CARSHARING: Establishing its Role in the Parking Demand Management Toolbox

A thesis

submitted by

Gina Filosa

In partial fulfillment of the requirements
for the degree of

Master of Arts

in

Urban and Environmental Policy and Planning

TUFTS UNIVERSITY

May 2006

ADIVSOR: Ann Rappaport

ABSTRACT

One of the most common regulatory mechanisms used in North America to control the parking supply in developments is through zoning or building codes that specify requirements for off-street parking for every building, with actual requirements varying with the type of land use. Such parking requirements often result in the over supply of parking which, in turn, consumes land and natural resources, encourages automobile use and increases the associated air and water pollution. The desired alternative to such inefficient parking regulations is to provide flexibility to address the range of parking needs that exist within a city, through either supply-side or demand-side strategies. Strategies that aim at avoiding oversupply encourage better use of existing parking facilities and better evaluation of parking needs, whereas those strategies that address demand are policies that seek to give individuals an alternative to driving, and thereby reduce the demand for parking.

This thesis explores the concept of using carsharing as a parking demand management strategy in developments through a review of the literature regarding parking policies and carsharing, as well as examining three North American cities, Boston, Massachusetts, Vancouver, British Columbia, and Austin, Texas, that have utilized carsharing as a parking demand strategy. Based on information gathered from the case studies and the literature review recommendations are made on how to incorporate carsharing into local parking policies. Recommendations on the preliminary process of policy development include: first, make updating parking policies a priority; second, increase the education/outreach efforts regarding the use and benefits of carsharing; and third, develop

a strong working relationship between the public and private stakeholders. Recommendations on implementing the use of carsharing as a parking demand policy include: establish a carsharing overlay zone, couple carsharing with supportive polices; and offer incentives to support alternative transportation. Governmental support of carsharing and its inclusion in the development process can be a powerful tool in helping cities improve the quality of life of residents and enhance the vitality of neighborhoods.

ACKNOWLEDGEMENTS

Special thanks are due to Ann Rappaport and Christine Cousineau of Tufts University for their guidance, support, and review of this thesis. I would also like to thank all of those who contributed to this work by sharing their knowledge on the subject, including Tracey Axelsson, Adam Brophy, Alison Felix, Katie Larsen, Paul Pinsker and Mark Walters. Last, but not least, I thank my family and friends for their support and encouragement throughout the process.

Table of Contents

List of Tables

List of Figures

CARSHARING: Establishing its Role in the Parking Demand Management Toolbox

Chapter I: Introduction

1.1 The Problem

Parking policies greatly impact the land use patterns within a city and are therefore closely intertwined with private vehicle use, traffic congestion, the cost of real estate development, affordable housing, water quality, smart growth, and livable community issues. One of the most common regulatory mechanisms used to control parking supply is through zoning or building codes that specify minimum requirements for off-street parking spaces for each type of land use. Planners typically base minimum parking requirements on parking generation rates developed by the Institute of Transportation Engineers (ITE). Yet, the ITE rates are based on peak demand with no regard for demographic issues, urban versus suburban sites, or the availability of public transit, and as a result the required parking often goes unused (Banfield, 1997; Crane, 2000; Shoup, 1997). Requiring enough parking to meet peak parking demand reduces a project's density levels, increases the cost of development, and perpetuates a car-dependent society, which is highly resource intensive and produces negative environmental and health effects.

While zoning for parking has historically focused on supply-side strategies, an alternative approach aims to reduce the demand for parking. Such demand side policies include site-specific requirements, traffic demand management, charging market rate for parking, unbundling parking costs from rental costs, and developing car-free housing (Litman, 2000). One such innovative parking policy that can be utilized in urban areas to reduce parking demand is encouraging the incorporation of carsharing on a site.

Carsharing, while popular in Europe since the 1980s, began to take hold in the United States in the late 1990s (Shaheen, Cohen and Roberts, 2005). Carshare organizations (CSOs) are membership programs that provide members with access to a fleet of vehicles for use on an as-needed basis. The idea of carsharing is based on the notion that the number of vehicles required to meet the demand of a group of individuals is less when they share vehicles than when each individual has his or her own vehicle. Carsharing can provide society with more efficient vehicle usage, reduction in space devoted to transportation infrastructure, as well as the benefits of diminished space as the result of vehicles being used more intensively, and therefore being less likely to sit unused in parking lots at transit stations, workplaces, and schools. In addition, upon joining a carsharing organization many members often give up a vehicle or avoid purchasing an additional vehicle. Furthermore, carsharing has positive impacts on increasing the use of alternative transportation modes such as walking, bicycling and public transportation.

1.2 Scope and Objectives

Reducing the amount of land designated for parking can have both environmental and social benefits. Less area dedicated to parking can lead to increased density, lower development costs, less impervious surface and a reduction in automobile use. While there appears to be a large amount of interest in the concept of offering carsharing in developments as a tool to reduce parking requirements, implementation of the practice is not widespread. This paper seeks to explore the concept of carsharing as a parking demand management strategy in developments, and determine if it is a viable policy for municipalities to pursue, and if so, how best to implement it. Questions explored include:

1. What impacts does carsharing have on parking demand?
2. How is carsharing currently being incorporated into new developments?
3. What are the obstacles to utilizing carsharing as a parking demand management strategy?
4. What are the roles of the city, the carshare organization and the developer in promoting carsharing as a parking demand management strategy?

1.3 Methodology

Using a series of interviews with interested stakeholders and a review of the literature, this thesis seeks to better understand the utilization of carsharing as a parking demand strategy. The thesis also examines three North American cities that have utilized carsharing as a parking demand strategy and analyzes the process by which this policy developed. The three cities analyzed are:

1. Austin, Texas: provides incentives for developers to incorporate carsharing into projects located in one specific neighborhood zone.
2. Vancouver, British Columbia: parking by-laws structured to provide incentives for developers to incorporate carsharing into their projects.
3. Boston, Massachusetts: carsharing used as a mitigation measure in the site planning process for large developments.

Information gathered from the case studies, as well as the literature review are used to make recommendations on how to incorporate carsharing into local parking policies. This analysis begins by looking at the history and use of parking requirements in North America.

Chapter II: Overview of Parking Requirements

Parking plays a key role in a community's overall transportation strategy. Parking affects the livability, affordability, and economic success of a development. In addition, policies affecting the supply and cost of parking can play a role in promoting a shift away from automobile dependency to more ecologically sound transportation modes such as walking, cycling and mass transit. One of the most common regulatory mechanisms that communities use to control parking supply is through zoning or building codes that specify minimum parking requirements for off street parking for every building, with actual requirements varying with the type of land use. Minimum parking requirements were originally imposed in order to ensure that adequate on-site parking was provided so as to limit spillover parking into surrounding areas, as well as to support enhanced commerce at the site (Kuzmyak, et al, 2003). In its early years, zoning for parking was applied mainly to problem land uses or building types, namely multifamily housing for areas with high automobile ownership rates. Zoning for parking advanced slowly in the first half of the twentieth century, with barely one in five American cities with populations exceeding 10,000 zoning for parking. However, by 1969, a mere two decades later, over 95% of American cities with populations above 25,000 zoned for parking (Ferguson, 2004).

Parking requirements are the responsibility of local governments and are thus defined by local needs and attitudes. Municipalities require minimum parking requirements to ensure that a development contains an adequate number of spaces in order to avoid parking spillover onto adjacent streets and properties, to maintain traffic circulation and to ensure the economic success of the development (Willson, 2000). The science behind creating parking standards is extremely complex as it is often difficult to determine the actual demand for parking that a development will create. Supplying too little parking can inconvenience residents, and result in spillover of parking into adjacent neighborhoods. Conversely, supplying too much parking can increase the cost of the development, and thus reduce its affordability, while at the same time creating unnecessary environmental impacts such as encouraging additional car ownership and use, and increasing the amount of impervious surface on a site. Furthermore, parking, specifically in the form of surface parking lots, creates a visual eyesore by interrupting the flow of the streetscape. The expanse of asphalt between and around buildings reduces pedestrian accessibility, often creating an incentive (and at times a necessity) to drive from building to building instead of walking.

While a very common practice, zoning for parking has been criticized over the years as being a highly inefficient means to deal with traffic and parking problems. The American Planning Association's Planning Advisory Service (PAS) stated in *Off-Street Parking Requirements* that:

> It is widely accepted within the professional literature that a requirement of "excessive" amount of parking yields only lower densities and larger impervious surface areas. Off-street parking can grow quickly and eat up a tremendous amount of land if it is not looked at critically (PAS Report 432, Bergman, 1991).

Despite the controversy surrounding it, zoning for parking remains an extremely popular planning tool which goes virtually unchallenged in most planning departments today (Ferguson, 2004).

2.1 Established Parking Requirements

While nearly every city planner works with parking requirements, few have the professional training necessary to establish them. Furthermore, little attention is given to parking requirements in leading planning literature. For example, the American Planning Association's 2002 publication *Growing Smart Legislative Guidebook: Model Statutes for Planning and the Management of Change* provides statutory options from contemporary planning practice to assist legislators, state and local government officials, planners and citizens to make informed choices on present day planning issues. While the guide seems to address just about every planning issue and tool, it does not address parking requirements at all (Shoup, 2005). Shoup identifies other books published by the APA that ignore parking requirements including *The Citizen's Guide to Planning; City Zoning: The Once and Future Frontier; Comprehensive City Planning: Introduction and Explanation; Growth Management Principles and Practices: Guidelines for Preparing Urban Plans; Making Places Special; Neighborhood Planning: A Guide for Citizens and Planners; Planning Small Town America; The Practice of Local Government Planning; Strategic Planning: Threats and Opportunities for Planners;* and *Zoning and the American Dream* (Shoup 2005). With a lack of training and few resources to guide the process, how do planners create parking requirements?

Establishing parking requirements is a three step process. First, a planner needs to identify the land use; second, choose the unit of measurement for the requirement; and third, establish how many parking spaces to require per unit of the basis.

Step 1: Identify the land use

Land use refers to the kinds of activities on the land or the major purposes of the occupancy of the land (Shoup, 2005, p.609). The major land use categories are residential, commercial (including both office and retail uses), industrial and institutional. Within these categories, classification systems vary greatly from city to city, and state to state. The two extremes of classification systems range from, on the one side, defining a small number of land-use categories to reflect the important variations in parking supply and demand, and on the other, defining a larger number of minutely differentiated land-use categories (Ferguson, 2004). Leading institutions recommend parking standards from 49 categories in Smith (1999) to 174 in Bergen (1991). See Table 1 for examples of land uses.

Table 1: Example of Land Use Categories

Abattoir	Ice cream manufacturing	Rifle range	Batting Cage	Junkyard
Convent	Sex novelty shop	Kennel	Landfill	Tea room
Diet clinic	Night club	Horse stable	Pet cemetery	Zoo
Veterinarian	Gas storage plant	Funeral parlor	Fast food restaurant	Movie theater
Taxi stand	Bowling alley	Church	Bank	Barber
Golf club	Hotel	Hospital	Laundromat	School

Source: Derived from Shoup, 2005.

