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Publication Date

1995-06-01

Involuntary Mobility, Gender, and Travel Demand Management
in Metropolitan Phoenix

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Presidential address delivered to the Association of Pacific Coast Geographers,
Sonoma, California, June 16, 1995

Metropolitan Phoenix is an international exemplar of a low-density, automobile-dependent city where car travel is required to conduct daily activities (Newman and Kenworthy 1989). Population growth, political pressure for new highway construction, and efforts to manage travel demand for air quality improvement purposes coexist. The paper focuses on how people and institutions have created this distinctive urban travel landscape and on some of its key consequences for travel behavior.

Three themes in human geography lend structure to this discussion: direct experience of the landscape, generalization of this experience, and evaluation of efforts to modify behavior in this landscape. The present travel landscape emerged over the past 40 years. Examining personal experience of the daily commute provides confirmation of the direct implications of this landscape for urban travelers. Mobility processes then provide a wider context for this landscape through examination of the cycle of travel demand and the role of gender in shaping commuting choices. These perspectives illustrate how the local traveling community - men, women, and children - responds to efforts to manage urban travel.

Transportation Landscape of Metropolitan Phoenix

In 1995, the metropolitan Phoenix population of 2.4 million spread 100 miles east to west and 60 miles north to south. The smaller urbanized area of 741.1 square miles had an average density of 2,707 persons per square mile in 1990. A grid network serves the region with wide local and arterial roads set every mile and two interstate highways. Local historians and geographers note the population's preference for the privacy and mobility offered by private vehicles and lack of support for mass transit (Sargent 1988), while explaining the slow development of the area's urban freeway system as a combination of "apathy and opposition" (Luckingham 1989, p. 199).

The linked problems of urban air pollution primarily due to vehicle emissions and traffic congestion on local roads emerged in the 1950s when the county population doubled from 332,000 in 1950 to 664,000 in 1960. Metropolitan Phoenix participated in the federal interstate highway program with preparation of a long-range transportation plan that foresaw 140 miles of freeways by 1980. The first seven-mile freeway opened in 1960. By 1980, only 32 freeway miles were completed, although public awareness of the need for limited access freeways was strong. In 1973, Eugene Pulliam, publisher of the Arizona Republic and Phoenix Gazette newspapers, actively campaigned against and led to the defeat of an elevated inner-loop freeway link north of Phoenix's central business district that would separate the downtown from the rest of the city. When this Papago Freeway segment was approved by voters in 1975 as a depressed and landscaped corridor partially covered by a city park, it became the last link in Interstate-10, opened in 1990, and the last link in the original Interstate Highway Program. No additional freeway plans

were approved until 1985, when most American cities had completed their urban sections of the interstate system with federal funding assistance.

By October 1985, however, population growth combined with road congestion led to widespread support for a regional freeway system to expand the existing system. Maricopa County voters approved by a three-to-one margin a half-cent countywide sales tax until the year 2005 to raise \$5.8 billion dollars to build 233 miles of urban freeways. This vote also created the Regional Public Transportation Authority. Regional freeway construction has not kept pace with projections, however. The local recession in the late 1980s slowed sales tax revenues, while rights-of-way land acquisition design, and construction costs were higher than projected.

As the 75 freeway miles in the Phoenix area in 1988--4 miles of freeway per 100,000 people--was the lowest per capita than of any million-plus urban area in the United States (Johnson, 1988), political pressure to complete urban freeway construction remained high. Local voters reconfirmed their preference for highways when they voted down a regional elevated rail system proposal in 1989. Voters also defeated a 1994 measure to increase and extend the sales tax funding for an equal funding of freeways and the regional bus system.

When this measure failed, Governor Fife Symington intervened in December 1994 and directed the Arizona Department of Transportation to develop an additional 107-mile freeway network that would not require raising taxes, rather than the planned 231-mile network (Arizona Republic, December 14, 1994). The proposed regional freeway network will lack complete belt routes and multiple radial corridors in the future.

