RIDESHARING IN NORTH AMERICA: PAST, PRESENT, AND FUTURE

Nelson D. Chan
Graduate Student Researcher, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street, Bldg. 190; Richmond, CA 94804-4648
510-665-3461 (O); 510-665-2183 (F); ndchan@berkeley.edu

Corresponding Author:

Susan A. Shaheen, Ph.D.
Honda Distinguished Scholar in Transportation, University of California, Davis, &
Co-Director, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street, Bldg. 190; Richmond, CA 94804-4648
510-665-3483 (O); 510-665-2183 (F); sashaheen@tsrc.berkeley.edu; sashaheen@ucdavis.edu

2011 Transportation Research Board Annual Meeting

August 1, 2010

Word Count: 7,500 words, including 2 figures and 2 tables

RIDESHARING IN NORTH AMERICA: PAST, PRESENT, AND FUTURE

ABSTRACT
Since the late-1990s, numerous ridematching programs have integrated the Internet, mobile phones, and social networking into their services. Online ridematching systems are employing a range of new strategies to create "critical mass:" 1) regional and large employer partnerships, 2) financial incentives, 3) social networking to younger populations, and 4) real-time ridematching services that employ "smartphones" and automated ridematching software. Enhanced casual carpooling approaches, which focus on "meeting places," are also being explored. Today, ridesharing represents approximately 8 to 11% of the transportation modal share in Canada and the United States, respectively. There are approximately 613 ridematching programs in North America.

Ridesharing's evolution can be categorized into five phases: 1) World War II car-sharing (or carpooling) clubs; 2) major responses to the 1970s energy crises; 3) early organized ridesharing schemes; 4) reliable ridesharing systems; and 5) strategy-based, technology-enabled ridematching. While ridesharing's future growth and direction are uncertain, the next decade is likely to include greater interoperability among services, technology integration, and stronger policy support. In light of growing concerns about climate change, congestion, and oil dependency, more research is needed to better understand ridesharing's impacts on infrastructure, congestion, and energy/emissions.

KEY WORDS: Ridesharing, liftsharing, carpooling, vanpooling, North America

WORD COUNT: 7,500 words, including 2 figures and 2 tables

INTRODUCTION
Increasingly, ridesharing is being discussed as a powerful strategy to reduce congestion, emissions, and fossil fuel dependency. It is the grouping of travelers into common trips by car or van. It is also widely known in the United Kingdom as liftsharing and car sharing (this should not be confused with the more popularized "carsharing" or short-term auto use (*1*, *2*)). Ridesharing differs from for-profit taxis and jitneys in its financial motivation. When a ridesharing payment is collected, it partially covers the driver's cost. It is not intended to result in a financial gain. Moreover, the driver has a common origin and/or destination with the passengers.

Ridesharing's modal share has declined since the 1970s in the United States (U.S.). In 1970, 20.4% of American workers commuted to work by carpool, according to the U.S. Census. This has declined to 10.7% in 2008 (*3*). The largest drop occurred between 1980 and 1990, when carpooling declined from 19.7% to 13.4%. A drop in gasoline prices, as well as improved fuel economy and shifting social trends, contributed to this decline (*4*).

However, ridesharing has increased slightly in recent years. From a low of 10.1% in 2004, carpooling has risen slightly and settled around 10.7% since 2005 (*5*, *6*). Similarly, ridesharing has increased somewhat since 2001 in Canada. Approximately 7% of Canadian workers commuted as a passenger in 2001; this increased to 7.7% in 2006 (*7*). Interestingly, there are seven times as many U.S. passenger-miles for commute trips by carpool and vanpool as there are for public transit (Cindy Burbank, unpublished data).

In this paper, the authors explore the past, present, and future of ridesharing in North America. The study approach included a literature review, an extensive Internet search for all major ridesharing programs operating in North America today, and interviews with a broad range of ridesharing experts. This paper is organized into five sections. First, the authors define and classify ridesharing, as well as discuss its benefits and barriers. Next, ridesharing's history in North America is described with a focus on the first four phases. The third section explores the fifth phase: current ridesharing programs. Ridesharing's future is explored in the fourth section. Finally, the authors conclude with a summary and recommendations for future research.

BACKGROUND

Ridesharing typically includes carpooling and vanpooling. Carpooling involves grouping travelers into a private automobile, while vanpooling entails individuals sharing a ride in a van. Ridesharing also includes more unique forms, such as casual carpooling. Since the authors define ridesharing as non-profit, with similar origins and/or destinations for both driver and passenger, cab sharing, taxis, and jitneys are not included.

In Figure 1, the authors propose a ridesharing classification scheme. This classification is based on how ridesharing appears today and the relationship among its participants. The "acquaintance-based" carpool is typically formed among families and friends (including families arranging carpools for children's events), often called "fampools," as well as among coworkers. Next, the "organization-based" division refers to the carpools and vanpools that require participants to join the service whether through formal membership or simply visiting the organization's website. The term does not necessarily refer to consistent participation in the same carpool or vanpool every day, as some schemes allow for varying carpool participants. Vanpools are categorized into four types, depending on how the vanpool is owned and operated: 1) owner-operated vanpools, 2) third-party vanpools, 3) Transportation Management Association (TMA)/employer vanpools, and 4) public transit agency vanpools (*8*). Finally, "ad-hoc" ridesharing requires little relationship between participants and does not include membership. Ad-hoc ridesharing is realized through casual carpooling. The last division is based upon the mechanism that organizes the shared rides. This includes self-organization, incentives, notice boards, and various computerized ridematching products.

