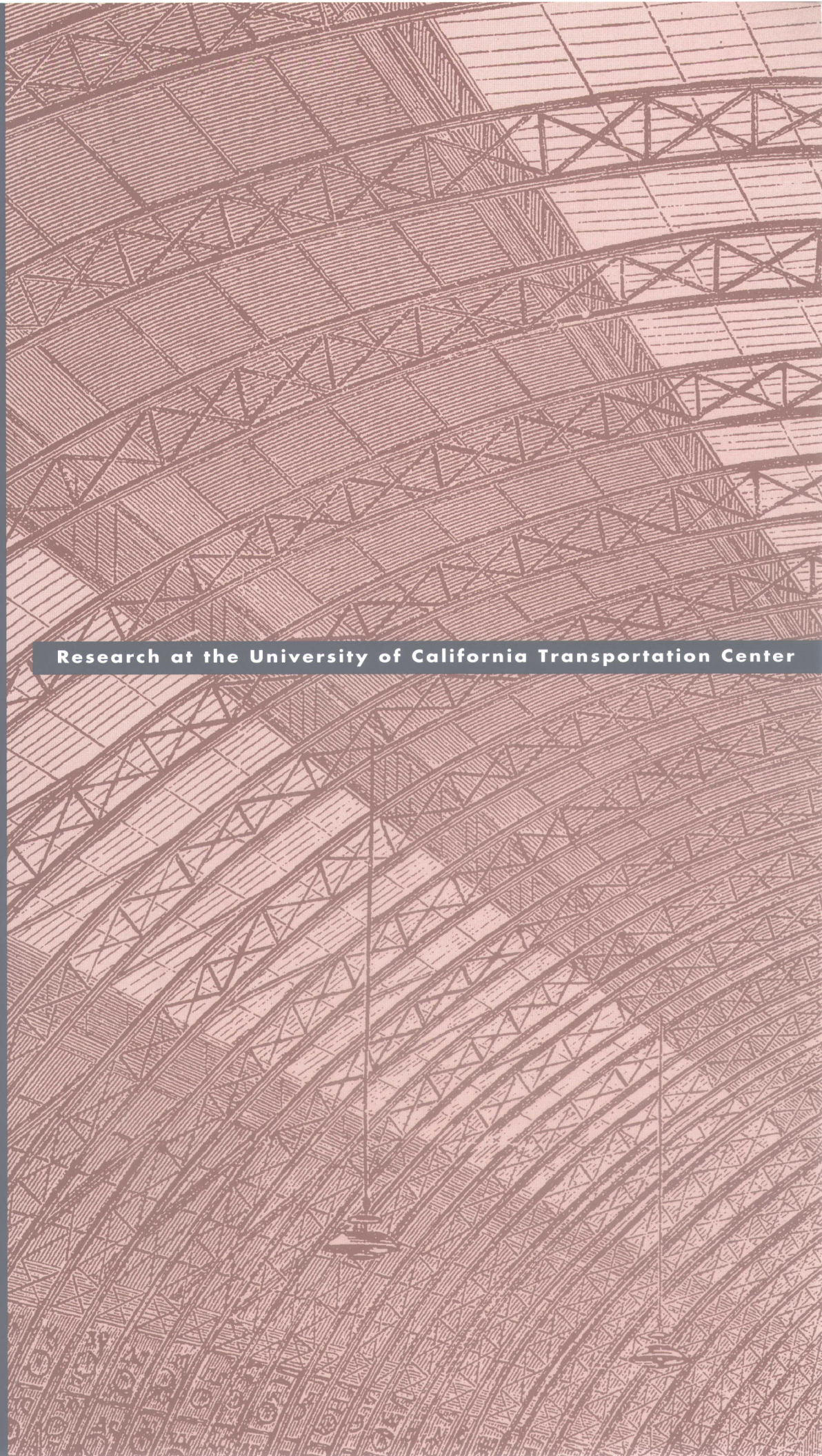
ACCESS



Research at the University of California Transportation Center

SPRING 1996
NUMBER 8

CONTENTS

ACCESS No. 8 SPRING 1996

University of California Transportation Center
Berkeley, CA 94720-1720
Tel: 510-643-5454
Fax: 510-643-5456
access@uclink4.berkeley.edu
http://violet.berkeley.edu/~uctc

introduction

I arrived here at the UC Transportation Center just nine months ago. A former lawyer and aspiring writer, I had only a layman's knowledge of transportation systems, mostly based on my personal experiences.

Growing up in Hilo, Hawaii, I thought traffic jams meant having to circle the parking lot twice to find a space. No one worried about ozone or took cars in for smog checks. Every desirable destination—shopping malls, movie theaters, beaches, even downtown—was within a few minutes' drive.

Life's different now. I live in Berkeley—a town allegedly within easy reach of the Napa Valley vineyards, Lake Tahoe, and San Francisco's cosmopolitan scene. When I moved here from Los Angeles, I thought I'd escaped traffic jams, but a recent UC-Berkeley report says that median Bay Area commute time is the same as LA's, about twenty-four minutes. Besides, my own experience has made me wary. A simple drive across the Bay Bridge during rush hour can be a nightmare—there's no detour—so I typically just stay home.

In nine months, I've learned a lot. When telling friends I work on a transportation magazine, most immediately assume it focuses on the design of freeways and traffic signals. "No, it's more," I say, struggling to describe UCTC research in a single breath. "Transportation is an essential feature of every function in modern society."

As editor of ACCESS, I've discovered that transportation is a many-disciplined field, that it really does touch everything in modern economic and social life. This University's roster of professors teaching transportation is a clear indication of that. It includes economists, civil engineers, mechanical engineers, chemical engineers, electrical engineers, political scientists, urban planners, sociologists, computer scientists, public health specialists, lawyers, vision scientists, environmentalists, landscape architects, psychologists, and no doubt others.

Of course, none of these subfields can deal with transportation problems by itself. Scientists and engineers may develop a feasible electric car that alleviates air pollution—but neither automakers nor policy makers will accept it unless the economics and the market conditions assure a benefit to them. Even then, nonpolluting cars alone won't relieve congestion.

Planners may contend that congestion will decline only with increased transit riding and reduced auto driving. That would require high-density development, or congestion pricing, or better transit service, or new vehicle technologies. But these won't occur unless local residents agree to zoning changes, builders offer attractive apartments and townhouses, suburbanites move back to the city, manufacturers invest in more R&D, public officials impose user fees, and more. Changes of these sorts may have to wait for a major cultural change, a switch in lifestyles, a shift in incomes, improved industrial processes, and a different politics.

