Moving Together in the 21st Century:
How Ridesharing Supports Livable Communities

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This white paper is a follow-up to the Volpe Center report for FHWA, “Ridesharing Options Analysis and Practitioners’ Toolkit.” The white paper provides an update to current ridesharing options and further explores technology and policy developments that make new methods of ridesharing possible. In addition, the report assesses ridesharing as a key contributing factor to supporting livable communities, and in particular, how ridesharing can be part of a "tipping point" in reducing the need for vehicle ownership and demand for parking.

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I. Introduction

Many characteristics draw people to communities that embody the characteristics of "livability," including availability of multiple transportation options, equitable and affordable housing, and reliable transportation systems that enhance the economic competitiveness of communities. Ridesharing is a key contributor to livable communities, and recent advances in technology have expanded its potential to complement and enhance existing highway and transit systems. Ridesharing can be an important contributor to a "**tipping point**" whereby the full suite of transportation options become reliable, convenient, affordable and otherwise attractive enough to compete with single occupant automobile travel.

Ridesharing is not a mode of transportation, but by allowing travelers to opportunistically utilize excess capacity in vehicles that would already be on the road, it effectively acts as a form of transit and provides many of the same benefits. For the purpose of this report ridesharing is defined as *the practice of coordination among any subset of people sharing a common vehicle*. This coordination comes in many different forms, ranging from pre-arranged trips using online ridematching services, to instantaneous services that connect drivers and riders in real-time on an ad-hoc basis available through smartphone applications.

For transportation planning professionals, the benefits of ridesharing include reducing the number of vehicles on roadways; mitigating roadway congestion; and reducing transportation impacts on the environment. Rideshare users may share these values, but may also be concerned with reducing transportation costs, cutting travel times, and reducing the need to own a personal vehicle. As congestion on the Nation's roads continues to worsen, environmental concerns continue to mount, and fuel prices continue to oscillate yet gradually increase, people are increasingly looking for outlets to share rides. These factors combine with many emerging technologies and strategies to make ridesharing a more viable and increasingly less burdensome transportation option for a larger subset of travelers.

Ridesharing is very much part of a multimodal approach to transportation planning. Many ridesharing connections are made at formally established or informal hubs that typically exist at multimodal transfer centers such as park-and-ride lots or commuter rail stations. These hubs are natural gathering spots for people with similar transportation patterns. Ridesharing, therefore, is often coupled with bus, rail, ferry or other transit trips, or with walking or biking. Ridesharing is also increasingly being paired with carsharing services, which make private vehicles available on a short-term, hourly basis, and help users combine shared and solo trips using shared vehicles when more flexibility is required.

The growth of both ridesharing and carsharing is leading real estate developers and city planners to reconsider the allocation of parking spaces, which has impacts on housing density and livability. Excess and poorly designed parking facilities are antithetical to livable community principles. Ridesharing is proving to be a tipping point that allows people to increasingly rely on alternative transportation for a larger portion of their needs, and may lead them to reconsider both the costs and the necessity of vehicle ownership. This report examines this tipping point, its impact, and the resulting contributions of ridesharing to livable communities.

Purpose of this Report

This report is a follow-up effort to the Volpe Center December 2010 report for FHWA, "Ridesharing Options Analysis and Practitioners' Toolkit." The intent of the report is to provide an update to current ridesharing options and to further explore technology and policy developments that make new methods of ridesharing possible. In addition, the report assesses ridesharing as a key contributing factor to supporting livable communities, and in particular its ability to reduce the need for vehicle ownership and demand for parking.

Intended Audience

This report is written for the benefit of various constituencies, representing both the public and private sectors, which are working to enhance appreciation of ridesharing as a viable alternative transportation strategy. More specifically, this report is intended to showcase how technology and greater interconnectedness decrease and, in some cases, fully eliminate the barriers to entry into the ridesharing market. Among the entities that may gain insight from this report are:

- Municipal, city, and State governments;
- Transit agencies;
- Metropolitan Planning Organizations (MPOs);
- Real estate developers;
- Software engineers;
- Venture capitalists; and
- Academics.

Structure of the Report

This report is a white paper that explores various concepts, many of which are still under development or being piloted in the U.S. and around the world. In many ways, technology and private sector service providers are adapting advances in ridesharing more rapidly than are governments and public agencies that are responsible for implementing ridesharing. Therefore, many of the case examples provided are either conceptual or in their preliminary stages, with possible implementation to follow. The goal of the report is not only to describe the status of the ridesharing market as it exists today, but also to identify new and innovative solutions that are likely to be realized in the near future or have the potential to further transform the role of ridesharing in the overall multimodal transportation system.

This report first describes some of the core principles that define livable communities and the role of ridesharing in supporting them, and then explores key aspects of how improved ridesharing can contribute to a tipping point related to livability. The report concludes with a series of case examples that demonstrate these relationships in practice or in concept, in the following categories:

- Smartphone and Web-Enabled Regional Ridematching
- Dynamic Ridesharing
- Next-Generation Carsharing
- Mobility Hubs
- Partnerships With Developers

II. Benefits of Ridesharing for Livable Communities

Ridesharing has been shown to address several mobility, affordability, land use, and equity issues that persist despite the efforts of planners and policymakers. The combination of improved mobility, affordability and environmental quality is often referred to as livability.

According to FHWA's *Livability in Transportation Guidebook:*[1]

> "Livability in transportation is about using the quality, location, and type of transportation facilities and services available to help achieve broader community goals such as access to good jobs, affordable housing, quality schools, and safe streets. This includes addressing road safety and capacity issues through better planning and design, maximizing and expanding new technologies such as intelligent transportation systems (ITS) and quiet pavements, and using travel demand management (TDM) approaches in system planning and operations. It also includes developing high quality public transportation to foster economic development, and community design that offers residents and workers the full range of transportation choices. And, it involves strategically connecting the modal pieces—bikeways, pedestrian facilities, transit services and roadways—into a truly intermodal, interconnected system."

By making use of the otherwise empty seats in vehicles traveling on the roadway network or sitting idle in dedicated parking spaces, ridesharing supports livable communities in numerous ways. Because much of our country's transportation system is road-based, access to a car is perceived as a fundamental need and unavoidable expense for the majority of U.S. residents. Ridesharing expands the pool of potential travelers who can affordably utilize the substantial roadway and highway investments the country has made over the past several decades without requiring each traveler to own a personal vehicle. Furthermore, ridesharing mitigates traffic congestion and improves the cost-effectiveness of the highway network, thus reducing the need for government expenditures to expand roadway capacity. Perhaps most significantly, when ridesharing enables a household to reduce the number of vehicles it owns and maintains it can be a catalyst that unlocks the potential of public investments to improve the livability of communities through more efficient use of public transportation, nonmotorized transportation, and more affordable housing and transportation.

Connections between Ridesharing and Livability

The Partnership for Sustainable Communities, an effort led jointly by the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA), has identified six livability principles that are central to building and supporting sustainable communities. Table 1 describes the six principles and how they connect to ridesharing.

[1] http://www.fhwa.dot.gov/livability/case_studies/guidebook/

Table 1: The HUD-DOT-EPA Partnership for Sustainable Communities' Livability Principles and Connections to Ridesharing

Livability Principles	Connection to Ridesharing
Provide more transportation choices. Develop safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health.	• Provides additional affordable transportation options • Reduces demand for fuel and reduces vehicle emissions • Promotes active, nonmotorized transportation modes that are beneficial to public health
Promote equitable, affordable housing. Expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.	• Reduces combined housing and transportation costs • Reduces the need for dedicated parking • Reduces the need for vehicle ownership
Enhance economic competitiveness. Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well as expanded business access to markets.	• Improves accessibility to employment, education, and basic services • Improves the reliability of highway travel by mitigating traffic congestion
Support existing communities. Target federal funding toward existing communities -- through strategies like transit-oriented, mixed-use development and land recycling -- to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes.	• Supports compact, walkable land use patterns typical of existing and historic communities • Reduces the demand for low-density suburban-style development designs that can disrupt the historic urban fabric of existing communities
Coordinate and leverage federal policies and investment. Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy.	• Makes more efficient use of Federal, State, and local investments in roadway infrastructure • Supplements fixed-route public transportation with flexible point-to-point travel options • Mitigates the need for large roadway expansion expenditures • Lowers the cost of providing paratransit service in rural and low-density communities.
Value communities and neighborhoods. Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods -- rural, urban, or suburban.	• Supports travelers who rely primarily on nonmotorized modes for short and mid-length trips • Reduces the demand for dedicated parking, enabling more walkable urban design • Promotes formation of community and neighborhood interpersonal relationships

Ridesharing Provides Increased Transportation Choices

Ridesharing provides affordable transportation options for a variety of travelers, including both middle- and low-income persons. Some examples of individuals whose transportation choices are expanded by ridesharing include those who:

- own a personal vehicle but wish to reduce their fuel costs or carbon footprint;
- own a personal vehicle and wish to take advantage of time savings offered by high-occupancy vehicle (HOV) or other managed highway lanes;
- rely primarily on fixed-route public transit but require occasional access to a personal vehicle;
- cannot afford to own and maintain a personal vehicle; or
- are unable to operate a personal vehicle.

Transportation choices are an important part of livable communities because they enhance the flexibility of travelers to adapt their transportation behavior to their values and lifestyles in ways that advance their financial, social, health and environmental goals. In urban areas, expanded rideshare options enable households to reduce their vehicle ownership, particularly for those with convenient access to alternative transportation for a portion of their travel needs. In rural areas, or in areas poorly served by public transit, ridesharing can be an essential link to centers of employment, particularly for individuals with low-incomes, or those unable to operate a vehicle. In all cases, ridesharing provides an affordable alternative to driving alone.