Step 2: Unit of Measurement

Once the land use is identified, a planner must then select the unit of measurement to use to determine the number of parking spaces required on the site. Planners choose factors that will help them determine parking demand for the site. Similar to land uses, the variety of units of measurements used is extreme. Planners have identified 216 factors that supposedly predict peak parking demand (Shoup 2005, p.610). The basic units used fall into three categories (Ferguson, 2004):

- Supply-side
    - Dwellings, apartments, cabins, suites, sleeping units, rooms, classrooms, chapels, beds, chairs, holes, bays, pumps, alleys, stalls, tables, courts, billiard tables, washing machines, etc.
- Demand-side
    - Persons, families, residents, occupants, members, pupils, staff, barbers, vehicles, loading, etc.
- Spatial
    - Gross-floor-area (GFA), gross and net leasable area, floor area, lot area, pool area, pew space, etc.

Step 3: Specifying the number of parking spaces required

The third step in setting a parking requirement is for the planner to specify the number of parking spaces required by the land use identified. Since estimating the parking demand that a development will generate is a complex task for which few planners are properly trained, many municipalities utilize short cuts instead of performing their own studies. Two of the most common short cuts used by planners are to either copy the parking requirements employed by near-by cities, or consult published data.

A. Copy other cities

Many planners survey the parking policies of nearby cities for answers to guide them in setting parking requirements. While this practice may be inexpensive and non-controversial, it may not be the best system if the policies of neighboring towns are out of line with actual parking demand levels. As a result, copying other cities' parking requirements might mean copying their mistakes as well. The Planning Advisory Service (PAS) has published three national surveys of parking requirements in zoning ordinances. These surveys provide a myriad of examples of zoning ordinances that local officials may choose from to decide what would work best in their individual city (Ferguson, 2004;

Shoup, 1997, p.27). However, such examples are based on national averages that do not take into consideration site characteristics such as density, demographics, availability of non-motorized travel options and the surrounding land use mix (EPA, 1999). Depending upon generic requirements to guide policy for specific sites may result in a surplus of parking spaces, while at the same time subsidizing automobile use. This in turn encourages auto use even in areas that are well served by public transportation.

B. Consult ITE Data

The second most commonly used source of information to help establish parking requirements is the Institute of Transportation Engineers' (ITE) report *Parking Generation.* This report provides information on the parking generation rate of 64 different land uses. The parking generation rate is defined as the average peak demand of parkers that would be attracted to a site. Half of the 101 parking generation rates reported in the ITE are based on four or fewer studies, and 22 percent are based on a single study (Shoup, 2005, p.32). In addition, a majority of the studies were on suburban developments with little or no transit ridership, and ample free parking. As a result the parking rates developed by the ITE data do not address a host of situations found in urban environments, and thus may not be an accurate resource for city planners. In addition, the information provided by ITE pertains to parking demand only, and does not discuss parking need. Parking need refers to the number of parkers who need to be accommodated in a giving facility after the use of alternative parking facilities or transportation options are considered (Keneipp, 1983, p.17). Table 2 provides an example of ITE's recommended minimum parking requirements for several land uses.

Table 2: ITE's recommended minimum parking requirements

Building Type	Unit of Measure	Number of parking spaces
Single family	Dwelling	2.0
Multiple family	Dwelling	1.5
Hotel	Room	1.0
Office	1000 Square feet	3.65
Retail	1000 Square feet	3.65
Restaurant	1000 Square feet	17.15
Theater	Seat	0.38
Industrial	Employee	1.0

Source: Derived from Ferguson 2004, p.190

Many critics (Shoup 2005, Willson 2000, Litman 2004) argue that the parking requirements that come out of this three step process are an ineffective tool for matching parking supply with parking demand. While the goal of off-street parking is to assure adequate parking, if such requirements are set incorrectly they carry with them numerous negative consequences.

2.2 Impacts of flawed parking requirements

Minimum parking requirements which result in the over supply of parking consume land and natural resources, encourage automobile use and increase air and water pollution. Minimum parking requirements can also act as an indirect form of density control when they limit density to less than the permitted floor-to-area ratio (Willson, 2000). The excess land utilized for parking has an opportunity cost in terms of less land being available for other productive uses. Developers lose out on the revenue that could have been generated from building denser (for example the rental or sale of more units). In addition, the land lost to parking could have alternatively been used to provide open green space which could increase the value of the development. The opportunity costs that the developer is incurring in order to provide parking is just one of the factors in the cost equation of parking.

2.3 Costs of providing parking

In addition to the money that is lost from providing parking instead of using the land for a higher value use, the developer also has direct costs in building parking. The cost per space varies widely depending on whether the parking is surface, above ground structured, or underground. Structured parking is far more costly than surface parking but is often required in infill and/or urban locations, where the developer has no other choice but to build up (or down) rather than out in order to fulfill the parking requirements. Shoup (1998, 200) reports that parking structures at UCLA have cost *at least* $22,500 per space added. Additional considerations are lot location (urban versus suburban), engineering and design considerations (smaller lots have higher costs per parking space because of the fixed capital costs). Cost per parking space includes land, construction, maintenance, utilities, insurance, administrative, and operating costs (EPA, 2006, p.9).

In addition, parking imposes further financial costs on society because parking costs are typically incorporated into the costs of buildings and developments. While consumers rarely pay out right for the cost of parking, they pay for such services through higher rents, lower wages and benefits, higher property taxes, and higher prices for retail goods (Litman, 2000). Because parking costs are usually charged indirectly rather than directly, consumers are forced to pay for the cost of parking regardless of whether they use the service or not.

Beyond these purely financial costs, parking also generates numerous environmental costs. The large expanse of pavement associated with surface parking lots is impermeable and thus increases stormwater runoff and flooding. This runoff collects the various pollutants associated with automobiles, including oil, gasoline and salt, and carries them into the local water body system resulting in degraded water quality. Parking lots also create indirect environmental costs, which include the increased use of air conditioners and energy needed to offset the "heat islands" that are created from large expanses of dark asphalt artificially raising the air temperature in an area. Furthermore, an abundant supply of convenient parking encourages individuals to drive private vehicles, while at the same time discouraging alternative travel modes such as walking or cycling. When driving is the most convenient and rational choice, vehicle miles traveled (VMT) will be high, which in turn increases air pollution, global warming and dangerous ground-level ozone problems.

2.4 Conclusion

Many planners' lack of professional training and use of inadequate and imperfect planning guides have resulted in the requirement and provision of abundent parking spaces in developments. Many new developments, particularly office buildings and shopping plazas, have large parking lots that are underutilized for the majority of the time, with the exception of a few days of the year when demand is at its peak, namely the holiday season. Requiring an abundant amount of parking spaces limits the prospect of urban infill projects, reduces the density of developments, and encourages the use of private vehicles as the primary transportation mode. While minimum parking requirements have been the method of choice used by many municipalities to control parking supply, the negative consequences generated by this planning tool have prompted many planners to question the effectiveness of this method and search for alternative strategies. The following chapter provides examples of the various innovative parking policy strategies that municipalities can use to overcome the numerous problems associated with inefficient parking requirements and the associated development patterns they create.

Chapter III: Beyond Minimum Parking Requirements

The inflexibility of minimum parking requirements that many local governments enforce have created an auto-oriented land use pattern in numerous North American cities. Developers believe that the market demands alternative approaches to the current land use patterns, but such alternatives are undersupplied because of local government regulations (Levine & Inam, 2004, p.409). The desired alternative to the familiar inefficient parking requirements would provide flexibility to address the range of parking needs that exist within a city. The following section presents a number of innovative strategies that municipalities are using to address parking issues. The strategies can roughly be divided into two categories: those that are aimed at addressing the oversupply of parking and those that seek to minimize parking demand. Strategies that aim at avoiding oversupply encourage better use of existing parking facilities and better evaluation of parking needs, whereas those strategies that address demand are policies that seek to give individuals an alternative to driving, and thereby reduce the demand for parking (EPA, 2006, p.13).

3.1 Avoiding Oversupply

When parking requirements are set city-wide they inevitably result in an inefficient supply of parking at some development sites. Such blanket requirements ignore the fact that each development has unique features, including the socio-economic and demographic market it attracts, the location of the site, and its proximity to public transit, all of which will impact its parking needs. As the previous chapter explained, inefficient parking requirements which result in an abundant supply of parking consumes land and natural resources, decreases the density of the development, encourages automobile use and increases associated air and water pollution. Strategies aimed at avoiding the oversupply of parking include:

- Location specific requirements
- Market specific requirements
- Maximum parking requirements
- Enforcing a parking freeze
- Shared parking
- Centralized parking facilities
- In-lieu of parking fees
- Unbundling parking costs
- Charging higher fees for parking

3.1.1 Location specific requirements

Instead of uniform parking requirements for an entire city, parking requirements can be tied to zoning districts and/or specific neighborhoods in order to more accurately reflect the particular parking needs of the area. For example, downtown areas and central business districts are more compact, mixed-use and more walkable then areas on the edge of a city, and therefore, such zoning districts should have lower parking requirements to reflect its need and to maintain its character. Similarly, cities can define transit overlay districts, or areas that are well served by transit, including both rail and bus services. The availability of public transit means that individuals have an alternative to private vehicle use, and therefore such areas should require less parking. In Montgomery County, Maryland, parking requirements for office developments located less than 800 feet from the Metrorail station are reduced by as much as 20 percent (Montgomery County, Maryland)

3.1.2 Market specific requirements

Similar to location specific requirements, market specific requirements are ones that are tied to the housing type, namely affordable and/or senior housing. Individuals with lower incomes and the elderly tend to own fewer vehicles. As a result, parking requirements are reduced for below-market-rate units and senior housing. Reducing parking requirements not only more accurately reflects the particular needs of the housing development, but also reduces the overall cost of providing such housing types and can therefore increase the number of units supplied.

3.1.3 Parking Maximums

In order to control the amount of land area allocated to parking, a number of cities have established parking maximums. Parking maximums are structured similarly to parking minimums, except that they define the maximum number of parking spaces on a per unit basis that a development can provide. Developers may provide fewer parking spaces than the maximum allows. In San Francisco, California, parking minimums exist for a number of the city's zoning districts, but maximum parking requirements are enforced in the downtown residential district (DTR). The minimum requirements of other areas serve as the maximum amount of off-street parking that may be provided in the DTR district (City of San Francisco).

3.1.4 Parking Freeze

A parking freeze caps the total number of parking spaces in a particular metropolitan district. Boston, Massachusetts has had a parking freeze in effect for a number of years in three areas: Downtown, South Boston and East Boston. The goal of the city's parking freeze is: "to reduce vehicle miles traveled in the Boston area, to promote the use of public transit, and to encourage transit-related development by restricting the number of off-street parking spaces (City of Boston, 2006). After imposing a cap on the number of parking spaces a city will then conduct an inventory of existing spaces and develop procedures by which parking permits are issued. New parking permits cannot be granted unless there are available spaces in the parking freeze bank, which represents the difference between the cap and the number of spaces currently allocated through permits. Parking freezes have the most success in cities that have strong economies and viable public transit systems (EPA, 2006, p.15).