Habitual readers of ACCESS already know that our researchers speak in many tongues. Our Spring 1996 lineup further reflects their diversity. First, in a compelling argument based jointly in property law and economic principle, Daniel Klein et al. say cities should give private jitneys access to curb space rather than reserving transit stops exclusively to public buses. He argues that, if the present bus monopoly were replaced by open competition between the two transit modes, travelers would have more choices and better service, and transit riding would rise.

Everyone acknowledges the pervasive role of automobiles and knows their benefits don't come free. Now Mark Delucchi has done the intensive analysis to expose the total social-cost of automobile use. He has worked through a complex maze of causal connections to categorize different types of costs and to construct dollar estimates for each. We expect his intricate analysis will generate a lively discussion, and ACCESS will eagerly provide a forum for it.

A much-cited 1990 study reported that vehicle-miles-traveled (VMT) rose by forty-one percent between 1983 and 1990. That seemed implausible to Charles Lave, so he checked it out using other estimating methods, including some of his own invention. He finds that the study significantly overestimated growth in VMT, then provides alternative estimates showing much more modest increases.

Michael Southworth says our current transit information media fail to serve many potential users. It seems that a high proportion of Americans are illiterate and thus can't read instructions or maps. By exploiting new electronic technology that can present understandable information to persons who can't read, he expects transit can become an attractive, rather than onerous, mode of travel for them.

Hoping to help cities respond effectively to future disasters, Martin Wachs and Nabil Kamel analyze the ways transportation agencies reacted to the 1994 Northridge earthquake in Los Angeles. He explains how the multitude of federal, state, and local agencies happened to work together during the emergency and why the highway system got fixed in record time.

The research summarized in ACCESS offers only a glimpse into the numerous investigations being supported by UCTC and its DOT and Caltrans sponsors. Although the various researchers have different agendas and different styles of inquiry, they all share a passion for understanding how our transportation system works, why it falls short of expectations, and how to make it better.

However varied their formal disciplines, it strikes me that they all seem to share a faith in the inherent value of greater knowledge. They also seem to share a belief that better understanding will prove useful in leading to improved transportation. Their commitment is contagious. Already my position as editor is more than just a job.

—Luci Yamamoto
Editor

Free To Cruise:

Creating Curb Space For Jitneys

BY DANIEL B. KLEIN, ADRIAN T. MOORE, AND BINYAM REJA

Public buses can't compete with private automobiles because bus rides usually involve long waits, slower commutes, limited route and destination choices, and less privacy. To improve transit, it may be necessary to overhaul our current government-owned bus system by legalizing private transit services. Consider one promising alternative, "jitneys"—small private vehicles that carry passengers over regular routes but allow flexible schedules.

Freely competing with buses in an unregulated transit market, jitneys can greatly increase transit riding. But open competition would let jitneys steal bus riders by interloping on established, scheduled routes. For this reason, jitneys have been almost universally banned in the United States.

Following national urban transit policy, local governments have created monopolies for scheduled bus service by prohibiting competition along given routes. Subsequently, bus operation has become highly regulated, subsidized, bureaucratized, and politicized.

We believe that jitneys and buses can coexist if government sets new rules, based on property rights, governing passenger pick-up areas. Instead of giving buses exclusive operation over routes, they should have exclusive rights only to designated bus stops, sharing routes with jitneys that have their own curb space.

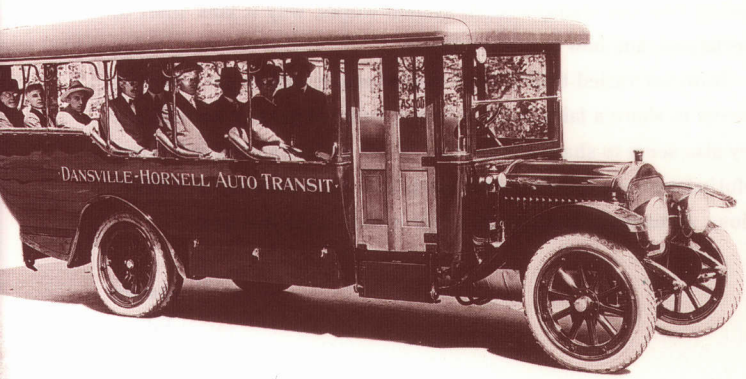
We want to highlight three examples of successful jitney operations—the 1914-1916 jitneys in the United States, jitneys in less-developed countries, and current illegal jitneys in New York City. We then want to show how to introduce jitneys into the system of regulated bus transit.

THE JITNEY EPISODE OF 1914-1916

At the turn of the century, the most popular urban transit option was the electric streetcar, which enjoyed a monopoly in the form of exclusive franchises for routes. By 1914, however, automobile owners began using their private cars to provide mass transportation. These jitneys—named after the slang term for a nickel—often ran just ahead of the streetcars, picking up waiting passengers.

Jitneys offered service comparable to private automobiles because they were quick and convenient, often providing door-to-door service. Jitney drivers operated independently. They were usually people between jobs, working part-time, or simply com-

Daniel B. Klein is assistant professor of economics and both Adrian T. Moore and Binyam Reja are graduate students in economics, all at the University of California, Irvine, CA 92717.



muting to work themselves. They could adjust for the weather, congestion, time of day, and day of week.

By 1915, there were 62,000 jitneys operating nationwide, spurring formation of industry customs, voluntary associations, and company fleets that helped drivers obtain insurance, pay maintenance costs, and, in some cases, coordinate routes and schedules.

Jitneys undoubtedly interloped on streetcar business, yet they also filled specific market niches. People chose jitneys mainly for short distances, especially if they were not served by streetcars. The number of jitney passengers far exceeded the number of riders intercepted from streetcars, suggesting that jitneys were attracting new transit riders. But the streetcar companies saw the jitneys as infringing on their monopoly right and lobbied government to end the "jitney menace." Municipalities gave in to their demands, in part because streetcars paid taxes and gave free transportation for police officers and fire fighters.

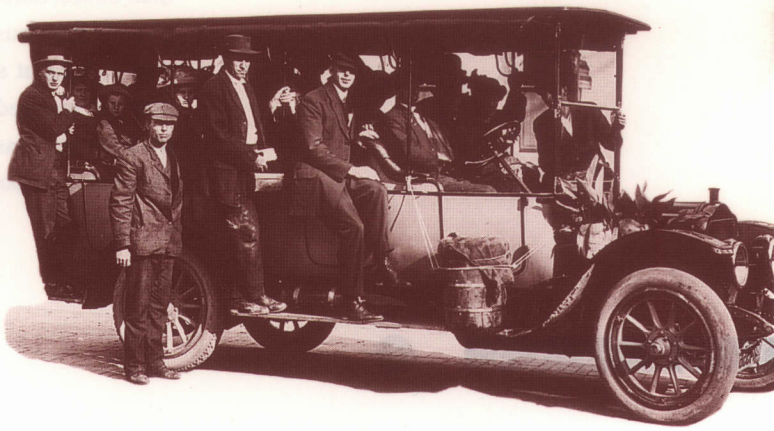
The 1914-1916 jitney episode illustrates the freewheeling type of transit that came with the automobile. It also introduced a fundamental issue in property rights: Does interloping on scheduled service constitute thievery? Or is it fair competition? Back then, government believed it was outright thievery. Instead of developing a framework to accommodate competitive coexistence, freewheeling transit was stamped out in favor of large-scale monopoly.

