2. A Short History of Carsharing in the 90's

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Editor's note: This is one of several recent useful overviews of international carsharing experience over the last decade. We have chosen to open the report with this particular summary since it provides a competent introduction to the more detailed materials that follow. For more extensive treatment and analysis from other, at times somewhat broader perspectives, the reader is referred to the careful Harms and Truffer 1998 report: "The Emergence of a Nationwide Carsharing Co-operative in Switzerland: A Case Study for the Project -- Strategic Niche Management as a Tool for Transition to a Sustainable Transportation System. (EAWAG—Eidg. Anstalt fur Wasserversorgung und Gewasserschutz); and Graham Lightfoot,'s 1997 survey, "Pay As You Drive Carsharing Final Report. EUSAVE" Both of these reports can be downloaded from the @CarShare Consortium site. It also can be usefully read and weighed against the ideas set put by Steven Cousins in the immediately following piece. A number of the projects mentioned here are in fact covered in detail in the body of the report, in most cases by people who have been directly involved in making them work.

Introduction

The vast majority of automobile trips in U.S. metropolitan regions are drive-alone car trips. In 1990, approximately 90 percent of work trips and 58 percent of nonwork trips in the United States were made by vehicles with only one occupant (United States Department of Transportation, 1995). Vehicles are unused an average of 23 hours per day. This form of transportation is expensive and consumes large amounts of land.

Private vehicles are attractive. Their universal appeal is demonstrated by rapid motorization rates, even in countries with high fuel prices, good transit systems, and relatively compact land development. But the environmental, resource, and social costs of widespread car use are also high. One strategy for retaining the benefits of car use while limiting costs is to create institutions for sharing vehicles.

The principle of carsharing is simple: Individuals gain the benefits of private cars without the costs and responsibilities of ownership. Instead of owning one or more vehicles, a household accesses a

fleet of vehicles on an as-needed basis. Carsharing may be thought of as organized short-term car rental. Individuals gain access to vehicles by joining organizations that maintain a fleet of cars and light trucks in a network of vehicle locations. Generally, participants pay a usage fee each time they use a vehicle.

Carsharing provides the potential to reduce the costs of vehicle travel for the individual as well as for society. When a person owns a car, much of the cost of owning and operating the vehicle is fixed. The variable cost of using the owned vehicle is relatively low, and thus the driver has an incentive to drive more than is economically rational. In contrast, payments by carsharing participants are closely tied to actual vehicle usage. A carsharing system in effect transforms the fixed costs of vehicle ownership into variable costs.

Carsharing is most effective and attractive when seen as a transportation mode that fills the gap between transit and private cars, and can be linked to other modes and transportation services as a mobility package. For long distances, one might use a household vehicle, air transport, rail or bus, or a rental car; and for short distances, one might walk, bicycle, or use a taxi. But for intermediate travel activities, even routine ones, one might use a shared vehicle. The shared-car option provides other customer attractions: It can also serve as mobility insurance in emergencies, and as a means of satisfying occasional vehicle needs and desires such as carrying goods, pleasure driving in a sports car, or taking the family on a trip.

Over the past decade, carsharing has become more common, especially in Europe and North America. Mostly it involves the shared usage of a few vehicles by a group of individuals. Vehicles typically are deployed in a lot located in a neighborhood, a worksite, or at a transit station. A majority of existing carsharing programs and businesses still manage their services and operations manually due to a low amount of cars. Users place a vehicle reservation in advance with a human operator, obtain their vehicle key through a self-service, manually controlled key box, and record their own mileage and usage data on forms that are stored in the vehicles, key box, or both. As carsharing programs expand beyond 100 vehicles, manually operated systems become expensive and inconvenient, subject to mistakes in reservations, access and billing, and vulnerable to vandalism and theft.

Automated reservations and car access, key management, and billing constitute one response to these problems. The larger European carsharing organizations (CSOs), especially in Germany and Switzerland, have started to deploy a suite of automatic technologies that facilitate the operation and management of services, offer greater convenience and flexibility for users, and provide additional security for vehicles and key management

systems. In northern California, a "smart" carsharing demonstration program, called CarLink[3], with 12 compressed natural gas Honda Civics, began testing and evaluating a variety of state-of-the-art advanced communication and reservation technologies in January 1998 (Shaheen *et al.*, 1998). 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.

Smart carsharing makes intermodalism more viable, thereby creating the potential for even greater benefits. For example, on returning from work at the end of a day, a traveler rents a shared-use vehicle at a transit station (or other rental site) close to home. She drives the car home and, should she wish, other activity locations during the evening and then drives it back to the station in the morning. After riding the train for the rail part of her trip that morning, she "rents" another vehicle to get to work from the train station. During the day, the vehicle is used as a fleet vehicle at her office. Altogether, a shared-use vehicle could be used for up to ten distinct trips per day, plus facilitate up to four additional transit trips.

History of Carsharing in Europe

Most carsharing efforts remain small scale and focused in Europe. One of the earliest European experiences with carsharing can be traced to an early cooperative, known as "Sefage" (Selbstfahrergemeinschaft), which initiated services in Zurich, Switzerland, in 1948 (Harms and Truffer, 1998) [4]. Membership in "Sefage" was primarily motivated by economics. It attracted individuals who could not afford to purchase a car but who found sharing one appealing. Elsewhere, a series of "public car" experiments were attempted, but failed, including a carsharing initiative known as "Procotip," which began in Montpellier, France, in 1971, and another, called "Witkar," which was deployed in Amsterdam in 1973 (Doherty *et al.*, 1987; Muheim and Partner, 1996). [5]