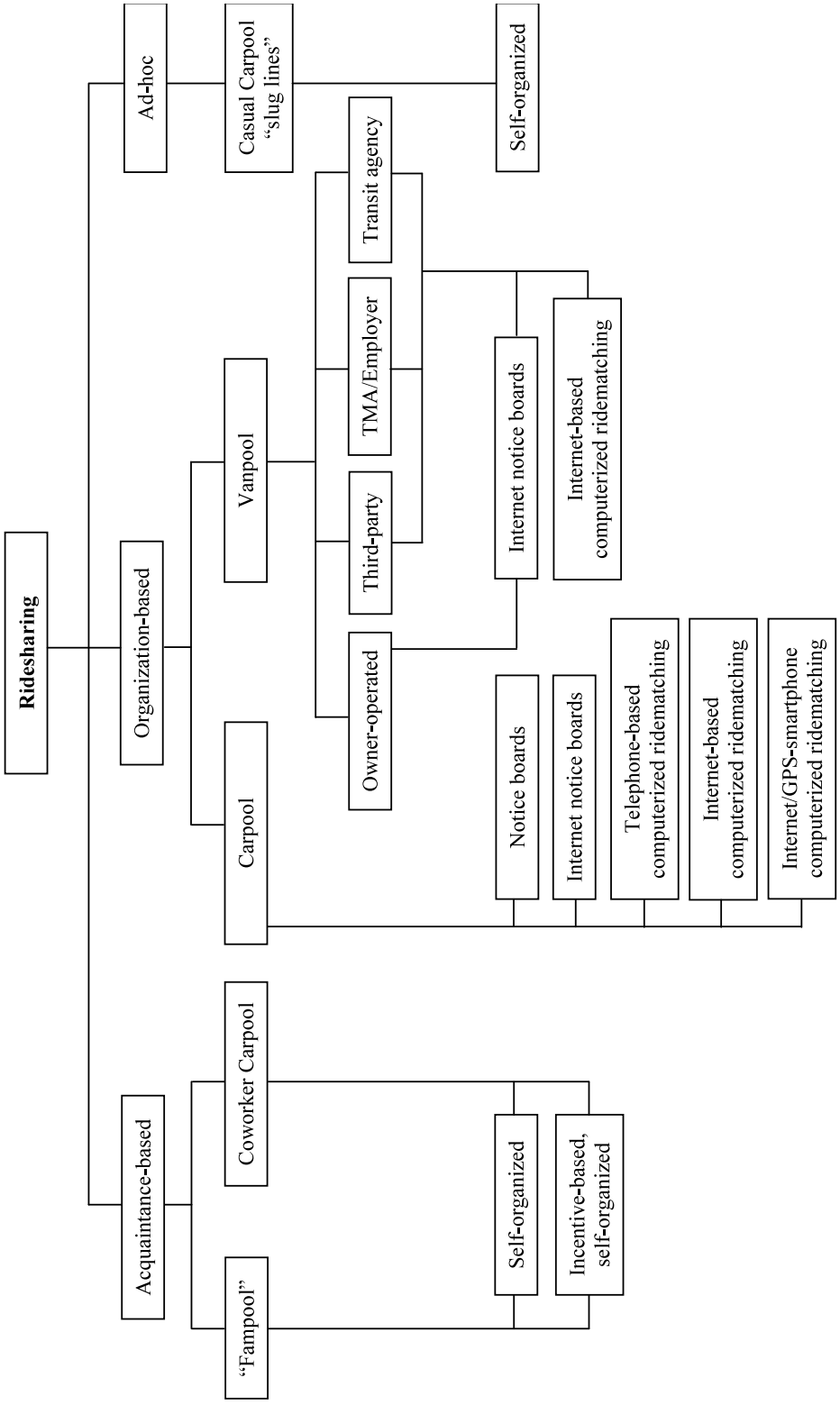

FIGURE 1 Ridesharing classification scheme.

Since ridesharing reduces the number of automobiles needed by travelers, it claims numerous societal benefits. Noland et al. (2006) assert that enacting policies to increase carpooling is the most effective strategy to reduce energy consumption besides prohibiting driving (*9*). Other benefits include reduced emissions, traffic congestion, and parking infrastructure demand; however, the magnitude of such benefits is unclear.

On an individual level, the benefits are more tangible. Carpool and vanpool participants experience cost savings due to shared travel costs, travel-time savings by employing high-occupancy vehicle (HOV) lanes, and reduced commute stress. In addition, they often have access to preferential parking and additional incentives.

Despite its many benefits, there are numerous behavioral barriers to increased ridesharing use. Individuals face a lack of flexibility or convenience when ridesharing, which is often associated with differing work schedules. Personal security is also a concern when sharing a ride with strangers, although this is a perceived risk (Marc Oliphant, unpublished data). Forming and maintaining a carpool or vanpool often is a hassle, resulting from an inherently unstable arrangement (Mark Evanoff, unpublished data). Many programs have attempted to address these barriers to compete with solo driving.

Carpooling is often referred to as the "invisible mode," because it is difficult to observe, study, and champion (Paul Minett and Philip Winters, unpublished data). There is little systematic documentation of carpooling's history and few quantitative data, simply because carpools are difficult to record and count. Because there is little research and public education, public ridesharing programs are often viewed as "second-tier" after bus or rail services and are the first cut during a budget crisis (Park Woodworth, unpublished data).

HISTORY OF NORTH AMERICAN RIDESHARING

In this section, the authors provide an overview of ridesharing's history. North American ridesharing's evolution can be categorized into five key phases: 1) World War II car-sharing clubs (1942 to 1945); 2) major responses to energy crises (1970s); 3) early organized ridesharing schemes (1980s to 1997); 4) reliable ridesharing systems (1999 to 2004); and 5) strategy-based, technology-enabled ridematching (2004 to present). Jitneys of the 1910s are not included in this paper because there is no evidence that they directly gave rise to ridesharing. Table 1 provides a glossary of ridesharing terms, which are used throughout this paper.

TABLE 1 Glossary of Key Ridesharing Terms

Ridesharing Term	Description
Car-Sharing Clubs	The first organized ridesharing schemes, which were sponsored by the U.S. government during WWII. They were used to promote ridesharing as a way to conserve resources for the war effort.
High-Occupancy Vehicle (HOV) Lanes	These are special lanes reserved for use by buses and automobiles with typically two or more (sometimes three or more) occupants. They are built to encourage and facilitate public transit and ridesharing, including vanpools and casual carpools.
Casual Carpooling (also known as "Slugging")	Casual carpools are a user-run, informal form of ad-hoc ridesharing. This involves the formation of impromptu carpools of typically three or more commuters per vehicle: one driver ("bodysnatcher") and two or more passengers ("slugs"). Carpools form during morning commute hours at park-and-ride facilities or public transit centers and take advantage of existing HOV lanes to get to a common employment center. Carpools also form during the evening commute but usually on a smaller scale.
Park-and-Ride Facilities (also known as Carpool Parking Lots)	These are parking lots for commuters to park personal vehicles and then use public transit or ridesharing for the remainder of the journey to work. There are two types in North America: 1) lots situated at suburban commuter rail stations to encourage public transit use and 2) lots located by freeway entrances in suburban areas ("fringe" or "remote park-and-ride facilities") to encourage ridesharing and bus use. The authors focus on the latter type.
Vanpooling	Vanpooling is ridesharing on a larger scale than carpooling, which occurs in a large van. Vanpools are used by commuters traveling to a common employment center and are almost always prearranged. There are currently no known dynamic vanpooling programs (*10*). Participants share operating costs. Often, vanpools are partially subsidized by employers or public agencies, further lowering commuting costs.
Transportation Management Associations (TMAs)	TMAs are voluntary organizations formed by large employers, developers, and local politicians to address local transportation and air quality issues. They are typically nonprofit and represent the private sector's involvement in transportation demand management (TDM) strategies. TMAs promote a wide range of transportation options as an alternative to solo driving and often manage the region's carpooling and vanpooling programs.
Employer-Based Trip Reduction (EBTR) Programs	An EBTR program is a type of trip reduction ordinance (TRO) requiring employers to reduce the number of employees driving to work alone. Ridesharing programs are often used to comply with such an ordinance. They are also implemented to mitigate traffic congestion, air quality concerns, or both (*12*).
Telephone-Based Ridematching	This is the earliest form of "dynamic ridesharing." This approach allows users to request rides, offer rides, and receive ridematching information in real-time over the telephone. Either human operators or an automated interface communicates with users. "Enhanced" telephone-based ridematching adds Internet, e-mail, mobile phone, personal digital assistants (PDAs), and geographic information system (GIS) capabilities.
Online Ridematching Programs and Platforms	This approach entails Internet-based computerized ridematching, which employs GIS technology to match potential users traveling to and from similar places. Some software companies have developed ridematching "platforms"—a suite of services that a public agency or employer could purchase for a monthly fee.
Traveler Information Services ("511")	These are telephone hotlines (with telephone code "511") for traveler information dissemination. The traveler information provided differs by region; it may include traffic and weather conditions, road construction and closures, public transit schedules, and ridesharing information.
Real-Time Ridesharing	These services use GIS and global positioning system (GPS) technologies on Internet-enabled "smartphones" to organize ridesharing in real-time, just minutes before the trip takes place. Drivers post their trip as they drive, and potential riders request rides right before their desired departure time. Ridematching software automatically matches riders to drivers with similar trips and notifies each party's smartphone.