3.1.5 Shared Parking

Shared parking is based on the idea that different land uses generate traffic and parking demand at different times of the day. For instance, banks typically only operate during the daytime hours, while restaurants experience peak demand during the evening hours. As a result two complementary businesses can share one pool of parking spaces in order to meet the parking demand of both locations (EPA, 2006, p.18). In areas of mixed uses, instead of setting parking requirements based on the maximum demand of each site, requirements may be set based on the shared demand of the sites. Shared demand is determined by looking at the parking required for each separate land use during specific time intervals, including daytime, evening and nighttime. See the example described in Table 3.

Table 3: Example of Parking Requirement for Mixed Use Area

Land use	Weekday Daytime	Weekday Evening	Weekend Daytime	Weekend Evening	Nighttime
Office	300	30	30	15	15
Retail	170	250	280	200	15
Entertainment	40	100	80	100	40
TOTAL	**510**	**380**	**390**	**315**	**70**

Source: Adapted from EPA 2006, p.19.

If parking requirements were set separately for each of the 3 land use types above, the total number of spaces needed would be 680 (300 for office, 280 for retail and 100 for entertainment). However, with shared parking only 510 parking spaces are needed to meet the shared peak parking demand of the three sites. Shared parking reduces the total number of parking spaces needed for this site by nearly 200 parking spaces.

3.1.6 "In-Lieu of" Parking Fees and Centralized Parking

In some cities developers have the option of paying a fee in-lieu of providing on-site parking. In turn, the city uses the revenue generated from the fees to provide centralized public parking facilities in a general area. Public parking built with the in-lieu revenue provides many benefits over on-site parking. It allows for the shared use of parking among different sites in the area that may not share peak demand times, thus reducing the number of spaces required to meet the combined peak parking demands (Shoup, 2004, p.231). Centralized facilities also provide customers with the ability to park once and visit a number of local businesses instead of driving from site to site, thereby reducing vehicle traffic and congestion. Public parking facilities also have the ability to improve the urban design of the area by allowing for continuous storefronts without the gaps caused by on-site parking lots.

3.1.7 Unbundling Parking Costs

Most people do not realize the true costs associated with parking because they typically enjoy free parking in most locations. Even when people are not explicitly paying a fee for parking, they are nonetheless paying for the availability of parking through higher prices in general. A result of requiring off-street parking for each building is that the cost of supplying the parking gets incorporated into the prices of everything else associated with the site. If the site provides housing, the price of each unit will be higher in order to capture the cost of the parking. Similarly, a business will increase the price of its goods in order to cover the costs of supplying parking. Abundant free parking encourages most people to drive wherever they go, and those who do use alternative transportation are penalized by paying more for something they do not use. Unbundling the price of parking will help to alter peoples' behavior. For example, many apartment buildings typically include one or two parking spaces in the monthly fee. If instead of including the spaces in the monthly fee residents were given the option to rent or lease a housing unit and parking space separately, only those who require, and are willing to pay will use the parking space. Pricing and providing housing and parking separately allows the market to reveal how much residents value and truly need parking spaces and then developers could build parking accordingly (Shoup, 2004, p.569).

3.1.8 Charging Higher Fees for Parking

The under-pricing of a good is like to result in more consumption that is socially optimal. Motorists park free for 99 percent of all automobile trips, and as a result the cost of parking rarely influences decisions on whether to own or use a car (Shoup, 1997, p.14). A way to avoid this situation is to charge market prices for curb parking. The higher, explicit cost for parking will limit the use of automobiles, and provide an incentive for travel by foot, bicycle and mass transit.

3.2 Reducing Demand

In contrast to the strategies described above which focus on the supply and pricing of parking, the following parking policy strategies aim at encouraging alternatives to driving privatively owned vehicles, and thus reducing the need for parking at the source. Strategies aimed at reducing parking demand include:

- Cashing out employer-paid parking
- Providing incentives for transit
- Bicycle parking requirements
- Carsharing

3.2.1 Parking Cash Out in Lieu of Parking Spaces

Many employment facilities provide free parking for their employees. In order to decrease demand for parking at employment facilities businesses can offer commuters the option to “cash out” their employer-paid parking subsides, thereby removing the perception that parking is free. While parking is still not charged for, the value of the parking will increase, becoming equivalent to the forgone cash that is being offered in its place (Shoup, 2004, p.262). Commuters can continue to park for free at work, but the cash option rewards and provides an equivalent transportation subsidy to those employees who carpool, ride public transit, walk or bike to work.

3.2.2 Providing Incentives for Transit

Offering transit passes to commuters can significantly reduce the demand for parking. Free or reduced-priced transit passes can be an effective strategy for a number of development types including businesses, universities, theaters, stadiums, hotels and apartments. In several cities, such as Dallas, Denver, Salt Lake and San Jose, transit agencies offer employers the option to buy "Eco Passes" which give all their employees the right to ride free on all local transit lines (Shoup, 2002, p.2). Subsidizing transit passes allows developers and employers to save money on the capital costs of supplying parking, gives commuters expanded transportation choices, increases transit ridership rates, and reduces traffic congestion and air pollution (Shoup, 2004, p. 262).

3.2.3 Bicycle Parking Requirements

Many cities are beginning to require bicycle parking facilities in developments of certain sizes. Requiring bicycling parking helps to support a non-motorized, environmental friendly form of transportation. When individuals see that bicycle parking is safe and convenient, and that they will not have to lock their bike to a tree or a sign post along the sidewalk, they will be far more likely to consider bicycle commuting (State of Washington, 1999, p.58).

3.2.4 Carsharing

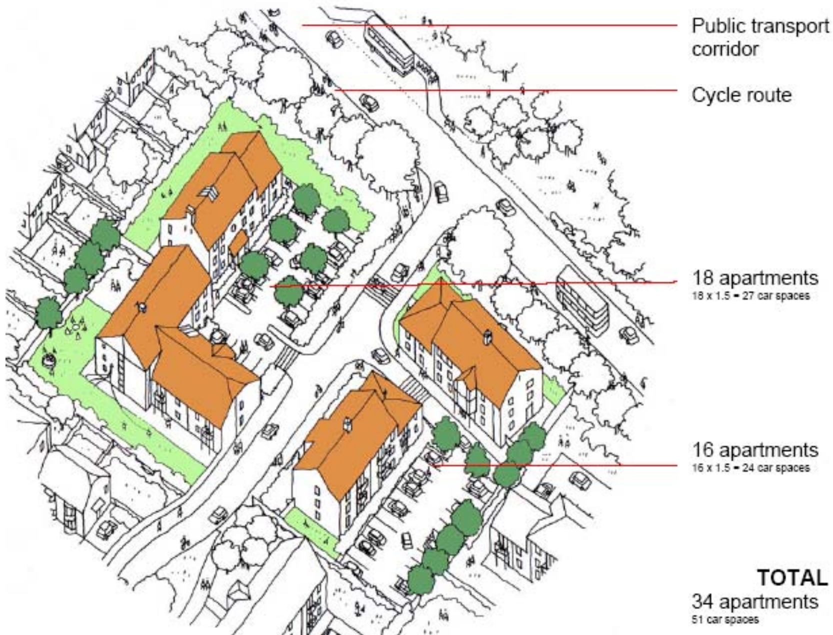
Carsharing is a membership program that allows members to use vehicles from a fleet on an hourly/daily basis, providing its members with an alternative to car ownership. Many members of carshare organizations often give up a personal vehicle, or forego the purchase of an additional vehicle, thereby reducing the demand for parking spaces. Housing developments that incorporate carshare vehicles on-site can reduce the amount of parking required by the residents. Several cities now allow new developments that incorporate carsharing to receive a reduction in required on-site parking spaces, while other cities, such as Vancouver, British Columbia, may require developments of a certain size to provide carshare vehicles (Pinsker, personal communication February 7, 2006).

Reducing the demand for parking, and in turn reducing the supply of parking can lead to an increase in the density of the development and/or the inclusion of green space. The following situation provides an example of how carsharing can impact the nature of a development (see Figures 1 through 3 for a visual depiction):

Development specifications:

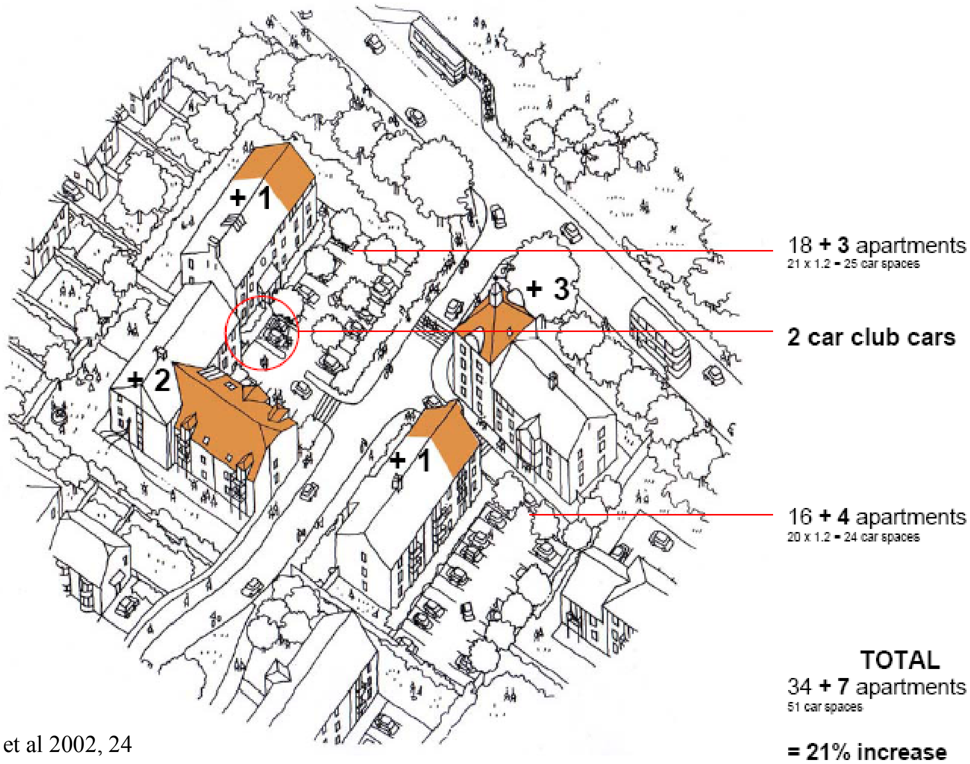
- Housing development of 34 units (assume that 1.5 adults occupy each unit for a total of 51 adults)
- Zoning requires 1.5 parking spaces per dwelling, for a total of 51 parking spaces
- Participation rate in the carsharing program among residents is 20%, or 10 adults
- If upon joining the carshare program these 10 people gave up their personal vehicles and no longer need a private parking space, then the parking spaces per dwelling can be reduced from 1.5 spaces to 1.2 spaces per dwelling