Ridesharing has also been shown to mitigate traffic congestion and reduce vehicle emissions. A 1999 study of vanpools in the Puget Sound region in Washington found that the area's 1,238 vanpools were responsible for reducing regional travel demand by 22,000 trips daily, resulting in a reduction of 2.7 million vehicle miles traveled (VMT), 370 tons of air-polluting tailpipe emissions and 63,475 tons of greenhouse gas emissions annually. Even basic employer-based carpooling programs with limited ride matching services and marketing have been shown to attract between 5% and 15% of trips to a given workplace, while more advanced programs that include coordination with managed lanes (for example, HOV or High-Occupancy/Toll (HOT) lanes) or priced parking have seen higher rates of success.[2]

Carsharing programs also increase travelers' access to automobiles while tending to decrease VMT relative to levels of non-carshare members. A study of carshare members from 2001 through 2005 found that carshare members' annual VMT decreased significantly relative to VMT of non-carshare members'.[3] This may have been because carsharing shifts the costs of vehicle ownership and operation from primarily up-front, sunk costs (e.g., purchase price, insurance, dedicated parking) to costs paid on a marginal, time-of-use basis (e.g., hourly rate).[4] In effect, the usage-based carsharing pricing scheme enables users to more accurately assess the costs of each trip, and provides a clear incentive to avoid unnecessary or low-value trips in order to avoid usage fees.

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[2] **Fabricatore, B. Y.** (2001). *Puget Sound Vanpool Market Assessment.* Washington State Department of Transportation, Office of Urban Mobility.

[3] **Robert Cervero, A. G.** (2007). City CarShare: Longer-Term Travel Demand and Car Ownership Impacts.

[4] **Transit Cooperative Research Program.** (2005). *TCRP Report 108: Car-Sharing: Where and How It Succeeds.* Transportation Research Board. Washington, D.C.

Ridesharing Promotes Affordable Housing

Housing and transportation costs are inherently linked. For example, land prices tend to decrease as distances from centers of employment and cultural activity increase.[5] However, because household members who live in distant locations must travel farther to access employment, education and other essential services, transportation costs tend to increase as distances increase. While some areas near the edge of a metropolitan area may have relatively affordable rents, these areas may not be affordable for low and moderate income persons because transportation options for residents of these areas are typically quite limited, with many residents having little to no access to public transit or adequate walking and biking infrastructure. Therefore, residents of these areas must purchase and maintain a personal vehicle to access desired destinations. The additional cost of vehicle ownership drives up combined housing and transportation costs and reduces the affordability of living in these areas.

Ridesharing strategies provide affordable transportation options that reduce combined housing and transportation costs. Ridesharing allows residents to access the existing roadway transportation network at much lower costs than that of private vehicle ownership, maintenance, and operation. The *Ridesharing Options Analysis and Practitioner's Toolkit* report showed that in 2009 and 2010, the average U.S. solo driver could save over $2,000 annually by participating in a four-person daily carpool to work.[6] These benefits are likely to increase if fuel costs, commute distance, or roadway congestion continue to increase. According to the Bureau of Transportation Statistics, in the U.S. the average annual cost of vehicle ownership in 2011 was $8,946.[7] If ridesharing strategies, combined with nonmotorized transportation and transit, can provide similar levels of mobility to that of private vehicle ownership, then substantial savings can be realized by those households that are able to reduce the number of vehicles they would otherwise need to own and maintain.

One ridesharing strategy that has shown potential to significantly reduce the need for private vehicle ownership is carsharing. Carsharing allows members to rent vehicles stored in convenient locations on an as-needed, short-term basis. One survey of carshare members found that nearly one-third of participating households reduced their vehicle holdings within one year of joining a carshare program.[8] The same survey found that the average number of vehicles owned per household fell by nearly 50% over the same period (0.47 to 0.24). Notably, much of this reduction was from formerly one-car households that no longer owned cars after one year of carshare membership; many auto trips were replaced with walking or biking trips to nearby destinations, often in combination with transit.

Ridesharing and carsharing strategies reduce the demand for dedicated parking which can lead to more affordable housing developments. Even in walkable, bikeable areas with good transit service, it is not uncommon to find housing developments with large areas of dedicated parking. This is partially because even when residents have good access to transportation alternatives, many still desire the utility and flexibility of access to a personal vehicle for shopping, recreation and other non-work trips. However, dedicated parking adds significant costs to the development of housing and other buildings, particularly in densely developed areas. For instance, the cost of building dedicated off-street parking in San Francisco has been estimated to add between $20,000 and $30,000 per space to the cost of a new

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[5] **Alonso, W.** (1964). *Location and Land Use.* Cambridge: Harvard University Press.
[6] http://www.planning.dot.gov/documents/RidesharingOptions_Toolkit.pdf
[7] **BTS.** http://www.bts.gov/publications/national_transportation_statistics/html/table_03_17.html.
[8] **Elliot Martin, S. A.** (2010). *Impact of Carsharing on Household Vehicle Holdings: results from North American Shared-Use Vehicle Survey.*

building, on average.[9] These costs are passed on to residents through higher rents and sales prices. Convenient ridesharing and carsharing can enable developers to build fewer parking spots, lowering eventual rents or sales prices and facilitating denser site designs. Providing one dedicated spot for a vanpool, carpool, or carsharing vehicle can eliminate the demand for other parking spaces.

Ridesharing Enhances Economic Competitiveness

The Texas Transportation Institute's *2012 Urban Mobility Report* estimates that the average commuter experienced over 38 hours of delay due to roadway congestion in 2011.[10] The report estimates the aggregate annual economic costs of this congestion at over $120 billion. Congestion is a significant and growing concern, particularly in areas with few transportation options. Meanwhile, millions of empty passenger seats go unused in personal vehicles every day on highways. Ridesharing strategies fill more of those empty seats, decreasing the roadway space and vehicle-miles required to transport each traveler to his or her destination (as opposed to driving alone), thereby helping mitigate congestion.

Ridesharing is an important tool for connecting people to employment opportunities. Workplaces have become more spatially dispersed over the last several decades and are now often located in auto-oriented suburban locations that are difficult and expensive to serve with public transit. Carpooling and vanpooling have long been an essential component of supporting the economic viability of these workplace locations; emerging technologies present significant opportunities for expanding the benefits of ridesharing as a means for accessing employment, education and other basic services.

Ridesharing Supports Existing Communities

Ridesharing supports the vast public and private sector investments in the Nation's existing and historic communities. Because many places were built before the widespread advent of the personal automobile, few of them have sufficient land set aside to accommodate the automobile-centric transportation system of today. Many existing and historic communities are well-suited to fixed-route public transportation for longer trips and nonmotorized transportation for most short- and mid-range trips because of their compact development patterns and higher relative densities. However, many existing communities have seen the unique character of historic walkable neighborhoods weakened due to increased demand for parking.

Historic communities are often highly livable places precisely because they have compact development patterns that support a range of transportation options. In many existing communities residents can access routine destinations on foot or bike, reducing their need to own and maintain private vehicles. Nevertheless, because established communities exist within the context of a regional economic and transportation network that is primarily automobile-centric, many residents own cars and many businesses perceive the need to convert adjacent land into dedicated parking. The conversion of land to surface parking tends to weaken the urban fabric and character that make historic communities attractive.

Ridesharing provides options for residents of existing communities that enable them to take full advantage of the nonmotorized and public transit networks in their neighborhoods, while maintaining access to the flexible mobility of a private vehicle when they need it. Ridesharing also provides

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[9] **Dunphy, R.** (2007). *Parking: The Expensive Amenity.*
[10] **Texas Transportation Institute**. *2012 Urban Mobility Report.* http://mobility.tamu.edu/ums/

additional means for visitors to access businesses, public spaces, and other regional amenities, while protecting the historic neighborhoods, downtowns, and rural landscapes that make these places special.

Ridesharing Supports Federal Policies and Coordinated Investments

In an era of budget deficits and increasing infrastructure construction and maintenance costs, ridesharing provides an opportunity to increase the coordination and impact of Federal transportation investments to support livable communities. As evidenced by the establishment of the HUD-DOT-EPA interagency partnership, the Federal government recognizes the value of improved connections between Federal policies and investments in housing, transportation and environmental stewardship. Ridesharing makes all of these investments work together in ways that create a whole greater than the sum of its parts. Some examples of the synergies that ridesharing creates between Federal investments and policies include:

- Ridesharing simultaneously lowers combined housing and transportation costs, mitigates roadway congestion, reduces demand for fuel and lowers pollution from vehicle emissions.
- Ridesharing reduces the demand for dedicated parking, enabling more compact, walkable neighborhood design, which leads to less demand for fuel and lower vehicle emissions.
- Ridesharing enhances the mobility of travelers who rely primarily on fixed-route public transit, the most energy-efficient mode of motorized transportation.
- Ridesharing reduces the need for costly highway and transit capacity expansions which may damage the character of rural areas, divide existing communities, or have negative impacts on natural and cultural resources.

Ridesharing Supports Healthy, Safe, Walkable Neighborhoods

A livable neighborhood, whether urban, suburban, or rural, is one where it is safe and pleasant to walk the streets. Ridesharing supports walkable neighborhoods by providing an alternative to driving alone. When neighborhoods are designed primarily to support personal vehicle ownership, large areas must be devoted to parking, which results in lower density development patterns that are less conducive to walking and biking. By reducing the need for households to own personal vehicles, ridesharing supports compact, walkable neighborhoods. Furthermore, compact neighborhoods support public health by providing an attractive context for nonmotorized transportation and physical activity.

Emerging Potential of Ridesharing as a Livability Tipping Point

Ridesharing is not a catch-all remedy for all communities. For most people, ridesharing is not the solution to all transport and mobility needs; it is just one option of many. However, what makes ridesharing particularly compelling for livable communities in the 21st century is its flexibility and adaptability to meet a wide range of transportation needs. Well-used ridesharing contributes to a tipping point of alternative transportation services that have the potential to alter travel behavior sufficiently to reduce the need for vehicle ownership, thus strengthening the performance and utility of other alternative transportation options, reducing household travel costs, and allowing livable communities to thrive.

In addition to daily commuting, modern ridesharing can support many non-work transportation needs, including: an intercity trip to visit friends for a weekend; a day trip to visit family; or an occasional visit to a regional grocery store or shopping center. Without reliable ridesharing, these types of sporadic trips often require, or at least encourage car ownership. Many people, particularly those who live and work in dense urban areas may only use a personal vehicle once per week, or even once per month, but it is these types of irregular, non-work trips that lead to a maxim that vehicle ownership is necessary, and that all development should accommodate convenient vehicle access and parking.