[3] See below for first-hand details on the project.
[4] See below ffor first-hand details on the project.
[5] Editors Note: The authors use the term "failed" here in describing these two projects. However, we, who spent time with both projects and the groups behind them at the time have a rather different perspective. We by contrast stand in admiration of their accomplishments, which in both cases were considerable. That they did not manage to take hold on a permanent basis, in our view has more to do with the fact that they were both well ahead of their time and not particularly well supported by the transport establishment either within the two cites or at the respective national levels. These were great learning projects and should be understood in this perspective. Successful innovation in complex **socio-**

In 1983, "Vivalla bil" began in Oerebro, Sweden, as a transportation research experiment. In existence until the summer of 1998, its members decided to cease operations when the organization's chairperson resigned and several households decided to leave at the same time. Vivalla bil was a relatively small organization with 35 households sharing five cars. Although small, it inspired all of the existing Swedish carsharing organizations, including "Majornas Bilkooperative," which now is the oldest and largest CSO in Sweden. This organization has 180 households, 14 vehicles, and a 30 percent annual growth rate. [6]

Even more successful experiences with carsharing began in Europe in the late 1980s. Approximately 200 CSOs are active in 450 cities throughout Switzerland, Germany, Austria, the Netherlands, Denmark, Sweden, Norway, Great Britain, and Italy. These carsharing countries collectively claim over 125,000 participants. The European Car Sharing Association (ECS), established in 1991 to support carsharing lobbying activities, reports a membership of approximately 70 CSOs (ECS, 1997). (CSO membership in ECS represents a smaller proportion of total European CSOs.) In June 1998, the German carsharing association (formerly BOA—Bundesverband fur organisiertes Autoteilen, which means organization for organized carsharing) merged with ECS to form the new German carsharing association, known as BCS—Bundesverband Car Sharing. Most BCS member organizations also belong to ECS.

Until a few years ago, virtually all CSO start-ups were subsidized with public funding (with a few supported by corporate subsidies). Although many organizations received start-up grants, typically operational costs were not subsidized in European CSOs.

The two oldest and largest carsharing organizations are Mobility CarSharing Switzerland[7], with 1,200 cars (as of mid-1999) and Stadtauto Drive[8] (formerly StattAuto Berlin) with about 300 cars. The Swiss program, begun in 1987, now operates in 800 locations in over 300 communities, with over 26,800 members. Stadtauto Drive, begun in 1988, now has approximately 7,000 members; their current membership size reflects the 1998 merger of StattAuto Berlin and Hamburg (Euronet and ICLEI, 1996).

Though founded only one year apart, these two organizations evolved independently and quite differently. The nonprofit

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technical systems does not take place overnight and the process of experimentation means that there will always be failures along the way. Especially if one is working in a generally hostile environment as was the case with these two early, and important, projects.

[6] See below for first-hand details on the project.

[7] See below for first-hand details on the project.

[8] See below for first-hand details on the project.

corporate business 'Mobility CarSharing Switzerland' (a May 1997 merger of Auto Teilet ATG AutoTeilet Genossenschaft (ATG) and ShareCom Genossenschaft) sprang from a grassroots effort to spread carsharing throughout neighborhoods and transit stations in Switzerland. In contrast, Stadtauto Drive was launched as a university research project to demonstrate that carsharing could offer a viable transportation alternative for Germany. These two organizations are recognized worldwide as modern pioneers of carsharing. Both grew about 50 percent per year until 1996 (Lightfoot, 1997). Mobility CarSharing Switzerland continues to grow about 25 percent per year, while Stadtauto Drive's growth rate has slowed more considerably (Harms and Truffer, 1998).

Stadtauto Drive attributes three reasons for this stagnation (Harms and Truffer, 1998):

- First, many members have moved out of the inner city to the countryside where public transit is limited. This has forced many individuals to purchase private cars because they can no longer easily access carsharing vehicles and transit.

- Second, another group of members realizes after joining the CSO that they only require a shared car on rare occasions. Many in this group drop out because the yearly CSO membership fees do not justify occasional usage. At present, Stadtauto Drive members have two fee options: they can pay 192 marks per year or avoid an annual fee by paying a one-time initiation fee and higher usage rates based on mileage. If an individual's vehicle use is less than 200 marks or $120 a year, this individual will typically drop out of the organization and use traditional auto rentals to fulfill their occasional vehicle needs.

- Finally, other members require vehicles so often for tripmaking that the effort to reserve and access shared-use cars becomes too great a burden. Often these individuals leave the CSO because they prefer dedicated private vehicles over carsharing.

For the first group of individuals—those who move to the country—no solution has been found. To regain their former clients and attract new ones, Stadtauto Drive has started some new initiatives, which are described in the section "Innovating Through a CSO Lifecycle."

Both organizations are preparing to enter a modernization phase, moving from manual "key box" operations to a system of smart card technologies for making automatic and advanced reservations, accessing vehicle keys, securing vehicles from theft, and facilitating billing. The shift to smart cards simplifies vehicle

access for customers and eases the administration and management of large systems. However, the large investment required for the new communication and reservation technologies puts pressure on these organizations to continue expanding to generate revenue to pay off these investments.

A few smart shared-use vehicle tests have already been implemented in Europe. Lufthansa Airlines instituted automatic rental systems at the Munich and Frankfurt airports in 1993, in which a computer releases a key and starts the billing. After the car is returned, the vehicle communicates distance traveled and fuel consumed to a central computer system. By the end of 1994, 12,000 employees at the two German airports had access to this "carpool" system. Lufthansa reportedly has saved over $20 million in avoided parking infrastructure costs (Morias, 1994). These cost savings have been used as a justification for corporate subsidies of the program. As of 1999, the system is being modernized with a smart card system and coordinated with local transit operators (BMBF, 1998). A similar program, called "CarShare," was introduced in 1993 by Swissair at the Zurich airport for flight attendants. It is technologically simpler and works in collaboration with Hertz Rent-a-Car Switzerland (Wagner, 1997).