Phase One: Car-Sharing Clubs (1942-1945)

Ridesharing began during World War II through "car clubs" or "car-sharing clubs." A 1942 U.S. government regulation required that ridesharing arrangements to workplaces be made when no other alternative transportation means were available (*13*). The U.S. Office of Civilian Defense (OCD) asked neighborhood councils and leaders to encourage four workers to share a ride in one car to conserve rubber for the war effort. They also created a ridesharing program that was called the Car Sharing Club Exchange and Self-Dispatching System. The self-dispatching system—a precursor to today's Internet notice boards—matched riders and drivers via a bulletin board at work (*14*). Large industrial factories and companies were responsible for forming these car-sharing clubs. Churches, homemakers, and parent teacher associations were also responsible for forming carpools to and from church, shopping, and school, respectively (*15*). Each of the five ridesharing phases is summarized in Figure 2 below.

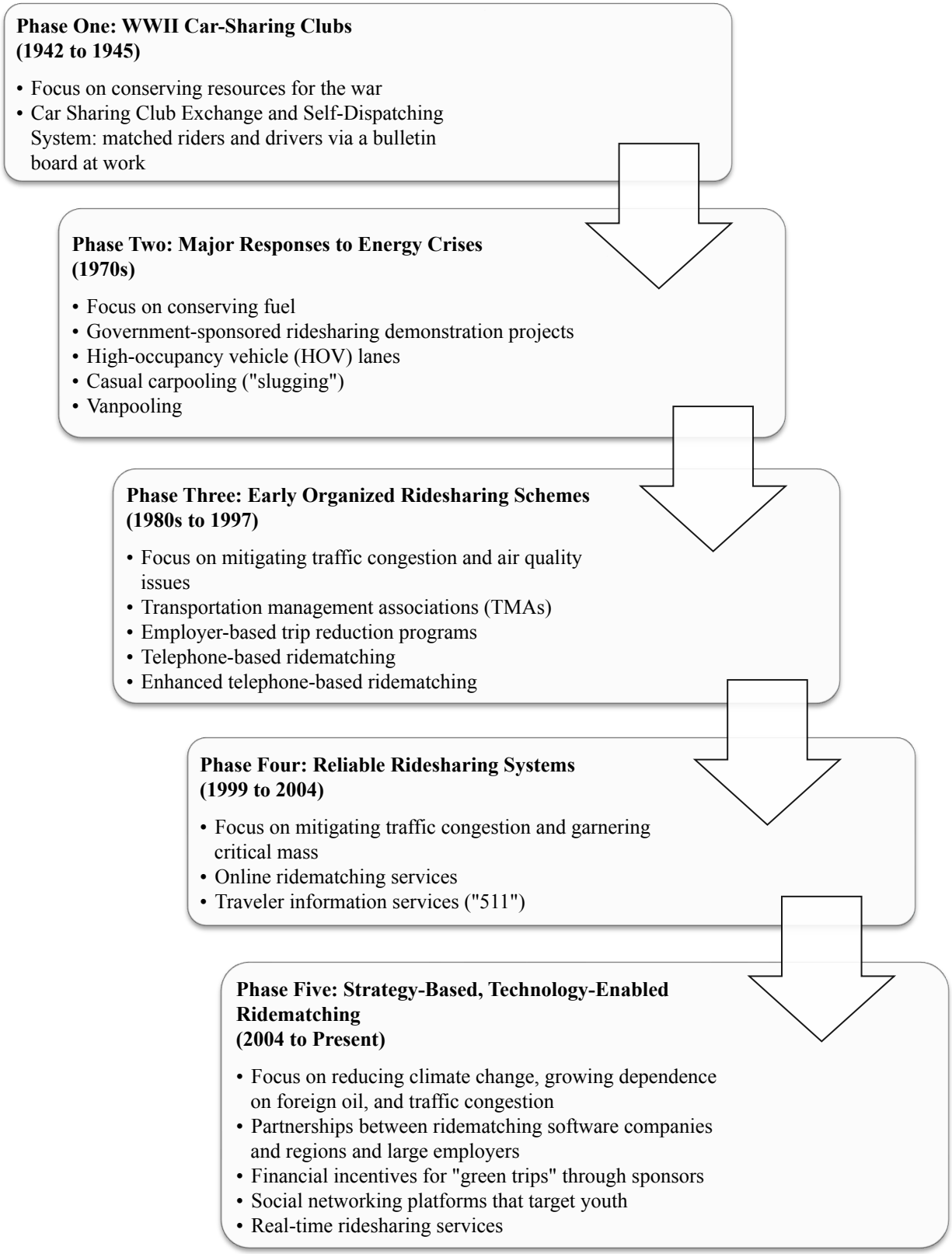

FIGURE 2 Five phases of North American ridesharing.

Phase Two: Major Responses to Energy Crises (1970s)

Ridesharing reappeared in the 1970s in response to the energy crisis and the Arab oil embargo of 1973 to 1974 (*11*). The 1974 Emergency Highway Energy Conservation Act allowed for federal highway funds to go to 106 carpool demonstration programs in 96 U.S. metropolitan areas through 1977 (*16*). In 1975, the Federal Highway Administration began publishing ridesharing guidebooks on carpooling and vanpooling (*17*). The U.S. Department of Transportation (USDOT) then established the National Ride-Sharing Demonstration Program (NRDP) in March 1979, with the objective of increasing ridesharing use by 5% (*11*). As part of the NRDP, the USDOT and U.S. Department of Energy developed computerized ridematching. The Carter Administration recognized ridesharing's potential and established a National Task Force on Ridesharing on October 25, 1979 (*18*).

Other ridesharing strategies employed during the 1970s include HOV lanes, casual carpooling, park-and-ride facilities, and vanpooling.

High-Occupancy Vehicle (HOV) Lanes

The first HOV lanes opened in 1969 along the Shirley Highway (I-395) in Northern Virginia and Washington, D.C. (*19*). Since then, regions across the U.S. and Canada have built extensive HOV lane networks. As of 2008, there were 345 HOV facilities in the U.S. with over 2,300 directional lane miles (*19*, *20*). California alone has 88 HOV facilities with about 1,410 directional lane-miles (*19*, *21*). Canada began building HOV lanes in the early 1990s. As of 2007, Canada had 35 facilities with approximately 280 lane-kilometers or 174 lane-miles (*22*).

