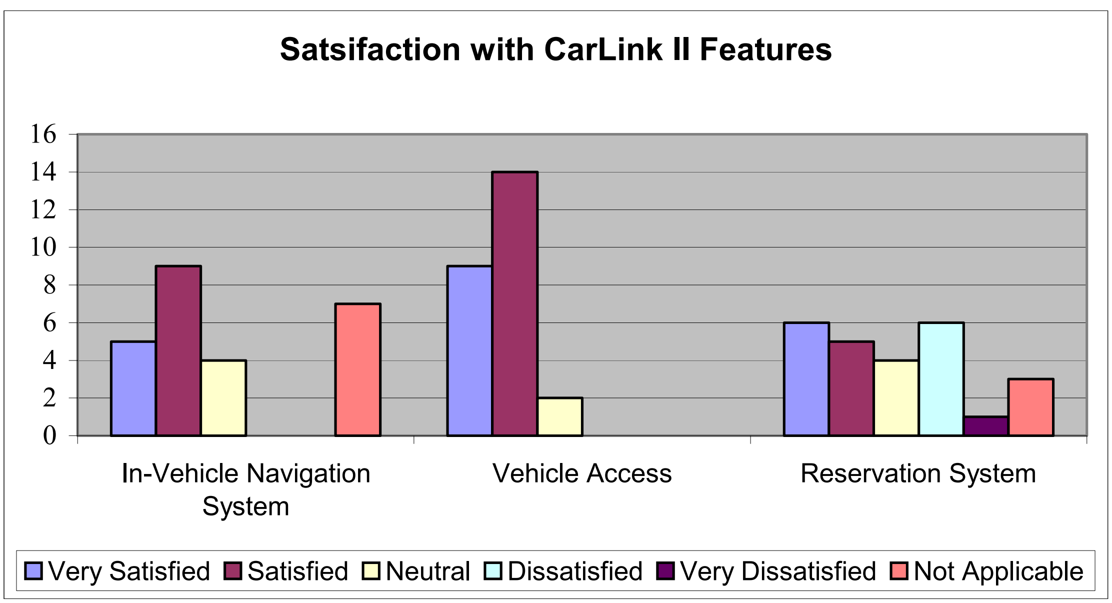

Figure 3: User Satisfaction with CarLink II Features

A discussion of each CarLink II technology component, featured in Figure 3, follows.

In-Vehicle Navigation: The interviewees found the in-vehicle navigation system satisfying, although many members had never used it. Of those that had, only two used it regularly (one Workbased Commuter and one Homebased User), while the rest only "tried it out" a few times. Since the majority of user trips were on known routes, limited use could be expected.

Vehicle Access: Vehicle access is defined as unlocking the car with a key fob and logging into the computerized system with a PIN, which released the ignition immobilizer and attributed the current trip activity to the user's ID number. Fifty-six percent of respondents were satisfied, and 36 percent were very satisfied with the vehicle access system. Two respondents said that the fobs were occasionally difficult to use, and one found the PIN-input keypad difficult to operate. A few interviewees indicated that they at first had difficulties with the keypad screen, but adjusted to its use by the time of the interviews.

Reservation System: The reservation system allowed Workbased Users to reserve vehicles in advance for Day Use trips. Generally, one of the CarLink II vehicles could not be reserved in advance to provide an overall system buffer. The reservation and access systems did not provide a "lockout" component (i.e., preventing one member from taking a vehicle reserved by another), so members were entirely on an "honor system."

As shown in Figure 3, reaction to the CarLink II reservation system was mixed, with 28 percent of respondents claiming to be dissatisfied or very dissatisfied, while 44 percent said they were satisfied or very satisfied. Dissatisfied members started using the reservation system less often, but most believed that the problems were being resolved and planned to start using it again. The primary reason for reservation system dissatisfaction was the lack of a lockout system—guaranteeing that a reserved vehicle would be waiting for the person who requested it. Vehicle lockout was identified as an area for next generation technology development, as it was not addressed during the CarLink II pilot program due to costs and time requirements. Table 3, below, shows how often a reserved vehicle was not available at specified times among those interviewed after they joined the program (essentially during the first six months of the CarLink II pilot).