The current freeways do serve the metropolitan core, improving access to the regional Sky Harbor International Airport and Phoenix's central business district. The fixed-route bus system operated by the City of Phoenix remains focused on bringing commuters to downtown Phoenix and is based on routes designed in the mid-1970s. In sum, the urban highway system expands by surface roads at the outer edge, while the regional airport remains in the core and the freeway network expands outward from the center.

The Daily Carpool: Life in the Fast Lane

Direct experience of this transportation landscape is driving on a road system where different jurisdictions have left their legacy. Completing a single trip can require travel on a discontinuous physical system, where roads widen by one or two lanes and then narrow, because different jurisdictions have used different design standards and priorities. Individual highway segments provide distinct travel experiences through their design and landscape qualities. Driving central city freeways in Phoenix, even where the expanded system is most fully in place, is an exercise in vehicle positioning to anticipate lane exits and route changes, an exercise familiar to travelers in other congested urban areas. As one example, the Squaw Peak Parkway, despite its bucolic name, is a late addition to the regional freeway system funded by the City of Phoenix. A single off-ramp leads from Interstate-10 to the less-generously designed parkway - a three- to four-lane elevated, limited access highway along a narrow right-of-way corridor carved through older neighborhoods to northeastern suburbs.

Expensive reconstruction of unanticipated bottlenecks was required after traffic flows were heavier than predicted. A one-lane off-ramp connecting two freeways, for example, was unable to accommodate two large, distinct streams of traffic: vehicles turning west toward central Phoenix, San Diego, and Los Angeles, and vehicles turning east to East Valley suburbs and Tucson (Figure 1). Urban impact mitigation is minimal and includes artwork of large pottery dishes and decorated pitchers to remind travelers of adjacent residential neighborhoods. These artifacts perch on eight-foot high walls that act as only partial barriers to traffic vibration, noise, and air-borne dust and other pollutants. Expensive reconstruction of unanticipated bottlenecks was required after traffic flows were heavier than predicted. A one-lane off-ramp connecting two freeways, for example, was unable to accommodate two large, distinct streams of traffic: vehicles turning west toward central Phoenix, San Diego, and Los Angeles and vehicles turning east to East Valley suburbs and Tucson (Figure 2).

Always trying to catch up with land development and increasing traffic, local construction proceeds by completing road sections as funding becomes available or timing becomes imperative. A driver traveling on the congested Squaw Peak Parkway moves south to Interstate-10 where wide vistas open up on new east-west freeway segments using the Salt River as a travel corridor. Multiple access roads now serve the Sky Harbor International Airport including the 1990 Barry M. Goldwater Terminal expansion.

Until 1996, a well-known road bottleneck existed on the south side of the Salt River. A Southern Pacific Railroad bridge serves freight and (until 1996) passenger service just west of the original railroad crossing that first connected the Phoenix region

in 1879 to the Southern Pacific national rail network at Maricopa, Arizona. A four-lane access road narrowed to two lanes with a stop sign marking a street entrance from the south. Before the 1996 Super Bowl at Arizona State University, a traffic signal replaced the stop sign and the road was widened to four lanes, completing the east-west connection between major arterial roads 1 and 2 miles away and improving campus access (Figure 3).

This driver, for one, concludes that road design and construction serves the immediate access requirements of adjacent land uses and road builders, who admittedly have little local freeway construction experience. Uninterrupted regional mobility for local drivers between dispersed origins and destinations is not yet a reality, however. The above examples were selected because they illustrate a personal family carpool commute that includes dropping off a child at a central Phoenix school before continuing to Arizona State University in Tempe. This family carpool has a one-way, 16-mile trip route linking home and work rather than a direct 8-mile trip. Clearly, present and past construction result in a Phoenix road system with significant landscape evidence of past decisions that shape the daily experience of frustrated travelers.