Figure 1: Original Development without Carsharing



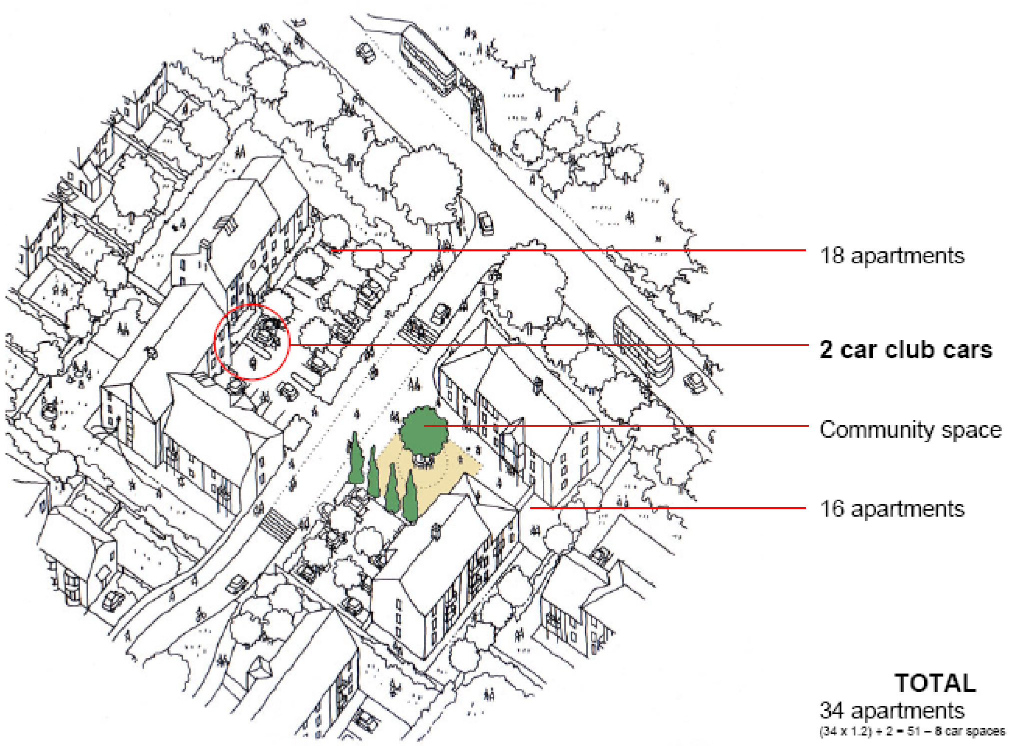
Source: Ball et al., 2002, p.24

Figure 2: Increased Density



Source: Ball, et al 2002, 24

Figure 3: Increase Open Space



Source: Ball, et al 2002, 24

Because some members of carshare organizations give up their vehicles upon joining, the number of parking spaces needed to support the parking demand at a residential development decreases. The space no longer needed for parking can be used to provide more housing units or additional open space, both of which increase revenue for the developer.

3.3 Conclusion

The effectiveness of all of the parking strategies described above is based on the idea that when automobile users are faced with reduced parking supply and/or an increase in the direct cost of parking, then they will begin to think differently about their transportation choices. When alternatives to private vehicles are readily available and convenient, and people are given incentives to choose the alternatives, then positive outcomes will occur: people will consider and choose travel means other than driving, they will drive alone less, and the negative effects of such driving including air pollution, congestion, fuel consumption, and the demand for more costly streets and highways will all decrease. Such outcomes will improve the urban design and livability of cities, thereby enhancing the welfare of its residents. The remainder of this paper will focus specifically on carsharing as a strategy for reducing parking demand.

Chapter IV: Carsharing

North American society's immense reliance upon private vehicles is the source of numerous environmental and social problems. Automobile use contributes 70% of carbon monoxide, 45% of nitrogen oxide, and 33% of hydrocarbon emissions in U.S. cities (Katzev 2003, 16). Furthermore automobile dependency has radically altered the physical environment, with vast portions of the urban environment paved over for highways, parking lots and service facilities. The United States has over 38.4 million acres of roads and parking lots, with more land being devoted to cars than to homes (Holtz Kay, 1997, p.83). In 2001, 92.1% of U.S. and 78.2% of Canadian households owned at least one vehicle, while over 60% of U.S. and 36% of Canadian households owned two or more vehicles (Shaheen et al 2005, p.2), with most of these vehicles sitting unused an average of 23 hours per day (Shaheen et al,1998, p.1). The vast quantity of vehicles coupled with their low annual usage results in an inefficient use of valuable assets and resources. Carsharing provides society with a remedy to improve the inefficient use of private vehicles.

Carsharing can be defined as a membership program intended to offer an alternative to car ownership under which persons or entities that become members are permitted to use vehicles from a fleet on an hourly basis (State of Washington as reported in Millard-Ball, 2005, p.2-33). Carsharing is premised on the concept of vehicle access versus vehicle ownership, by offering individuals the benefits of private cars without the cost and responsibilities of ownership. Carsharing is also based on the idea that the number of vehicles that is needed to meet the demand of a group of individuals is less when they share vehicles than when each individual owns a private vehicle. While carsharing increases the utilization capacity of each car by reducing the amount of time it sits unused, it also restructures the economic incentives of vehicle use. With private vehicles, the majority of costs are fixed, i.e. purchase price, depreciation, financing, registration and insurance. As a result, private vehicles are expensive to own but cheap to drive, providing an incentive for owners to maximize usage (Litman, 1999, p.1). In contrast, the majority of costs associated with carsharing are variable, which provides members with an incentive to drive less and use alternative transportation more. Carsharing is still a relatively new transportation method that has yet to reach a large market. However, in its young history carsharing has grown substantially and contains the potential to alter the face of urban transportation.

4.1 History of Carsharing

4.1.1 European Experience

While the concept of carsharing can be traced back to as early as the 1940s, successful carsharing began in Europe during the 1980s. In 1987 Auto Teilet Genossenschaft (ATG) was launched in Switzerland, and a year later StattAuto began in Berlin. ATG, currently called Mobility CarSharing Switzerland, began as a grassroots effort, and grew in 19 years to 60,000 members, 1,750 cars at 1,000 locations in 400 towns (Muheim, 2005). StattAuto Berlin, which began with one car as a university research effort to show that carsharing could provide a transportation alternative for Germany, has grown to 310 vehicles at 100 station points, and over 8,000 members (Bischoff & Petersen, 2001). While StattAuto Berlin and Mobility CarSharing Switzerland are the two most successful carsharing organizations, CSOs do exist in many other European countries including Denmark, England, France, Ireland, Italy, Norway, Austria and the Netherlands. There are approximately 200 CSOs in 350 cities throughout Europe for a collective total of well over 100,000 members (Shaheen et al, 1998, p.3).

4.1.2 North American Experience

The earliest example of carsharing in North America began at Purdue University in 1983. University researchers developed Mobility Enterprise, which encouraged participants to use smaller, more fuel-efficient vehicles, and discouraged the purchase of additional personal vehicles. Participants in the program leased a very small vehicle for local trips, and had access to shared vehicles, which were of a larger size. The mini vehicles were used for 75% of participants' vehicle miles of travel, with the larger shared vehicles used for the remainder. Researchers determined that the program could be economically viable only if the shared vehicles were run through an efficient existing organization. While researchers considered the program a success in promoting shared use, it ran for only 3 years because it was deployed as a research experiment (Shaheen, Sperling and Wagner, 1998, p. 40). During the same time, in San Francisco the Short-Term Auto Rental Service (STAR) was established by a private firm as a demonstration project at a large apartment complex, where residents had access to a fleet of 51 shared vehicles. Members were charged a low rate per minute and mile of use for short trips, as well as a low daily rate for longer trips. STAR set the rates low in order to discourage auto ownership and encourage transit use. The program was initially designed to operate for three years but failed halfway through. The program failed due to a number of issues including the low and erratic income of many of the tenants, the discovery that many members were not credit worthy for car ownership, and the use of poor-quality cars which often broke down resulting in large repair and towing fees (Shaheen, Sperling and Wagner, 1998, p. 40).

The two pilot projects of the mid-1980s, while short lived due to economic considerations, were able to attract numerous members. Following these early programs, a number of carsharing organizations (CSOs) were founded in the early 1990s, and have been able to maintain long term status due to stronger operational and business models. As of 2005, 32 North American cities are serviced by 28 carsharing organizations. These 28 CSOs have a combined total of over 70,000 members and 1,400 vehicles (see Figure 4 below).

Figure 4: Carsharing in North America

Source: Millard-Ball, et al. (2005) p2-8.

4.2 How Carsharing Works

4.2.1 Carsharing Models

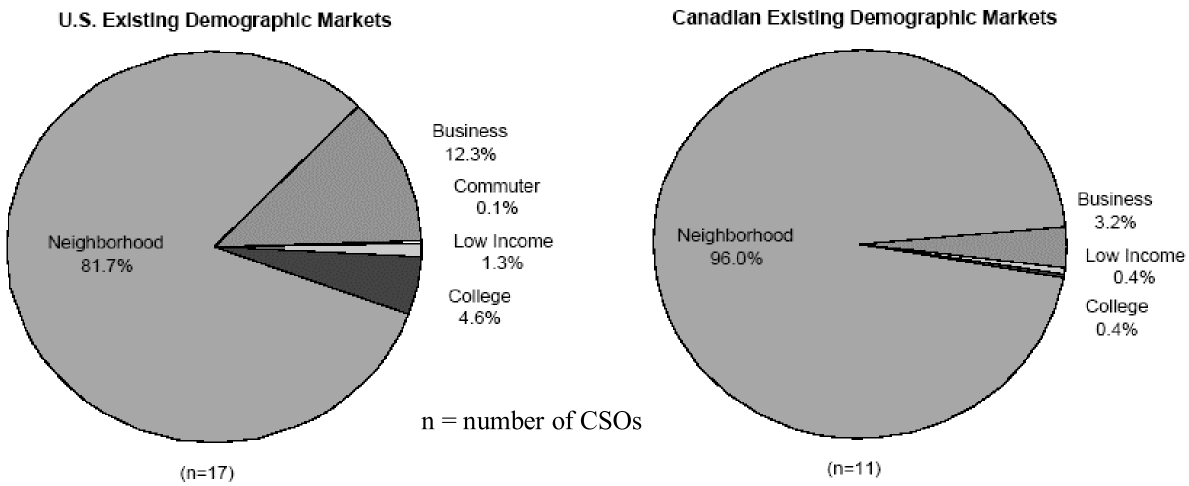
As described previously, carsharing provides members access to a vehicle on an as needed basis. There are various forms of carsharing from the traditional neighborhood carsharing model to the commuter carsharing model, with each form serving unique demographic markets. The neighborhood model involves a fleet of vehicles dispersed throughout an urban area, with parking locations being stationed close to residential areas. In contrast, station or commuter carsharing is tied to a transit station. The station or commuter carsharing model seeks to provide a link to transit and employers in suburban locations, with the primary user group being daily commuters. A first group of commuters drives the car from home to the commuter station in the morning, take the train to and from work, and drives the car from the station back home in the evening. These commuters keep the cars overnight and on the weekends. A second user group picks up the car at that commuter station, drives to work, and returns that car in the evening in time for the first user to retrieve the car to drive home. In addition to these two user groups, a third group can access the car from the workplace where it is parked during the day to do errands. See Table 4 below.