In October 1997, the French "Praxitele" program began operation with 50 Renault electric vehicles that were rented and driven between 11 "Praxiparcs" located near transit stations and office blocks (Massot *et al.*, 1999). After nearly two years in operation, the program ended in June 1999 due to high costs and lowered demand.

In October 1997, Volkswagen launched a smart carsharing program in Germany. Their aim is to reduce the number of cars on Europe's roads, reduce car-use costs, and maximize vehicle usage. At present, they are developing automatic information systems that enable car drivers to quickly and easily transfer to public transportation, particularly when roads are congested. Volkswagen is currently running two carsharing projects. The first is operated in an apartment complex, which shares several vehicles that are located outside the building. In a second program, a commercial organization shares a range of vehicles. In both cases, a small user fee is collected. An automatic booking system, COCOS—developed by INVERS in Siegen, Germany—is employed. Participants have rated this service highly. Volkswagen believes that the carsharing market will grow at a rate of 50 percent per year for a potential market of 2.45 million shared-use vehicles across Europe within the next ten years.

Along with these success stories are many failures. Most organizations have found it difficult to make the transition from grassroots, neighborhood-based programs into viable business ventures. They miscalculate the number of vehicles needed, place

too great an emphasis on advanced technology, or expend funds for marketing with little return. Many of the failed organizations have merged or been acquired by larger European CSOs.

Recent Study Results from Europe

Recently, a two-year project, known as Pay-As-You-Drive Carsharing (PAYDC), was completed to explore shared use as an alternative transportation mode in Ireland, the United Kingdom, and the Netherlands. As part of this program, several pilot projects were planned and implemented. These projects operated between six months to one year and were completed in May 1998. One pilot program was deployed in each region. CampusCar, which was implemented at Cranfield University in England, studied a campus application of carsharing[9].

CarSharing Delft in the Netherlands aimed at strengthening the design of private carsharing models. Private carsharing involves one or more individuals who share a car that is either owned by one individual or all of the participants collectively. This project focused mainly on private household carsharing, rather than commercial enterprises, because of the limited knowledge regarding this model in the Netherlands. [10]

Finally, Co-op Car in Ireland focused on a station car application of carsharing. These pilot projects provided brief, yet notable experience from which all three regions have benefited.

A final project component included development of a business plan for a start-up organization in Edinburgh, called Edinburgh City Car Club[11]. City Car Club could be one of the most advanced carsharing system in Europe, using on-board computers and GPS technologies for authorizing use, data collection, and vehicle security. City Car Club hopes to have up to 100 vehicles in its fleet, supplied by Budget Rent-a-Car, by the end of its first year. A full operational launch, with an initial fleet of five cars, occurred in March 1999. As of June 30, 1999, City Car Club had approximately 50 members.

History of Carsharing and Station Cars in North America

The North American experience with carsharing is far more limited. There have been two formal carsharing demonstrations in the United States. The first was Mobility Enterprise, operated as a Purdue University research program from 1983 to 1986 in West Lafayette, Indiana (Doherty *et al.*, 1987). Each household leased a

[9] See below for first-hand details on the project.
[10] See below for first-hand details on the project.
[11] See below for details on the project.

very small "mini" car for short local trips, and was given access to a shared fleet of "special purpose" vehicles (i.e., large sedans, trucks, and recreational vehicles). Mobility Enterprise created a hypothetical cash flow for its operations. They claimed economic viability, but only if the shared-use vehicle services were run through an existing organization, such as a large fleet operator.

In this field test, the mini vehicles leased to participants were used for 75 percent of the households' vehicle miles of travel (VMT). In contrast, the shared-use vehicle fleet was only used 35 percent of the time that it was available to households throughout the experiment. (The Mobility Enterprise study findings did not provide the percentage of a household's total VMT that was made with a special-purpose fleet vehicle.) Although this program was considered a success in promoting shared use, Mobility Enterprise did not continue because it was deployed as a research experiment.

A second major U.S. carsharing project was the Short-Term Auto Rental (STAR) demonstration in San Francisco (Doherty *et al.*, 1987). The STAR company operated as a private enterprise from December 1983 to March 1985, providing individuals in an apartment complex use of a short-term rental vehicle for a few minutes up to several days. Feasibility study funds were made available from the Urban Mass Transportation Administration and the California Department of Transportation.

STAR was operated from the parking garage of a 9,000 resident apartment complex located near San Francisco State University. Users paid on a per-minute and per-mile basis until a maximum daily rate was reached. This rate was kept low to discourage auto ownership and encourage transit use. The maximum daily rate for subcompact, mid-, and full-sized vehicles ranged between $8 and $9 per day with an additional mileage charge of 10 cents a mile. The members shared a fleet of 51 vehicles (44 cars, five wagons, and two light-duty trucks), with 10 additional vehicles available as backups during periods of peak demand. The fleet size was maintained until January 1985, when it shrank to 35 vehicles. Membership peaked at approximately 350 participants (Walb and Loudon, 1986).

This project failed halfway through the planned three-year program. The primary problem was the low and erratic income of many of the tenants. Many were later discovered not to be credit worthy for car ownership; many were students who shared an apartment and were not actually listed on the lease. Another failing was the pricing structure of STAR, which encouraged long-term, as well as short-term rentals. Long rentals sometimes resulted in long-distance towing charges when the old, often poor-quality cars broke down several hundred miles from San Francisco. STAR's management tried to cut costs by purchasing used, economy-class

vehicles, but this resulted in high repair costs. Also, STAR apparently offered too many models in each vehicle class, leaving members dissatisfied when a particular car was unavailable.