Jitneys are faster and cheaper than buses, and they offer a more comfortable ride, with drivers who speak languages other than English.

TRANSIT IN LESS-DEVELOPED COUNTRIES

Jitney services similar to the early ones in the United States are operating in hundreds of cities throughout less-developed countries (LDCs) such as Peru, India, and the Phillipines. There, official bus services receive subsidies, but illegal jitneys flourish by interloping on scheduled services. There are laws governing jitney safety, routes, and fares, which are meant to limit interloping; but those laws are rarely enforced.

Jitney operators often create informal route associations to regulate service with explicit rules setting routes and fares, and prohibiting interloping. The associations achieve a degree of order sufficient to control wasteful conflict among individual operators, but they also operate as a cartel. Jitneys that initially transgressed on buses' curb rights at bus stops eventually establish curb rights for themselves. To protect those rights from new interlopers, they usually resort to physical intimidation and strong-arm tactics. ➢



Fresh-air jitneys in the tropics.

Once organized, route associations may turn to government for official recognition. After much lobbying, bribery, and petition gathering, route associations may acquire official status and receive permits or licenses. Along with official recognition, however, come political obligations and regulations—and invasion by new operators remains a threat.

Ultimately, the transit history of LDCs illustrates that without curb rights—established officially or otherwise—no street transit system can survive.

ILLEGAL JITNEYS IN THE UNITED STATES TODAY

Illegal jitneys continue to operate in the United States today, most notably in New York and Miami. People who ride illegal jitneys here cite various reasons for preferring them to public buses. They say jitneys are faster and cheaper than buses and that they offer a more comfortable ride, with drivers who speak languages other than English.

Jitney riders believe jitneys are safer than buses. Since jitneys arrive more frequently than buses, riders don't have to wait as long at street stops, where they may get mugged. Further, jitney drivers tend to reject passengers who are drunk, disorderly, or pose other threats.

Jitneys flourish in cities where transit is popular and enforcement efforts either have not succeeded or have not yet begun. In New York, modern jitney operation began during the transit strike of 1980, when illegal jitneys emerged to provide local service and feeder service to the Long Island Railroad station in Jamaica (Southeast Queens). Jitney service first developed in neighborhoods of Caribbean immigrants, perhaps because those riders were accustomed to riding jitneys in their native land. Jitneys thrived even after bus service resumed because enforcement against them was only sporadic.

The *New York Times* reported that in the eighteen-month period preceding December 1991 a special task force issued 11,773 criminal summonses against jitney operators. But jitneys remain uncontrollable, with many vans driven by Caribbean immigrants who pay little attention to the legal citations. The *Wall Street Journal* found that over a one-year period in 1990, jitneys were assessed fines of over $4 million, but the city collected only $150,000. The New York example suggests that unsubsidized private enterprise can supply fixed-route transit despite governmental prohibitions, as long as private operators can establish sufficient curb rights.

THE JITNEY'S ROLE IN DIFFERENT TRANSIT MARKETS

The determining factor for the viability of both jitneys and buses is whether jitneys have free run of the streets and access to curbs.

As we mentioned earlier, U.S. cities typically protect bus systems from interlopers by giving them exclusive rights, or franchises, to specific routes. These rights prevent all interloping. If interloping is effectively prohibited, bus companies have an incentive to establish routes and schedules. They publicize their services and may enter new markets, trying to attract more riders, because they reap the benefits. However, giving buses exclusive curb rights leads to inadequate competition and an inert monopoly, which may lead to low-quality service, lack of innovation, and higher fares.

In contrast, consider what happens where there are no franchised routes and no ban on competition—no exclusive rights at all—either because they are not granted or not enforced. In this case, the entire route is open to any operator. The jitney systems in LDCs and in New York City illustrate this situation. With open competition, the viability of both jitneys and buses depends on whether the market is thin (low demand) or thick (high demand).

If the market is thin, interlopers will run just ahead of scheduled buses collecting the waiting passengers and leaving few for the buses. Scheduled bus service may cease to operate due to lack of passengers. In turn, jitney riders will be less enthusiastic about congregating at the curb because they won't have guaranteed scheduled service. Further, without scheduled service, there won't be set arrival times at the stops. In a sense, scheduled service is the "anchor" of the market, and the entire market—buses and jitneys—may be destroyed if that anchor is dissolved.

If the market is thick, the lack of curb rights may not be a serious problem. Even without the anchor of scheduled bus service, the market may be thick enough to sustain jitneys alone. However, other problems may occur, such as low quality, irregular service, confusion over terms, and lack of trust among participants.

The choice between exclusive rights for buses or none at all poses a dilemma. Giving buses exclusive rights may create an ineffective transit monopoly, but legalizing jitneys to bring competitive energy into the market may dissolve bus service entirely. Instead of choosing either extreme, however, we propose an arrangement that takes a middle ground.

THE SOLUTION: CURB RIGHTS

The dilemma between monopoly and anarchy can be transcended by an option that maintains limited exclusive rights for scheduled service, yet permits free-wheeling competition on the route. Our solution is based on a previously unnoticed policy opportunity: *creation of exclusive and transferable curb rights that allow buses and jitneys to coexist.* ➢

Buses and jitneys competing for New York's curbs.

FIGURE 1

Spatial Demarcation of Property Right Assignments to Curb Zones

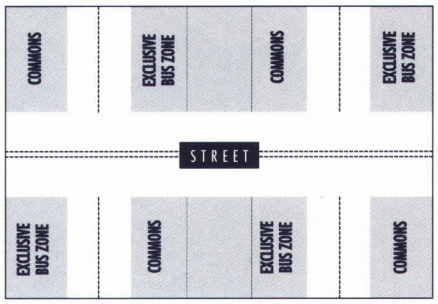


Figure 1 depicts how curb rights can include both exclusive areas for buses where their passengers congregate, and nonexclusive stops elsewhere along the route—designated as "commons"—where jitneys can pick up other passengers. These rights don't have to be static, but can vary to accomodate the market. For example, in nonpeak hours, the commons may become additional bus-only zones.