FREQUENCY	NUMBER
Never	9
Once	4
Twice	4
Three to Five	1
More than Five	2

Table 3: Number of Times Reserved Vehicle Not Available

While "missing" reserved vehicles was a frequent complaint at one company, most interviewees felt the majority of blame belonged to fellow users (rather than the CarLink II technology). Indeed, some users simply ignored the reservation system. At the time of the interviews (early 2002), most participants felt that CarLink II staff were bringing about changes that would effectively solve this problem (e.g., requiring Workbased Commuters as well as Day Users to "sign-out" vehicles at the front desk). Other reservation system complaints involved the overall reservation process and web site formatting, including:

- Scrolling on the web page was difficult;
- There were too many steps involved in making a reservation;
- All cars should be available to reserve in advance (i.e., not keeping one of the company's CarLink II fleet vehicles in reserve);
- The reservation page's clock was not always accurate; and
- There was no way to inform the reservation system directly (e.g., automated phone interface) that a Day Use trip was running longer than expected—verses asking CarLink II staff to check the reservation's page and notify the next scheduled user.

Despite reservation difficulties, many participants who were vocal about reservation concerns, seldom if ever, actually experienced a problem. However, the perception that a reserved vehicle might not be available became so dominant that many saw this as the most critical CarLink II concern. The next section reflects member feedback from the final focus groups and interviews, conducted at the close of the 12-month program.

CarLink II User Feedback: Final Focus Groups & Interviews

This section provides technology highlights from the two final CarLink II focus groups and an interview session conducted by PATH researchers in May 2002. A total of 22 individuals participated in the focus groups (n=18) and interviews (n=4), including 12 women and 10 men. The sessions generally began with a discussion of participant's transportation methods prior to and during CarLink II enrollment, including likes and dislikes of these modes. The discussion then focused on CarLink II experiences and perceived program strengths and weaknesses. All groups provided suggestions on how to improve the recruitment process among other recommendations. Overall, the focus group participants had a very positive reaction to CarLink II. This section focuses on CarLink II technology feedback exclusively.

Primarily at one CarLink II member company, many users had difficulties with the on-line reservation system. In at least one case, this led to a member dropping out of the program. Some problems were relatively minor, such as difficulty scrolling through the web page. Others were more significant, including inaccurate scheduling clocks. More serious problems occurred when: 1) a member reserved a vehicle, but found that it had already been taken by another user; or 2) individuals reserved a vehicle, but they did not actually use it (preventing other members from taking it). In the latter case, members were unable to use a "reserved" vehicle even though the car was still in the lot (i.e., the reservation page did not automatically "open up" a reservation when a scheduled vehicle was unused). Another problem arose when a vehicle was reserved but was not returned on time. Possible solutions offered by the group included: 1) a lockout system for at least the first ten minutes of a timed reservation, and 2) user fines for individuals who took a vehicle, which has been reserved by someone else.

Focus group and interview participants also noted other CarLink II problems. Nearly everyone reported that the key entry fobs should unlock the vehicles more rapidly (i.e., users were required to hold their key fob over the vehicle reader for several seconds verses just a few), and many noted occasional problems logging (or entering their PIN) into the message display terminal keypad. Some also said that they would like to access vehicles at different worksites and transit stations. In general, the most serious complaints were vocalized by individuals who had been stranded—either because a vehicle was unavailable or the CarLink II technology had malfunctioned (and refused access). To counter such difficulties, the CarLink II program included a guaranteed ride (either taxi or rental car) and 24-hour, 1-800 roadside assistance. Overall, the majority of complaints focused on convenience and ease of system use.

Summary

Throughout the CarLink II pilot program, technology refinements and feature values were amassed. Benefits were attributed to:

- Enhanced user convenience via online reservations and smart key fob access;
- Streamlined operations and cost savings resulting from automated reservations and billing;
- Vehicle tracking and automated data collection features (e.g., user ID, time of use, VMT, and fuel level) provided valuable logistics understanding and labor savings; and
- Additional cost savings were received from insurance discounts resulting from CarLink II's tracking and ignition immobilization features.