Ridesharing is somewhat unique among transportation options due to its flexibility. It requires little in terms of dedicated infrastructure or advanced planning because, for the most part, it utilizes the existing roadway and parking infrastructure. Ridesharing can therefore support trips that occur only occasionally, especially those trips that would otherwise tend to steer people toward vehicle ownership. As people come to realize that these occasional types of trips can be done without owning a vehicle, a tipping point is reached as people begin to rethink the value of vehicle ownership and the full costs of owning a vehicle.

If ridesharing can increasingly provide the flexibility desired to support both regular work trips and occasional non-work trips, it is logical to assume that many people will choose to reduce trips by personal vehicle, instead relying more frequently on alternative options to connect origins to destinations, including nonmotorized transportation and public transit, or on both in linked trips. To an extent, this concept can be seen in the recent rise in popularity of urban bike sharing programs. For example, a survey of bike share participants in Washington, D.C., found that 16 percent of trips made using the shared bicycle service replaced automobile trips.[11] Increasingly, bike share systems are being used to support other alternative transportation modes, like public transit. Similarly, 21st century ridesharing has the potential to allow travelers to connect to other transportation modes, or as in bike sharing, the flexibility to reach a wide diversity of destinations or provide convenient options for the first or last mile of a trip.

[11] **Shaheen S. and Guzman S.,** *Worldwide Bikesharing*. ACCESS #39, Fall 2011. http://www.uctc.net/access/39/access39_bikesharing.shtml

III. Case Examples of Ridesharing Supporting Livable Communities

The following nine case examples present 21st century ridesharing strategies that illustrate the potential for ridesharing to support livability in many ways. The case examples are organized into five categories:

1. Smartphone and Web-Enabled Regional Ridematching
2. Dynamic Ridesharing
3. Next-Generation Carsharing
4. Mobility Hubs
5. Partnerships With Developers

Table 2 lists the nine case examples and shows their connections to the six HUD-DOT-EPA livability principles presented in the previous chapter.

Table 2: Case Examples of Ridesharing and Connections to Livability Principles

	Provide more transportation choices	Promote equitable, affordable housing	Enhance economic competitiveness	Support existing communities	Coordinate and leverage federal policies and investment	Value communities and neighborhoods
RideArrangers	✓	✓	✓	✓	✓	✓
Casual Carpooling in Washington, DC	✓	✓	✓			
Washington State DOT Carpool Pilot Project	✓	✓	✓	✓	✓	
RelayRides	✓	✓	✓	✓		✓
mobile.punkt	✓	✓	✓	✓	✓	✓
San Bruno Ridesharing Transfer Hub	✓	✓	✓	✓	✓	
1801 North Lynn Street: Arlington, Virginia	✓		✓	✓	✓	✓
MTC *Developing Parking Policies to Support Smart Growth*	✓	✓	✓	✓	✓	✓
Stellwerk 60: Cologne, Germany	✓	✓			✓	✓

A. Smartphone and Web-Enabled Regional Ridematching

Most ridesharing systems rely on drivers and riders to pre-arrange trips, a process called "ridematching." Finding matches of drivers and passengers with similar origins, destinations, and schedules has historically been the biggest barrier to successful rideshare participation, in part because prospective participants have been limited to a relatively small pool of potential matches, consisting primarily of friends, neighbors, and coworkers. However, in recent years more sophisticated, modern ridematching systems have emerged. These systems use the web to better connect prospective rideshare participants at a regional level, to communicate the value of ridesharing in terms of cost savings and environmental benefits, and to connect users to related services. The most advanced systems can be accessed via smartphones and other mobile computing devices, making it more convenient than ever to search for and make ridesharing arrangements.

In the early days of formal ridesharing programs, prospective rideshare participants had to rely on bulletin board postings, decks of index cards with route, time, and contact information, and employer-based rideshare coordinators to find rideshare partners. Today, the vast majority of ridematching is done online, through websites and smartphones; these systems are increasingly becoming integrated at the regional level. Ridematching systems are often integrated into regional transportation demand management (TDM) programs provided by State departments of transportation (DOTs), metropolitan planning organizations (MPOs), and local transportation management organizations (TMOs). These programs typically provide a suite of complementary services in addition to ridesharing, that often include shuttle buses, guaranteed ride home programs, or rewards programs for alternative transportation users. The FHWA desk reference on TDM provides a comprehensive review of TDM and transportation planning.[12]

RideArrangers: Regional Online and Smartphone-based Ridematching

RideArrangers,[13] a program of the Denver Regional Council of Governments (DRCOG), is an example of a state-of-the-art online regional ridematching system. Increasingly, ridematching systems are evolving to a regional scale, to expand the databases of potential drivers and riders, to help connect riders with local TMOs, and to allow users to access ridematching services through multiple portals, including smartphone applications and social media. RideArrangers and programs like it are making ridesharing more convenient and showing how ridesharing can be an important piece in the overall portfolio of alternative transportation options that support livable communities throughout a region. This and other examples of regional scale approaches to transportation demand management and nonmotorized transportation are evaluated in the recent FHWA and Volpe Center report, "Developing a Regional Approach to Demand Management and Nonmotorized Transportation: Best Practice Case Studies," posted on the FHWA and FTA Transportation Planning Capacity Building web-site at http://www.planning.dot.gov/. A 2012 Transportation Research Board report provides an excellent resource for the combined topic of demand management and carsharing, covering research on parking pricing and for affordable housing, performance measures for demand management, and carsharing strategies and impacts.[14]

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[12] **Federal Highway Administration.** *Integrating Demand Management into the Transportation Planning Process: A Desk Reference*, FHWA-HOP-12-035, http://www.ops.fhwa.dot.gov/publications/fhwahop12035/index.htm

[13] http://www3.drcog.org/RideArrangers/

[14] **Transportation Research Board**, Transportation Research Record No. 2319. Demand Management and Carsharing 2012. http://www.trb.org/Main/Blurbs/168554.aspx

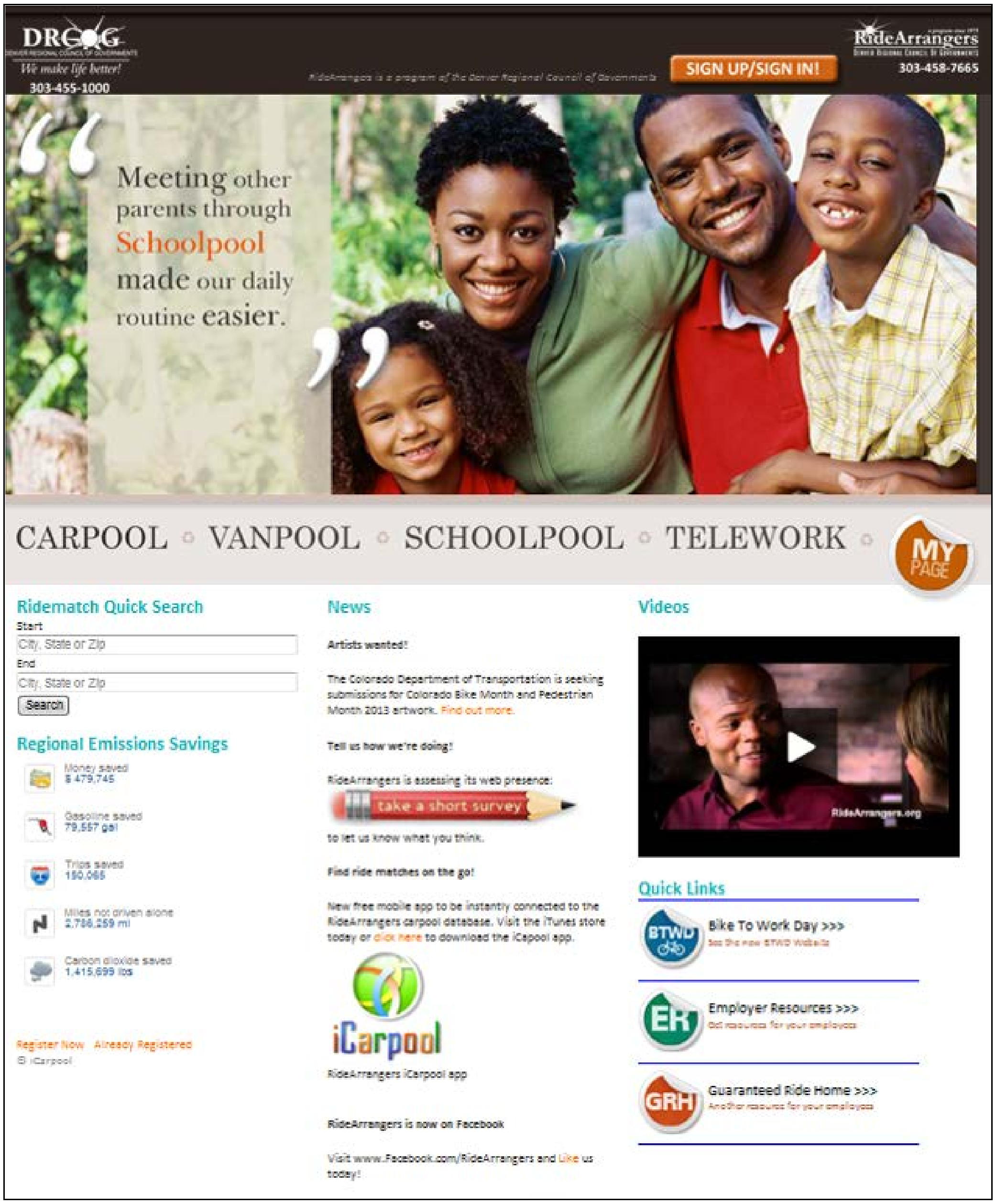

Figure 1: Main RideArrangers web portal homepage
SOURCE: http://www3.drcog.org/RideArrangers/

The RideArrangers system is powered by iCarpool,[15] a ridematching software technology, which drives the main RideArrangers web portal as well as sub-portals that target specific user groups. Many of the TMOs in the Denver region have customized sub-portals that provide users with a tailored experience, while also allowing them to connect to the entire regional pool of potential rideshare matches. For instance, 36 Commuting Solutions,[16] a TMO that focuses on providing information and services for users who frequent the U.S. Highway 36 (U.S. 36) corridor between Denver and Boulder, has developed a customized portal that guides its customers to the regional ridematching system. Users who register

[15] http://www.icarpool.com/
[16] http://36commutingsolutions.org/

through this system become members not only of the 36 Commuting Solutions ridematching database, but of the full regional database.