Our scheme relies on government enforcing the designated curb rights. We think this is possible with video cameras that record illegal "trespasses." Riders of trespassing jitneys can also be held liable, to ensure that they wait for jitneys in legal areas outside exclusive bus zones.

Further, suppose government deregulated and privatized our current bus system. If this happened, exclusive curb zones could be leased to private bus companies—either sold at set prices or auctioned off. Imagine, further, that companies may sublet or resell their leases. This may spawn an industry of curb rights: entrepreneurs who buy available curb zones, sublet rights, and manage and monitor bus stops.

CONCLUSION

Current transit practice grants exclusive rights to scheduled bus service, which leads to monopoly. The alternative, permitting lawless competition, may destroy the market entirely.

Our proposal, which gives curb rights to both buses and jitneys, takes advantage of both transit options. It will eliminate government control and overregulation, avoid market imperfections, and rejuvenate transit entrepreneurship and innovation. Property rights for both will help assure competition between jitneys and buses, thus improving overall transit service. ◆

FURTHER READING

Otto A. Davis and Norman J. Johnson, "The Jitneys: A Study of Grass Roots Capitalism," *Journal of Contemporary Studies*, Winter 1984, pp. 81-102.

Hernando De Soto, *The Other Path: The Invisible Revolution in the Third World*, translated by June Abbott (New York: Harper & Row, 1989).

John Diandas and Gabriel Roth, "Alternative Approaches to Improving Bus Services in Sri Lanka," *Fourth International Conference on Competition and Ownership in Land Passenger Transport*, conference papers, New Zealand, 1995, pp. 463-482.

Ross D. Eckert and George W. Hilton, "The Jitneys," *Journal of Law and Economics*, Vol. 15, 1972, pp. 293-325.

Jose Gomez-Ibanez and John R. Meyer, *Going Private: The International Experience with Transport Privatization* (Brookings: Washington, DC,1993).

Sigurd Grava, "Paratransit in Developing Countries," *Transportation and Development Around the Pacific* (New York: American Society of Civil Engineers, 1980), pp. 278-289.

Daniel B. Klein, Adrian T. Moore, and Binyam Reja, *Property Rights Transit: A Framework for Competition and Entrepreneurship* (book forthcoming).

Gabriel Roth and Anthony Shephard, Wheels Within Cities: *New Alternatives for Passenger Transport* (London: Adam Smith Institute, 1984).

Arthur Saltzman and Richard Solomon, "Jitney Operations in the United States," *Highway Research Record*, vol. 449, 1973, pp. 63-71.

Isaac K. Takyi, "An Evaluation of Jitney Systems in Developing Countries," *Transportation Quarterly*, January 1990, pp. 163-177.

Total Cost Of Motor-Vehicle Use

BY MARK A. DELUCCHI

What costs are involved in motor vehicle transportation? Many people consider only the dollars they spend on cars, maintenance, repair, fuel, lubricants, tires, parts, insurance, parking, tolls, registration, and fees. But motor vehicles cost society much more than what drivers spend on explicitly priced goods and services.

There are also "bundled" costs, which aren't explicitly priced but are bundled into the prices of other items. For example, "free" parking at a shopping mall is unpriced to shoppers, but it's not costless; the cost is included, or bundled, into the prices of goods and services sold at the mall.

Further, there are public-sector costs. Government incurs huge expenses every year to build and maintain roads and provide services, such as police and fire protection, judicial and legal services, environmental regulation, energy research, and military protection of oil supplies.

Beyond these *monetary* public- and private-sector expenditures are the *nonmonetary* costs of motor-vehicle use—costs that aren't valued in dollars in normal market transactions. These include air pollution, personal injury damages from accidents, and travel time. Some of these nonmonetary costs, such as pollution, are externalities, that is, they affect people other than the driver. Others, such as travel time, are what we'll call "personal" nonmonetary costs.

The all-inclusive economic cost to society of using motor vehicles is the sum of all costs mentioned above: explicitly priced private-sector costs, bundled private-sector costs, public-sector costs, external costs, and personal nonmonetary costs. (See Table 1.)

Purpose Of A Social-Cost Analysis

Researchers use social-cost analyses to support many different purposes and policy positions. Some use them to argue that motor vehicles and gasoline are greatly underpriced; others, to downplay the need for drastic policy intervention.

By itself, a total social-cost analysis cannot say whether motor-vehicle use is good or bad, or better or worse than some alternative, or whether it is wise to tax gasoline, restrict automobile use, or travel in trains. Rather, such an analysis is just one of many factors that may enlighten the transportation debate. ➢

Mark A. Delucchi is a research associate at the Institute of Transportation Studies, University of California, Davis, CA 95616.

Specifically, a social-cost analysis can help:

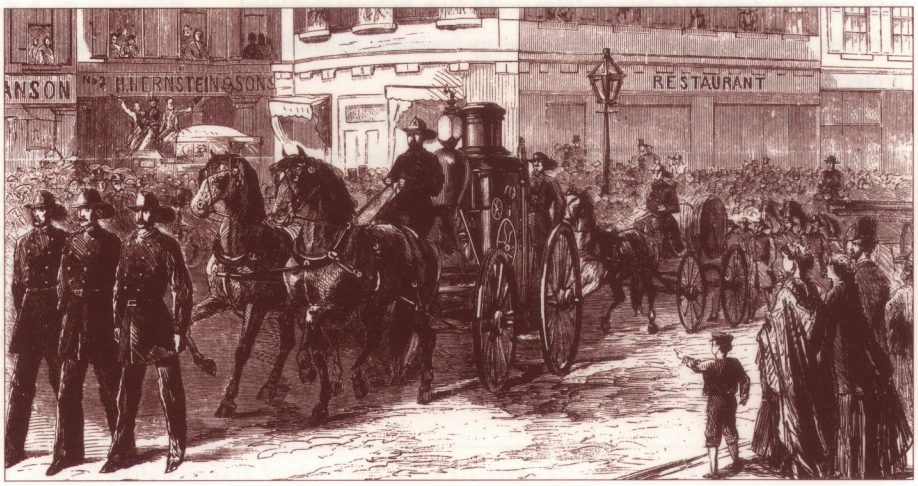
- Estimate efficient prices for roads, emissions, and other costs. It can estimate the gap between current prices (which may be zero, as with emissions) and theoretically optimal prices. It can help us create policies to narrow the gap and thus use transportation resources more efficiently. However, unless an analysis is done with extraordinary specificity and with an eye to pricing, it can't determine the precise optimal prices for any motor-vehicle cost.
- Evaluate the costs of alternative transportation investments. A social-cost analysis may help find the alternative that will provide the highest net benefits to society. But it remains only half of the full social-cost-benefit analysis needed to make defensible investment decisions.
- Set priorities for efforts to reduce transportation costs. Detailed comparison of costs can help policymakers decide how to fund research and development to reduce transportation costs. For example, when funding research on the sources, effects, and mitigation of pollution, it's useful to know that emissions of road dust are probably more costly than are emissions of ozone precursors, which in turn are more costly than are emissions of toxic air pollutants.