Table 4: Commuter Carsharing

MORNING		
Home	**Commuter Station**	**Work**
A leaves	A drops off	B drops off
	B picks up	C picks up
EVENING		
Work	**Commuter Station**	**Home**
C drops off	B drops off	A returns
B picks up	A picks up	

A survey by Shaheen, Cohen and Roberts (2005) of both American and Canadian carsharing organizations found that the neighborhood residents were by far the largest group served by carsharing, with businesses, colleges, low-income households and commuters trailing behind (see Figure 5 below).

Figure 5: Carsharing Demographic Markets



In addition to differences in the target market, carsharing organizations (CSOs) can also differ in their organizational structure. CSOs can be for-profit, non-profit, municipally run, or a cooperative, where members join by purchasing a share in the organization. While CSOs can take on various models and structures, each carsharing operation shares some common features: an organized group of members, the sharing of one or more vehicles, the ability to book usage in advance for short periods of time, and the ability to self-access the vehicle.

4.2.2 Pricing Structure

While each carsharing organization differs in its specific pricing structure, most organizations charge a refundable deposit or annual fee, then charge for the use of a vehicle on a per hour or per mile basis. These charges cover all vehicle operating expenses, including fuel and insurance.

Examples of pricing structures: (Please note that each pricing plan is for personal use of carsharing. Business pricing plans may differ)

Flexcar (for-profit):

While exact prices vary from city to city the typical Flexcar member is charged a $35 application fee, $40 annual membership fee, and usage is charged at $9/hour, which includes unlimited miles.

Zipcar (for-profit):

Again, Zipcar operates in multiple cities and the exact pricing varies with each location. The typical Zipcar member is charged a $100 fully refundable membership deposit, a $25 non-refundable application fee, a $50 annual fee, and usage is charged from $8.50/hour or $65/day. Usage charge includes 125 miles per day, with each additional mile costing $0.20.

Cooperative Auto Network (CAN) (cooperative):

Each member is charged a one-time refundable fee of $500 to purchase a share in the cooperative, as well as a $20 registration fee. CAN operates three pricing plans that differ depending upon the monthly usage level of the member:

- Higher Usage Plan: $40 monthly fee and $0.18 per kilometer driven
- Moderate Usage Plan: $15 monthly fee and $0.28 per kilometer driven
- Lower Usage Plan: $6.25 monthly fee and $2.00 per hour and $0.38 for every kilometer driven.

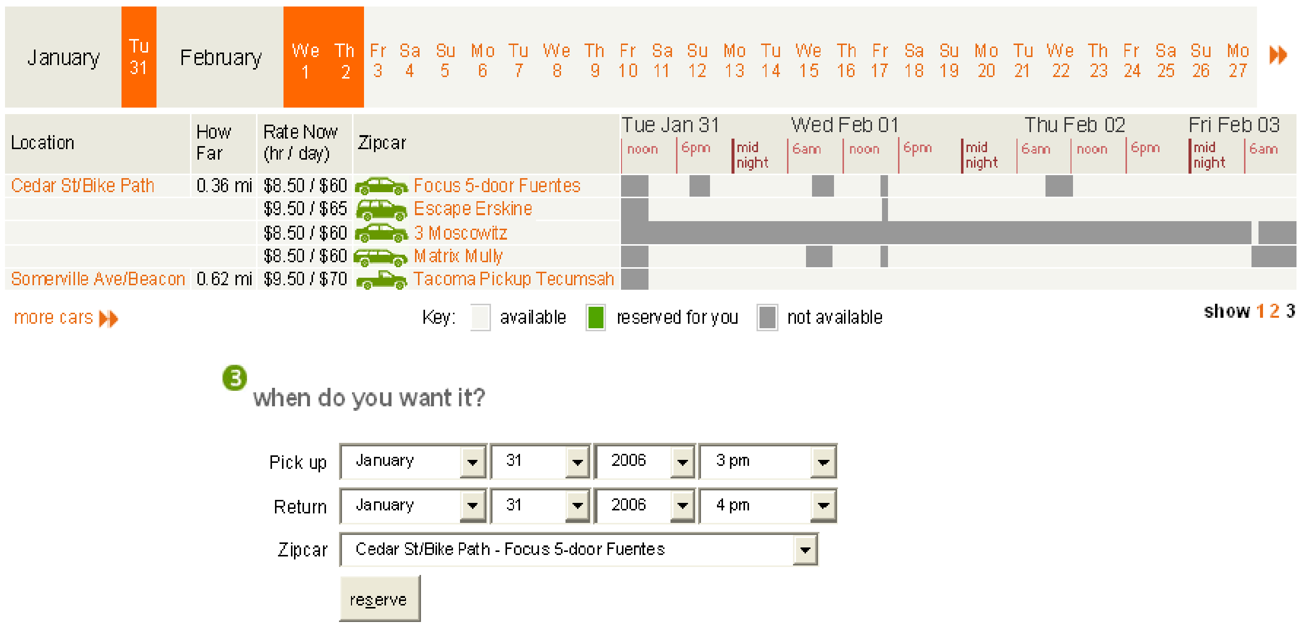
City CarShare (non-profit):

Members are charged a one-time $300 fully refundable security deposit, a $30 application fee, $10/month in membership dues, and usage is charged at $4/hour plus $0.44/mile for most cars in the fleet.

4.2.3 Technology

Even though carsharing is a relatively young concept, its operational technology has changed dramatically from earlier days. In the beginning, carshare organizations (CSO) were run on a manual system, where members had to telephone into a live operator to reserve a vehicle. They gained access to the vehicle from a manually controlled key locker that they accessed through a master key or a personal identification number. As CSOs grew, they began to utilize more advanced technology to improve and simplify the process. Members may still choose to telephone in a reservation via a voice activated or touch-tone telephone reservation system or they may use a web reservation system (see Figure 6 for an example of an on-line reservation system). The improved reservation management system allows members to make, modify or cancel reservations with ease.

Figure 6: Reservation Webpage for Zipcar



Source: Zipcar.com

In addition to improvements to the reservation system, CSOs have also utilized advanced technology for members to access the vehicles. While some CSOs still use the lockbox system many operate using smartcard technology. Members gain entry into the reserved vehicle using a smartcard. Each member's smartcard has a unique number that when activated is used to open the car that s/he reserved. The smartcard allows a member to enter the vehicle and obtain the ignition key that is kept inside the car. A few simple steps and the member is equipped to drive away.

While car use is far more damaging to the environment than walking, bicycling and public transit, in many American cities private vehicle use is necessary due to poor land use and/or a weak public transportation infrastructure. In such areas carsharing can provide a necessary link in the urban transportation infrastructure. Carsharing offers the benefits of private vehicle use while removing the necessity of ownership, and the costs and responsibilities that accompany it. In addition, carsharing can provide society with more efficient vehicle usage, a reduction in the space devoted to transportation infrastructure, as well as the benefits of gained space as the result of vehicles being used more intensively in parking lots at transit stations, workplaces, and schools (Sperling, Shaheen and Wagner, 1999). In order to determine if carsharing is an effective traffic and parking demand strategy to pursue in the North America it is helpful to analyze the population segment that is currently utilizing carsharing.

4.3 Demographics of Carshare Users

While awareness and participation in carsharing organizations has increased over the past decade, its overall market penetration rates are extremely low, in most cases accounting for less than 1 percent of total trips taken (Sperling, Sheehan and Wagner, 2000). Market acceptance is a function of travelers' attitudes and values, which will vary considerably across cultures and locations. Several studies on carshare users have been conducted in Europe, the United States and Canada that provide insight into who is using carsharing and what motivates them to do so.

In Germany, surveys found that carshare users were between 25 and 40 years old with above-average education, were more likely to be male, earned a below-average income and were sensitive to environmental and traffic problems (Sperling, Shaheen and Wagner, 2000). Convenient neighborhood locations and reliable availability were rated as the most important motivating factors in Germany (though cost was not considered) (Baum and Pesch, 1994 as reported in Sperling, Shaheen and Wagner, 2000). Muheim (1998) found that in the early days of carsharing in Switzerland ecological motives were key; however in subsequent years the proportion of those who joined for ecological reasons fell to just 6% in 1997 when practical reasons, such as cost savings and the need for a second vehicle, became a much more important factor. A survey of Dutch carshare members found that the motivation of members varied considerably among those who owned a car before adoption and those who did not. Car owners tended to be very cost conscious when adopting carsharing services and were motivated to join because of various negative experiences with car ownership, such as parking problems and maintenance tasks. Similar to the experience among Swiss participants, environmental attitudes in the Netherlands were found to have some impact in the adoption of services, but overall the environment was found to play a subordinate role to economic concerns (Meijkamp, 2000). In contrast to the above studies which focused on what factors motivated members to join a carsharing organization, a survey by Lightfoot on individuals who did not participate in carsharing found that the principal reasons for not participating were that carsharing organizations (CSO) had an 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 an individual’s home (as reported in Sperling, Shaheen and Wagner, 2000). From these various studies on the European carsharing market it seems as though financial reasons are the primary motivating factor for individuals’ decision to join a CSO, with convenience and ecological considerations being secondary concerns.

Many of the studies of carshare organizations within the United States focused more on the demographics of CSO participants and less on what motivated them to join. However, one study that examined the adoption process of first year members of Car Sharing Portland (CSP) found that while environmental goals were an important factor for some members, a sizeable majority of members were largely motivated to join CSP because it met their periodic need for a vehicle or the financial savings they expected to realize by becoming a member (Katzev, 2003, p.71). Such early adopters of CSP were a highly educated, relatively affluent group who were primarily employed in professional occupations. A market analysis of City CarShare members in San Francisco found that its first wave of members were highly unrepresentative of the Bay Area population. Members were mainly professional-class residents, with annual incomes above the area’s average, who did not own cars and who lived either alone or in non-traditional households (Cervero and Tsai, 2003). Similarly, members of CarLink, a commuter carsharing model in the San Francisco area, were found to more educated, in a higher income bracket, and more likely to be professionally employed than the average Bay Area resident. In addition, these members displayed sensitivity to congestion and environmental concerns, and showed a willingness to experiment (Shaheen and Rodier, 2004).

A recent study surveyed current members of nine carsharing companies across the United States and Canada and reported findings on both the members' demographics and reasons for joining. The survey found that the primary reasons for joining a carsharing company were given: eliminate hassles of car ownership (21.8%), like the carsharing philosophy (19.1%), like having another mobility option (15.5%), and couldn't afford to own personal vehicle (14.5%) (Millard-Ball et al, 2005, p.3-5). The results on the demographics of carshare members were quite similar to the other research on carsharing clubs in North America. The mean age of members was 37.7 years, with an age range of 20-75 years old. Fifty percent of survey respondents had incomes of $60,000 or more, while 13 percent had incomes of $30,000 or less. Survey respondents tended to be highly educated with 35% having a Bachelor's degree, and 48% having some post-graduate work or an advanced degree. The majority of respondents were white (87 percent), with 6% Asian, 4% other, 4% Black or African American, and 3% Hispanic. The average household size of the carshare members surveyed was 2.02 persons, with 72% of respondents residing in a household with no cars [(the national average of households with no access to a vehicle is 9%) (U.S Department of Transportation 2005)] (Millard-Ball et al, 2005, p. 3-6).

The studies of American CSO members indicate that many early adopters are highly educated, relatively affluent and work in professional occupations. While few studies have focused on what motivated such individuals to join, the study on CarSharing Portland found that reasons members gave for joining a CSO were similar to those reported in Europe, with financial savings and the need for an additional vehicle being the most important motivating factors.