Other participating organizations, such as large employers, schools, or universities, can also create sites within the regional or TMO portals. These sites allow users to connect easily with coworkers and neighbors (the traditional pool of potential rideshare matches) while also accessing the regional rideshare community. This approach allows TMOs and employers to use the same portal to provide specialized information or services to their members that may not be available for all participants throughout the region, such as guaranteed ride home services. It also provides users with a familiar brand that communicates the relevance of the service to them. For example, 36 Commuting Solutions promoted their ridesharing portal as an option for dealing with the anticipated congestion of a multi-year construction project on U.S. 36.[17] The purpose of the construction project was to add a managed highway lane for high-occupancy vehicles and bus rapid transit service. Therefore, the portal also helped promote the message that rideshare arrangements formed to deal with anticipated construction traffic would also be able to take advantage of the new managed lane when it opened to the public.

The iCarpool software that powers the RideArrangers portal is a common platform used by many ridematching services.[18] iCarpool also provides a smartphone application that allows users to access the ridesharing network remotely, enhancing the abilities of travelers to incorporate ridesharing as one of multiple options to meet their needs, and to leverage location-based technology, such as global positioning system (GPS) tools to increase the relevance and accuracy of search results. Another feature of iCarpool and similar rideshare software platforms is integration with social networking websites. Users can choose to allow iCarpool to access their list of friends on Facebook, Twitter, or similar services and to announce their participation in the ridesharing program through these sites, to post available rides or ride requests, or to restrict their pool of potential ride matches to their list of friends or followers.

Ridematching has evolved to keep up with and take advantage of advances in online, mobile, location-based, and social networking technology. State-of-the-art systems like RideArrangers now enable providers to tailor the information and services they offer to specific audiences, and allow users to customize their ridematching criteria to fit their individual preferences. Perhaps most significantly, these regional systems are helping communicate the connections and synergies between various available transportation options.

Lessons Learned

Modern online ridematching systems make ridesharing more convenient and better able to suit a variety of users' needs, strengthening the ability of ridesharing to supplement and fill gaps in the existing transportation network, and to support livable communities. These modern systems expand transportation options, reduce combined housing and transportation costs, make it easier for people to get to work, and help make more efficient use of the Nation's transportation system investments. They help users discover that ridesharing can be a piece in a larger puzzle of alternatives to driving alone, whether that be through a daily, pre-arranged commuting trip, or an occasional non-work trip.

The shift to regional ridesharing can help to reduce barriers to ridesharing participation. The use of centralized databases of riders and drivers greatly expands the pool of potential matches, and

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[17] **Broomfield Enterprise.** *New high-tech car pool tool tries to fend off looming traffic jams on U.S.36.* http://www.broomfieldenterprise.com/ci_19690573?source=most_viewed

[18] Other popular services include NuRide, GreenRides, and Zimride, among others

coordination with related services improves their convenience and effectiveness. While not all ridematching services have adopted this model, there appears to be a trend in this direction and users can reasonably expect to see an increase in the use of this technology over the next several years.

Ideas for Further Research

- What proportion of large metropolitan areas has adopted regional online ridematching services? Has a measurable increase in rideshare participation occurred as a result?
- How might regional online ridematching services be better-linked to public transportation information services, real-time traffic information, and weather forecasts?
- Are ridematching smartphone applications being adopted by rideshare users? In what ways is this development changing rideshare participation?
- Can the regional online rideshare service model be adapted to commercial pre-arranged or on-demand transportation services, such as taxis, airport shuttles, and services for the elderly and disabled?
- Which marketing, education, and outreach strategies are most effective at increasing the public's familiarity with, acceptance of, and use of ridesharing?

B. Dynamic Ridesharing

Real-time or "dynamic" ridesharing is not a new concept; rather, it has been utilized in an ad-hoc manner for decades. In the mid-1970s, for example, several factors contributed to its growth: soaring fuel prices, increased suburban clustering of employment centers, and the construction of High Occupancy Vehicle (HOV) lanes in some of the most congested highway corridors in the country. Around this time, commuters began joining forces to achieve the cost and travel time savings associated with sharing rides.

Although ridesharing technology has evolved to now incorporate smartphones, GPS navigation devices, and social networks, there are still some metropolitan areas in the U.S. with ridesharing much like it existed decades ago. This section illustrates both an example from Washington, D.C. that began in the 1970s and a more recent groundbreaking example from Seattle, Washington, that utilizes the latest technologies to increase usage and efficiency.

Casual Carpooling in Washington, DC

"Slugging" is the term used to describe a unique form of commuting found primarily in the Washington, D.C., area. With slugging, cars that require additional passengers to meet the 3-person HOV lane minimum pull up to identified slug lines, which are typically found at park-and-ride lots, bus stops, or known transit hubs. The driver announces his or her destination to a group of commuters standing by; once there are three or more people in the vehicle the carpool is established and the group leaves together to drive on the HOV lanes. No currency is exchanged, as the time savings is enough of an incentive to encourage slugging for both drivers and passengers.

The first slug line was established after the HOV lanes on the Shirley Highway (I-395) opened to carpools in 1975.[19] Drivers started pulling up to a line of commuters waiting for the bus and offering a ride to anybody in line. Slugging was viewed as a cheaper, faster, more reliable, and sometimes less stressful experience than riding the bus.

Today, there are more than 25 established slug line locations in the greater Washington area, as indicated by Figure 2 below.

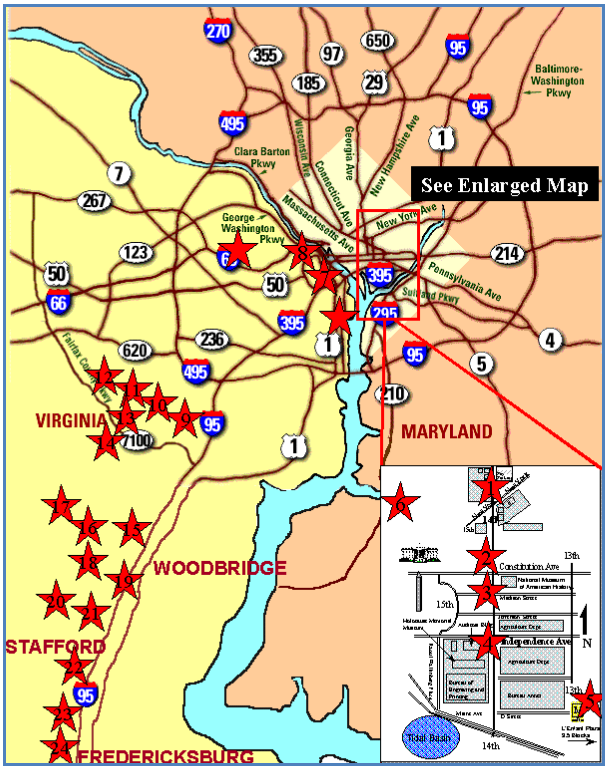

Figure 2: Map of slugging locations in Washington, DC, metro area.
SOURCE: http://slug-lines.com/Slugging/Map.asp

For people in the Washington, DC, area, the frequency and reliability of casual carpooling opportunities at any of these 25 slug line locations suggests that the slugging community will continue to thrive in areas where it is already well engrained into the transportation habits of its participants. Casual carpooling tends to grow over time, as indicated by the fact that the intricate system in the Nation's capital has grown over the course of four decades.

Other communities and private companies are taking a more proactive approach by utilizing technological advances that serve to expand the possibilities for real-time ridesharing. As the next examples demonstrate, rideshare matches and both pickup and drop-off locations can be established remotely, in real-time, without the need to rendezvous at any pre-established location.

Washington State DOT Dynamic Carpooling Pilot Project

In 2009 the Washington State Legislature directed the Washington State DOT (WSDOT) to conduct a dynamic carpool pilot on the State Road 520 (SR 520) corridor in King County. The legislature provided

[19] **Slug Lines.** http://www.slug-lines.com/slugging/About_Slugging.asp

$400,000 to fund the pilot and set project requirements established in the State's 2009-2011 transportation budget. WSDOT awarded the Dynamic Carpool Pilot Project grant to Avego to develop and manage the pilot project. The pilot operated from late January through May 2011.

Figure 3: Avego Smartphone Interface for SR 520 pilot program
SOURCE: http://go520.avego.com/st-pilot/

The pilot program employed a smartphone application that enabled drivers to post notice of vacant seats in their personal vehicles and receive real-time notification of riders seeking transportation along their intended route. Riders could also send a text message to drivers that included their pickup location and destination. Figure 3 above shows Avego's proprietary smartphone interface for establishing pickups and drop-offs.

This technology provided a verifiable and auditable trip trail that was used to calculate reductions in vehicle trips, vehicle miles traveled, and greenhouse gas emissions. The application also provided a number of safety features, such as user authentication via a PIN number that the rider must provide to the driver before the start of a trip.

When the system matched a prospective rider with a driver, it sent each party detailed trip information, including vehicle description, pickup time and location, and the maximum trip fee via text message or smartphone app. Once the trip was completed, the system automatically requested both driver and rider to rate their experiences with the other participant to inform future users' expectations for experience and comfort. The system included automatic payments for services between riders and drivers based on actual miles traveled. This created a secure economic incentive for drivers to fill empty seats in their vehicles, helped to encourage carpooling without requiring time-consuming pre-arrangements, and provided an affordable transportation option primarily to commuters who would otherwise drive alone, but also to riders who may not have convenient access to public transportation or a personal vehicle.

Avego offered incentives to attract and encourage individuals to sign-up and participate in the pilot project. Specifically, drivers could earn a $15 or $30 gas card each month, depending on the number of carpool trips they completed with participating riders. Riders could earn up to $30 each month in ride credits, which could be used only toward future trip costs they incurred while participating in the pilot.