Mobility Processes

The fundamental research question is how and why individuals and households act as they do in a particular local environment. Travel behavior occurs in a setting of growth in the number of trips, vehicles, and workers that is linked to the existing cycle of urban transportation demand. Each day, men, women, and children make individual and household travel decisions to conduct their daily activities. The cumulative impact of

their decisions leads to distinctive local transportation behavior, especially in fast-growing cities like Phoenix.

Nationally, the growth of urban populations over the past thirty years has been exceeded by an even greater mobility increase. The volume of daily trips increased as people made more trips for work, shopping, personal business and socializing (Hu and Young, 1992). Commuting trips increased as the number of workers increased by more than twice the rate of increase (56 percent compared to 21 percent) of the total United States population . The composition of people doing the traveling, especially commuters, also changed as more women entered and stayed in the labor force, including women with very young children, under 6 years of age.

Phoenix, with Houston, set these trends for fast-growing sunbelt cities, including Sacramento and San Diego, California. In Phoenix, increased population growth (55 percent) triggered even greater employment (79 percent) matched by increased use of private vehicles for work trips (80 percent) (Pisarski 1987, p. 52), while working women increased from 31 percent of the Phoenix labor force in 1960 to 44.8 percent in 1990. By 1990, 89 percent of local journey to work trips were taken by privately owned vehicle. Seventy-five percent drove alone while 14 percent shared a carpool. More people either worked at home (2.94 percent) or walked to work (2.65 percent) than took the bus (2 percent) (Rosetti and Eversole 1993).

These trends describe a demand cycle for urban transportation that is difficult to slow or reverse (Plane, 1995). Metropolitan Phoenix's transportation experience reflects the familiar cycle of urban population growth leading to road congestion, increased demand for highway construction and a repeated cycle of population growth and demand

for highways. While new construction cannot be assumed to always add air pollution or to relieve congestion, it is clear that physical highway capacity cannot be expanded indefinitely to meet ever-increasing urban travel demand (Transportation Research Board, 1995). Negative impacts include direct construction costs, which divert scarce public funds from other public priorities, neighborhood disruption, and increased urban decentralization.

While metropolitan Phoenix focused unsuccessfully on providing additional highway capacity in the 1980s to reach the level of freeway service found in other cities, national recognition of transportation and environmental concerns related to highway expansion increased. As highway construction slowed across the country, transportation systems management focused on greater use of the existing transportation system with more persons per vehicle and more vehicles per highway lane. One benefit of the delayed construction of the Phoenix freeway system is the inclusion of some high-occupancy vehicle lanes and traffic monitoring.

Reliance on private automobiles for every trip remains the overriding issue. This involuntary mobility limits the progress that can be made in addressing air pollution and congestion. One environmental success of the past twenty years is the reduction in carbon monoxide emissions through technological improvements such as catalytic converters and improved fuels and vehicle emission inspection. While carbon monoxide levels declined in Phoenix over the past 20 years, summer ozone and particulate problems remain severe.

Reducing or eliminating the need for travel has emerged as an additional management strategy to complement existing approaches. Travel demand management programs focus primarily on commute trips where carpooling, bus, and telecommuting

can provide options to driving alone. The Arizona Legislature enacted such a program in 1988 because the two largest metropolitan areas, Tucson and Phoenix (with over 70 percent of the state's population) were not in compliance with federal clean air standards. In 1990 Arizona was one of eleven states with legislatively mandated travel demand management programs. The state had the largest number of employees in the country (after California) covered by mandatory programs.

The metropolitan Phoenix trip reduction program is a regional effort that requires employer participation but does not require achievement of reduced commuting (Burns 1992). All employers with over 100 employees at a single site conduct annual surveys of employee travel, prepare a plan with measures to increase carpooling, bus, and telecommute use, and make a good faith effort to achieve annual 5 percent reductions in single occupant vehicle commutes. Costs and benefits of compliance focus on employer participation and employee education rather than on the ability of employees to adjust their behavior.

