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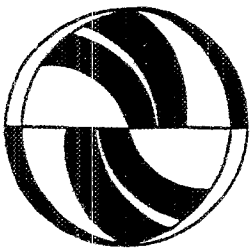

Carsharing in Europe and North America: Past, Present and Future

Susan Shaheen
Daniel Sperling
Conrad Wagner

Reprint
UCTC No 467

The University of California
Transportation Center

University of California
Berkeley, CA 94720

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Carsharing in Europe and North America: Past, Present, and Future

Most automobiles carry one person and are used for less than one hour per day. A more economically rational approach would be to use vehicles more intensively. Carsharing, in which people pay a subscription plus a per-use fee, is one means of doing so. Carsharing may be organized through affinity groups, large employers, transit operators, neighborhood groups, or large carsharing businesses. While carsharing does not offer convenient access to vehicles, it does provide users with a large range of vehicles, fewer ownership responsibilities, and less cost (if vehicles are not used intensively). Societal benefits include less demand for parking space and the indirect benefits resulting from costs being more directly tied to actual usage and vehicles being matched to trip purpose. This article reviews the experience with shared-use vehicle services and explores their prospects for the future, focusing on the trend toward expanded services and use of advanced communication and reservation technologies

by Susan Shaheen, Daniel Sperling, and Conrad Wagner

The vast majority of automobile trips in U.S. metropolitan regions are drive-alone car trips. In 1990, approximately 90% of worktrips and 58% of nonwork trips in the United States were made by vehicles with only one occupant.[1] Vehicles sit 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 carsharing by joining organizations that maintain a fleet of cars and light trucks in a network of vehicle locations. Generally, participants pay a modest fixed charge plus a usage fee each time they use a vehicle.

Carsharing provides the potential to reduce the costs of vehicle travel to the individual as well as society. When

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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 fixed costs of vehicle ownership into variable costs

Carsharing is most effective and most attractive when seen as a transportation mode that fills the gap between transit and private cars, and that can be linked to other modes and transportation services For long distances, one might use another household vehicle, air transport, rail, bus, or 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 has 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. 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 or at a transit station. Virtually all existing carsharing programs and businesses manage their services and operations manually. Users place a vehicle reservation in advance with a human operator, obtain their vehicle key through a self-service, manually controlled key locker, and record their own mileage and usage data on forms that are stored in the vehicles, key lockers or both As carsharing programs expand beyond 100 vehicles, manually operated systems become expensive

Carsharing provides households and individuals access to a fleet of vehicles on an as-needed basis
Photo courtesy of Mobility CarSharing Switzerland.

Carsharing allows one to enjoy pleasure driving in a luxury vehicle. *Photo courtesy of Mobility CarSharing, Switzerland*

and inconvenient, subject to mistakes in reservations and billing, and vulnerable to vandalism and theft.

One response to some of the problems of manual carsharing operations is the development and use of automated reservations, key management, and billing. The larger European carsharing organizations (CSOs), especially in Germany and Switzerland, are beginning to deploy a suite of automatic technologies that facilitate the operation and management of services, offer greater convenience and flexibility

Carsharing satisfies occasional vehicle needs such as carrying several passengers or goods *Photo courtesy of Mobility CarSharing Switzerland*

for users, and provide additional security for vehicles and key management systems. In northern California, a "smart" carsharing demonstration program with 12 vehicles began testing and evaluating a variety of state-of-the-art advanced communication and reservation technologies in mid-1998.[2]

Smart carsharing makes intermodalism more viable, thereby creating the potential for even stronger 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 possibly other activity locations during the evening and then drives it back to the station in the morning. After riding the train for the line-haul part of her trip that morning, she "rents" another vehicle to get to work from the station. During the day the vehicle is used as a fleet vehicle at her office. Altogether, a shared-use vehicle is used for up to ten distinct trips per day, plus facilitating up to four additional transit trips.