4.4 Mobility Impacts of Carsharing

Perhaps a more important factor than why members join a carsharing organization, is what impact carsharing has on a member's travel behavior. Opinions differ on the net travel impacts of carsharing, with one view being that carsharing will reduce vehicles miles traveled because individuals will become more conscious of the marginal cost of each trip and thus forego non-essential trips, versus the opposite view that carsharing will increase vehicles miles traveled because of the increased access to cars by members who previously did not have such access. Such members will substitute motor vehicle travel for travel they previously made by alternative means. Similar to the market acceptance of carsharing, impacts on travel has been found to vary between cultures and locations.

In Germany, Baum and Pesch reported that carsharing reduced private car mileage by 58%, from 4,375 miles to 2,530 miles per year, after membership. In a study of Mobility CarSharing Switzerland, Munheim and Partner (1998) found that members who gave up their car as a result of joining reduced their amount of car travel by 72%. The mobility behavior of members who gave up access to a private car after joining a CSO is similar to that of people who do not have access to a car. Yet, people who do not own a car prior to joining a CSO, or those who use carsharing as a second vehicle, only change their mobility behavior very slightly after joining (Muheim and Partner, 1998). Similar results were reported in an evaluation of carsharing in the Netherlands. While a 33 percent reduction in car mileage was reported from before adoption levels for all CSO members, the actual change differed between the different market segments of adopters. The largest reduction in car mileage was attributed to members who gave up a private vehicle after joining the CSO. In contrast, an increase in vehicle miles traveled was found for those members who use carsharing services as a second car (Meijkamp, 2000).

Another trend reported by European carsharing clubs is that members use alternative means of transportation more than they did before they joined the carsharing organization. Meijkamp (2000) reported that the overall tendency of members of carsharing organizations in the Netherlands is that trips by car are substituted by the use of alternative travel modes (bicycle trips increased by 14%, train by 36% and bus by 28%). In Germany Baum and Pesch (1994) found that public transportation use by carshare members increased by 960 miles per year.

While the results of European carshare organizations hold a valuable promise for environmental benefits through the reduction of vehicle miles traveled, such findings may not necessarily be applicable to carshare organizations within the United States. The United States is a far more car dependent society, its urban environment is less dense and the public transportation infrastructure is far less developed and expansive than that in Europe. As a result the reduction in VMT achieved in Europe might not be realized in America.

An evaluation of the mobility behavior of Car Sharing Portland (CSP) members during the first year they belonged to the organization found that there was very little change between pre-membership and post-membership for mobility measures such as personal-vehicle trips, other-vehicle trips, and non-vehicle trips. It was noted that individuals who did not own a personal vehicle drove more miles after they joined Car Sharing Portland after the first year, while those members who did own a car did not drive much less. Thus the aggregate net effect of membership in CSP was either no change or a slight increase in vehicle miles traveled (VMT) (Katzev, 2003). However, 26% of survey respondents reported that they sold a personal vehicle after joining CSP, and 53% reported that they avoided purchasing a personal vehicle (Katzev, 2003, p.79). Similarly, an evaluation of San Francisco's City CarShare found evidence of travel inducement, with members' carshare trips being generally farther and longer than private car trips, and members also averaging higher vehicle-miles-traveled (VMT) than non-members (Cervero, 2002). Given that around two-thirds of surveyed City CarShare members come from zero-car households, the sudden availability of cars likely stimulated automobile travel for some. In contrast, an evaluation of the same program after its second year of operation found that the average daily VMT fell slightly for members, yet increased for non-members, however the results were not statistically significant. Additionally 29% of members reduced car ownership, and 67.5% of members forewent the purchase of a motor vehicle (Cervero and Tsai, 2003). Similar results regarding vehicle ownership were found in Millard-Balls' et al. (2005) survey of nine carsharing organizations throughout the United States and Canada. The study found that 20% of car-sharing members gave up their primary vehicle or a second or third one (2005, p 4-9). In addition, many more forewent the purchase of a new car. The study found that at least five private vehicles are replaced by each shared car, with the possibility of ratios being much higher (p 4-11).

Carsharing's impacts on alternative modes of transportation in the United States are mixed. An evaluation of first year Car Sharing Portland members found that many used alternative modes of transportation such as public transit, walking, and bicycling, more often for commuting, shopping, and personal errands during their first year of membership, however this increase did not represent a major shift in their travel behavior (Katzev, 2003, p. 79). A survey of Flexcar Portland members indicates that 21% of respondents walk more often than before joining, 30% use transit more often, and 27% bicycle more often (Scott, Brook and Perussi, 2003).

4.5 Conclusion

Comparable studies of CSO members in both Europe and the United States indicate that carsharing has been much more successful at decreasing vehicle miles traveled in Europe than it has in America. However, the literature from several evaluations of U.S. carsharing organizations has shown promising results; upon joining a carsharing organization many users have reduced car ownership and driving in favor of alternative transportation modes such as walking, bicycling and public transportation. It should be noted however that the travel-behavior data from both the European and American studies are based on retrospective estimates of selective samples of car-sharing members. Self-reported information obtained from individuals who had expected to drive less or whose positive attitudes towards carsharing might have biased their information and should thus be viewed cautiously (Katzev, 2003). Furthermore, most research into the mobility impacts of carsharing focuses on the behavior of early adopters, which may not reflect the behavior of members in future years, or as membership lengths expand.

Chapter V: Carsharing in Action

Carsharing as a parking demand management strategy is just beginning to enter into the development process, and is currently used by only a handful of cities. The two main ways that cities are including carsharing in the development process is through its use as a mitigation measure during the site planning process, and through zoning decisions, which include structuring incentives for developers to incorporate carsharing into their projects. The following section highlights three cases where carsharing has been used as a parking demand strategy.

5.1 Austin, Texas

Parking requirements in Austin are established by politics. In 2003, the Watershed Protection and Development Review Department sought to change the parking requirements so that instead of each land use having its own parking requirement, there would only be 4-5 parking ratios, and uses would be grouped according to most appropriate parking ratio. However, the ratios selected resulted in an increase in parking requirements for several uses, including offices. Staff in the transportation planning department worked to have the ratios adjusted so that less parking would be required, but the staff was unsuccessful. The City Manager's office was not interested in altering off-street parking requirements, mainly out of fear of spillover parking into surrounding neighborhoods as well as a lack of confidence that changing parking requirements would change travel behavior (email communication Larsen, March 10, 2006).

While local authorities were not receptive to lowering parking requirements for the entire city, the city is more open to making changes to parking requirements at the neighborhood planning level. Neighborhood planning allows citizens to provide input and help shape the area in which they live, work, own property, or manage a business by addressing land use, zoning, transportation, and urban design issues. In August of 2004 the city adopted the Central Austin Combined Neighborhood plan. The vision statement for the Central Austin Combined Neighborhood Plan is to

> preserve the historical character and integrity of single-family neighborhoods. It shall allow multifamily development and redevelopment in appropriate areas to reflect the historical nature and residential character of the neighborhood. The plan will address the needs of a diverse, pedestrian-oriented community and provide safe parks and attractive open spaces. The plan will foster and create compatible density in areas that are appropriate for student housing; new development will be appropriately oriented and scaled relative to its neighborhood in the combined planning area (City of Austin, 2004, p.13).

As part of this process, the University Neighborhood Overlay Zoning District (UNO) was created in order to implement some of the goals of the Central Austin Combined Neighborhood Plan. The zoning ordinances created for the UNO promote a more urban neighborhood for this area located west of the University of Texas. The goals of the ordinance are to provide a safe environment, maintain the community character and increase the reliance on alternative transportation modes in the area. To this end the parking requirements for the UNO include a section on carsharing, which allows a developer to reduce the required parking by 40% if the development participates in a carsharing program. The ordinance states:

> For a mutli-family residential use, the minimum off-street parking requirement is 40 percent of that prescribed by Appendix A (Tables Of Off-Street Parking And Loading Requirements) if the mutli-family residential use…participates in a car sharing program that complies with the program requirements prescribed by administrative rule, as determined by the director of the Watershed

> Protection and Development Review Department (Austin City Code Section 25-6-601).

So far, of the projects located in the University Neighborhood Overlay district that are under review, construction, or completed none has opted for the carsharing parking reduction; neither have any of the 20-25 projects in various planning stages (personal communication Walters, February 27, 2006).

In addition to the University Neighborhood Overlay (UNO) redevelopment-oriented ordinance the city is also currently working on a comprehensive design standard for commercial developments everywhere in the city. The working draft of the design standards includes language that would apply to developments of greater than 100 units that would allow the minimum parking requirement to be reduced by 20 spaces for each carsharing vehicle provided (McCracken's' Task Force, 2005, p.21).

While language regarding carsharing's use as a parking demand strategy is now included in city ordinances, there is currently no carsharing organization operating in Austin. Katie Larsen, senior planner for the City of Austin, has been instrumental in getting carsharing language written into the code, and is also dedicated to bringing carsharing to Austin. While studying at the University of Texas (UT), Katie Larsen became interested in carsharing due to the practical and financial benefits it offered to her and fellow students. While many of them owned cars, they rarely used them because most necessities were in walking distance and the area had a great shuttle bus system. Ms. Larsen approached UT staff about having the University sponsor or support a carsharing start-up, and then when she got a job with the City of Austin in the transportation planning department Ms.

Larsen continued her efforts and took on the responsibility of bringing carsharing to Austin. With help from Flexcar and Zipcar, two national carsharing organizations that are interested in expanding into the Austin market, Ms. Larsen has been able to build support for car-sharing at the staff level at some of the State of Texas agencies, as well as those at the Capital Metro Transportation Authority, Austin's transit agency, and the University of Texas. However, support from the top managers of each agency, as well as those in the City Manager's office, has been harder to garner. The support of such high level officials is key to bringing carsharing to Austin. Ms. Larsen saw the development of the UNO ordinance as an opportunity to promote the use of carsharing. It was hoped that the inclusion of carsharing language in a section of the Land Development Code would expedite the formation of carsharing in the city. The provision has helped to increase awareness about carsharing, but efforts to educate key decision makers on the benefits of carsharing are still a work in progress.

5.2 Vancouver, British Columbia

The City of Vancouver has an explicit goal of reducing residential parking standards where warranted to support a shift from auto reliance to walking, cycling and using transit. Historically, Vancouver has performed parking surveys to determine the appropriate parking requirements for residential developments. The results of the residential parking surveys are used to perform a linear regression analysis to determine the number of parking spaces per floor area of a unit. The detailed studies have resulted in differing standards of parking requirements for residential uses, depending upon location, housing type, and market versus non-market pricing (personal communication

Pinkser, February 7, 2006). In addition to these location and market specific parking requirements, other parking strategies included in Vancouver's parking by-law are payment-in-lieu relief, maximum number of parking spaces, compact car parking areas, collective parking and bicycle parking.