Conceptual Framework

In this study, the "social cost of motor-vehicle use" refers to the annualized total cost of motor vehicle use, based on 1990-1991 cost levels, which equals the sum of the following:

- operating costs—including those for fuel, vehicle and highway maintenance, salaries of police officers, travel time, noise, injuries from accidents, and pollution;and
- the value of all capital—including cars, highways, parking lots, garages, and other items that have a useful service life lasting more than a year, converted into a flow of equivalent annual costs over the life of the capital.

This annualization approach is essentially an investment analysis, or project evaluation, in which the "project" is the entire motor-vehicle use system. Of course, it is awkward to treat the entire system—every car, every gallon of gasoline, every mile of highway—as a project to be evaluated. However, comprehensive accounting is necessary to generate data and methods for estimating the social cost of all motor-vehicle use.



What Counts As a Cost Of Motor-Vehicle Use?

In economic analysis, "cost" refers to "opportunity cost." The opportunity cost of an action is the opportunity one forgoes—what one gives up, uses, or consumes—as a result of doing it. For a resource to count as a cost of motor-vehicle use, a change in motor-vehicle use must result in a change in that resource. Thus, gasoline is a cost of motor-vehicle use because a change in motor-vehicle use causes a change in gasoline use, assuming all else equal. Conversely, general spending on social security or education is not a cost of motor-vehicle use because a change in motor-vehicle use will not induce a change in resources devoted to social security or education.

For purposes of planning, evaluating, or pricing, one must consider not only whether something is a cost of motor-vehicle use, but also, if it *is* a cost, exactly *how* it relates to motor-vehicle use. For example, pollution is a direct, immediate cost of motor-vehicle use. But defense expenditures in the Persian Gulf, if they are costs of motor-vehicle use at all, are only indirect, long-term, and tenuous ones. This distinction is important because costs that are tenuously linked are harder to model and estimate. They often lag behind changes in motor vehicle use and depend on the specific characteristics and amounts of those changes.

Costs Versus Benefits

In this project, we estimate the dollar social cost but not the dollar social *benefit* of motor-vehicle use. Of course, we have not forgotten that there are benefits of motor-vehicle use, nor have we presumed that the benefits are somehow less important than the costs of motor-vehicle use. Rather, we know of no credible way to estimate *all* benefits and do not attempt to do so. Indeed, motor-vehicle use provides enormous social benefit and, in our view, probably greatly exceeds the social cost.

Because ours is a *cost analysis* only, we decline to comment on net dollar benefits or cost-benefit ratios, and on whether a particular transportation system is "worthwhile," or better or worse than another system. For example, our analysis indicates that motor-vehicle use may cost more than people realize. But, even if so, this does not mean that motor-vehicle use costs more than it's worth, or that we should prefer a transportation option that has near-zero external costs, or a transportation option that has lower total social costs. Those determinations would require estimating the dollar value of all benefits in addition to the dollar value of all costs.

Average Cost Is A Poor Indicator Of Marginal Cost

Any social-cost estimate must reflect the real-world. Thus, there's no utility in a social cost estimate that tells us what we'd save if we had no motor-vehicle system at all.

But an estimate of the annualized cost of the entire system can be useful if it is scaled down to a realistic "project size." That is, if the cost of a proposal to increase the motor-vehicle use system by ten percent is approximately ten percent of the cost of the entire system, the gross estimate would be a useful starting point for evaluating the proposal.

Do costs have such a linear relationship with use? In most cases, probably not. For example, we know that nonmarket costs of air pollution are a nonlinear function of motor-vehicle pollution and that congestion delay costs are a nonlinear function of motor-vehicle travel. Most costs of motor-vehicle use do not vary directly with use, down to the mile or gram or decibel or minute. Still, the data and methods used in a total social-cost estimate may be useful in marginal analyses, and the results may help in tracking trends and setting priorities for research.

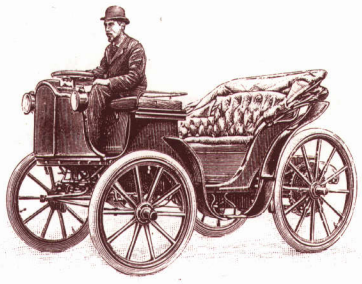
Classification Of Cost Components

In Table 1, I group the costs of motor-vehicle use according to how efficiently they are priced and allocated. For example, there are costs that are unpriced but perhaps efficiently allocated ("personal nonmonetary costs"), costs that are priced explicitly but not necessarily optimally ("private-sector costs"), and costs that are unpriced and inefficiently allocated ("externalities"). I also consider whether a cost is valued in dollars in real markets—that is, whether it is monetized, such as gasoline or parking, or nonmonetized, such as air pollution. This distinction is important methodologically because nonmonetary costs are much harder to estimate.

Description Of Components

Column 1: "Personal" nonmonetary costs. "Personal" nonmonetary costs are self-imposed, unpriced costs that result from the decision to travel. The largest of these are travel time during uncongested conditions and the risk of getting into an accident caused by oneself.

These costs will be inefficiently incurred if people do not fully recognize them. True marginal-use value may not equal true marginal consumer-cost, and people may drive more or less than they would if fully informed. For example, people may underestimate the chance that they'll fall asleep at the wheel and thus make trips despite the high risk of getting into accidents.➢



Column 2: Private-sector goods and services. The economic cost of motor-vehicle goods and services supplied in private markets is the value of resources allocated to supplying vehicles, fuel, parts, insurance, and other items. In principle, an estimate of the private-sector resource cost should exclude taxes paid (taxes are a transfer from consumers or producers to the government) and any revenues exceeding a normal economic profit (such excess revenues are a transfer from consumers to producers).

Prices and quantities in private markets are rarely optimal, not only because of distortionary taxes and fees, but also because of poor information, externalities, and imperfect competition, standards, and regulations affecting production and consumption.

Column 3: Bundled private-sector costs. Some very large costs of motor-vehicle use are not explicitly priced. Foremost among these are the costs of free nonresidential parking, home garages, and local roads provided by private developers. However, all are included in the price of "packages," such as houses and goods that are explicitly priced.

This bundling is not necessarily inefficient: In principle, a producer will bundle a cost, instead of pricing it separately, if the cost of collecting a separate price exceeds the benefit. In a perfect market, one would expect any observed bundling to be efficient, and that forcing unbundling would be inefficient.