History of Carsharing in Europe

Most carsharing efforts are small scale and in Europe. One of the earliest European experiences with carsharing can be traced to a cooperative, known as "Sefage" (Selbstfahrergemeinschaft), which initiated service in Zurich, Switzerland, in 1948.[3] This early effort was mainly motivated by economics. Individuals who could not afford to purchase a car instead shared one. Elsewhere, a series of "public car" experiments were attempted, but failed, including a carsharing initiative known as "Procotip" that was started in Montpellier, France, in 1971, and another called "Witkar" that was deployed in Amsterdam in 1973.[4]

More recent and successful experiences with carsharing began in Europe in the mid-1980s.[5] Current CSOs exist in Denmark, England, France, Ireland, Italy, Norway, Scotland, and Sweden. Approximately 200 CSOs are active in 350 cities throughout Switzerland, Austria, the Netherlands, and Germany. The four most active carsharing countries in Europe collectively claim over 100,000 participates. The European Carsharing (ECS) association, established in 1991 to support carsharing lobbying activities, recently reported a membership of 40 CSOs which collectively serve over 40,000 individuals with 2,500 cars at 700 locations.[6]

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, with 1,000 cars (as of mid-1998) and StattAuto Berlin with about 200 cars. The Swiss program, begun in 1987, now operates in 600 locations in 300 communities, with over 20,000 members.[7] StattAuto in Berlin, begun in 1988, now has nearly 4,000 members.[8]

Though founded only one year apart, these two organizations evolved independently and quite differently. Mobility CarSharing Switzerland (a May 1997 merger of Auto Teilet Genossenschaft [ATG] and ShareCom) sprang from a grassroots effort to spread carsharing throughout neighborhoods and transit stations in Switzerland. In contrast, StattAuto Berlin was launched as part of university research to demonstrate that carsharing could offer a viable transportation alternative for

Germany These two organizations are recognized worldwide as modern pioneers of carsharing Both have been growing about 50% per year until 1996.[9] Mobility CarSharing Switzerland continutes to grow about 50% per year, but StattAuto Berlin's growth rate has slowed (although 1,000 new members were admitted in 1997).[10]

StattAuto Berlin attributes three reasons for this stagnation.[11]

1. Many Berlin citizens 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 car-sharing vehicles and transit
2 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, StattAuto members pay an annual fee of 170 marks or $100. If an individual's vehicle use is less than 200 marks or $120 a year, this individual will typically drop out of the CSO and use traditional auto rentals to fulfill their occasional vehicle needs.
3 Finally, other members require vehicles so often for tripmaking that the effort to reserve 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, who move to the country, no solution has been found. To regain their former clients and attract new ones, StattAuto Berlin has started some new initiatives, which are described in the section "Innovating Through a CSO Lifecycle."[12]

Both organizations are preparing to enter a modernization phase, moving from manual "key box" operations to a system of smartcard technologies for making automatic and advanced reservations, accessing vehicle keys, securing vehicles from theft, and facilitating billing The shift to smartcards eases administration and management of large systems, but the large investment required for the new communication and reservation technologies, in turn, is putting pressure on these organizations to continue expanding to generate the 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 billing [13] After the car is returned, the vehicle communicates distance traveled and fuel consumed to a central computer system or advanced fleet management 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 [14] These cost savings have been used as a justification for corporate subsidies of the program. As of 1998, the system is being modernized with a smartcard system and coordinated with local transit operators.[15] A similar program, "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.[16]

The French "Praxitele" program also uses advanced technologies In

October 1997, Praxitele began operation of 50 Renault electric vehicles that are rented and driven between five "Praxiparcs" located near transit stations and office blocks.[17] At present, there are over 200 users, with plans to expand to 1,000 system users in the near future. All cars will eventually have global positioning system (GPS) location and navigation systems, contactless smartcard technologies, and a central computer to manage the system.[18] Recently, Praxitele announced that the city of Paris plans to deploy a similar system with 2,000 cars in the year 2000

Along with these success stories are many failures Most organizations have found it difficult to 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 CSOs have merged or been acquired by larger European CSOs

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 [19] Each household leased a very small "mini" car for local trips, and was given access to a shared-vehicle 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 efficient existing organization, such as a large fleet operator.