Lessons Learned

Widely differing examples from the Washington, D.C., metro area and in Seattle, Washington demonstrate that unarranged, dynamic ridesharing already exists in various forms and is accessible to virtually anyone in those respective communities. The Washington, D.C. example is one of the earliest and best known examples in the U.S., and demonstrates that commuters in congested D.C. travel corridors have long recognized the benefits of ridesharing, and have created a network of slugging that is world-renowned and highly reputable. The Seattle example provides a contrast because it involves carpoolers whose intentions are quite similar to those in Washington, D.C., but uses smartphone technology and incentives to potential users. The Seattle example also showcases the interests of private companies such as Avego that seek to profit from the ridesharing market.

Ideas for Further Research

- In what instances has dynamic ridesharing been utilized at established TODs or other livable communities? What has been the role of the private sector (i.e., developers) in making these efforts successful?

- What are the possible effects of HOT Lanes on slugging? Drivers who would be assured of free-flow for a toll may be more willing to pay than to pick up strangers. The construction of the Capital Beltway HOT Lanes (I-495) in Virginia may provide keen insight.

- In the case of HOT lanes, how can the public interest in reducing roadway congestion be balanced with a private concessionaire's profit motive? Are these interests fundamentally at odds, or can systems be devised to align them?

- What can be done to further enhance safety measures for dynamic ridesharing systems? Many informal rules are in place to promote safety and security, however there is no way to fully ensure safety.

C. Next-Generation Carsharing

Over the past decade, many private companies have sought to enter the carsharing market through business-to-consumer (B2C) operational strategies. Under such models, a company owns a fleet of cars and facilitates the sharing among a group of members. The types of companies entering the B2C market include:

- Carsharing brands (e.g., Zipcar, StattAuto, GoGet)[20]
- Auto manufacturers (e.g., BMW, Peugeot, Daimler)
- Rental brands (e.g., Hertz, WeCar)

[20] On January 2nd, 2013, it was announced that Avis Rental Group agreed to purchase Zipcar.

Another business model is not-for-profit (NFP) or co-op, whereby a local organization or community serves as the facilitator of car sharing services with the goal of changing driver habits over making a profit. These exist in cities large and small, from San Francisco, Philadelphia and Chicago to Ithaca and Boulder. The NFP carsharing services operate similar to the B2C models, except that they redistribute any revenues back into the program, whereas the B2C companies are profit-seeking.

Carsharing has been increasing steadily in popularity over the past decade. As the Figure 4 below indicates, in North America there were over 500,000 carshare users in 2010, sharing over 10,000 vehicles. This represents more than a 200-fold increase in carshare participation in just ten years, dating back to 2000.

Figure 4: Growth of Carsharing in North America, 2000-2010.
SOURCE: http://futureofcarsharing.com/

Until recently, an entirely untapped market has been individual car owners themselves. The aforementioned companies all have their own fleets of vehicles, rather than utilizing the excess capacity that exists in vehicles already on the road.

One variation of this technique, peer-to-peer (P2P) carsharing, allows owners of vehicles to rent them to other drivers, who may not own or have access to a vehicle. Many companies are entering into this market, including RelayRides, Getaround, JustShareIt, and Wheelz. These companies are part of a greater "collaborative consumption" movement of civic-minded, Web-savvy people seeking to save money and realize environmental benefits.

Peer-to-Peer (P2P) Carsharing: RelayRides

In the U.S., the average personal vehicle is in use for only one hour per day, leaving the vehicle idle and available for others to utilize for the remaining 23 hours.[21] From a systems perspective, this is a massively inefficient use of resources which imposes high costs on private vehicle owners. Vehicle owners are beginning to monetize this excess capacity by enrolling in P2P carsharing programs that

[21] **Green Car Reports.** *OnStar Lets Owners Rent Out Their GM Cars via RelayRides.* http://www.greencarreports.com/news/1077800_onstar-lets-owners-rent-out-their-gm-cars-via-relay-rides.

enable their vehicles to be used by others during times when the owners don't need to use them. Such programs, much like other carsharing and ridesharing programs, enable many people to have access to a vehicle when they need one without the cost, inconvenience, and potentially negative public and private land use implications of vehicle ownership. This is particularly true for those who live in relatively dense, transit-accessible urban areas with high land values.

RelayRides is a P2P carsharing service that launched in Cambridge, MA, in late 2010 and has since expanded to San Francisco and other major urban areas in the U.S.[22] Unlike traditional carsharing services, RelayRides neither owns nor maintains vehicles. Rather, they offer a platform for car owners and renters to connect, thus generating scalability and lower pricing. In this system, vehicle owners set their own prices and receive 60 percent of the cost to the user. RelayRides retains the remaining 40% to pay for insurance and administration. RelayRides estimates that vehicle owners can earn between $2,300 to $7,400 annually, based on hourly rates ranging from $6 to $12.

Process

To make the vehicle available for rent through RelayRides, an owner signs onto the network and states the time and place where the vehicle will be available. The owner is then notified of any reservation requests and has the opportunity to approve or deny them. Finally, the owner and the renter meet to exchange keys; all transactions are handled electronically. Through a partnership with General Motors, owners with the OnStar system can use OnStar's remote unlock feature to open their car via smartphone, without the need for a key handoff.

Safety

RelayRides performs background checks of vehicle registration and inspection, as well as the renter's safety records. Drivers as young as 18 years old may use the service. However, drivers of any age will not be accepted into the program if they have two or more speeding violations, a single speeding violation that was more than 25 miles-per-hour over the posted speed limit, two or more red light or stop sign violations, or reckless driving or driving under the influence (DUI) infractions.

Insurance

A key legitimate concern with P2P carsharing is insurance and liability. RelayRides provides $1 million in coverage per incident. However, it should be noted that $1 million may not be sufficient to cover claims involving multiple injuries or death. For example, in February 2012, a customer rented a 2003 Honda Civic Hybrid thru RelayRides and during the course of the rental, was involved in a fatal crash that killed him and injured four others.[23] It is estimated that total insurance claims for this incident may total $1.5 million; more than the RelayRides insurance policy coverage limit.

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[22] **Wicked Local; Cambridge.** *Cambridge startup RelayRides lets neighbors share their cars.* http://www.wickedlocal.com/cambridge/news/x861575573/Cambridge-startup-RelayRides-lets-neighbors-share-their-cars#axzz2Asq2GkmR

[23] **New York Times.** *Fatal Collision Makes Car-sharing Worries no Longer Theoretical.* http://www.nytimes.com/2012/04/14/your-money/relayrides-accident-raises-questions-on-liabilities-of-car-sharing.html?pagewanted=all&_r=0.

Next Generation Carsharing Benefits and Challenges

There are both advantages and disadvantages to the B2C and P2P carsharing business models. Tables 3 and 4 below outline some of these benefits and challenges of Next Generation Carsharing.

Table 3: Advantages and Disadvantages of Business-to-Consumer (B2C) Carsharing Models

Business-to-Consumer (B2C) Advantages	Business-to-Consumer (B2C) Disadvantages
Roadside assistance	Limited fleet
Newer vehicles	Startup costs (e.g., securing parking spaces)
Expansive insurance options	
User interface	

B2C carsharing programs tend to provide more peace of mind to the renter by operating newer vehicles, and by providing supplemental insurance options and 24-hour roadside assistance. They are also generally faster to adopt friendly user interfaces for their mobile and computer applications. Among the challenges of the B2C model are that fleets may be limited and constrained to certain areas where the demand is high. Startup costs for the business also tend to be higher because they generally invest in, and use as a selling point, the availability of new vehicles. Also, the costs B2C carsharing programs incur to secure parking in highly desirable areas with dense development and foot traffic may contribute to higher prices.

Table 4: Advantages and Disadvantages of Peer-to-Peer (P2P) Carsharing Models

Peer-to-Peer (P2P) Advantages	Peer-to-Peer (P2P) Disadvantages
Lower startup costs	Liability and insurance concerns
No need for new dedicated parking spaces	Generally older vehicles
No net additional vehicles on roadways	Limited, if any, roadside assistance
Potentially larger fleet size	

P2P programs share vehicles that are already driving on the roads and already have dedicated parking. This leads to no net additional vehicles and lower startup costs. These programs also allow for a potentially much larger pool of available vehicles, and can potentially make vehicles available in less dense, even remote locations, providing a valuable option for rural areas. However, as indicated in the RelayRides example, there are concerns about insurance, and the vehicles tend to be older and potentially less reliable.

Lessons Learned

Carsharing is evolving beyond the established B2C model to include a P2P model that allows ordinary people to rent out their personal vehicles to other members of the P2P system that they may or may not know personally. All forms of carsharing are not without their liabilities, particularly with regard to insurance, however they appear to be more prevalent with P2P carsharing. Most promising about P2P carsharing, however, is that it utilizes excess capacity of vehicles that have already been purchased, rather than introducing new vehicles. This is a more efficient use of resources. With further refinement and clarity regarding some of the liability issues, P2P carsharing may prove to be a viable business model. P2P carsharing promises to benefit both vehicle owners, that do not need exclusive use of the vehicle at all times, and occasional users, who cannot or do not wish to own a car, but require periodic access to the flexibility and convenience of private vehicle transportation.

Ideas for Further Research

- How is the growth of carsharing affecting land use patterns long-term (e.g., parking minimum reductions)? How might an expansion in P2P carsharing affect these trends?
- How to further quantify the propensity of carsharing to reduce vehicle ownership, particularly in cities and around college campuses? How might P2P carsharing affect these trends?
- How might carsharing services be tailored to better serve the unique transportation needs of retirement communities and an aging population, or rural areas?
- What are the barriers to entry into the carsharing market, and how may these be overcome?

D. Mobility Hubs

New ridesharing technologies are developing at a fast pace in the U.S. and worldwide. Many of these technologies are based in the private sector and rely on users to connect in an ad hoc manner through the use of smartphones and other mobile technology. However, for the promise of new ridesharing technologies to be fully realized, they must be more fully integrated within the existing multimodal transportation infrastructure so that they can become a seamless part of a door-to-door journey. While smartphone and GPS technology show potential to connect users in new ways and provide valuable real-time information, the value of physical connection and transfer points has long been known.