The characteristics of a successful HOV facility are:

1. Enough HOVs using the facility to move more people than mixed-use lanes and to appear full enough to gain public acceptance;
2. Travel-time savings over mixed-use lanes;
3. An increase in the number of people moved through the corridor;
4. Evidence that the facility impacts travel mode choice; and
5. Compliance with facility rules (*23*).

Key lessons learned include the need for regional coordination and integration, enforcement of HOV rules, long-term monitoring, and effective marketing for public awareness (*22*).

Casual Carpooling

Casual carpooling—also known as "slugging"—began during the 1970s and exists today on a large scale in three U.S. metropolitan areas: Houston, Texas; Washington, D.C. and Northern Virginia; and the San Francisco Bay Area. As of 2007, Houston's "slug lines" have 900 daily participants (*24*). As of 2006, Washington, D.C.'s slug lines attract 6,459 daily participants (*25*). As of 1998, the San Francisco Bay Area has 8,000 to 10,000 daily participants (*24*).

Slug lines between Northern Virginia and Washington, D.C. began around 1975 in response to the Arab oil embargo and the recently constructed Shirley Highway (I-395) HOV lanes (*26*). At that time, minimum vehicle occupancy was four, so drivers without enough passengers would drive to a bus stop and offer rides to bus riders. Slugging grew because it was a more inexpensive and reliable option for bus passengers, and it gave drivers a way to meet HOV requirements. Today, Washington, D.C.'s system has about 25 pick-up locations and destinations (*27*).

Casual carpooling exists in the San Francisco Bay Area between the communities east of the San Francisco Bay (known as the "East Bay") and downtown San Francisco. It began in the 1970s around the same time as the D.C. slug lines, partially due to public transit fare increases and service disruptions (*28*). Casual carpooling has grown due to the HOV lane on I-80 and the HOV/bus-only bypass at the San Francisco-Oakland Bay Bridge toll plaza (*29*). Today, the system has approximately 24 morning pick-up locations (*30*).

Several barriers hinder more widespread casual carpooling use. One is concern for personal safety. Currently, there are casual carpooling forums where participants can warn others about reckless drivers or discourteous passengers. While helpful, they are not fully effective in keeping drivers and passengers accountable. Because there is no governmental or agency support, websites are loosely run, often lacking user-friendliness and up-to-date information. Liability and insurance coverage is another participant worry.

A legitimate concern for public agencies is the impact of casual carpooling on existing traffic and public transit ridership. Several Bay Area studies, which employed different methodologies, estimated the impact on Bay Bridge traffic ranged from 89 cars removed from the road to 645 cars added (*28*, *29*). Thus, casual carpooling's effect on congestion is unclear.

Park-and-Ride Facilities

Park-and-ride facilities began in the U.S. in the 1930s as impromptu parking along bus routes (*31*). Remote park-and-ride facilities began to gain interest from planning agencies in the late-1960s. Subsequently, the Federal Aid Highway Act of 1968 authorized federal funding for demonstration projects, such as remote park-and-ride facilities. The first of such was built in Woodbridge, New Jersey (*32*).

Today, California has the largest remote park-and-ride lot capacities in the U.S. As of June 2009, there were 323 park-and-ride facilities run by the California Department of Transportation, with 31,833 parking spaces (*33*).

Remote park-and-ride facilities in Canada were first started in the 1970s in the Province of Ontario. The Ontario Ministry of Transportation (MTO) developed a Travel Demand Management Strategy, which included carpool lots, HOV lanes, and ridesharing. During the 1970s, illegal and unsafe parking near freeways began raising concern. MTO opened its first carpool lot in 1979, providing safe parking for carpooling commuters (*34*). Since then, it has grown to the largest in Canada, with 80 carpool lots and 5,671 spaces (*35*).

Several lessons can be applied to future plans for park-and-ride facilities. A park-and-ride network should be comprehensive and well documented, focusing on transportation system connectivity, future infrastructure investments, and other needs for the surrounding communities (*36*). Moreover, each facility should be safe, well lit, and comfortable. Those near capacity must discover ways to increase parking supply without compromising cleanliness and security (*37*).

Vanpooling

During the 1970s, vanpooling had a strong start in the U.S. The first employer-sponsored vanpool program began in 1973 with the "3M Commute-A-Van" pilot program. The Federal-Aid Highway Act of 1976 spurred much of this vanpooling growth. This same year, the National Association of Van Pool Operators (NAVPO) was formed (*38*).

There are four types of vanpools. First, there are owner-operated vanpools, which are privately managed by individuals who typically own or lease the van and organize the ride arrangements. Second, there are TMA/employer vanpools that are sponsored for employees to

commute to and from a common employment center. TMAs often work with employers to assist and provide incentives to vanpoolers. Third, there are public transit agency vanpools, which are used to supplement the region's existing bus system. One example is King County Metro's Commuter Van Program, which is the largest public vanpool program in the U.S. (*39*). Finally, third-party vanpools are run by companies that lease vans to groups of commuters or employers and provide insurance and ridematching. VPSI Inc.®, Enterprise Rideshare, and The Rideshare Company's Easy Street® are examples of third-party vanpool companies.

Key lessons learned from operating a public vanpool program are to minimize costs and provide excellent customer service, particularly when riders are paying most of the cost (Syd Pawlowski, unpublished data). A public transit agency vanpool program can keep costs down by subcontracting vehicle maintenance and properly assessing whether to purchase or lease vans (Park Woodworth, unpublished data).

Phase Three: Early Organized Ridesharing Schemes (1980s to 1997)

As energy conservation efforts waned in the 1980s and 1990s, transportation demand management shifted focus to improving congestion and air quality issues. Advances in computerized ridematching during this period also marked a move toward more dynamic ridesharing applications in the form of telephone- and Internet-based ridematching programs. However, as gasoline prices returned to lower levels during this time, ridesharing lost much of its competitiveness. Many of the early schemes, with developing and imperfect technology, never gained much use. Nevertheless, they formed the basis for many of today's ridesharing services.

Employer-Based Trip Reduction (EBTR) Programs

Ridesharing programs in the 1980s shifted focus to reducing traffic congestion in new suburban office parks. These suburbs began using trip reduction ordinances (TROs) to encourage commute alternatives to driving alone. One type of ridesharing TRO was the mandatory employer-based trip reduction (EBTR) program.

One of the first EBTR programs was launched in Pleasanton, California in 1984 (*12, 42*). This TRO limited peak-hour solo driving to no more than 55% of the daytime workforce. Employers with 100 or more employees were required to meet this standard by any means, including ridesharing. Pleasanton's TRO only moderately increased carpooling and vanpooling, however (*40*).