Today, there are nine existing carsharing organizations in North America. They share a similar operational model. Members access vehicles at a neighborhood lot that is located a short walking distance from their home or work site, and they make carsharing reservations over the phone. One organization has recently implemented an automated reservation system based on a computerized "Voice-Response-System." At present, none of these CSOs use smart technologies to facilitate reservations, operations, and key management. Four of them are run as for-profit businesses, and the rest as nonprofit cooperatives. Recently, developments have been initiated to found the North American Car Sharing Association.

Five of the nine North American CSOs are located in Canada. The first and oldest is Auto-Com, located in Quebec City. Auto-Com, which began operations in August 1994, currently has 450 members and 34 cars. Interestingly, this organization began as a nonprofit cooperative, but changed to a for-profit business in 1997. In September 1995, the same group launched a second CSO in Montreal, CommunAuto, Inc. Currently, CommunAuto has over 550 members and 32 cars. CommunAuto was founded as a for-profit business.

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 250 members and 14 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 5 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 8 vehicles and120 members. Finally, five additional regions are developing carsharing plans in Ottawa, Guelph, Calgary, Edmonton, and Kitchener.

Four carsharing organizations, all two years old or less, operate in the United States. Another two are being planned in the Pacific Northwest, a third in San Francisco, and a fourth in Chicago. Boulder CarShare Cooperative was launched in Boulder, Colorado, in May 1997. The Boulder CSO has 8 members who share 1 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, 3 biodiesel vehicles, and supplies an average of 370 VMT 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, that began operation in February 1998 with two Dodge Neons. Currently, CarSharing Portland, Inc. has 171 individual members, 11 vehicles, and 9 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 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.

A fifth CSO, Motor Pool Co-Op, is planned to be launched in the near future in Corvallis, Oregon. Motor Pool will begin its program with nine members and will be run as a nonprofit cooperative. In the fall of 1999, the City of Seattle, King County Metro, and University of Washington plan to begin carsharing in Seattle in four high-density neighborhoods, launching the program with 10 vehicles. Based on a contract with the City and Metro, Mobility Inc. will operate 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 has been 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 second 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) consisting of public agencies and nonprofit organizations. City CarShare began seeking funds in late 1997. They hope to begin a three-year pilot operation in the fall of 1999, with 50 members and a minimum of 8 cars, with the goal of reaching 100 vehicles by 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 projected to begin operation in fall 1999, with a fleet of approximately 12 to 14 vehicles. ShareCarGo! hopes to service its anticipated membership of 100 people through 5 to 6 sites around the city.

Better funded efforts to launch carsharing programs in the United States have their roots in "station cars." These are vehicles deployed at passenger rail stations in metropolitan areas and made available to rail commuters. Station car demonstrations are at various stages of planning, funding, and implementation across the country. Station car vehicles are made available either near the home or work end of a transit commute. The largest was the Bay Area Rapid Transit (BART) station car demonstration program in the San Francisco area, with nearly 50 electric vehicles, including 40 PIVCO City Bees from Norway; 2 Toyota RAV-4s; and 5 Kewets from Denmark (Bernard and Collins, 1998). This project ended successfully 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.

Several station car programs were launched in the mid 1990's 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 have struggled with the high cost and low reliability of first-generation electric cars. While shared use is the goal, as of mid-1999 none has yet incorporated shared-use practices (Bernard and Nerenberg, 1998). In January 1999, BART released a proposal seeking a for-profit "shared-vehicle" program with at least 25 cars each at 4 suburban BART stations. Hertz submitted a proposal in May 1999. Launch of this program is planned for early 2000.

Recent Developments in Asia

Since 1997, there have been increasing developments in carsharing in Singapore and in Japan by two auto manufacturers.

In August 1997, NTUC INCOME car co-operative Limited (Car Co-op) launched its first test of a carsharing system, using an electronic key box and on-board computers, at the Toh Yi estate in Upper Bukit Timah, Singapore. Within the first few weeks of the launch, over 150 people registered to join, although the Co-op could only accept 80 members. The residents of the estate now share four Mitsubishi Lancers. The Car Co-op is being extended to private homeowners. Residents of Villa Marina and Rivervale will automatically become members of the Car Co-op and have access to a fleet of cars, including a Mercedes-Benz limousine and several multi-purpose vehicles. There will be one car for every 40

residents. The developers of the two condominiums will each pay approximately $100,000 towards this operation during the first three years of the program. Members will not pay membership fees during the first years, but they will pay for usage. For example, it will cost $20 per hour to book the limousine. Carsharing lots will be located near public transit stations, so users can rent vehicles at the end of a transit trip. The estates will provide shuttle services to the transit stations.

In October 1997, Honda Motor Company announced its version of carsharing, known as the Intelligent Community Vehicle System (ICVS), which is being tested at their Twin Ring Motegi site in Japan. The ICVS site in Motegi is comprised of multiple lots from which four different types of electric-powered vehicles can be selected for use. The City Pal, Step Deck, Mon Pal, and Racoon are the vehicles available; the designs vary from medium-range, high-speed to minimal range residential transportation. In the future, ICVS could be used in conjunction with an individual's private vehicle and public transportation to relieve traffic congestion and parking problems. The advanced technologies used in this system allow its users to rent a vehicle at any ICVS lot using their smart cards. These same cards are used to unlock and start the vehicle, thereby eliminating the need for a vehicle key. User fees are calculated automatically and members may have their fees automatically deducted from their bank account. The lots and vehicles are equipped with technologies, including GPS, that allow the ICVS management center to monitor vehicle location in real time. Further, the vehicles are outfitted with platooning technologies that allow a system worker, driving the first vehicle, to lead up to four unmanned, cued vehicles to another port. These same vehicles have an autodriving feature—guided by magnetic nails, induction cables, and ultrasonic sensors—that allows them to enter and leave a port unmanned. Finally, the vehicles are equipped with an autocharging system that instructs the vehicles to dock at a charging terminal when batteries are low.