New York's Grand Central Station is among the best-known and most-used multimodal transportation hubs in the United States. Grand Central Station is primarily a rail hub, requiring massive infrastructure and the convergence of multiple rights-of-way. Here, travelers typically transfer to public transportation or nonmotorized modes upon arriving at Grand Central Station for a relatively short final leg of their journey. However, in contrast to heavy rail transportation which requires massive dedicated infrastructure, ridesharing technologies primarily use the existing roadway infrastructure, and vehicles that can easily reach decentralized locations. Therefore, transportation hubs focused around ridesharing technologies may be much smaller and more numerous, dispersed throughout an urban area at logical activity and transfer points. These smaller "mobility hubs" need not be located at

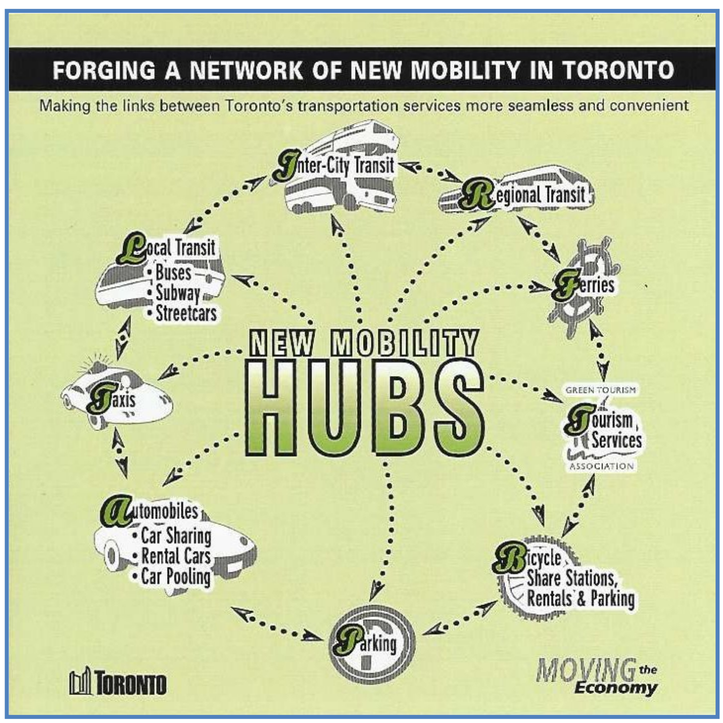

Figure 5: The mobility hub concept as envisioned in Toronto, Canada. SOURCE: Moving the Economy Initiative

the confluence of major rail lines as in Grand Central Station (although some certainly could be), rather they can be more dispersed, located at more modest transfer points between a single public transportation line and a ridesharing or carsharing network pickup or drop off point, supporting a more decentralized neighborhood orientation for mobility and accessibility.

The concept of mobility hubs originated in Bremen, Germany, the only city where it has been implemented on a large scale. Toronto, Canada conducted an early pilot project, and researchers at the University of Michigan Transportation Research Institute (UMTRI)[24] and others, have expanded-on, promoted, and piloted the concept in several locations worldwide. A variation on the mobility hub concept has also been proposed to address traffic congestion and connectivity issues between the city of San Francisco and the major employment centers of Silicon Valley. Figure 5 above illustrates the mobility hub concept from Toronto, Ontario.

mobile.punkt: Bremen, Germany

Bremen, a city of over 500,000 people and Germany's tenth most populous city, was already known for being a livable community in the late 1990s, perhaps due to the city's dense, historic development pattern, good public transportation, and bicycle-friendly streets. However, rising traffic and parking demands led the city to seek an innovative way to better connect users of public transit and nonmotorized transportation with the newly emerging carsharing industry. In 2002, Bremen launched a pilot project to better integrate multimodal transportation options at logical transfer points and activity areas called "mobil.punkts," which combined public transportation, private carsharing, nonmotorized transportation facilities, and taxi stands, all located together at curbside in the public right-of-way.[25]

Figure 6: A mobil.punkt station in Bremen, Germany. SOURCE: City of Bremen

The City of Bremen began partnering with a private carsharing company in 1996 by launching a new annual transit pass that also provided transit users with access to the carsharing system. A primary goal of the partnership was to improve the efficiency of the public transportation and private carsharing systems through better coordination. In 2002, with financial support from the CIVITAS Initiative ("City-Vitality-Sustainability") of the European Commission, the city launched the customer-oriented, attractively-branded mobil.punkt mobility hub pilot project. The mobil.punkt stations, marked by highly-visible signs, provided physical space on city streets, often next to transit stops, for carsharing vehicle storage, nonmotorized transportation facilities such as bike racks and lockers, and taxi stands.[26]

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[24] http://www.umtri.umich.edu/news.php

[25] **CIVITAS Initiative.** "*Mobilpunkt": Interchanges between Car-Sharing, Public Transport and cycling.* http://www.civitas-initiative.eu/alt/measure_sheet.phtml?lan=en&id=70

The mobil.punkt project successfully reduced the demand for parking in the densely developed central city, and although public opposition was initially feared, it never materialized. Analysis of a 2005 survey of the first two moble.punkt stations' 5,100 users estimated that at least 95 private vehicles had been replaced by the 10 carsharing vehicles provided. Furthermore, 30 percent of non-corporate users had replaced a private car with the carsharing service and 55 percent had not purchased a vehicle due to the availability of carsharing. Similar figures were reported by corporate users, which comprised 17 percent of all users. The convenient locations of the carsharing vehicles were cited as a key factor in the attractiveness of the service.[27]

By 2009, the mobil.punkt program had been expanded to 34 stations, distributed throughout the area with a total of 134 carsharing vehicles. Analysis estimated that the carsharing service had removed approximately 1,000 vehicles from Bremen's roads. Although the specific effects on traffic congestion and air pollution are not known, it is clear that the project had a positive impact on the livability of the city by providing affordable, convenient access to auto transportation without the need for personal vehicle ownership. The use of shared vehicles also likely reduced the demand for parking spaces in the densest areas of the city. An analysis of the expanded mobil.punkt program indicated that had the program not taken place, it would have cost between 12 million and 25 million EUR to construct the 1,000 underground parking spaces that would have been required to achieve similar mobility outcomes. The project was recognized as a best practice by The Federal Ministry of Transport, Building and Urban Development and was featured at the 2010 Shanghai EXPO.[28]

The integration of modes in the mobile.punkt project suggests the potential for expansion beyond carsharing into other forms of ridesharing, and that the concept could be transferable to cities in the U.S. Many of the stations are located at logical transfer points and activity nodes that would be logical locations for casual carpooling (also known as slugging), an established practice in at least three U.S. cities that has potential for expansion if HOV and HOT lanes become more common. Another logical extension would be the provision of bike sharing, a concept that is gaining popularity in many U.S. cities[29]. By coordinating both public and private transportation options in convenient locations, the mobil.punkt concept improves the attractiveness of all of the alternative transportation options provided at the stations.

Dynamic Ridesharing Transfer Hub Concept: San Bruno, California

A concept for a dynamic ridesharing (also known as "iPooling" or "instant ridesharing") transfer hub along the US-101 corridor between San Francisco (SF) and Silicon Valley (SV) illustrates the role that physical transfer points could play in supporting dynamic, web and smartphone-enabled ridesharing. Furthermore, the proposed hub's close proximity to the Bay Area Rapid Transit (BART) and Caltrain regional passenger rail services shows the potential for a mobility hub to connect transit users to

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[26] **Mobil.punkt.** http://www.mobilpunkt.info

[27] **CIVITAS.** *"mobil.punkt": Interchanges between Car-Sharing, Public Transport and Cycling in Bremen, Germany.* http://www.add-home.eu/docs/FGM_Bremen_MobilPunkt_ADDHOME.pdf

[28] **Wekstattstadt.** *Car-Sharing-Stationen im offentlichen Strassenraum: Bremen "mobil.punkt."* *http://www.werkstatt-stadt.de/de/projekte/212/*

[29] **Institute of Transportation Studies, University of California, Berkeley**. *Public Bikesharing in North America: Early Operator and User Understanding*. http://tsrc.berkeley.edu/sites/tsrc.berkeley.edu/files/ITS_Berkeley_Public%20Bikesharing%20in%20North%20America_Early%20Operator%20and%20User%20Understanding.pdf

ridesharing services, potentially improving the attractiveness, reliability and efficiency of both public and private transportation services. Improved ridesharing service between SF and SV could have many of the same livability benefits of dynamic ridesharing including reduced roadway congestion, reduced demand for private vehicle ownership and reduced demand for dedicated parking.

Cities 21, a research firm focused on technology-driven solutions to urban transportation and land use challenges, proposed a concept for a ridesharing transfer hub located in the public right-of-way next to U.S. Highway 101 in San Bruno, California (see Figure 7 below).[30] The concept sought to fill a critical gap in current transportation options for workers living in SF who commute to jobs at many of the high-tech industries headquartered in SV. SV employers draw from large commute sheds that encompass most of the San Francisco Bay Area. In particular, many younger employees prefer to live in SF where social and entertainment options are numerous, creating a significant commute vector between SF and SV. The employment locations of many large companies in SV are typically large single-employer campuses with no access to regional commuter rail services. The San Bruno transfer hub concept proposed combining emerging dynamic ridesharing technologies with a physical transfer point located along the primary commute flow between SF and SV to provide a more efficient travel option for employees living in SF. Additional transfer hubs could theoretically serve employees who live in other cities in the Bay Area.