Air quality districts began implementing similar EBTR programs. In December 1987, the Southern California Air Quality Management District (SCAQMD) passed Regulation XV, the largest mandatory EBTR program in the U.S. affecting over 3.8 million workers in six Southern California counties (*11*, *12*). Its goal was to achieve National Ambient Air Quality Standards by 2010. To accomplish this, employers were required to meet a minimum average vehicle ridership (AVR) number (*11*).

On the state level, the California Clean Air Act (CCAA) was passed in 1988, requiring regions to create plans to manage air quality. One strategy employed was an EBTR program similar to that of SCAQMD. On a federal level, the Federal Clean Air Act of 1990 required regions with serious and extreme ozone non-attainment to implement an EBTR program (*12*, *40*).

By the early 1990s, however, opposition for EBTR programs was increasing. First, Regulation XV was unable to achieve its AVR goals. California's Senate Bill (SB) 437 was passed in 1995, prohibiting any agency from mandating EBTR programs. On the federal level,

H.R. 325 was passed in 1995, allowing states to use programs other than EBTR to reduce emissions. Soon after, SCAQMD changed its focus from reducing trips to reducing emissions and eliminated Regulation XV (*12*).

There are several lessons to be learned from the EBTR program: 1) the problem to be addressed must be clearly defined, 2) all parties much be involved, 3) reasonable targets should be established and phased in over time, and 4) costs and benefits much be fully analyzed and monitored (*12*).

Telephone-Based Ridematching

During the 1990s, several cities began telephone-based ridematching programs. The University of Washington alongside the Bellevue Transportation Management Agency conducted the "Bellevue Smart Traveler" pilot from November 1993 to April 1994. Los Angeles's Commuter Transportation Services tested the "Los Angeles Smart Traveler" program from July to September 1994; the pilot was limited to the 68,000 people affected by the 1994 Northridge Earthquake (*41*). Sacramento Rideshare also conducted a field operational test of "Rideshare Express" from 1994 to 1995 (*42*). Rideshare Express interfaced with users through human operators, while Bellevue Smart Traveler and Los Angeles Smart Traveler used an automated interface.

Due to high costs and low use, the programs were deemed unsuccessful. Bellevue Smart Traveler only had six logged ridematches (*41*). Los Angeles Smart Traveler cost about $110 per call and had an average of 34 weekly users, with only a 20% chance of a successful ridematch (*43*, *44*). Rideshare Express received 10 to 15 match requests, but it did not provide any successful match. (*45*).

Enhanced Telephone-Based Ridematching

After the telephone-based pilots failed, several "enhanced" programs were proposed, adding new and developing technologies. The University of Washington launched the "Seattle Smart Traveler" pilot from March 1996 to May 1997 (*46*). This program added Internet and e-mail capabilities, resulting in 500 ride requests and 150 potential ridematches (*42*). It was more successful than its Smart Traveler predecessors because of its closed environment; it was open only to faculty, staff, and students of the University of Washington (*47*). Alleviating personal security concerns alongside strict on-campus parking restrictions also made the service more successful than its predecessors.

Two other enhanced programs, ATHENA and MINERVA, were also proposed but did not progress beyond the developmental stage. The Federal Transit Administration and the City of Ontario, California began developing the ATHENA smart traveler program between 1994 and 1996. ATHENA's ridematching and user interface were completely computerized, employing mobile phones and PDAs with GIS technologies to identify and record users and trips. MINERVA built upon ATHENA, adding online services such as online banking and shopping to reduce errand trips (*47*). Both systems were never implemented. However, their Internet and GIS components formed the basis of many ridesharing programs in use today.

Phase Four: Reliable Ridesharing Systems (1999 to 2004)

With most dynamic ridematching applications of the 1980s and 90s failing to overcome the "critical mass" barrier (providing enough users to consistently create a successful instant ridesharing match), most North American ridesharing systems between 1999 and 2004 focused

on more reliable strategies to encourage ridesharing. This included online ridematching and traveler information services. These almost exclusively targeted commuters who had the most reliable trip schedules.

Initial Online Ridematching Services

With the proliferation of the Internet, many ridesharing systems took online forms, known as online ridematching. Full-fledged, online ridematching services began around 1999. Before that, websites were either simple pages listing agency contact information, online forms for users to e-mail the agency to receive a matchlist, or online notice boards for users to manually post or search carpool listings (*48*). After 1999, private software companies began developing ridematching "platforms," providing their suite of services to clients for a monthly fee.

Carpools formed through online ridematching tended to be more static and inflexible and required prearrangement. While it was easier to find ridematches in a larger online database, these carpools still suffered from the same drawbacks as traditional carpools; namely, regular commuters lost the flexibility that private auto travel offered. Consequently, online ridematching programs were best suited for commutes with regular schedules.

Traveler Information Services ("511")

In the 1990s, over 300 telephone numbers for traveler information were being used in the U.S. (*49*). On July 21, 2000, the Federal Communications Commission designated "511" as the traveler information telephone number available for local, regional, and state agencies to use across the U.S. (*50*). Canada had similar plans for a uniform traveler information telephone hotline. The first "511" service in Canada began in Nova Scotia in January 2008 (*51*).

As of January 2009, 43 "511" services were available in 35 states to over 150 million Americans (*52*). Four services were available in four provinces in Canada, as of December 2009 (*53*). As of 2009, only 13 of the 43 U.S. 511 services had a carpool and/or vanpool information option (*52*). Québec "511" was the only Canadian service with a ridesharing option.

A major lesson learned from traveler information services is that uniform "511" branding across North America helped consumers remember and easily access the service (David Lively, unpublished data). Further, a "511" ridesharing option must be easily accessible to be well used.

NORTH AMERICAN RIDESHARING: THE PRESENT

In this section, the authors explore ridesharing today, focusing on activities from 2004 to the present. It encompasses the fifth ridesharing phase, called: "Strategy-Based, Technology-Enabled Ridematching." While this period continues to include casual carpooling, HOV lanes, and park-n-ride ridesharing efforts, it is most notable for the widespread integration of the Internet, mobile phones, and social networking into ridesharing services. At present, the majority of North American ridematching services use online websites as their chief technology medium. Many of them are based on a ridesharing software platform purchased from a private company. There are approximately 13 such companies in North America that offer this software (e.g., Ecology and Environment, Inc. offers GreenRide® and Pathway Intelligence Inc. offers Jack Bell Ride-Share). While the abundance of online ridesharing systems is promising, it has resulted in disparate, non-standardized databases that leave many programs with a lack of critical mass. Four key developments characterize the present and aim to address the common ridesharing concerns of critical mass, safety, or both. These developments are summarized in Table 2 below.

As of July 2010, the authors estimated that there were 613 ridematching services in North America, based on an extensive Internet search. This tally includes both online (most have an Internet-based component) and offline carpooling and vanpooling programs. Those located in sparsely populated rural areas, which appeared to have very low use, were excluded. Institutions that have their own ridematching website but employ a common platform were each counted separately. Of the total, 384 are located in the U.S., and 252 are in Canada (23 programs span both countries). Carpooling attracts the largest focus, with 587 programs offering ridematching for carpools, and 153 providing vanpool ridematching; 127 offer both.