Travel and Gender

When these trends and priorities are considered, a complex link between gender, commuting, and travel demand management appears. Historically, salaried women have had different transportation patterns than men. Employed women worked closer to home, traveled shorter time and distance to work, and more often used mass transit than men. These disparities were thought to be the result of economic differences, simply reflecting the fact that so many more women had low incomes rather than crucial noneconomic considerations. Until recently, few analysts believed that women with comparable

incomes but different household situations--married or single, with or without children--might have diverse travel patterns or that employed men and women with comparable incomes might have also.

Parallel research during the last 2 decades shows that, in contrast with traditional thought, working women have different and more diverse travel patterns than comparable men (Rosenbloom 1993; Rosenbloom and Burns 1993). Women make more trips for domestic purposes than their male counterparts; make fewer social or recreational trips; and make more trips solely for children's needs. Women appear to make transportation and other decisions in order to successfully juggle employment with traditional primary child care and domestic responsibilities (Wachs, 1987; Hanson and Johnston 1985).

This difference between these economic assumptions and reality holds true for single parents who must balance employment and domestic responsibilities without a resident partner and who make more trips and travel further for all purposes than comparable married workers. Even though single women with children may be less likely to own a car, they are more likely to make work trips in cars and have longer work trips than comparable married women (Johnston-Anumonowo 1989).

Clearly, women's travel decisions are made in a context of multiple work and non-work priorities. Not only work, but child and elder care, education, and other domestic responsibilities increasingly require travel outside the home. Moreover, most of these findings were made in Midwestern and Northeastern cities where pre-automobile high-density urban cores and established transit systems offer different travel conditions than those found in newer, Western cities.

Rosenbloom and Burns (1994, p. 40) conclude that “most women would suffer seven major types of problems if they switched to alternative modes or mandated work schedules.” 1) Additional child or elder care expenses caused by time lost in traveling via alternative modes. 2) Women may lose the ability to conduct out-of-home domestic responsibilities (shopping, chauffeuring children) because of lack of time or flexibility. 3) Women may also lose time to conduct in-home domestic responsibilities (preparing meals, spending time with children or aging parents). 4) Moreover, appropriate child or elder care providers whose hours match new work schedules or longer commutes via alternative modes may be hard to find or not available. 5) Women may be unable to respond to at-home emergencies or disruptions (a child becomes ill at school). 6) Women are more concerned than men about their exposure to additional (perceived or real) danger walking to and from bus stops or riding transit. 7) Finally, women may also be unable to find or use alternatives matched to work schedules or home location (buses that run infrequently or require several transfers or a long walk from employment site to stop).

The Traveling Community: Men, Women, and Children

The current metropolitan Phoenix trip reduction program covers 1,400 employers at 2,500 separate work sites and 500,000 employees. When the program started in 1988, initial employee surveys were phased from 1988-1990 to provide information about commuting behavior before the program began, while surveys conducted in 1991 provide the first information about changes in commuting behavior. Surveys that reflect the experience of the largest employers were available for analysis in 1990 (73,623 employees) and 1991 (62,654 employees).

Aggregate commuting behavior (Table 1) confirms that women are almost as likely to drive alone as men (81.4 percent versus 83.0 percent). One-way commute distances were slightly longer for men than women in 1990 (12.7 miles versus 11.4 miles) and declined slightly in 1991 (12.5 miles versus 11.3 miles). When men and women in the same occupational groups are compared, women have shorter travel times than men in the same occupational group. Commute times were identical for men and women in 1990 (24.5 minutes) and diverged in 1991 as men's travel time dropped (24.2 minutes) and women's travel time increased (24.7 minutes).

Men and women differed in their responses when questioned about effectiveness of policies designed to increase use of alternative modes. Both women and men respond to economic incentives such as employer rewards and the value of increased bus service in area coverage and daily schedules. Women were more sensitive to economic disincentives of new or increased parking fees and were more responsive to strategies that addressed their domestic and childcare responsibilities, including easier access to childcare and schools, a guaranteed ride home.

Unexpectedly, women reduced their driving alone proportionately more than men (76.7 percent versus 79.9 percent) in the program's initial year. Women appear aware of both economic and domestic concerns, but at least initially appear able to balance them in ways that allow their participation in the trip reduction effort.