In this field test, the mini vehicles leased to participants were used for 75% of the households' vehicle miles of travel (VMT). In contrast, the shared vehicles were only used 35% of the time that they were 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.[20] The STAR company operated as a private enterprise from December 1983 to March 1985 providing individuals in an apartment complex the 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 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 to $9 per day with an additional mileage charge of 10¢ a mile. The members shared a fleet of 51 vehicles (44 cars, 5 wagons, and 2 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.[21]

This project failed halfway through the planned three-year program. The primary problem was the low and erractic 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 not actually listed on the lease. Another failing was the pricing structure of STAR. it 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 keep costs low 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 not available.[22]

Today, there are eight existing carsharing organizations in North America They share a similar operational model. Members access vehicles at a neighborhood lot, which is located a short walking distance from their home or worksite, and they make carsharing reservations over the phone. At present, none of these CSOs use smart technologies to facilitate reservations, operations, and key management Three are run as for-profit businesses, and the rest as non-profit cooperatives.

Four of these 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 340 members and 24 cars The vehicles are reportedly used 50% of the time they are available (i.e., 12 hours per day). Interestingly, this organization began as a non-profit 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 300 members and 21 cars. Its vehicles are also reportedly used 50% of the time that they are available. CommunAuto was founded as a for-profit business, not as a non-profit cooperative.

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. In mid-1998, CAN had 140 members and 11 vehicles This CSO operates as a non-profit cooperative. In February 1997, Victoria Car-Share Co-Op launched its operations in Victoria. This non-profit cooperative currently has 56 members and 3 vehicles. Victoria's vehicles are in use seven to eight hours per day. In the summer of 1998, another CSO plans to launch operations in Toronto, and still another is being considered for deployment in Ottawa.

Four small carsharing organizations, all less than two years old, operate in the United States. Another three are being planned in the Pacific Northwest. Boulder CarShare Cooperative was launched in Boulder, Colorado, in May 1997. The Boulder CSO has seven members from five households who share one vehicle. Members pay a modest monthly fee and mileage charges for vehicle use. This CSO also provides assistance to other neighborhood groups interested in forming a car co-op.

Dancing Rabbit Vehicle Cooperative (DRVC), located in Rutledge, Mis-

soun, has been in operation since July 1997. This CSO currently has six members, one biodiesel van, and supplies an average of 380 VMT per week to its members. Dancing Rabbit operates under a non-profit, 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 operations in February 1998 with two Dodge Neons The project, Car Sharing Portland, Inc , currently has over 50 members and three vehicles 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 non-profit cooperative since March 1998. Olympia has 6 members and one car This operation guarantees members use at least two weekend days per month and unlimited weekday usage

A fifth CSO, Motor Pool Co-Op, is planned to be launched by the end of summer 1998 in Corvallis, Oregon. Motor Pool will start its program with three vehicles and run as a non-profit cooperative. In early 1999, the city of Seattle and King County Metro plan to begin carsharing in Seattle in two to three high-density neighborhoods. The startup will initially be subsidized by Metro with the goal of deploying 100 vehicles and enrolling 1,500 subscribers by the end of its first year. 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.

And in San Francisco, a group of individuals began seeking funds to launch a CSO in late 1997, hoping to begin operations in the spring of 1999, with 50 members and a minimum of eight cars.

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 in Atlanta, Boston, Long Island, New Jersey, Sacramento, San Francisco, southern California, southern Florida, and Washington, D C , and a number of other regions are at an exploratory stage. Station car vehicles are made available either near the home or work end of a transit commute. The largest is the Bay Area Rapid Transit District station car demonstration program in the San Francisco area, with nearly 40 electric vehicles, including: 30 PIVCO City Bees from Norway, 2 General Motors EV-1s, 2 Toyota RAV-4s, and 5 Kewets from Denmark.[23]

Station car programs were launched in the mid-1990s by rail transit operators seeking to relieve parking shortages at stations (and desiring to avoid the high cost of building more parking infrastructure), by electric utilities eyeing a potential initial market for battery-powered electric vehicles, and 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-1998 none have yet incorporated shared-use practices [24]

Innovating Through a CSO Lifecycle

To date, all non-corporate carsharing organizations have begun as small, local operations, usually with government funding and usually 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 novel and less expensive ways of owning and employing cars indeed were the core constituents of pilot carsharing projects in the Netherlands and the United Kingdom.[25] 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. They are exploring partnerships with transit, car-leasing programs, car rental agencies, and taxis.