TABLE 2 Four Key Developments in Phase Five

Development	Description
Partnerships between ridematching software companies and regions and large employers	From 2004 to the present, a new generation of ridematching platforms has been developed for regions and employers to use. Moreover, there has been significant growth and overall success with this strategy. Partnerships between ridematching software companies and its large-scale clients take advantage of existing common destinations and large numbers of potential members. These firms sell their ridematching software "platforms" to public agencies and employers, which are sometimes used as standalone websites for each group. While this partnership strategy has gained more users than previous ridesharing phases, it is most suited for commuters with regular schedules.
Financial incentives for "green trips" through sponsors	Many public agencies and companies promote ridesharing by providing its members with incentives. One example is NuRide—an online ridesharing club with over 48,000 members in seven U.S. metropolitan areas (*54*). NuRide rewards points when members carpool, vanpool, take public transit, bike, walk, or telecommute for both work and personal trips. These points can be used for restaurant coupons, shopping discounts, and attraction tickets. NuRide partners with public agencies, employers, and businesses to sponsor the incentives. Similarly, RideSpring works with employer commute programs and participating employees can enter monthly drawings for prizes from over 100 retailers (*55*).
Social networking platforms that target youth	The rise of social networking platforms, such as Facebook, has enabled ridesharing companies to use this interface to match potential rides between friends or acquaintances more easily. These companies hope that social networking will build trust among participants, addressing safety considerations. One example is Zimride, which has partnered with 50 U.S. colleges, universities, and companies that each has their own "network" of members (*56*). In addition to each network's website, Zimride also uses the Facebook platform to attract public users. Another service is PickupPal, with over 148,000 members in 116 countries (*57*). It allows members to create their own groups based on common area, company, school, and shared interests. However, social networking may limit itself by relying on more isolated groups and excluding less tech-savvy users. Currently, there are four major North American ridesharing programs focused on social networking: GoLoco™ , Gtrot, PickupPal, and Zimride.
Real-time ridesharing services	In North America, two companies are beginning to offer real-time ridesharing services: Avego™ and Carticipate. Real-time ridesharing uses Internet-enabled "smartphones" and automated ridematching software to organize rides in real time. This enables participants to be organized either minutes before the trip takes place or while the trip is occurring, with passengers picked up and dropped off along the way. These programs attempt to address the inconvenience of traditional carpooling and vanpooling. As in most ridesharing services, a high subscriber base is required.

RIDESHARING'S FUTURE

The lessons learned from previous and existing ridesharing services and policies have led to a limited, but growing, body of knowledge. This along with ongoing technology and policy developments will contribute to ridesharing's evolution over the next decade. In this section, the authors discuss three key areas that will likely influence future developments: technology interoperability and integration, enhanced casual carpooling, and public policy.

Not surprisingly, technology will play a critical role in ridesharing in the future. Perhaps its greatest contribution will be to help overcome the critical mass barrier, which has limited the potential of this mode in the past. Interoperability among numerous ridesharing databases could achieve a notable step in this direction. Open source data sharing among ridematching companies could enable members to find matches across all databases. This would require a standard protocol that shares data, while still maintaining competition among firms. OpenTrip is one proposed protocol format, which is still in development (*58*). Another idea is a "ridematch aggregator"—a website or other interface that searches all ridesharing databases. The online travel agency industry already employs such aggregator websites.

Another area that could foster growth is multimodal integration—the seamless connection of ridesharing with other transportation modes, such as public transit and carsharing. Indeed, Zimride and Zipcar (the largest North American carsharing operator) launched such an integrated partnership in 2009 (*59*). The Zipcar-Zimride application enables university members to share rides by posting their trip date, time, and destination to the Zimride campus community. If a ride is not matched, Zimride members can also share a local Zipcar. In the future, travelers could go online to view travel times and costs by mode and choose which is best for them (Andrew Amey, unpublished data). Multimodal integration could even facilitate transfers between modes, making alternative transportation more convenient. A significant challenge to future integration and interoperability, however, is the establishment of institutional arrangements that could facilitate collaboration among public agencies and private companies to support this.

While many in the ridesharing industry focus on technology to increase modal share, others emphasize "meeting places," such as casual carpooling sites because they do not require prearrangement (Marc Oliphant and Paul Minett, unpublished data). In the future, "enhanced" casual carpooling could incorporate transponder technology into casual carpooling systems to guarantee membership and participant payment (*60*). One proposed system is formalized flexible carpooling. Marin County, California implemented a rudimentary program from 1979 to 1980, which employed major intersections near bus stops as designated meeting places (*61*). Future formalized flexible carpooling programs could build upon this idea. In July 2010, the Washington State Department of Transportation announced its Flexible Carpool Pilot Project, which plans to incorporate Avego™ 's smartphone ridematching technology with flexible carpooling along high-volume commuter routes in the Seattle metro area (*62*).

Finally, supportive policies in the U.S. and Canada are essential to facilitating ridesharing growth over the next decade. A range of TDM policy strategies could integrate and promote ridesharing, such as free or reduced-price access to high-occupancy toll (HOT) lanes, parking cash-out (employees can opt out of a parking space and receive compensation from their employer who leases/owns the space), and pretax commuter incentives (commuter is not taxed on ridesharing expenses). Ultimately, effective policies must demonstrate to employers and travelers that ridesharing will positively impact their lives through tangible incentives.

CONCLUSION

Ridesharing has evolved through many stages since its beginnings 68 years ago. The authors categorize North American ridesharing into five key phases: 1) World War II car-sharing clubs; 2) major responses to 1970s energy crises; 3) early organized ridesharing schemes; 4) reliable ridesharing systems; and 5) strategy-based, technology-enabled ridematching. In the first phase, government and employer ridesharing promotion greatly spurred travelers to conserve resources for the war effort. The reemergence of ridesharing during the 1970s was characterized by efforts to conserve fuel through policy measures to increase vehicle occupancy. These measures included demonstration projects, HOV lanes, park-and-ride facilities, and vanpooling. The 1980s marked a shift away from national policy, with early organized ridesharing schemes mitigating traffic congestion and air quality issues on a more regional basis through local TDM measures and telephone-based ridematching systems. The fourth phase reverted to more reliable systems, incorporating the Internet to attract more users. Online ridematching and traveler information services began during this phase and targeted commuters with the most reliable trip schedules.

Today, there are an estimated 613 ridematching services in the U.S. and Canada. Phase five is characterized by the incorporation of the Internet, mobile phones, and social networking into ridesharing services. Moreover, the development of ridesharing platforms spurred expansion to regions and employers throughout North America. Key developments during this phase include regional and employer partnerships, financial incentives, and social networking to younger populations to achieve critical mass. Several companies have begun real-time ridesharing through smartphones and automated ridematching technology, but they still require a higher subscriber base.