In November 2005, Vancouver's Parking by-law was amended to include the use of carsharing as a parking demand strategy. The Parking by-law text reads as follows:

> The Director of Planning and General Manager of Engineering Services, on conditions that are satisfactory to them, may allow the substitution of co-operative vehicles and associated parking spaces for the required parking spaces at a 1:3 ratio, up to 1 co-operative vehicle for each 60 dwelling units, rounded to the nearest whole number, or such greater substitution of co-operative vehicles and associated parking spaces at such ratio and for such number of dwelling units as they may consider appropriate with respect to the site (Vancouver Parking By-Law No. 6059, Section 3.2.2).

The inclusion of this language resulted from the lobbying efforts of many sustainable development groups in the area, and specifically from Tracey Axelsson, founder of the Cooperative Auto Network, Vancouver's carsharing organization. Ms. Axelsson viewed carsharing as a means to reduce parking requirements, and over a ten year process, beginning in the 1990s, she met with planning officials, real estate agents, marketing executives, and developers to refine the concept. At first the city was not open to it and developers had no idea what the concept was. It was only after the Cooperative Auto Network was in operation for a number of years that the city began to be more open to the concept of using carsharing as a parking demand strategy (personal communication Axelsson, February 22, 2006).

The first development to take advantage of the carsharing provision was a city project, known as #1 Kingsway. It is a mixed-use project with just under 100 dwelling units, a library, a community centre, a daycare, and a small café. The site is providing 2 co-op spaces and paying for 2 vehicles; in exchange, it is having its parking requirement reduced by 6 spaces, or a net of 4 spaces after they supply the 2 spaces for the co-op vehicles. The project is at an early stage of construction, and should be completed some time in 2007 (email communication Pinsker, March 22, 2006).

Currently, while carsharing is offered as an option for developers to take, however the City is looking to make carsharing a requirement in certain areas, namely the South East Falls area. The South East Falls areas is currently undergoing rezoning, and through this process the City is considering including language that mandates the inclusion of a carshare vehicle and dedicated parking space in projects of a certain size. The plan is to require developments of 50-149 units to include 1 carshare vehicle and parking space, and projects with greater than 150 units to include 2 carshare vehicles and parking spaces (City of Vancouver, 2004).

5.3 Boston, Massachusetts

Whereas Austin and Vancouver have codified carsharing into zoning requirements, the City of Boston is encouraging carsharing through its access and site planning process. The Boston Zoning Code's Article 80 Development Review and Approval requires that the Boston Redevelopment Authority review, through a public process, the design of real estate developments and their effect of the surrounding community and the city as a whole, and approve them according to required appropriate conditions. Large projects, typically those of 100,000 square feet or greater, are required to satisfy the components of Large Project Review including transportation, environmental protection, urban design, historic resources, infrastructure systems, site plan, tidelands; and Development Impact Project (Boston City Zoning Code Section 80B-1).

The transportation component requires an applicant to submit a Transportation Access Plan to the Boston Transportation Department that analyzes the proposed project's impact on the transportation network, and that proposes measures intended to mitigate, limit, or minimize, to the extent economically feasible, any adverse impact on the transportation network reasonably attributable to the proposed project. The plan serves as a basis for a Transportation Access Plan Agreement (TAPA) between the city and the applicant specifying the measures necessary to mitigate and monitor the transportation impacts of the proposed project. The Transportation Access Plan may consist of one or more of the following elements, (a) Traffic Management Element; (b) Parking Management Element; (c) Construction Management Element; and (d) Monitoring Element.

The Boston Transportation Department’s (BTD) primary tool for managing off-street parking supply is through this development review process and its authority in approving the Transportation Access Plan agreement (TAPA). Commitments to manage parking and encourage the use of alternative modes are incorporated in the project’s TAPA permit. The BTD’s review considers the appropriate amount of parking given the proximity of the project to transit, the potential use of alternative modes to access the site and the availability and use of on-street and off-street parking near the site. The TAPA outlines the travel demand management (TDM) measures that the project will employ to reduce its transportation impacts. TDM measures can include the following:

- promoting and subsidizing public transportation,
- reducing parking supply and increasing parking fees,
- facilitating ridesharing and car-sharing,
- encouraging bicycling, and
- improving pedestrian, bicycle, and public transportation facilities (City of Boston, 2000).

The TDM measures that a project includes are determined on a case-by-case basis, and are developed through a process between the applicant and the BTD. The BTD uses an Access Plan Agreement template and, as the site planning progresses, specific strategies are chosen and written into the agreement. Carsharing is one TDM measure that the BTD greatly supports and encourages applicants to utilize. Developers have been very open-minded and receptive to the concept of carsharing, and as a result numerous projects have included carsharing in the site plans. Once a developer chooses to incorporate carsharing into the site as a TDM measure, the developer works directly with the local carshare organization, Zipcar, to work out the specific arrangements.

5.4 Analysis of Cases

The cases above offer insight into the process of developing carsharing as a parking demand management strategy and provide examples of how it is currently being incorporated into the development process. There are a number of mechanisms that cities can use to promote the use of carsharing. Both Austin, Texas and Vancouver, British Columbia have written carsharing into the local zoning code as a means for developers to reduce the number of parking spaces required at a site. Boston, Massachusetts does not formally endorse the use of carsharing as a parking demand management strategy in its zoning codes, but does support its use as a mitigation measure during the site planning process. While the mechanisms used differ, the goal of promoting carsharing as a means to reduce parking demand and the traffic impacts associated with a site are similar across the three cities.

In addition to sharing similar goals, the cities also faced similar obstacles in formalizing the use of carsharing. The inclusion of carsharing into zoning code language was a difficult and timely ordeal for both Austin and Vancouver, and came about largely through the lobbying efforts of carsharing advocates. In the early stages, city management was not supportive of the concept of offering a reduction in the number of parking spaces in exchange for the use of carsharing. Only after extensive education and outreach efforts in regards to the benefits of carsharing were supporters able to gain the level of support necessary to pass the ordinance, and in Austin in particular, such efforts are still underway. In contrast, the use of carsharing in Boston seemed to develop much more smoothly. Unlike in Austin and Vancouver where the use of carsharing was directly linked to a reduction in the supply parking spaces, in Boston inclusion of carsharing into a site does not in itself grant the developer the ability to build less parking. Carsharing is used as one strategy that a developer can use to achieve the requirement of mitigating the traffic impacts of the project.

The inclusion of carsharing into the zoning codes and/or the development process has only been in place for a few short years, and a relatively small number of projects in both Boston and Vancouver have actually used carsharing to achieve parking reductions. As a result, it is too early to evaluate the success of using carsharing as a parking demand management strategy.

Chapter VI: Conclusion and Policy Considerations

For years the common attitude towards parking policy was that the generous supply of off-street parking spaces would help to reduce traffic congestion, limit spillover parking into the surrounding neighborhoods, and support enhanced commerce at the site. However, the creation of abundant and free parking consumes land and natural resources, reduces pedestrian accessibility, reduces the density of developments, increases development costs, encourages automobile use and increases the associated air and water pollution.

Ensuring that a site has adequate transportation infrastructure to support it is a primary concern in the development process. Yet, all too often, the principal focus is on how the site will support the private automobile and not on the more comprehensive transportation system. Such a narrow focus perpetuates society's dependence on the private vehicle by ensuring that it is the most convenient form of transportation to and from a site. Land-use and transportation planners have begun to develop and enforce alternatives to the familiar inefficient parking regulations of yesterday. Such a progressive approach seeks to use parking policies as a means to facilitate a shift away from an auto reliant land use pattern to one that is more conducive to walking, cycling and using transit. Carsharing is one such strategy that offers a unique advantage in that it provides a link between the transportation system of yesterday and that of the future. The nature of our cities' land use and design currently makes it difficult, if not impossible, for most individuals to do without a vehicle completely. Carsharing provides individuals with access to a vehicle without the need for ownership. Through its pricing structure, vehicle location and the need to plan ahead, carsharing provides its members with an incentive to drive less and use alternative transportation more. The use of carsharing as a parking demand strategy in new developments will help to increase densities and create more compact developments, both of which reduce the need to travel by car.

Carsharing as a parking demand management strategy is just beginning to enter into the development process, and is currently used by only a handful of cities. The integration of carsharing into zoning requirements, as well as other land use and transportation policies, provides benefits to carsharing organizations by aiding the growth and acceptance of carsharing as a transportation choice, but also aids communities in reaching their overall environmental and sustainable development goals. The support of carsharing at the municipal level provides the following benefits:

For Carsharing Organizations:

- Provides dedicated parking spaces for carshare vehicles
- Increases the visibility of carsharing as a transportation option
- Improves accessibility to new partners, particularly developers
- Increases the credibility of carsharing

For the City:

- Helps to reduce vehicle miles traveled and emissions, including greenhouse gas emissions
- Reduces parking demand

- Helps in realizing financial savings through the reduction of a city-owned fleet of vehicles
- Increases transportation alternatives to the general public, including providing low-income households with access to vehicles
- Improves the quality of life and the economic vitality of urban areas by reducing sprawling developments and traffic congestion

In order for carsharing to succeed as a parking demand strategy, the support and involvement of a number of key stakeholders is required, including carshare organizations, city planners, city councils, and developers. As the case studies of Vancouver, Boston and Austin showed, some of the key players, namely government officials, are not yet familiar with the concept and associated benefits of carsharing. Enoch (2002) gives this lack of knowledge about what carsharing is and how it works as a key reason to its limited use. Enoch states

> Overall, the formation of nation-wide organizations to "educate" policy makers and the wider public as to the role and benefits of car share clubs appears to have been a key reason that such schemes prospered in Switzerland and Germany. It is interesting to note that one of the major barriers faced by car share clubs in Canada and the USA, where such knowledge is not yet widespread, is the ignorance of local authorities of the whole car share club concept (Enoch 2002, p.1-2).

The municipalities that do support carsharing's use as a parking demand management strategy did so largely as a result of the educating and lobbying efforts of carshare advocates and organizations. Yet, the education of governmental officials is just one step in the process. As the City of Austin experience depicts, the inclusion of carsharing into a zoning code is not in itself the end goal. The city also needs an established organized carsharing organization to facilitate the carshare program, as well as developers who are willing to participate. The city government, the developers and the carsharing organizations are all integral players, and the support of all three is necessary for carsharing to succeed as a parking demand management strategy.

While the support of all three stakeholders is required, each one is uniquely suited to benefit from and to influence the expanded use of carsharing as a parking demand strategy. Following are a number of recommendations for actions by the key stakeholders. The recommendations flow from the previous review of literature regarding parking and carsharing, as well as from the analysis of case studies on Boston, Vancouver and Austin. The recommendations are offered as options for realizing the full range of carsharing's benefits.

Recommendations

Preliminary Stage:

- ***Make updating parking policies a priority:*** City planners and government officials need to understand the role that parking policies play in an area's transportation and land-use system. Many municipalities are concerned about altering their current parking requirements for fear of the effect it will have on spillover parking and the lack of confidence that changing parking requirements can change travel behavior. Unless local authorities understand this connection they will not be open to any strategy that lowers parking requirements.

- ***Increase education/outreach efforts****:* One of the major obstacles currently inhibiting carsharing's use as a PDM strategy is a lack of awareness about the concept of carsharing throughout the upper levels of city management.