In May 1999, three hundred Toyota employees began using a smart carsharing system, called "Crayon," in a one-year experiment. This system employs a suite of advanced electronics, including smart cards; a reservation, location, and recharging management system; automatic vehicle location; a vehicle information and communications system; and a fleet of 35 small electric E-com cars (with plans to increase to 50 cars). Employees, working at Toyota headquarters in central Japan and at the Motomachi Heliport, Hirose Plant, are reserving vehicles and driving them between home and work sites. Eight parking sites will provide charging facilities (with six locations at Toyota headquarters and two at the Hirose Plant). Employees may also charge the vehicles at their homes using a household 110-volt current. Toyota plans to monitor usage and recharging behavior (Toyota, 1999).

Innovating through a CSO Lifecycle

To date, all noncorporate carsharing organizations have begun as small local operations, usually with government funding and inspired by ideological concerns about car dependence and the negative impacts of cars on urban settlements. Based on a study tour and literature review of carsharing in Europe, Lightfoot found that people seeking unique and less expensive ways of owning and employing cars indeed were the core constituents of pilot carsharing projects in the Netherlands, the United Kingdom, and Ireland (Lightfoot, 1997). Given their strong local ideological roots, he concluded that new start-up CSOs are more likely to succeed if they remain at a self-organizing local level as long as possible. Recent history has shown that it is difficult to transform a small grassroots CSO into an economically viable business.

Large successful European CSOs are developing a range of new services. Given the absence of successful models, CSO pioneers are exploring a variety of new services and technologies, including partnerships with transit, car-leasing programs, car rental agencies, and taxis. This partnering process includes business and marketing collaborations and/or use of advanced information and communication technologies (Wagner and Shaheen, 1998). Existing examples are described below.

Autodate (Netherlands)

Autodate, founded in 1995, is an umbrella organization that serves 90,000 CSO participants in the Netherlands. In addition to supplying conventional information and marketing functions, Autodate also provides the following services:

- Facilitates linkages between private carsharing services and other businesses (e.g., taxi companies and car rental agencies).
- Links carsharing providers to private companies interested in sharing their fleet vehicles.
- Promotes the use of shared-vehicle management in land development (e.g., establishment of carsharing in new residential areas).

Autodate is financed entirely by the Dutch Ministry of Transport, but expects other governmental agencies and private businesses to assume an expanding share of the budget (Harms and Truffer, 1998). [12]

[12] See below for first-hand details on the project.

EASYDRIVE (Austria)

EASYDRIVE, a for-profit organization in Austria, was founded in August 1997. The Denzel Group, a large automotive sales company, runs EASYDRIVE. The Denzel Group rents the CSO's 85 vehicles from Europcar, a division of Denzel. Every six months, Europcar replaces the EASYDRIVE vehicles with new ones. At present, EASYDRIVE has 70 stations and 1,050 members. In 1999, EASYDRIVE plans to expand its fleet to 200 vehicles. These vehicles will be equipped with on-board computers.

EASYDRIVE has several innovative partnerships that facilitate management and attract new members. Partners include Europcar, Wien Municipal Public Transport, OeBB (Austrian Rail), and OeAMTC (an Austrian Car Club, with over two million members). OeAMTC acts as a mobility provider, not just a car club, by advertising for EASYDRIVE, providing information about carsharing, and taking EASYDRIVE reservations. Furthermore, EASYDRIVE is exploring partnerships with developers to establish carsharing lots in new housing communities. Finally, in cooperation with the Austrian Ministry of the Environment, EASYDRIVE has planned the project "Sun&Ride" to encourage car-free tourism, providing tourists with easy access to electric vehicle rentals. [13]

MobiCenter (Germany)

The MobiCenter, operated by Wuppertal AG (WSW), encourages public access to all types of transportation and mobility services, including: information on public transportation (e.g., timetables, fares, park and ride schemes, carsharing, carpooling, car rental, bike and ride, etc.); ticket sales (i.e., local and long distance); seat reservations on German railways; car rental reservations; carsharing; delivery services; and advice/consultation on trip planning.

In its first year (beginning March 1995), MobiCenter averaged about 6,000 customer contacts per month. Two-thirds were questions about timetables, and one-third were about fares and tickets. This organization's goal is to create a central point for mobility information, which is operated by a large-city public transportation provider.

Mobility CarSharing Switzerland

Mobility CarSharing Switzerland recently deployed two new mobility service programs. The first, Zuri Mobil, is a successful mobility package that is based on a regional public transit offer that

[13] See their own chapter below for details on the project.

also includes carsharing and car rental. The second, Zuger Pass Plus (ZPP), provides a discounted combination of carsharing, public transit, car rental, taxi, bicycle, and other nontransport related services for its customers (similar to a frequent flyer program). ZPP is a partnership of several transportation providers and other businesses.

On September 1, 1998, a third partnership was launched with the Swiss National Rail System (SBB), offering a mobility package to 1.5 million SBB passholders (approximately 35 percent of the country's adult population). This package provides users with special discounts and easy smart card access to carsharing vehicles, rental cars, and transit (Wagner and Schmeck, 1998). Starting as a pilot project in 2001, EASY-RIDE will encompass most Swiss transportation activities, including rail, bus, taxi, carsharing, and car rental by 2005. EASY-RIDE will make all services accessible by smart card. This will simplify ticketing and marketing and open new options for intermodal tripmaking. Almost every public transportation company in Switzerland is a partner in a carsharing mobility package. In the future, this relationship is likely to grow even stronger.