[30] **Cities21.** *SF to Silicon Valley Instant Ridesharing with Transfer Hub*. Submitted in response to Transportation Research Board Committee AP020 call for papers. August 2009. http://www.cities21.org/TRB_SFtoSJ_iPooling_with_Hub.pdf

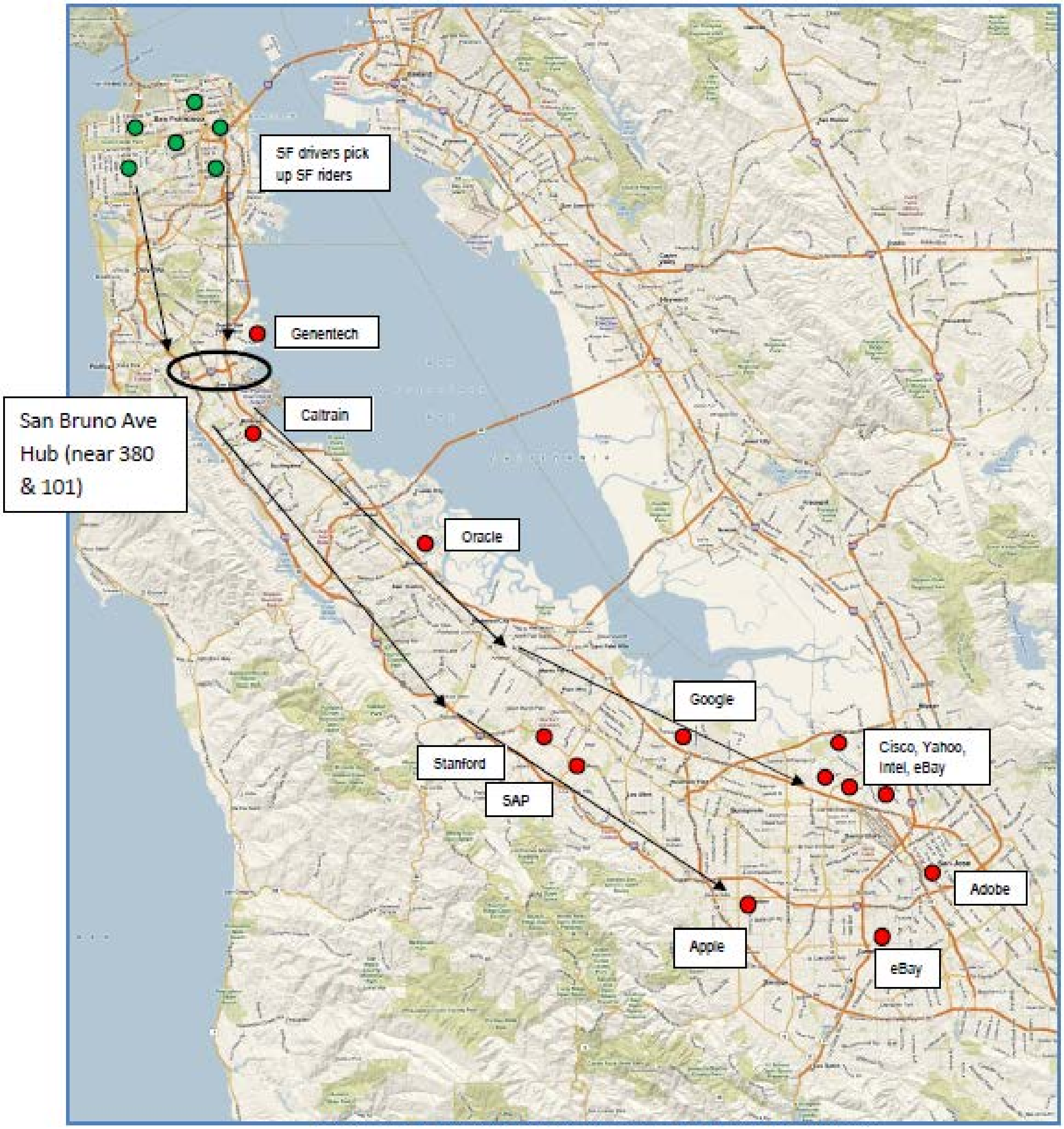

Figure7: Map of the San Francisco Bay Area Bay Area illustrating the proposed San Bruno transfer hub location (black oval), theoretical commute origins (green circles), commute destinations for 13 major employers in Silicon Valley (red circles) and major commute flows from San Francisco.
SOURCE: http://www.cities21.org/cms/index.php?page=sf-to-sj-via-hub

The Cities 21 San Bruno transfer hub scheme proposed that workers living in SF neighborhoods could rideshare to the transfer hub through a variety of mechanisms. The scheme theorized that because most SF to SV commuters would normally pass nearby the proposed transfer hub location regardless of their final destination, workers from different companies who lived in the same neighborhoods could share the ride to the transfer hub without incurring significant additional time costs. In particular, it was expected that many SF residents would choose new dynamic ridesharing options that do not require pre-arranging rides. Upon arrival at the transfer hub, passengers would switch to vehicles driven by workers bound for the same final destination or to existing private bus services provided by their employers that could be rerouted to the hub. The location of the hub in the public right-of-way would also significantly decrease the amount of time that ridesharing would add to the trip. During busy commute periods, it was expected that vehicles and riders would be ready for transfer with very little wait time. The proposal also suggested methods for accommodating workers with irregular work hours and guaranteeing that all participating users would always be able to catch a ride.

The Cities 21 proposal envisioned the transfer hub primarily as a place for ridesharing users to transfer from an origin-oriented ridesharing vehicle to a destination-oriented ridesharing vehicle. However, the hub could also easily incorporate additional public and private transportation services to increase the user base for the ridesharing system. The proposed location of the San Bruno hub was within close proximity to the San Bruno and San Francisco International Airport BART stations and the San Bruno Caltrain station. Were these systems to be integrated into the transfer hub by shuttle bus or other means, the hub could potentially become a multimodal mobility hub with a much wider regional reach.

While the San Bruno transfer hub scheme has not been implemented, the concept illustrates the potential role that mobility hubs could play in supporting ridesharing. As the San Bruno proposal points out, one of the major barriers to ridesharing is the building of a critical mass of users large enough to provide travelers with a high likelihood of catching a ride to their preferred destination without imposing significant delays. Building this critical mass is particularly problematic when residential origins and work destinations are spatially dispersed, as is the case with the SF to SV commute. The San Bruno transfer hub proposal could potentially overcome these barriers by providing a convenient transfer point along a major commute flow, eliminating the need for point-to-point ridesharing and significantly increasing the available user base.

Lessons Learned

The mobil.punkt system and San Bruno transfer hub concept suggest that even in the modern age of mobile communications devices, there is a role for physical location in supporting new ridesharing technologies. Both mobil.punkt and the San Bruno transfer hub concept show that convenient and timely access to ridesharing services can be a major determinant of success. These mobility hub examples also illustrate the potential for increased cooperation between public transit services and ridesharing, with potential efficiency and ridership gains for both services.

Ideas for Further Research

- Pilot a mobility hub network or transfer hub concept in a U.S. city to determine results such as: decreased user and community costs, reduced car ownership, user demographics, and land use impacts.
- Are carshare vehicles located in places that maximize their attractiveness to potential travelers? How much might carshare use increase if cities and transit agencies were to provide more attractive locations?
- Is there a potential role for mobility hubs in the development of subsidized housing?
- Are there models for public-private cooperation in the U.S. that are applicable to mobility hubs?
- Are European experiences transferable to the U.S.?

E. Partnerships with Developers

Compact urban form and real estate development patterns are often components of livable communities. Compact development patterns support walking, biking and transit use, and are typical of established communities. Conversely when developments must be planned to accommodate large parking lots and structures, communities become less walkable, travel destinations become more spread out, and the costs of developments rise. Increasingly, developers are incorporating ridesharing as a strategy to provide convenient motorized access to potential residents while avoiding the high costs and design consequences associated with extensive vehicle parking facilities. Governments and private developers are increasingly partnering to support livable communities; ridesharing is one set of strategies enabling developers to build attractive developments that require fewer dedicated parking spots, increasing availability of affordable housing, supporting retention of traditional walkable urban form, and providing viable and less energy-intensive transportation alternatives.

Examples from Arlington, Virginia and the San Francisco Bay Area demonstrate how ridesharing can be used to reduce parking requirements and support the design and development of livable communities. An example from Germany, where ridesharing is more established, provides an illustration of the potential livability benefits that expanded ridesharing may foster, should partnerships between developers and governments become more widespread in the U.S.

1801 North Lynn Street: Arlington, Virginia

The 1801 North Lynn Street development in the Rosslyn area of Arlington County, Virginia, provides an excellent example of how ridesharing can contribute to enhanced livability by supporting walkable, transit-oriented urban form. This major development, completed in 2001, includes 347,295 square feet of office space and 6,065 square feet of retail space, and is located near the Washington D.C. Metro's Rosslyn Station. [31] To realize the maximum benefit of this proximity to high-capacity transit, the developer and the County Board formed an agreement to implement a suite of ridesharing and alternative transportation strategies in exchange for a two-third reduction in the amount of parking typically required for a development of this size. The final development includes only 386 parking spaces, less than one parking space per 1,000 square feet of commercial space, as is allowed by the County Board for areas in close proximity to metro stations that provide a vehicle trip reduction program. As a result, the developer was able to make much more efficient use of the prime, transit-oriented site than would otherwise have been possible.

The suite of ridesharing and alternative transportation strategies employed at 1801 North Lynn Street includes a ridesharing program managed and promoted by a dedicated full-time employee, a financial contribution to the Rosslyn Commuter Store, which provides commuter services to all travelers in the Rosslyn Station area, carpool ridematching assistance, parking subsidies for carpools, bicycle parking facilities with showers, and easy access to high-capacity transit via the Washington D.C. Metro.

[31] **U.S. Environmental Protection Agency.** *Parking Spaces / Community Places: Finding the Balance through Smart Growth Solutions.* 2006. www.epa.gov/smartgrowth/pdf/EPAParkingSpaces06.pdf

The reduction in the number of parking spaces the developer was required to build as part of the 1801 North Lynn Street development likely had a significant impact on the design of the final project. The cost to build structured parking in Arlington County at the time of the development ranged from $15,000 to $60,000 per space. Without the approval of the trip reduction program, it would have cost the developer between $12 million and $48 million to build the extra 800 parking spaces that would have been required by the typical national standard of 3.3 spaces per 1,000 square feet. This might have made the project financially non-viable. Alternatively, the developer may have opted to significantly reduce the scale of the project, resulting in a development that did not fully take advantage of the significant transit investment that Arlington County, the Washington D.C. Metro and the Federal Transit Administration had made in Rosslyn Station. Had the development been built without the inclusion of the trip reduction program and thus, not qualified for the special 1:1000 parking space to square foot ratio, it is reasonable to assume that the Rosslyn area would have experienced significantly increased traffic demand, congestion and polluting vehicle emissions. Furthermore, the urban fabric of the Rosslyn area may have been damaged if large areas of land were dedicated to structured or surface parking, creating larger gaps between activity centers in the area.