Arizona State University is the largest single work site in the trip reduction program with over 5,000 faculty and staff and 42,000 students. This university location provides a setting to evaluate commuting choices where use of alternative modes is common, parking is scarce, and parking fees are charged. Commuting to Arizona State

University already occurs under conditions that the trip reduction program seeks to encourage at all large metropolitan work sites. Arizona State University had 3,597 employees surveyed in 1990. The 1991 survey of 2,519 employees included questions about employee marital status and the presence and age of children.

University workers are highly dependent on the private automobile for commuting, although less so than regional workers. In 1991, over 75 percent of University workers drove alone to work compared with over 78 percent in metropolitan Phoenix. These employees had substantially shorter commutes than aggregate regional commutes. Well over three-fourths of University workers lived within 10 miles of their homes. Over 65 percent of workers traveled less than 20 minutes to work. Although driving alone dropped in the region from 1990 to 1991, driving alone increased slightly at the university. Conversely, the use of most alternative modes went down at the university while increasing regionally, e.g. carpool use dropped from 11.5 percent to 8.5 percent.

These employees reported marked differences in commuting patterns by sex. Women are much more likely to drive alone to work than men. This gap intensifies between 1990 and 1991 because fewer women switch to alternative modes and more switch away from alternative modes. Thus women are more likely to depend on the car even though they are concentrated in lower-paying clerical/secretarial jobs and less likely to be employed in professional/managerial and technical/research jobs than men.

These differences held true when marital status is considered. Although unmarried people generally are more likely to drive alone than those who are married, women are always more likely to drive alone to work, regardless of marital status. Over 82 percent of unmarried women at Arizona State University drive to work alone

compared with 17 percent of unmarried male workers. Conversely, married people of both sexes are substantially more likely to carpool than unmarried people.

Marital status and the presence of children have a joint impact on travel choices. Although the reported impact is more pronounced for women, having children tends to increase the likelihood that both men and women drive alone. For example, over 72 percent of married male workers with children drive to work compared with just under 71 percent of married men without children. But over 82 percent of married women with children drive to work at Arizona State University compared with 72 percent of married women without children. The difference between the sexes in driving alone holds when being a parent is added.

The reliance of women on driving alone is confirmed when the age of children is considered (Table 2). Both men and women are affected by the presence of children while the presence and number of young children (under 12 years) increases even more the likelihood a parent will drive alone. Women are much more affected than men, however, at each age level. At Arizona State University, the highest drive alone rate is among women having more than one child aged 6 to 12 whose responsibilities for elementary school and after-school activities are high. When children reach driving age, economic rather than domestic considerations predict commute behavior as more men (76.9 percent) drive alone than women (71.9 percent).

In sum, while early regional trip reduction experience showed a reduction in driving alone, this experience did not occur at Arizona State University where employees already have disincentives to drive alone. University workers who drive alone under these conditions clearly do so because only use of a private vehicle allows them to

balance their domestic and work responsibilities. Key variables of marital status and the presence of young children describe stages in an adult's life cycle that predict that men and women are likely to drive alone. Women are most affected and rely on use of private vehicles more than comparable men. This research confirms common-sense knowledge about daily commute choices and the conflicting daily priorities faced by working women (USA Today, July 13, 1994; Wall Street Journal, July 8, 1994).

1988-1996 Travel Demand Management Experience

Knowing that gender and domestic responsibilities affect the ability to change commute mode lends a new perspective to metropolitan efforts to limit travel demand. These findings, if generalized to all work sites, suggest that women will be less able or likely to shift their behavior from driving alone as part of trip reduction programs. Conversely, those men and women who bear fewer domestic and childcare responsibilities can take advantage of employer incentives, adopt flexible work hours, and use alternate modes. Women, however, will bear a disproportionate share of the future burdens of driving alone if employers adopt disincentives such as establishing or increasing parking fees or requiring alternate work schedules (Giuliano 1994).