Over the next decade, North American ridesharing is likely to include greater interoperability among services, technology integration, and policy support. A federal agency dedicated to ridesharing research and funding could substantially spur growth through a concerted effort to enact such policy measures (Cindy Burbank, unpublished data). Additionally, research into the behavioral economics of modal choice is needed to determine which psychological and emotional factors are involved in choosing between driving alone and ridesharing (Rick Steele, unpublished data). Marketing and public education are also important to raise awareness about ridesharing and its potential to reduce climate change and traffic congestion. Nevertheless, ridesharing's full potential is unclear. Among the industry, there is much debate over whether to emphasize technology and social networking or financial incentives and enhanced casual carpooling (Paul Minett, Rick Steele, Sean O'Sullivan, and John Zimmer, unpublished data). Moving forward, more ridesharing research is needed to better understand the role of behavioral economics, interoperability, multimodal integration, and public policy, as well ridesharing's impacts on infrastructure, congestion, and energy/emissions.

ACKNOWLEDGEMENTS

The Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley and the Honda Motor Company, through its endowment for new mobility studies at the University of California, Davis, generously funded this research. The authors thank Madonna Camel and Steven Chua of TSRC for their help in questionnaire development. The authors also acknowledge Andrew Amey, Cindy Burbank, Mark Evanoff, Allen Greenberg, David Lively, Paul Minett, Marc Oliphant, Sean O'Sullivan, Syd Pawlowski, Rick Steele, Phil Winters, Park Woodworth, and John Zimmer for their expert interviews. The contents of this paper reflect the views of the authors and do not necessarily indicate acceptance by the sponsors.

REFERENCES

1. Shaheen, S. A., A. P. Cohen, and M. S. Chung. North American Carsharing: 10-Year Retrospective. In *Transportation Research Record*, No. 2110, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 35-44.
2. Shaheen, S., D. Sperling, and C. Wagner. Carsharing in Europe and North America: Past, Present, and Future. *Transportation Quarterly*, Vol. 52, No. 3, 1998, pp. 35-52.
3. U.S. Census Bureau. *Commuting Characteristics by Sex*. 2008 American Community Survey 1-Year Estimates. http://factfinder.census.gov/servlet/STTable?_bm=y&-state=st&-qr_name=ACS_2008_1YR_G00_S0801&-ds_name=ACS_2008_1YR_G00_&-CONTEXT=st&-redoLog=false&-geo_id=01000US&-format=&-_lang=en. Accessed June 28, 2010.
4. Ferguson, E. The rise and fall of the American carpool: 1970-1990. *Transportation*, Vol. 24, No. 4, 1997, pp. 349-376.
5. U.S. Census Bureau. *Sex of Workers by Means of Transportation*. 2004 American Community Survey. http://factfinder.census.gov/servlet/DTTable?_bm=y&-geo_id=D&-ds_name=D&-_lang=en&-redoLog=false&-state=dt&-mt_name=ACS_2004_EST_G2000_B08006. Accessed July 7, 2010.
6. U.S. Census Bureau. *Commuting Characteristics by Sex*. 2005 American Community Survey 1-Year Estimates. http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2005_EST_G00_S0801&-ds_name=ACS_2005_EST_G00_&-_lang=en&-redoLog=false&-state=st&-format=&-CONTEXT=st. Accessed July 7, 2010.
7. Statistics Canada. *Commuting Patterns and Places of Work of Canadians, 2006 Census*. Catalogue no. 97-561-X. Statistics Canada, Minister of Industry, 2008.
8. Winters, P. L. and F. Cleland. *Vanpool Pricing and Financing Guide*. Center for Urban Transportation Research, University of South Florida, undated.
9. Noland, R. B., W. A. Cowart, and L. M. Fulton. Travel demand policies for saving oil during a supply emergency. *Energy Policy*, Vol. 34, No. 17, 2006, pp. 2994-3005.
10. *Rideshare History & Statistics*. MIT Real-Time Rides Research, Department of Civil & Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA. Accessed December 26, 2009.
11. Weiner, E. *Urban Transportation Planning in the United States: An Historical Overview*. Praeger Publishers, Westport, CT, 1999.
12. Dill, J. Mandatory Employer-Based Trip Reduction: What Happened? In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1618, Transportation Research Board of the National Academies, Washington, D.C., 1998, pp. 103-110.
13. Rationing of Consumer Goods. *Columbia Law Review*, Vol. 42, No. 7, 1942, pp. 1170-1181.
14. *The Car Sharing Club Exchange and Self-Dispatching System*. U.S. Office of Civilian Defense, Publication 5011, Washington, D.C., 1942. http://arcweb.sos.state.or.us/exhibits/ww2/services/pdf/trans3.pdf, Accessed January 15, 2010.

15. *Whys and Hows about Car Sharing Clubs*. U.S. Office of Civilian Defense, Publication 5206, Washington, D.C., 1942. http://arcweb.sos.state.or.us/exhibits/ww2/services/pdf/trans4.pdf, Accessed January 15, 2010.
16. Wagner, F. A. *Evaluation of Carpool Demonstration Projects*. FHWA, U.S. Department of Transportation, Washington, D.C., 1978.
17. Winters, P. L. History of Carpooling and Vanpooling As We Know It. Presented at the 89th Annual Meeting of the Transportation Research Board, Washington, D.C., 2010.
18. Woolley, J. T., and G. Peters. *Jimmy Carter: The National Task Force on Ridesharing Appointment of the Membership*. The American Presidency Project, University of California, Santa Barbara. http://www.presidency.ucsb.edu/ws/?pid=31587. Accessed January 25, 2010.
19. Chang, M., B. Wiegmann, and C. Bilotto. *A Compendium of Existing HOV Lane Facilities in the United States*. Report No. FHWA-HOP-09-030. FHWA, U.S. Department of Transportation, 2008.
20. Metro.net. *HOV Frequently Asked Questions*. Los Angeles County Metropolitan Transportation Authority. http://www.metro.net/projects_studies/hov/faqs.htm. Accessed January 16, 2010.
21. *2008 High Occupancy Vehicle (HOV) Annual Report*. Office of Freeway Operations, HOV Operations Branch, California Department of Transportation District 7, 2009.
22. *High Occupancy Vehicle Lanes in Canada*. Urban Transportation Showcase Program: Case Studies in Urban Transportation, Issue Paper 54. Transport Canada, 2007.
23. Schijns, S. Arterial HOV Lanes: Where (and Why) Now? Presented at the 2005 Annual Conference of the Canadian Institute of Transportation Engineers, Banff, AB, 2006.
24. Minett, P. and J. Pierce. Estimating the Energy Consumption Impact of Casual Carpooling. In *TRB 89th Annual Meeting Compendium of Papers DVD*. DVD. Transportation Research Board of the National Academies, Washington, D.C., 2010.
25. Vanasse Hangen Brustlin, Inc. *Dynamic Ridesharing (Slugging) Data*. Virginia Department of Transportation, June 15, 2006.
26. Oliphant, M. The Native Slugs of Northern Virginia: A Profile of Slugging in the Washington D.C. Region. Major Paper for Master of Sciences in Urban and Regional Planning, Virginia Polytechnic Institute, 2008.
27. *Map of Slugging Sites in Washington DC*. Slug-Lines.com, Forel Publishing Company, LLC. http://www.slug-lines.com/Slugging/Map.asp, Accessed June 29, 2010.
28. Beroldo, S. Casual Carpooling in the San Francisco Bay Area. *Transportation Quarterly*, Vol 44, No. 1, 1990, pp. 133-150.
29. Beroldo, Paul. *Casual Carpooling 1998 Update*. RIDES for Bay Area Commuters, Inc., 1999.
30. *Casual Car Pool News*. Casual Carpool Sites East Bay and San Francisco, Ride Now. http://ridenow.org/carpool/. Accessed October 16, 2010.
31. Bullard D. L., and D. L. Christiansen. *Guidelines for planning designing and operating park-and-ride lots in Texas*. Texas Transportation Institute, College Station, TX, 1983.
32. Noel, E. C. Park-and-Ride: Alive, Well, and Expanding in the United States. *Journal of Urban Planning and Development*, Vol. 114, No. 1, 1988, pp. 2-13.