Nevertheless, technology components could be improved, including:

- A "lockout" feature for reserved vehicles should be developed;
- The key fob door-release speed should be increased;
- The PIN entry screen process should be improved;

- The vehicle immobilizer should be integrated with the engine control unit to make this feature much more secure;
- The online reservation page should be modified to improve scrolling and reflect the correct time;
- The number of steps involved in making an online reservation should be reduced;
- All CarLink II company fleet vehicles should be available for use (i.e., none should be kept in reserve, which might be addressed by the vehicle lockout feature);
- A means to directly inform the reservation system that a trip is going over time should be developed (e.g., automated phone interface); and
- Reserved cars that are unused should be converted to "available for use" automatically on the reservation page after a 10- to 15- minute waiting period. (Furthermore, users should be fined, if they do not cancel a reservation in advance.)

CONCLUSION

Advanced technologies can contribute significantly to enhancing the economic sustainability of innovative transportation alternatives and to increasing choice among available travel modes. Carsharing is one such alternative mobility option. The rapid growth of carsharing membership and fleet size, and the expansion/diversification of services aimed at new customer groups (e.g., business customers) indicate an unmet demand for shared-use vehicle services. Thus, advanced technologies can play an important role in supporting this emerging market, streamlining carsharing operations, increasing customer satisfaction, and enhancing economic viability.

Electronic and wireless technologies can provide automated vehicle usage data, consolidate reservations and billing, and allow real-time vehicle monitoring (e.g., location, fuel level, on-board diagnostics, etc.). Customer satisfaction can be increased through convenient reservations and seamless vehicle access. Primary economic benefits of advanced technologies are reduced management costs, insurance discounts, and expanded market growth (presumably due to increased convenience and customer satisfaction).

The CarLink II pilot program enabled testing of an integrated carsharing system, as well as the evaluation of advanced technology impacts on program logistics and costs. In general, online reservations proved to be efficient from both an operator's and customer's perspective. Key fobs and instant vehicle access (in contrast to a standalone lock box containing vehicle keys) were perceived as convenient. The vehicle immobilization feature (released via entry of a valid user PIN number) represents a cost-efficient means to maximize vehicle security and reduce insurance costs. Vehicle tracking provided valuable system performance data, reduced labor costs due to automated billing, and insurance discounts. Future technology development efforts should include lock-out mechanisms, which restrict user access to reserved vehicles. Based on the CarLink II pilot experience, the lock-out feature appears to be crucial to customer satisfaction and overall system efficiency. Similarly, a web-based vehicle reservation system should be designed to facilitate highly user-friendly reservations and vehicle scheduling changes (e.g., via phone from the road when a scheduled trip goes over time).

To provide comprehensive system data, CarLink II employed advanced, integrated technologies throughout. However, it is advisable for a shared-use vehicle start-up to initially use less advanced, off-the-shelf technologies. Due to the high initial fixed costs of implementing advanced technologies, periodic upgrades should be incorporated based on revenue generation once high initial start-up costs are recuperated. Vehicle tracking services can vary widely in price depending on the degree of tracking activity requested. Basic technologies that facilitate vehicle tracking and capture essential vehicle usage data are available for only a few hundred dollars per vehicle and are easy to install. Economies-of-scale arise when system components serve a larger fleet (e.g., 100 vehicles or more). Hence, advanced technologies are especially profitable for sizable fleets (e.g., when manual administration can be automated and streamlined).

Increased U.S. carsharing growth, as well as regulatory incentives (e.g., the California ZEV mandate), appear to be attracting automakers and technology providers to build closer ties with carsharing organizations. In turn, the shared-use vehicle industry will benefit from more advanced and affordable carsharing technologies. Increasingly, vehicles will be equipped with factory preinstalled and upgradeable technology components, creating a cost-effective interface for a variety of customized carsharing software and hardware systems. Not surprisingly, carsharing hardware/software installation times will decrease and overall quality control will increase with the emergence of factory preinstalled in-vehicle telematics. More widespread availability of vehicle telematics could also lead to greater interoperability among carsharing technologies/providers and between carsharing and public transportation operators. Finally, seamless, intermodal transit linkages could also result in increased carsharing customer satisfaction and market growth, as well as additional business opportunities (e.g., real-time traveler information services).

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The contents of this paper reflect the views of the authors and do not necessarily indicate acceptance by the sponsors.

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