This partnering process includes business collaborations and joint use of advanced information and communication technologies.[26] Existing examples are described below

Autodate

Autodate, founded in 1995, is an umbrella organization that serves 85,000 CSO participants in the Netherlands In addition to supplying conventional information and marketing functions, Autodate also provides the services described below [27]

1. Facilitates linkages between private carsharing services and other businesses (e.g., taxi companies and car rental agencies).
2. Links carsharing providers to private companies interested in sharing their fleet vehicles
3. 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 units and private businesses to assume an expanding share of the budget [28]

Mobility CarSharing Switzerland

Mobility CarSharing Switzerland recently launched a new mobility service program that provides a combination of carsharing, public transit, car rental, taxi, and other services to its customers. This program, known as the Zuger Pass Plus (ZPP), is a partnership with the regional transit company, Hertz, local taxi companies, and other businesses. ZPP provides discounts on car rentals, taxi services, and CSO annual membership fees, as well as priority service for CSO cars On September 1, 1998, another partnership was launched with the Swiss National Rail System to offer a mobility package to all 1.5 million passholders of the Swiss Railway Systems (approximately 30% of the country's entire adult population), providing them with special discounts and easy (smartcard) access to CSO cars [29]

StattAuto Berlin

Similarly, StattAuto Berlin has designed new innovative services, including CashCar, which allows clients to

lease a vehicle through the CSO. With CashCar, the customer has the option of making the leased vehicle available for CSO use when he or she is out of town. This transaction, which is based on flexible rates that are adjusted every hour based on supply and demand, reduces the cost of the lease by about $100 per month if the leased vehicle is rented for just one weekend each month.[30]

Another innovation of StattAuto Berlin is its Mobil Card, which carsharing customers can use for an expanded set of services and discounts. This smartcard provides a 15% cost reduction on public transportation, allows users to take taxis without exchanging cash, pay for food and beverage delivery, reserve a cargo-bicycle, and even book a canoe in Brandenburg, Germany. In early 1998, Mobil Cards could be purchased in 46 StattAuto locations throughout Berlin and Potsdam. Beginning in 1995, StattAuto Berlin also began offering its members a food and beverage delivery service called "Stattkauf." For a moderate fee, members can receive a Staffkauf delivery once a week.[31]

StattAuto Berlin, like Mobility CarSharing Switzerland, is also partnering with major car rental companies to provide vehicles to CSO members when it is more economical to rent a vehicle than to use a CSO car (e.g., when rental periods are greater than a day and on holidays when carsharing demand is at a peak).[32]

StadtAuto Bremen

Another German CSO, StadtAuto Bremen, which now has 1,100 carsharing members launched a transit pass program in June 1998, which links the city's transit pass to the CSO's smart auto card.[33]

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.[34] 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.[35] More sophisticated studies are underway at the University of California, Davis, and in Switzerland.[36]

Several surveys of users have been conducted in Europe by carsharing organizations. Although most of the surveys have small samples, did not use control groups nor travel diaries to collect data, and used 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, earn below-average incomes (in part due to the low average age of participants), and be sensitive to environmental and traffic problems.[37] In a separate study, StattAuto Berlin reported similar characteristics: 65% male, average age of 33, well educated, and modest incomes (U.S. $2,000 per-month).[38] Muheim and Partner[39] 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.[40]

In a German survey, Baum and Pesch[41] explored motivations to participate in a carsharing service. Cost was not considered and multiple answers

were possible. Exhibit 1 presents the response to this survey.

In another European study, Lightfoot (in collaboration with Wagner and Muheim) surveyed individuals who do not participate in carsharing [42] He found that the principal reasons for not participating were CSOs' unprofessional image, an insufficient variety of products and services, higher costs than transit, a system that was "complicated, impractical and time consuming," and vehicles that were not readily available near home.

Mobility CarSharing Switzerland foresees a large suburban market in Switzerland. It aspires to capture 12% of drivers, many of them in semirural areas. In contrast, Baum and Pesch characterize carsharing as a predominantly urban phenomenon in Germany.[43] They estimate a potential market of 3% 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.[44] 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.