33. *Park & Ride Inventory*. California Department of Transportation. http://www.dot.ca.gov/hq/traffops/systemops/hov/Park_and_Ride/P&R_06_09.xls. Accessed February 3, 2010.
34. Gan, T., B. Ogden, and J. Wales. *Ontario's Carpool Lot Program and Rideshare Experience*. iTRANS Consulting Inc, 1998. Received by e-mail request, February 9, 2010.
35. *Carpool Lots*. Ministry of Transportation of Ontario. http://www.mto.gov.on.ca/english/traveller/trip/carpool_lots.shtml. Accessed February 8, 2010.
36. Spillar, R. J. *Park-and-Ride Planning and Design Guidelines*. Parsons Brinckerhoff Inc., New York, 1997.
37. Shirgaokar, M., and E. Deakin. Study of Park-and-Ride Facilities and Their Use in the San Francisco Bay Area of California. In *Transportation Research Record*, No. 1927, Transportation Research Board of the National Academies, Washington, D.C., 2005, pp. 46-54.
38. Kircher, D. and L. Wapensky. *Vanpooling: An Overview*. Publication EPA-908/1-78-001. U.S. Environmental Protection Agency, Region VIII, Denver, CO, 1978.
39. *Metro Commuter Van Program*. Metro Transit, King County Department of Transportation, July 2010. http://metro.kingcounty.gov/tops/van-car/commutervans.html. Accessed July 27, 2010.
40. *Trip Reduction Ordinances*. U.S. Environmental Protection Agency. Transportation Control Measures, Transportation Control Measure Information Documents. http://www.epa.gov/otaq/stateresources/policy/transp/tcms/trip_reduction.pdf. Accessed April 18, 2010.
41. Haselkorn, M., et al. *Bellevue Smart Traveler: Design, Demonstration, and Assessment*. Report No. WA-RD 376.1 Washington State Department of Transportation, 1995.
42. Casey, R. F., et al. *Advanced Public Transportation Systems: The State of the Art, Update '96*. Report No. FTA-MA-26-7007-96-1. FTA, U.S. Department of Transportation, 1996.
43. Golob, J. M. and G. Giuliano. Smart Traveler Automated Ridematching Service Lessons Learned for Future ATIS Initiatives. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1537, Transportation Research Board of the National Academies, Washington, D.C., 1998, pp. 23-29.
44. Loukakos, D. and R. Picado. 2000. *Ridematching*. California Center of Innovative Transportation, Institute of Transportation Studies, University of California, Berkeley. http://www.calccit.org/itsdecision/serv_and_tech/Ridematching/ridematching_report.html . Accessed November 6, 2009.
45. Kowshik, R. R., P. P. Jovanis, R. Kitamura. *Evaluation of the Sacramento-Area Real-Time Rideshare Matching Field Operational Test Final Report*. Research Report UCD-ITS-RR-96-02, Institute of Transportation Studies, University of California, Davis, 1996.
46. Dailey, D. J., D. Loseff, and D. Meyers. Seattle Smart Traveler: Dynamic Ridematching on the World Wide Web. *Transportation Research Part C*, Vol. 7, No. 1, 1999, pp. 17-32.
47. Levofsky, A., and A. Greenberg. Organized Dynamic Ride Sharing: The Potential Environmental Benefits and the Opportunity for Advancing the Concept. Paper No. 01-0577, Transportation Research Board 2001 Annual Meeting, Washington, D.C., 2001.

48. Bower, D. Ridematching Online: An Evolution in Service Delivery. *TDM Review*, Vol. 12, No. 2, 2004.
49. *Frequently Asked Questions*. FHWA, Office of Operations, U.S. Department of Transportation, October 2008. http://ops.fhwa.dot.gov/511/about511/faqs.htm, Accessed March 1, 2010.
50. *History / Frequently Asked Questions*. FHWA, Office of Operations, U.S. Department of Transportation, June 2009. http://ops.fhwa.dot.gov/511/about511/history.htm, Accessed March 1, 2010.
51. Lombardi, R. *511 service off to slow start in Canada*. IT World Canada, May 20, 2008. http://www.itworldcanada.com/news/511-service-off-to-slow-start-in-canada/00008. Accessed July 9, 2010.
52. *Profiles of 511 Traveler Information Systems Update 2009*. Report No. FTA-TRI30-2009.1. FTA, Office of Research, Demonstration and Innovation, U.S. Department of Transportation, 2009.
53. CBC News. *P.E.I. mulling 511 system*. Canadian Broadcasting Corporation, December 14, 2009. http://www.cbc.ca/canada/prince-edward-island/story/2009/12/14/pei-511-road-conditions-584.html. Accessed July 9, 2010.
54. *NuRide*. NuRide, Inc. http://www.nuride.com/nuride/main/main.jsp. Accessed July 6, 2010.
55. *RideSpring clients report 50% growth in alternate commuting*. RideSpring, Inc., Press Releases, January 20, 2010. https://www.ridespring.com/home/index.php?mact=News,cntnt01,detail,0&cntnt01articleid=36&cntnt01returnid=60. Accessed January 20, 2010.
56. *Zimride*. Zimride. http://www.zimride.com. Accessed July 6, 2010.
57. *PickupPal: on your way*. PickupPal Online Inc. http://www.pickuppal.com/pup/intro.html. Accessed July 6, 2010.
58. Gorringe, C. OpenTrip: An Open Protocol for the Interchange of Travel Information Among Rideshare Providers. Presented at the MIT/CMU Real-Time Rides Workshop, Cambridge, MA, 2009.
59. Reidy, C. *Zipcar partners with ride sharing community*. Boston.com. http://www.boston.com/business/ticker/2009/04/zipcar_partners_2.html. Accessed July 26, 2010.
60. Kelley, K. L. Casual Carpooling—Enhanced. *Journal of Public Transportation*, Vol. 10, No. 4, 2007, pp. 119-130.
61. Dorosin, E. *Commuter Connection: Flexible Ridesharing in Marin County, California*. Final Report. 1981.
62. *Pilot Program Overview*. Avego. http://www.avego.com/st/wsdot.php. Accessed July 26, 2010.