Although partnerships with public transportation agencies are a very successful mobility strategy, partnerships should ideally be based on a broader set of partners (e.g., employment centers, car rental, auto companies, car dealers, gas stations, and auto clubs). New target groups for carsharing can be found in many areas. For instance, mobility packages can be designed in collaboration with auto manufacturers to meet the needs of intense car users.

Mercedes-Benz's "Smart," a small two-seater, combustion engine vehicle, is a complementary vehicle to carsharing and intermodal trips (i.e., its easy to park). When an individual buys a "Smart" in Switzerland, they can also purchase a mobility package (a value of $400) for just $50 per year. This package includes free access to all carsharing vehicles—with no membership fees—at a slightly higher hourly rate and the same mileage rate paid by carsharing members. This package also includes a half-price pass for the Swiss transportation system. This allows the passholder to purchase train and bus tickets for half price throughout the year. In this partnership, "Smart" fits smoothly into a new consumer-oriented mobility package that provides individuals and households with an expanded set of mobility options.

Sixt AG (Germany)

Sixt AG is a family-owned car rental company that began in Germany in 1912. They have expanded their scope beyond traditional car rental and created a new service called Car Express. With Car Express, authorized users can rent vehicles from self-service stations at any time of the day or week. Stations

exist in Berlin, Munich, Dusseldorf, and Vienna. This new service has made carsharing very simple and convenient to use and is designed to appeal to individuals who perceive themselves as a car renter, but not a carsharing participant. Because Car Express is part of a larger car rental company, it is unlikely that it will partner with more conventional carsharing organizations.

Stadtauto Drive (Germany)

Stadtauto Drive, with more than 7,000 members in Berlin and Hamburg, is Germany's largest CSO. Stadtauto Drive itself is collaborating with the company of Highly Organized and Integrated City traffic Elements (CHOICE), which has three equal partners: Stadtauto Drive, Volkswagen/Audi and the Center for Social Research Berlin. CHOICE leases vehicles to clients. With CHOICE, a customer has the option of making the leased vehicle, or "Cash Car," available for CSO use when he or she is out of town. This transaction, based on fixed rates with a supplemental bonus reflecting supply and demand, can reduce the cost of the lease depending on the time the vehicle is loaned back to CHOICE. If the vehicle is returned one-third of the time, the leasing rate is reduced about one-third the amount. CHOICE cars augment Stadtauto Drive's carsharing fleet most often for weekend or holiday use. Currently, CHOICE has 100 customers.

Another innovation of Stadtauto Drive is its Mobil Card, which carsharing customers can use for accessing an expanded set of services and discounts. This smart card provides a 15 percent cost reduction on public transportation, allows users to take taxis without exchanging cash, pay for food and beverage home delivery, reserve a bicycle, and even book a canoe in Brandenburg, Germany. In early 1998, Mobil Cards could be used at 46 Stadtauto locations throughout Berlin and Potsdam. Beginning in 1995, Stadtauto Drive also began offering its members a food and beverage delivery service called "Stattkauf." For a moderate fee, members can receive a Stattkauf delivery once a week (Moll, 1996).

Stadtauto Drive, like Mobility CarSharing Switzerland, is also partnering with major car rental companies and CHOICE to provide vehicles to CSO members when it is more economical to rent a vehicle (i.e., when rental periods are greater than two days) or when carsharing demand is at a peak (Petersen, 1998).

StadtAuto Bremen

Another German CSO, StadtAuto Bremen, which now has 1,700 carsharing members and 80 vehicles, launched a transit pass program in June 1998 that links the city's transit pass to the CSO's smart auto card. Members who purchase the "Bremer Karte,"

which is valid for one year, pay an initial fee of 30 Euro, and pay only for actual costs based on kilometers driven, use, and type of car. An additional innovation of StadtAuto Bremen is its on-board computer systems located in each vehicle (Glotz-Richter, 1998). [14]

User Characteristics and Market Potential

It is difficult to estimate demand for new technologies and new attributes when customers have no experience with those products and attributes (Kurani *et al.*, 1996). Determining the demand for shared cars is especially difficult because it implies some reorganization of a household's travel patterns and lifestyle. How much inconvenience are people willing to accept in return for less cost? Some market studies have been conducted in the United States, but are too tentative to be indicative (Cervero *et al.*, 1994; Cervero *et al.*, 1996). More sophisticated studies are underway at the University of California, Davis, and in Switzerland. (Muheim and Partner, 1998[15]; Shaheen *et al.*, 1998)

Several surveys of users have been conducted in Europe and North America by carsharing organizations. Although most of the surveys have small samples, did not use control groups nor travel diaries to collect travel data, and employed simple questionnaires, they do provide useful insights. A survey in Switzerland and Germany found that users were between 25 to 40 years of age with above-average education, were more likely to be male, earned a below-average income (in part due to the low average age of participants), and were sensitive to environmental and traffic problems (Muheim and Partner, 1996).

In a separate study, Stadtauto Drive reported similar characteristics: 65 percent male; average age of 33; well educated; and modest incomes (U.S. $2,000 per month) Muheim and Partner (1996) reported that men have a greater tendency than women to demand a larger, more diverse fleet of vehicles for a wide range of trip purposes (Hauke, 1993).

In a German survey, Baum and Pesch (1994) explored motivations to participate in a carsharing service. Cost was not considered and multiple answers were possible. Figure 1 presents the response to this survey. In Portland, the top two reasons for joining carsharing include the need for an additional vehicle and financial savings.

[14] See below for first-hand details on the project.
[15] See their own chapter below for details on the project.