Thus, the question is whether taxes or regulations (such as parking-space requirements) or any other factor is distorting the decision to bundle, and whether suppliers are correct in their assessments of the costs and advantages of bundling.

Column 4: Public infrastructure and services for motor-vehicle use. Government provides much infrastructure and service that support motor-vehicle use. The most costly item is the capital of highway infrastructure. Government costs are treated as a separate group because they are generally priced inefficiently or not at all.

Note that, whereas all government expenditures on highways and the highway patrol are a cost of motor-vehicle use, only a portion of other government expenditures—such as those for local police, fire, corrections, jails—are similarly incurred exclusively for motor-vehicle use. We have estimated the portion of government expenditures that can be attributed to motor-vehicle use as economic costs, such as the cost of police protection to combat motor-vehicle-related crime.

Column 5: Monetary externalities. Some costs of motor-vehicle use are valued monetarily at some point, yet remain completely unpriced for the responsible motor-vehicle user; hence they are external costs. The clearest example is accident costs paid by those not responsible for the accident. Vehicular repair costs inflicted by uninsured motorists clearly are unpriced from the perspective of the uninsured motorist yet valued explicitly in private markets. The largest costs in this category, "monetary externalities," are the costs of accidents and travel delay.

Column 6: Nonmonetary externalities. A nonmonetary externality is a cost or benefit imposed on person A by person B, but that is not accounted for by person B. Environmental pollution, traffic delay, uncompensated personal injury damages from accidents, and the loss to Gross National Product (GNP) owing to sudden changes in the price of oil are common examples of externalities. ➢

TABLE 1: CLASSIFICATION OF THE COSTS OF MOTOR-VEHICLE USE

1 Personal nonmonetary costs of using motor vehicles (unpriced)	2 Explicitly priced private-sector motor vehicles goods and services, net of producer surplus and taxes and fees	3 "Bundled" private-sector goods (implicitly priced)	4 Public infrastructure and services for motor-vehicle use	5 Monetary externalities (unpriced)	6 Nonmonetary externalities (unpriced)
NONMONETARY	**MONETARY**				**NONMONETARY**
Uncompensated personal (non-work) travel time, excluding travel delay imposed by others Accidental pain and suffering and death inflicted on oneself Personal time spent working on MVs and garages, refueling MVs, and buying and disposing of MVs and parts Noise inflicted on oneself Air pollution inflicted on oneself	*Usually included in GNP-type accounts:* Purchases of MVs (principal) Fuel, lube oil, except costs due to travel delay Maintenance, repair, washing, renting, storage, and towing; excluding external repair costs, costs attributable to travel delay Finance charges on purchases of MV Parts, tires, tubes, and accessories Automobile insurance: administrative and management costs and profit Accident costs paid for by *automobile* insurance of responsible party: lost productivity, medical and legal services, victim restitution Parking away from residence, excluding parking tax *Usually not included in GNP-type accounts:* Compensated (work) time of business, government, and commercial travelers, excluding travel delay imposed by others Overhead expenses of business, commercial, and government fleets Accident costs paid for by responsible party, but not by automobile insurance: lost productivity, medical services, legal services, damage to non-vehicular property, victim restitution Vehicle inspection by private garages Legal services, security devices due to motor-vehicle related crime	Nonresidential offstreet parking included in the price of goods and services or offered as an employee benefit Home garages and other residential parking included in the price of housing (including interest on home loans) Roads provided or paid for by the private sector and recovered in the price of structures, goods, or services	Public highway construction and maintenance (including on-street parking) Municipal off-street parking not priced at marginal cost Highway patrol Environmental regulation, protection, and clean up, including landfills and sewage treatment plants Energy and technology R&D Police protection (excluding highway patrol), court and prison system (net of cost of substitute crimes) Military expenditures related to the use of Persian-Gulf oil by motor vehicles Fire protection Motor-vehicle related costs of other agencies Strategic Petroleum Reserve: construction, operation, and oil-holding cost	Costs of travel delay imposed by others, including accident delay: extra fuel, oil, maintenance, and compensated (work) travel time Probabilistic loss of GNP due to sudden changes in the price of oil Accident costs *not* paid for by responsible party: lost productivity, medical, legal, property damage (including costs paid by government) Price effect of using petroleum fuels for motor vehicles: increased payments to foreign countries for oil used in other sectors (not an external cost globally) Losses from robbery in parking lots or theft from vehicles (net of dollar gain to criminals)	Air pollution (including toxics) inflicted on others: effects on human health, crops, materials, and visibility Accidents: pain and suffering, and death not paid by the responsible party; fear of accidents Extra uncompensated (non-work) time due to travel delay imposed by others, including accident delay Global warming due to fuel-cycle emissions of greenhouse gases (U.S. damages only) Noise inflicted on others Price effect of using petroleum fuels for motor vehicles: lost consumer surplus in other oil-using sectors (not an external cost globally) Water pollution: health and environmental effects of leaking storage & waste sites, oil spills, road runoff Pain, suffering, inconvenience, and other nonmonetary costs due to motor-vehicle related crimes *Not estimated here:* Land-use damage: habitat and species loss due to highway and MV infrastructure The socially divisive effect of roads as physical barriers in communities Vibration damages Esthetics of highways, vehicles, and service establishments

TABLE 2

Summary Of The Annualized Social Cost Of Motor-Vehicle Use (Billions of 1990 Dollars)

COST ITEM	COST FOR U.S. (Billion dollars/year)		COST PER REGISTERED VEHICLE (Dollars/year*)	
	LOW	HIGH	LOW	HIGH
(1) Personal nonmonetary costs of using motor vehicles	411	601	2,180	3,189
(2) Private-sector motor-vehicle goods and services	947	1,067	5,020	5,659
(3) Bundled private-sector costs	71	223	337	1,181
(4) Public infrastructure and services	125	207	662	1,099
(5) Monetary externalities	80	147	423	780
(6) Nonmonetary externalities	246	593	1,305	3,145
Grand total social cost of highway transportation	**1,880**	**2,839**	**9,967**	**15,054**
Subtotal: Monetary cost only: (2+3+4+5)	1,222	1,645	6,482	8,720
Subtotal: Payments by motor-vehicle users for highway infrastructure and public services	109	173	580	918

* This is the dollar cost per each of the 188.6 million motor vehicles (including heavy-duty trucks, buses, motorcycles, and publicly owned vehicles) registered in the U.S. in 1990-1991. I present this only to give an idea of the magnitude of the costs. One definintely should *not* infer from this presentation that: (1) any particular cost/vehicle is the same for all vehicle types; (2) costs are proportional to the number of vehicles; or (3) the most efficient way to address externalities is to raise the price of a motor vehicle.