Some reduction in driving alone can be achieved, however, if these concerns are met. Reductions in driving alone (3.9%) occurred at work sites in metropolitan Phoenix during the first program years as people who could shift their travel did so (Burns, 1995). At work sites where employers offered economic incentives - prize drawings, free carpool parking -and met domestic concerns - a guaranteed ride home, the percentage of drive alone commutes dropped. In addition, fewer drive alone commute miles were traveled at

work sites where employers offered specific economic incentives to carpool and vanpool users with long commutes - prizes, zipcode matching for potential shared rides, reduced or preferred parking - and responded to domestic concerns - a guaranteed ride home.

By 1996, however, metropolitan Phoenix drive alone commutes had leveled off in percentage (70.2 percent) and average one-way weekly miles (81.6 miles) (Maricopa County Regional Trip Reduction Task Force, 1996). The program's scope had been expanded to 1,500 employers with more than 50 employees at a single work site, 2,500 work sites, and over 500,000 employees. Its regulatory goals have been made more ambitious with annual 10 percent drive alone reduction goals; each employer is expected to reach and maintain a 60% drive alone rate. Actual commute behavior here and in Los Angeles shows that initial reductions in driving alone do not continue indefinitely, however, and regional response levels off after several years (Young 1995).

Nationally, trip reduction programs are now criticized as local examples of unworkable public mandates with profound negative impacts on employers and employees. The original environmental and transportation priorities underlying trip reduction efforts have not disappeared in metropolitan Phoenix and elsewhere, however. As carbon monoxide concerns diminish locally, high levels of particulates and ozone remain as concerns. Local population growth of 15 percent since 1989, continued employment growth, and increase in average commute trip length limit the program's benefit to regional air quality. Cities with few options to travel by car, like metropolitan Phoenix, are in a limited position to expect widespread changes in travel behavior.

Conclusions and Implications

First, Phoenix is an exemplar of an auto-dependent city in its physical travel landscape and consequences for travel behavior. Access to a private vehicle is a necessity for participation in the labor force and urban life. Public investment currently supports more highways to serve the expanding urban area in spite of well-known air quality and congestion problems.

Second, choices about commuting are made in the context of an individual and household's work and non-work responsibilities. Management efforts to reduce driving alone can be more successful as they respond to these responsibilities.

Finally, life cycle and demographic imperatives complement economic explanations for travel behavior. Women's work travel, especially, is dependent on driving alone to meet daily domestic and childcare responsibilities.

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Table 1: Phoenix Commute by Travel Mode*

Mode	1990		1991	
	Men (n=38,643)	Women (n=29,346)	Men (n=33,793)	Women (n=24,150)
Drive alone	83.0%	81.4%	79.6%	76.7%
Carpool	9.2	11.9	12.5	15.5
Bus	2.8	4.3	3.2	5.2
Bike	1.7	.5	1.8	.8
Walk	.9	.8	.5	.7
Other (motorcycle, work at home)	2.4	1.1	2.3	1.0

* trips taken 4 or more days a week in each mode.

**Table 2: Drive Alone to Work by Presence and Age of Children
Arizona State University, 1991**

	Men	Women
Children under 6 years	70.5%	84.8%
Children 6 - 12	77.7	91.1
Children 12 - 17	73.6	79.9
Children over 17	76.9	71.9
No children	67.9	77.5

Acknowledgments

The research reported in this paper was partially funded by the University Transportation Center, University of California, Berkeley.

Figure Captions

Figure 1. Light and heavy vehicles travel together on the Squaw Peak Parkway where sound walls abut adjacent neighborhoods.

Figure 2. This view south from an overpass on the Squaw Peak Parkway shows the interchange with Interstate-10. This interchange was reconstructed to accommodate east and west turning traffic.

Figure 3. This two-lane road on the south side of the Salt River in Tempe under the historic Southern Pacific Railroad bridge was improved to four lanes in 1996 for the 1996 Super Bowl at Arizona State University.