FIGURE 1: Reasons to Participate in Carsharing

Service Feature	% Rating Service Feature Highly	
Convenient neighborhood locations (i.e., a short distance to access vehicles)		71.2 %
High probability of vehicle availability	44.7	
Low usage tariffs		30.3
Safe and reliable automobiles		28.2
Flexible booking options	22.6	
Car-sharing stations available in other cities		< 10
Reduced capital investment (i.e., fixed car costs)	< 10	
Low membership fees (e.g., monthly and annual dues)	< 10	
Access to mid- and high-priced automobiles		< 10
Well-maintained vehicles		< 10
Mobility information services		< 10

Source: *Baum and Pesch,* 1994, sited in *Muheim and Partner,* 1996

In another European study, Lightfoot (in collaboration with Wagner and Muheim) surveyed individuals who have not participated in carsharing in Europe (Lightfoot, 1997). He found that the principal reasons for not participating were the unprofessional image of many CSOs, an insufficient variety of products and services, higher costs than transit, a system that was "complicated, impractical and time consuming," and vehicles not readily available near home.

Mobility CarSharing Switzerland foresees a large suburban market in Switzerland. They believe that they can capture 12 percent of drivers, many of them in semirural areas. In contrast, Baum and Pesch characterize carsharing as a predominantly urban phenomenon in Germany (Muheim and Partner, 1998; Shaheen *et al.*, 1998). They estimate a potential market of 3 percent of the population (approximately 2.45 million people).

Based on a more recent review of the carsharing literature, Lightfoot also characterizes commercial carsharing as an urban phenomenon, with significant participation by individuals between 25 to 40 years of age (Lightfoot, 1997). Lightfoot concludes that "rural" carsharing approaches are more informal and cooperative. Located in small, dispersed communities, they tend to attract higher female participation and are often used to substitute for the purchase of a second household vehicle.

Economics of Carsharing

The model CSO is one in which the vehicles are used intensively by customers who individually drive relatively little. The CSO needs high utilization to keep per-use costs low, but CSOs are economically attractive only to those who are not intensive vehicle users.

Unfortunately, it is difficult to evaluate the economics of existing CSOs to determine under what conditions and to what extent CSOs are economically successful. Economic data are sparse and not well documented due to the proprietary nature of much of these data, the casual organization of many CSOs, and their relative youth. The fact that virtually all CSO start-ups were subsidized until recently (many still are), and that many have failed or been acquired, further confounds an economic analysis. The economic data and findings for users and operators reported here help to parameterize the attributes of a typical CSO in Europe. These numbers should be considered indicative, not definitive.

The largest CSOs, aiming for a balance between high vehicle utilization and high customer convenience (in terms of proximity and availability), claim that they can guarantee their customers over 95 percent vehicle availability. They accomplish this level of availability by providing about one car for every 15-20 members (Muheim and Partner, 1996; Lightfoot, 1997). Based on a study of the moderately large Dortmund CSO (called “Stadtmobil”) in Germany, Lightfoot found that a clustering strategy of three vehicles per location provides optimal vehicle availability and easy physical access (Lightfoot, 1997). Optimal is defined here more in terms of consumer convenience than overall economics.

As an indication of vehicle utilization, Stadtauto Drive reports that their vehicles average 34,213 km (21,250 miles) per year, compared to the 14,587 km (9,060 miles) of the average German car. Vehicle trips tend to be of short duration and distance: 77 percent of Stadtauto Drive “rentals” are fewer than 24 hours in length, and 56 percent range between 19 and 100 km (12 and 62 miles) (the other 44 percent fall below 19 km (12 miles) and above 100 km (62 miles)). The average occupancy rate of a Stadtauto Drive vehicle is two persons, compared to the German average of 1.3 (Euronet and ICLEI, 1996). Vehicles are used fairly intensively, but individual members tend to be sporadic users, with Stadtauto Drive members driving less than half that of the average driver 4,025 v. 8,758 km (2,500 v. 5,440 miles) per year (Euronet and ICLEI, 1996).

As an indication of the economic attractiveness of carsharing, Muheim and Partner found that expenses of early Mobility members were reduced by 2,500 francs or $1,700 annually and that carsharing is cost effective for users who drive fewer than

9,064 km (5,630 miles) per year (Muheim and Partner, 1996). Baum and Pesch report the breakeven point for carsharing in Germany at 6,875 km (4,270 miles) per year (Baum and Pesch, 1994), and Petersen reported a breakeven point for Stadtauto Drive of 18,306 km (11,370 miles) (Petersen, 1993/1995). These findings are for Europe at varying times and situations and are not well documented.

Social and Environmental Benefits of Carsharing

Individuals deciding whether to participate in carsharing generally do not consider indirect and nonmarket effects (with the notable exception of a small group who may be ideologically motivated). Yet these environmental and social benefits may be large. If these effects are large, then it is important for the success of carsharing to quantify them so that government, employers, and others will be encouraged to support carsharing. For instance, Lufthansa financially supports carsharing for its employees because it can avoid the substantial cost of providing additional parking infrastructure. Large environmental, economic, and social benefits can be generated with carsharing primarily through a reduction in vehicle usage, but also by reducing the demand for parking space. Vehicle travel will tend to be reduced because drivers are more directly confronted with the per-usage cost of driving, and presumably will respond rationally by reducing vehicle use.

The magnitude of these nonmarket and indirect benefits are large according to several carsharing surveys. As indicated in Table 2, about 30 percent of individuals sell their cars after joining CSOs, according to three different carsharing surveys conducted between 1990 and 1994. Autodate reports a 39 percent reduction in vehicles (Autodate, 1998) and in Oslo, Norway, 68 percent of individuals reportedly gave up a vehicle after participating in carsharing (Klintman, 1998), which cites (Berge, 1997).