Limitations On Using Results

Table 2 summarizes the costs in the six categories in Table 1 and provides a separate estimate of user tax payments for motor-vehicle use. But I must caution against several common misuses of these kinds of estimates.

First, one should resist the temptation to add up all unpriced costs and express the total as dollars per gallon of gasoline, as if the optimal strategy for remedying every inefficiency is simply to raise the gasoline tax. The optimal pricing strategy is considerably more complex. Some sources of inefficiency, such as imperfect competition and distortionary income tax policy, are not externalities and therefore are not properly addressed by taxation.

Moreover, there is not a single external cost, with the possible exception of vehicular CO_2 emissions, that in principle is best addressed by a gasoline tax. For example, an optimal air-pollution tax would depend on the amounts and kinds of emissions, ambient conditions, and the size of the exposed population. It would not be proportional to gasoline consumption.

Second, it is misleading to compare the total social cost of motor-vehicle use with the GNP of the United States. GNP accounting is quite different from and conceptually more limited than our social-cost accounting. For example, GNP does not include nonmarket items such as air pollution.

Third, there is considerable uncertainty in these social-cost estimates. Among other things, we do not estimate every conceivable component or effect of every cost, nor do we accommodate the entire span of data or opinions in the literature.

Fourth, it is not economically meaningful to compare our estimates of user tax and fee payments with our estimate of government expenditures. I emphasize that it simply isn't true that any difference between payments and expenditures is a source of economic

inefficiency. This is because efficiency does not require that government collect from users revenues sufficient to cover costs.

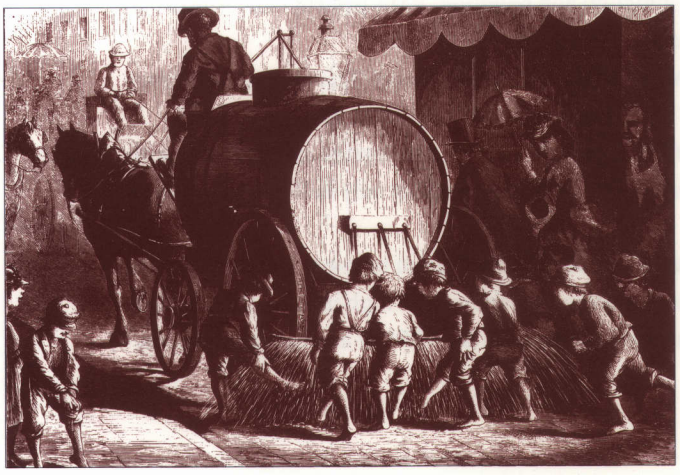
Finally, ours is an analysis of the *total* social cost of motor-vehicle use. Any particular policy or investment decision involves costs incremental or decremental to the total. Therefore, you should not use our average-cost estimates in marginal analyses unless you believe that the total-cost function is almost linear and, hence, that any marginal-cost rate is close to the average rate.

Further, our results will be less and less applicable as one considers times and places increasingly different from the United States in 1990 and 1991. However, even if our results per se may become irrelevant, these data, methods, and concepts may nevertheless be useful when analyzing specific pricing policies or investments.

Summary

We have classified and estimated the social costs of motor-vehicle use in the United States based on 1990-1991 data. Our analysis is meant to inform general decisions about pricing, investment, and research. It provides a conceptual framework for analyzing social costs, develops analytical methods and data sources, and presents some initial detailed estimates for some of the costs.

A social-cost analysis cannot tell us precisely what we should do to improve the motor-vehicle system. There are several kinds of inefficiencies in the system, along with several kinds of economically optimal measures. Moreover, measures to improve economic efficiency are only part of the solution because our society cares as much about equity, opportunity, and justice as it does about efficiency. Ultimately, a total social-cost analysis contributes only modestly in determining efficiency, which is just one of several societal objectives for transportation. ◆



FURTHER READING

The Institute of Transportation Studies (UC-Davis) and UCTC are publishing twenty reports that underlie the summary presented here.

1. The Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991: Summary of Theory, Methods, Data, and Results

2. Some Conceptual and Methodological Issues in the Analysis of the Social Cost of Motor-Vehicle Use

3. Review of Some of the Literature on the Social Cost of Motor-Vehicle Use

4. Personal Nonmonetary Costs of Motor-Vehicle Use

5. Motor-Vehicle Goods and Services Priced in the Private Sector

6. Motor-Vehicle Goods and Services Bundled in the Private Sector

7. Motor-Vehicle Infrastructure and Services Provided by the Public Sector

8. Monetary Externalities of Motor-Vehicle Use

9. Summary of the Nonmonetary Externalities of Motor-Vehicle Use

10. The Allocation of the Social Costs of Motor-Vehicle Use to Six Classes of Motor Vehicles

11. The Cost of the Health Effects of Air Pollution from Motor Vehicles

12. The Cost of Crop Losses Caused by Ozone Air Pollution from Motor Vehicles

13. The Cost of Reduced Visibility Due to Air Pollution from Motor Vehicles

14. The External Cost of Noise from Motor Vehicles

15. U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles

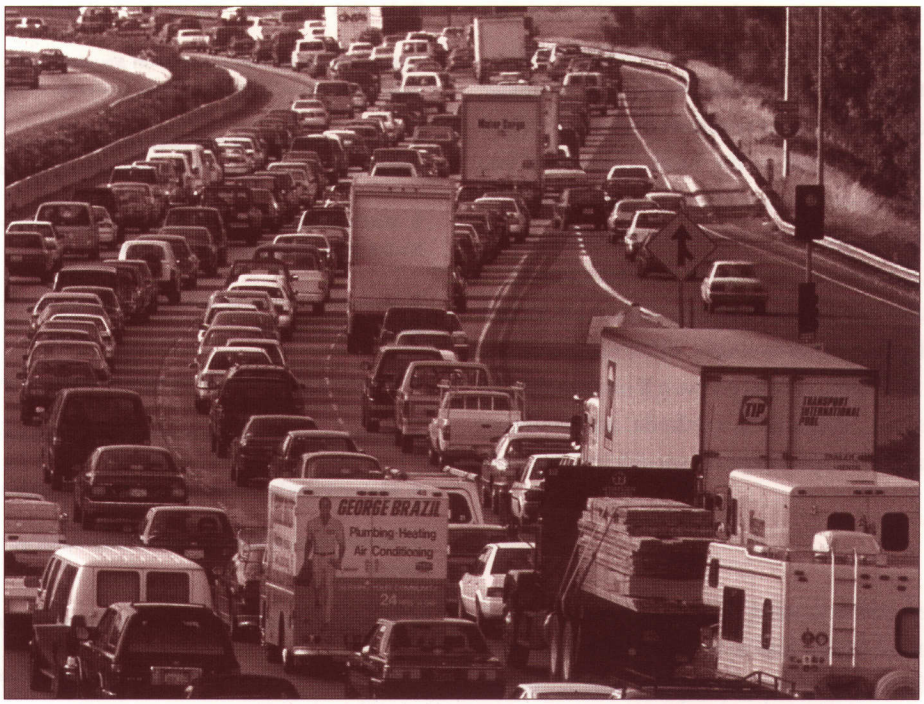
16. The Contribution of Motor Vehicles to Ambient Air Pollution

17. Payments by Motor-Vehicle Users for the Use of Highways, Fuels, and Vehicles

18. Tax Expenditures Related to the Production and Consumption of Transportation Fuels

19. Some Comments on the Benefits of Motor-Vehicle Use

20. References and Bibliography



Are Americans Really Driving So Much More?