Figure 8: 1801 North Lynn Street, Arlington, Virginia SOURCE:http://en.wikipedia.org/wiki/File:1801_North_Lynn_Street,_Rosslyn,_Virginia.jpg

The 1801 North Lynn Street project showed that ridesharing can play an important role in the planning of transit-oriented developments. Arlington County, the Washington D.C. Metro, and the Federal Transit Administration invested millions of dollars to provide the Rosslyn area with convenient access to high-capacity transit. However, without the incorporation of ridesharing and other trip reduction strategies, the developer may not have been able to make optimal use of the site because parking demands would have driven up costs dramatically. In this case, the synergy created between convenient transit access and ridesharing appears to have enabled the developer to employ a traditional downtown office tower design that was appropriate for the urban character of the Rosslyn area, enabling economic growth without sacrificing the livability of an established commercial center. The development enhanced the economic competitiveness of the Rosslyn area by providing new regional-serving commercial space that was well-integrated into the multi-modal transportation network, supporting timely and reliable access to employment and services for D.C. area workers and residents.

Developing Parking Policies to Support Smart Growth

Local parking policies are often a significant obstacle to developments that support walkable, vibrant, livable communities. Many local policies require that new developments provide enough parking spaces to satisfy peak parking demand, meaning that many parking spaces will be left empty much of the time. These policies seek to avoid negative transportation outcomes like roadways congested with motorists searching for parking spaces, a significant concern for local governments. However, such policies tend to under-value walkable, higher-density, established communities and favor low-density developments that are difficult to serve with a full range of transportation options. These policies often require developers to build oversized parking facilities, pushing destinations further apart, reducing walkability and increasing the demand for new highway infrastructure in the region. However, some communities have developed parking policies that are supportive of higher-density development patterns, where alternative transportation options can complement automobile travel. These policies encourage development in established communities where substantial Federal, State and local infrastructure investments have been made or are planned.


REFORMING PARKING POLICIES
TO SUPPORT SMART GROWTH

Toolbox/Handbook:
Parking Best Practices & Strategies For
Supporting Transit Oriented Development
In the San Francisco Bay Area

Metropolitan
Transportation
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June 2007

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Figure 9: Cover Page of MTC's *Reforming Parking Policies to Support Smart Growth* (2007)
SOURCE: MTC

In 2007, the Metropolitan Transportation Commission (MTC), the Metropolitan Planning Organization (MPO) for the San Francisco Bay Area published a guide that highlighted innovative parking policy practices of its member jurisdictions to support "smart growth," a term that refers to higher-density, mixed-use development. *Reforming Parking Policies to Support Smart Growth*[32] highlights several instances in which local jurisdictions in the Bay Area incorporated ridesharing into parking policies that support livable, "smart growth" development.

- The City of Alameda modified its off-street parking minimum requirements for proposed developments which demonstrate that anticipated parking demand will be reduced through one or more specified mechanisms, including subsidized or employer-sponsored carpools and vanpools, and free or subsidized transit passes.

- The City of South San Francisco passed a Transportation Demand Management (TDM) ordinance that allows parking minimum requirements to be reduced by 10 percent in exchange for TDM strategies such as free parking for carpools and vanpools, an on-site transportation coordinator,

[32] **Metropolitan Transportation Commission.** *Reforming Parking Policies to Support Smarth Growth.* June 2007. http://www.mtc.ca.gov/planning/smart_growth/parking/parking_seminar/Toolbox-Handbook.pdf.

a guaranteed ride home program, transit subsidies, and an agreement to charge employees at least $20 per month for parking.

- The City of Pasadena required that all projects exceeding 25,000 square feet designate a minimum of 10 percent of employee parking spaces for carpool and vanpool vehicles, provide convenient bicycle parking, and post alternative transportation information. Projects over 100,000 square feet had to provide a carpool and vanpool loading area.

The MTC guide also promotes parking best-practices that local jurisdictions in the Bay Area or beyond can use to promote livable community design. The guide recommends that communities base parking policies on observed parking demand and unique local context, rather than generalized national engineering standards. Over time, MTC suggests that parking minimums should be replaced with parking maximums and priced parking in dense activity centers where alternatives such as ridesharing and transit can provide significant alternative transportation options.

The guide also details a number of parking pricing strategies that can serve to reduce the demand for solo-driver automobile transportation and thus make ridesharing more attractive. These strategies include variable rate parking, where the price motorists pay to park is determined in-part by market demand; unbundled parking, where landlords rent parking spaces separately from residences; and parking cash-out programs, where employees can choose to decline free parking benefits in exchange for the cash equivalent of providing the parking space. These policies shift the economic incentives for users from ones that encourage over-consumption of parking to ones that encourage users to consume only the amount of parking that they are willing to pay for. Thus, pricing policies provide an incentive for travelers to use ridesharing and other alternative transportation modes to reduce their total transportation costs. Examples of local parking pricing policies that support livable communities include:

- As part of its Emission Reduction Plan, the City of Santa Monica, California required large employers to provide parking cash-out as an option to employees. A study later concluded that two employers that participated in the program reduced solo-driving by between seven and eight percent. While it is unknown if the employees shifted to ridesharing or other transportation modes, these results present strong evidence that parking cash-out policies can influence travelers to seek out alternatives.

- The City of San Francisco eliminated minimum parking requirements for new developments in its Central Waterfront Plan and required the unbundling of parking from the rental or sale prices of residential uses. Studies have indicated that the inclusion of off-street parking in housing units raises housing prices in San Francisco by over 10 percent. Therefore, the logical impact of requiring un-bundled parking in the Central Waterfront Plan is that new housing in the area will be affordable to a wider range of potential residents, particularly those who choose to forego auto ownership and rely on ridesharing, transit and other alternative transportation modes.

These examples from the Bay Area show that ridesharing can be a part of local parking policies and ordinances that incentivize developers to build in ways that support livable communities. Furthermore, the MTC guide demonstrates that there is a role for MPOs in supporting local jurisdictions that are interested in developing these policies.

Stellwerk 60: Cologne, Germany

Many European countries embraced ridesharing long ago as a strategy to maintain mobility while avoiding many of the high financial, environmental, and social costs of personal vehicle ownership. The Stellwerk 60 development is a 15 acre community of 400 homes in the Nippes district of Cologne, Germany that demonstrates the role that ridesharing (carsharing in this example) can play in designing ambitious new livable developments. While significant differences exist between the political, economic, and social structures of the U.S. and Germany, Stellwerk 60 provides a forward-looking example of what a livable community that has embraced ridesharing in combination with other alternative modes might look like in the U.S. if these strategies were implemented on a wide scale in consort with other multimodal transportation strategies.

The Stellwerk 60 community is a new-construction, master-planned development, located within easy walking distance to heavy and light-rail public transportation options and within reasonable bicycling distance to the Cologne city center. [33] The community was designed to provide residents with a lifestyle "free of the nuisance of motorized traffic." The community prohibits motorized vehicles from interior residential streets and strongly encourages residents to use alternative transportation modes to satisfy a portion of their travel needs. Vehicles are not stored adjacent to housing units, rather they are garaged at the edge of the development in a 120-space structure, resulting in a parking to housing ratio of 0.3 spaces per unit. Vehicle owners must purchase a parking space for 16,000 EUR and pay monthly maintenance fees that reflect the full costs of providing the parking space. The developers worked with the planning authority to negotiate reductions in the number of parking spaces required, and to designate interior streets as a nonmotorized zone.

Figure 10: Site plan for the Stellwerk 60 development.
SOURCE: ITDP

Although 80 percent of Stellwerk 60 residents' trips are by public or nonmotorized transportation, ridesharing is an important compliment that enables the community to achieve an attractive environment for residents. As an alternative to private vehicle ownership, the development includes 17 carsharing vehicles for which membership fees are waived. These carsharing vehicles appear to be a key component of Stellwerk 60 residents' overall mobility package. A 2010 survey of residents found that although only 29% of households own a private vehicle, 96% are licensed drivers and 67% use the on-site carsharing vehicles. These numbers stand out because in contrast to Stellwerk 60, more than 75% of German households own a private vehicle. Additionally, while many of the residents of Stellwerk 60 have long lived car-free, 21% of households that did not own a private vehicle indicated that they "gave

[33] **Institute for Transportation & Development Policy.** *Europe's Vibrant New Low Car(bon) Communities.* Summer 2011. http://www.itdp.org/documents/092611_ITDP_NED_Desktop_Print.pdf

up their car" when they moved to Stellwerk, indicating a possible pent-up demand for communities that make living without a private vehicle convenient.

The unique partnership between public planning regulations and the developer at Stellwerk 60 resulted in a model community for livability. The combination of walkable urban form, close proximity to public transit and convenient access to several carsharing vehicles drastically reduced the need for private vehicle ownership. As a result, residents of Stellwerk produce less than one-quarter of the vehicle emissions of the average Cologne resident. Many also avoid the significant expenses of vehicle and parking ownership and maintenance.

Lessons Learned

This white paper presents examples from Arlington, Virginia, the San Francisco Bay Area, and Cologne Germany that demonstrate how governments and private developers can work together to incorporate ridesharing strategies that advance livability as part of new developments. These often take the form of negotiated agreements to relax parking minimums in exchange for ridesharing and carsharing elements. Furthermore, the MTC guide shows that there is a role for MPOs in promoting methods to reduce barriers to using ridesharing as a component of regional multimodal transportation planning and local land use and development planning.

Ideas for Further Research

- What impacts do ridesharing strategies have on the average density of new developments?
- What impacts does ridesharing in commercial developments have on transit ridership?
- What are best practices in tying relaxation of height, setback, parking minimums and floor area ratios to provision of ridesharing?
- Which ridesharing strategies are most effective at decreasing demand for SOV travel to TODs, downtowns, and suburban office centers?
- What is the role of MPOs in promoting ridesharing as a tool to support livable communities, including potential to approach strategies at a regional scale?
- Is there a role for ridesharing in public subsidized housing development?
- What are best practices for the incorporation of ridesharing in joint development projects at high-capacity transit nodes?
- How can ridesharing be linked to effective parking strategies?