TABLE 2: Vehicle-Ownership Before and After Joining CSOs[16]

PASSENGER CAR-OWNERSHIP BEHAVIOR OF CSO MEMBERS	SHARE OF USERS		
	Wagner (1990)	**Hauke (1993)**	**Baum and Pesch (1994)**
Would never buy a car	37.2%	35.7%	12.9%
Forgone the planned purchase of a private car due to car sharing		15.6%	31.5%
Given up a private car because of car sharing	26.2%	42.4%	23.0%
Given up their car independent of car sharing	31.1%		29.7%
Continue to own a private car	5.5%	6.3%	3.0%

[16] Note these statistics are between four to eight years old and generally reflect the behavior of early adopters of carsharing.

Source: *Muheim and Partner,* 1996, which cites: *C. Wagner*, ATG-UMFRAGE 1990. ATG, Stans. German, 1990; *U. Hauke*, Carsharing-Eine Empirische Zielgruppenanalyse unter Einbeziehung Sozialpsychologischer Aspekte zur Ableitung einer Marketing-Konzeption. Hauke, Feldstrasse, 1993; *Baum and Pesch*, 1994.

Reduced car ownership generally translates into reduced driving. Indeed, a Mobility CarSharing Switzerland study (conducted by the former ATG) reported that car mileage for individuals who owned private vehicles was reduced by 33 to 50 percent after they joined the CSO. Most of these individuals increased public transportation usage to meet many of their other transportation needs (Muheim and Partner, 1996).

In the Netherlands, former car owners reduced car mileage by 37 percent—from 15,907 to 10,095 km (9,880 to 6,270 miles) annually. Former non-car owners reduced private vehicle mileage by 29 percent—from 5,394 to 3,800 km (3,350 to 2,360 miles). These numbers are the average of four CSOs that were studied. After joining a CSO, participants use bicycles and the train more frequently (Meijkamp and Theunissen, 1996).

Similarly, for Germany, Baum and Pesch reported that carsharing reduces private car mileage by 58 percent, from 7,044 km to 4,073 km (4,375 miles to 2,530 miles) per year, after membership (Baum and Pesch, 1994). Most of this reduced travel seems to be foregone travel, but some is transferred to other modes. Baum and Pesch, for instance, report that public transportation use by CSO members increased by about 1,546 km (960 miles) per year. Table 3 summarizes the change in modal split due to carsharing in Germany. This dramatic reduction in car use by CSO members—of half or more—is much greater in Europe than would be expected in North America.

TABLE 3: Change in Modal Split (percentage in annual kilometers)

Means of Transport	Without Carsharing	With Carsharing
Private or borrowed car	60.5	13.4
Carsharing	—	24.9
Car rental	2.9	3.1
Taxi	.8	1.3
Public transportation	35.8	57.3

Source: *Harms and Truffer,* 1998, which sites *Baum and Pesch,* 1994.

In contrast to the findings in the Netherlands, Muheim and Inderbitzin report that the mobility behavior of individuals in Switzerland, who did not own a car before CSO membership, was not altered significantly (Muheim and Partner, 1996). These investigators found that for this group of customers, carsharing

trips often substitute for vehicle trips that were typically made with a borrowed car (Muheim and Inberbitzin, 1992).

Overall, then, CSOs provide the promise of large reductions in car usage and associated adverse effects. It remains to be seen whether these effects persist as CSO participation extends beyond early adopter groups and into North America and Asia.

Conclusion

Until the past decade, almost all efforts at organizing carsharing organizations resulted in failure. For a variety of reasons, a new era began in the late 1980s in Europe. A number of carsharing organizations are now firmly established and on notable growth trajectories. These CSOs appear to provide large social benefits. Car travel and ownership diminish greatly when individuals gain access to carsharing, which is far greater than with virtually any other demand-management strategy known. Particularly appealing is that carsharing represents an enhancement in mobility and accessibility for many people, especially those less affluent.

Some lessons in how and where to launch carsharing are becoming apparent. Based on our review of the literature and the experience of our authors, this paper concludes that CSOs are more likely to be economically successful when they provide a dense network and variety of vehicles, serve a diverse mix of users, create joint-marketing partnerships, design a flexible yet simple rate system, and provide for easy emergency access to taxis and long-term car rentals. They are more likely to thrive when environmental consciousness is high; when driving disincentives such as high parking costs and traffic congestion are pervasive; when car ownership costs are rather high; and when alternative modes of transportation are easily accessible.

An even more important lesson, though not well documented, is the need for partnership management to offer enhanced products and services (Wagner and Shaheen, 1998). More business-oriented CSOs thrive by acquiring those that fail or lack strong leadership. But to retain customer loyalty, they must improve services and/or reduce costs. Two linked strategies are being followed: (1) coordinate and link with other mobility and nonmobility (e.g., food providers) services; and (2) incorporate advanced communication, reservation, and billing technologies in conjunction with significant membership growth. But advanced technologies are expensive and linking with other services is successful only if the customer base is large. And so, CSOs either remain quite small or follow a spiraling growth trajectory.

Taking a longer view, CSOs may be the prototype of an entirely new business activity: mobility service companies. As car ownership proliferates and vehicles become more modular and

specialized, entrepreneurial companies may see an opportunity to assume the full care and servicing of mobility needs in neighborhoods, work sites, transit stations, and shopping centers, based on a partnership management strategy (Womak, 1994). These new mobility companies might handle insurance, registration, and maintenance, and could substitute vehicles as household situations change. One can imagine a future in which the pioneering CSOs combine their operational expertise with the entrepreneurial capabilities of advanced technology suppliers and other businesses to create mobility services that enhance our social, economical, and environmental well being.

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References

The authors have developed an extensive bibliography consisting of some three dozen useful references which are not reproduced here for reasons of space and because World Transport Policy & Practice does not normally make use of long bibliographies as do many other journals. Moreover, most of the information about these developments is widely known and in the common domain. Readers wishing to have access to these references will find them in the stand-alone version of their paper that appears on the @CarShare Web site at www.ecoplan.org/carshare/

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