Exhibit 1
Motivations to Use Carsharing, Germany, 1994

Service Feature	% Rating Service Feature Highly
Convenient neighborhood locations (i.e., 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
Carsharing 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

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 users of vehicles

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 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% vehicle availability They accomplish this level of availability by providing about one car for every 15 to 20 members [45] 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 [46] Optimal is defined here more in terms of consumer convenience than overall economics As an indication of vehicle utilization, StattAuto Berlin reports that its vehicles average 21,250 miles per year, compared to the 9,060 miles of the average German car. Vehicle trips tend to be of short duration and distance: 77% of StattAuto Berlin "rentals" are less than 24 hours in length, and 56% range between 12 and 62 miles (the other 44% fall below 12 and above 62 miles). The average occupancy rate of a StattAuto Berlin vehicle is 2 persons, compared to the German average of 1.3.[47] Vehicles are used fairly intensively, but individual members tend to be sporadic users, with StattAuto members driving less than half that of the average driver (2,500 v. 5,440 miles per year).[48]

As an indication of the economic attractiveness of carsharing, Muheim and Partner found that expenses of early Mobility CarSharing members were reduced by 2,500 francs or $1,700 annually and that carsharing is cost effective for users who drive less than 5,630 miles per year.[49] Baum and Pesch report the breakeven point for carsharing in Germany at 4,270 miles per year,[50] and Petersen reported a breakeven point for StattAuto Berlin of 11,370 miles [51] 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 reduction in vehicle usage, but also by reducing the demand for parking space. Vehicle travel will be reduced because drivers are more directly confronted with the per-usage cost of driving, and presumably will

respond rationally by reducing vehicle usage.

The magnitude of these nonmarket and indirect benefits are large according to several carsharing surveys. As indicated in Exhibit 2, about 30% of individuals sell their cars after joining CSOs, according to three different carsharing surveys conducted between 1990 and 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 33 to 50% after they joined the CSO. Most of these individuals increased public transportation usage to meet many of their transportation needs [52]

In the Netherlands, former car owners reduced car mileage by 37% — from 9,880 to 6,270 miles annually. Former non-car owners reduced private vehicle mileage by 29%—from 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.[53]

Similarly, for Germany, Baum and Pesch reported that carsharing reduces private car mileage by 58%, from 4,375 miles to 2,530 miles per year, after membership.[54] 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 960 miles per year. Exhibit 3 summarizes the

Exhibit 2
Vehicle Ownership Before and After Joining CSOs[a]

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 carsharing		15 6%	31.5%
Given up a private car because of carsharing	26 2%	42.4%	23 0%
Given up their car independent of carsharing	31 1%		29.7%
Continue to own a private car	5 5%	6 3%	3 0%

a These survey results are four to eight years old and generally reflect the behavior of early adopters.

Source. P. Muheim and Partner, Car Sharing Studies An Investigation *Prepared for Graham Lightfoot, Ireland, 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, H. Baum and S. Pesch,* Untersuchung der Eignung von Carsharing im Hinblick auf die Reduzierung von Stadtverkehrsproblemen *Bundesministerium fur Verkehr, Bonn, 1994*

Exhibit 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 Baum and Pesch, 1994 from Harms and Truffer (1998).

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 it would be in North America.

Not surprisingly, the mobility behavior of individuals, who did not own a car before CSO membership, is not altered significantly.[55] Muheim and Inderbitzin found that for this group of customers, carsharing trips often substitute for vehicle trips that were typically made with a borrowed car.[56]

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.

Conclusions

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 steep growth trajectories. These CSOs appear to provide large social benefits. Car travel and car 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 a review of the literature (and the personal experience of one of the authors), this article 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; driving disincentives such as high parking costs and traffic congestion are pervasive; car ownership costs are rather high; and alternative modes of transportation are easily accessible

An even more important lesson, though not well documented, is the need for partnerships and mobility management to offer enhanced products and services.[57] 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 vehicle ownership proliferates and vehicles become more specialized, entrepreneurial companies may see an opportunity to assume the full care and servicing of a household's or an individual's mobility needs in neighborhoods, worksites, transit stations, and shopping centers, based on mobility management.[58] 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 pioneering CSOs combine their operational expertise with the entrepreneurial capabilities of advanced technology suppliers to create mobility services that enhance our social, economical, and environmental well being.

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