Furthermore, since it is a relatively new strategy, there is a lack of confidence that carsharing can influence parking demand. In addition, developers need to believe that providing fewer parking spaces at a site will not negatively affect its marketability. Transportation planners and carsharing organizations can play a key role in raising awareness of carsharing in general, and more specifically in addressing the concerns and answering the questions that local authorities and developers may have. Carsharing organizations should make such lobbying/advocacy efforts a top priority.

- ***Develop strong working relationships:*** Collaboration between city government, planning departments and the local carshare organizations is fundamental to carsharing's success as a PDM strategy. Carsharing organizations can provide planning departments with key information on how best to incorporate carsharing into the development process. The CSO can provide planners with data such as how many of its members get rid of a vehicle once joining, the ideal ratio of members to carshare vehicles, and in what locations and/or developments carsharing will work. Such information will assist a city in knowing how to best structure carsharing policies in order to fulfill their parking and/or transportation management goals.

Policy Implementation Stage:

- ***Establish a carsharing overlay zone:*** The effectiveness of carsharing as a PDM strategy is dependent upon specific conditions, namely a strong mass transit system and a mixed-use style of development. As a result, carsharing will be more effective in urban areas, with much more limited success in suburban areas. Furthermore, even in urban areas not every development project will be appropriate for carsharing. Therefore, carsharing should not be used as a universal PDM strategy for all development sites within a city, but instead should be tied to specific locations based upon their relation to mass transit.

- ***Couple carsharing with supportive policies:*** Carsharing has the ability to reduce parking demand and encourage alternatives to vehicle use when combined with policies that reinforce these goals. Coupling the use of carsharing as a parking demand strategy with policies that increase development density and promote more mixed-use and transit-oriented developments will strengthen the success of each.

- ***Offer incentives to support alternative transportation****:* Incorporating carsharing into a development project is one step in reducing the need for large amounts of parking. Beyond simply providing a carshare vehicle and parking space in a development, property managers can take additional steps to further encourage its use in order to fully realize the benefits that carsharing can offer. In residential developments, property managers can provide free or subsidized memberships to the CSO to all of its tenants. Similarly, transit agencies should offer subsidized transit passes to carshare members to encourage the use of alternative travel modes.

Carsharing, in its function as a parking demand strategy, has a key role to play in facilitating a shift away from an auto reliant land use pattern to one that is more conducive to walking, cycling and using mass transit. Currently, carsharing has experienced limited market penetration, but is slowly expanding. Governmental support of carsharing and its inclusion in the development process can be immensely influential in increasing its visibility and usage, which will quicken the transition to a sustainable transportation system. The need for such a system, one that is less environmentally destructive and improves access to all members of society, is paramount. Taking a critical look at current parking policies and being open to the benefits of carsharing can be a powerful tool in helping cities to improve the quality of life of its residents and enhancing the vitality of its communities.

References

Ball, C., Best, W., Ray, A., & Seasman, A. (2002). *Achieving low car housing: the role of carshare clubs.* Yorkshire and Humber Assembly. Leeds, UK.

Baum, H., & Pesch, S. (1994). Untersuchung der Eignung von Car-Sharing im Hinblick auf die Reduzierung von Stadtverkehrsproblemen. Bonn, Germany, Bundesministerium fuer Verkehr.

Bergman, D. (1991). *Off-Street Parking Requirements*. Planning Advisory Service Report 432. Chicago: American Planning Association.

Bischoff, G., & Petersen, M. (2001). "Berlin: Strattauto – Germany largest car-sharing company". 'SURBAN – Good practice in urban development' European Commission, Berlin. Accessed on January 27, 2006 from http://www.eaue.de/winuwd/86.htm.

Cervero, R., San Francisco (Calif.), Dept. of Transportation and Parking, University of California (System), & Institute of Urban and Regional Development. (2002). *City CarShare: Assessment of intermediate travel-behavior impacts*. Berkeley, Calif.: Institute of Urban and Regional Development, University of California, Berkeley. Access on October 15, 2005 from: http://www-iurd.ced.berkeley.edu/pub/WP-2002-03.pdf

Cervero, R., & Tsai, Y. (2003). *San Francisco City CarShare: Second-Year Travel Demand and Car Ownership Impacts.* Submitted to Transportation Research Board 2004 Annual Meeting, 2003.

City of Austin. (August 2004). *Central Austin Combined Neighborhood Plan*. Accessed on March 2, 2006 at http://www.ci.austin.tx.us/zoning/central_austin.htm.

City of Boston. (2000). *Access Boston 2000-2010: Boston's Citywide Transportation Plan. Parking in Boston: Development Review.* Accessed on March 1, 2006 from http://www.cityofboston.gov/accessBoston/pdfs/parking_development.pdf

City of Boston. http://www.cityofboston.gov/environment/sbf.asp. Accessed on March 1, 2006.

City of San Francisco. Article 1.5 Off-Street Parking and Loading. Section 151.1 Permitted Off Street Parking in Downtown Residential Districts. Accessed February 15, 2006 from http://www.amlegal.com/nxt/gateway.dll/California/planning/article15off-streetparkingandloading?f=templates$fn=altmain-nf.htm$3.0#JD_166

City of Vancouver. (December 3, 2004). *Policy Report: Development and Building. Southeast False Creek Official Development Plan*. RTS No. 4635. Accessed on November 28, 2005 from http://www.city.vancouver.bc.ca/ctyclerk/cclerk/20041214/p4.htm

Councilmember Brewster McCraken's Task Force. (March 2005). *Raising the Design Standards in Austin, Texas: Proposed Code Amendments to Improve Commercial Design.* Accessed on March 5, 2006 from http://www.ci.austin.tx.us/development/downloads/draft_march_21.pdf.

Enoch, Marcus (2002). Supporting Car Share Clubs. A Worldwide Review. Paper presented at the 3rd MOSES ESG Meeting, February 20-22, 2002.

Environmental Protection Agency. (1999). *Parking Alternatives: Making Way for Urban Infill and Brownfields Redevelopment.* Washington, DC: EPA.

Environmental Protection Agency. (2006). *Parking Spaces/Community Places: Finding the Balance through Smart Growth Solutions*. Washington DC, EPA Development, Community and Environment Division.

Ferguson, E. (2004). "Zoning for parking as policy process: A historical review". *Transport Reviews*. Vol. 24, No. 2: 177-194.

Holtz Kay, J. (1997). *Asphalt Nation: How the Automobile Took Over America and How We Can Take It Back*. Berkeley, California: University of California Press.

Katzev, R. (2003). Car Sharing: A new approach to urban transport problems. *Analyses of Social Issues and Public Policy,* 3(1): 87-109.

Keneipp, J. (1983). Parking demand. In Parking Consultants Council, & National Parking Association (Eds.), *The dimensions of parking* (Second ed.) (pp. 17-22). Washington: Urban Land Institute and National Parking Association.

Kuzmyak, J. R., Weinberger, R., Pratt, R., & Levinson, H. (2003). *Traveler response to transportation system changes: Chapter 18 - parking management and supply.* (TCRP Report No. 95). Washington, D.C.: Transportation Research Board.

Lightfoot, G. (1997). *Pay as you drive carsharing*: *Final report*. Unpublished report.

Litman, T. (1999). *Evaluating Carsharing Benefits*. Victoria, BC: Victoria Transport Policy Institute. Accessed on November 21, 2005 from http://www.bremen-initiative.de/lib/background/Eval_Carsharing_Benefits.pdf.

Litman, T. (2004). *Parking Requirements Impacts on Housing Affordability*. Victoria, BC: Victoria Transport Policy Institute.

Meijkamp, R. (2000). *Changing consumer behavior through eco-efficient services: An empirical study on car sharing in the Netherlands.* Delft, the Netherlands: Delft University of Technology Press. Accessed on November 19, 2005 from http://www.communauto.com/images/Meijkamp_CarSharing_in_NL.pdf.

Millard-Ball, A., Murray, G., Ter Shure, J., & Fox, C. (2005). *Car Sharing: Where and How it Succeeds*. TCRP Report 108. Transportation Research Board, Washington, D.C.

Montgomery County, Maryland. Chapter 59 Zoning, Article 59-E-3.2: Computing parking requirements for office development. Available at http://www.amlegal.com/nxt/gateway.dll/?f=templates&fn=default.htm

Muheim, P. & Partner, L. (1998). *Mobility at your convenience: Car sharing, the key to combined mobility*. Berne, Switzerland: Energie 2000, Transport Section.

Planning Advisory Service. (1964). *Off-Street Parking Requirements*. Planning Advisory Service Report No. 182. Chicago: American Planning Association

Scott, S., Brook, D. & Perussi, M. (2003). *Impacts of Car Sharing on Walking Behavior*. Accessed on November 2, 2005 from: www.metaresource.com.

Shaheen, S. (1999). Dynamics in Behavioral Adaptation to a Transportation Innovation: A Case Study of CarLink--A Smart Carsharing System. PhD Dissertation. Institute of Transportation Studies, Davis.

Shaheen, S., & Rodier, C. (2004). *Travel effects of a suburban commuter-carsharing service: a CarLink case study.* Submitted to Transportation Research Board (TRB).

Shaheen, S., Cohen, A., & Roberts, J.D. (2005). *Carsharing in North America: Market Growth, Current Developments, and Future Potential*. Institute of Transportation Studies. University of California, Davis. Accessed on February 22, 2006 from http://www.its.ucdavis.edu/publications/2005/UCD-ITS-RR-05-11.pdf

Shoup, D. (2002). *Eco Passes: An Evaluation of Employer-Based Transit Programs.* Unpublished Report. Accessed on February 17, 2006 from http://www.uctc.net/papers/727.pdf.

Shoup, D. (2005). *The High Cost of Free Parking*. Planners Press: American Planning Association. Chicago, IL.

Smith, M. (1999). Parking, in J.D. Edwards (Ed.), Transportation Planning Handbook, 2nd edn. p. 499-568. Washington, DC: ITE.

Sperling, D., Shaheen, S., & Wagner, C. (2000). Carsharing and Mobility Services: an updated overview. Accessed on November 10, 2005 from http://www.calstart.org/resources/paper/car_sharing.html.

Tumlin, J., & Siegman, P. Summer 1993. "The Cost of Free Parking." *The Urban Ecologist.*

U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. (November 2005). *Transportation Statistics Annual Report.* Washington, DC: U.S. Department of Transportation.

Washington State Department of Transportation, Commute Trip Reduction Office. (1999). *Local Government Parking Policy and Commute Trip Reduction: 1999 Review.*

Willson, R. (2000). "Reading between the Regulations: Parking Requirements, Planners' Perspectives, and Transit." *Journal of Public Transportation*. Vol.3, No.1: 111-128.

Personal Communications:

Axelsson, Tracey. Founder and President, Cooperative Auto Network. February 22, 2006.

Brophy, Adam. Director, Business Development, Zipcar. February 24, 2006.

Felix, Alison, AICP. Transportation Planner, Boston Transportation Department. March 10, 2006

Larsen, Katie. Senior Planner, Neighborhood Planning & Zoning Department, City of Austin. March 10, 2006

Pinsker, Paul. Parking and Development Engineer, City of Vancouver. February 7, 2006

Walters, Mark. Planning & Zoning Department, City of Austin. February 27, 2006