BY CHARLES LAVE

Many people seem to think that increased VMT (vehicle miles traveled) spells trouble. VMT growth bothers environmentalists because it implies greater energy consumption and pollution. VMT growth concerns urban planners because it suggests increased sprawl and decreased transit use.

Both groups found plenty to worry about when the 1990 Nationwide Personal Transportation Survey (NPTS) results were published—VMT apparently grew by 41% between 1983 and 1990. But is this true?

My research develops three alternative estimates of VMT growth. All three estimates agree closely with each other, but disagree with the NPTS results. I find that VMT per vehicle grew at only half the rate indicated by the NPTS.

What made the NPTS estimates too high? Budgetary constraints forced them to use telephone surveys instead of household surveys. Internal evidence in the phone survey data shows that high-income (hence high-VMT) households were over-sampled, thus producing an overestimate for the VMT of average households.

Charles Lave is professor of economics at the University of California, Irvine, CA 92717.

ALTERNATIVE ESTIMATE #1—CALIFORNIA ODOMETER SURVEY

As my first check on the NPTS results, I developed a VMT estimate for California. The data come from California's statewide, biennial smog-check inspections, involving nearly twenty million vehicles. Each inspection report contains the vehicle's odometer reading and its license plate number. By matching cars across inspections, we have two odometer readings and two dates, and can compute an objective VMT rate.[1]

After computing VMT for each vehicle, we aggregated the data to compute an average VMT by model-year and class (cars, light trucks, medium trucks). To compensate for any selection bias, we scaled these to state-level using the exact class and model-year distribution from vehicle registration data.

The calculated VMT growth rate for California was 1.6% per year, well below the 2.7% annual growth rate indicated by the NPTS survey. Does California's VMT growth differ from U.S. VMT growth? Perhaps. But if it does differ, most observers would have expected California's growth to be atypically high. Next, I turned to a nationwide sample.

ALTERNATIVE ESTIMATE #2—U.S. DEPARTMENT OF ENERGY SURVEY

For my second check on the NPTS results, I used the U.S. Department of Energy's Residential Transportation Energy Consumption Survey (RTECS). Only 3,000 households were surveyed. But, for purposes of VMT estimation, the RTECS data ought to have several advantages over the NPTS. The household sample comes from a national multistage probability survey, rather than from random-digit dialing; the initial interview is a personal interview in the home; and the great majority of the VMT data are based on ➢

1 Though simple in principle, the actual matching process involved considerable effort. To assure accuracy, we used only those matches where the license plate, model year, and make of the car were identical across the time period. Instances of broken odometers (0 VMT) were discarded, and recording errors were screened out. Identical screening procedures were applied to all years, thus any bias created by our screening is constant over time and will not affect estimates of growth rates.

FIGURE 1

NPTS versus National Auto Registrations

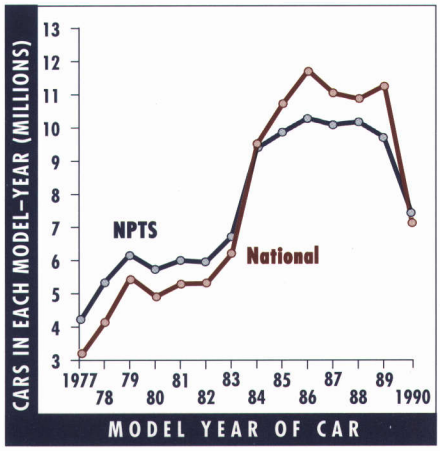
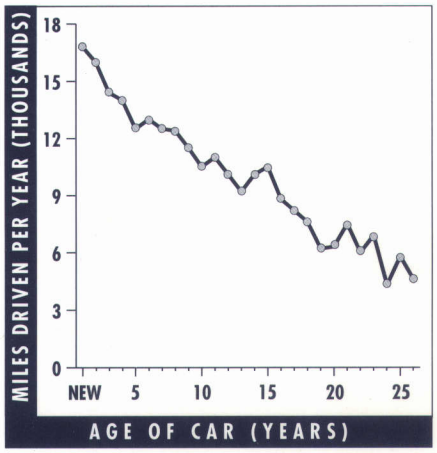


FIGURE 2

Annual VMT



actual odometer readings, taken about a year apart. Thus, like California's, this survey is an objective source of VMT data. The NPTS data are subjective, based on respondents' recollections of miles driven.

Estimates of VMT growth based on the RTECS survey are nearly identical to those based on the California data: 1.5% per year in the RTECS sample, compared with 1.6% for California, and 2.7%, NPTS.

ALTERNATIVE ESTIMATE #3—FEDERAL HIGHWAY ADMINISTRATION DATA

The Federal Highway Administration (FHWA) collects VMT statistical data from the fifty states, compiles them, and publishes them in *Highway Statistics*. The state VMT estimates are derived from fuel-consumption data, supplemented by sample traffic counts. The states have improved the quality of these estimates over time, but they still rely heavily on estimates of parameters—for example, average miles per gallon—rather than on actual measurements. (California has an elaborate model to estimate the average miles per gallon of its vehicle fleet.)

Given the uncertainties in the data sources, I would not use these as a primary standard. But, taken in combination with the other results, they do provide a useful comparison. Estimates of VMT growth rates based on the FHWA data are nearly identical to my other estimates: 1.4% FHWA, 1.5% RTECS, 1.6% California, compared to 2.7% reported by NPTS.

Therefore, the results from analyzing three alternative data sets appear strikingly similar with one another, but show a VMT growth rate that is only about half as fast as the NPTS estimate.

WHY ARE THE NPTS RESULTS TOO HIGH?

What are the possible sources of error? First, the NPTS estimate is based on subjective data. Respondents are asked: "How many miles did you drive last year?" There are good reasons to doubt the reliability of respondents' answers to such a subjective question concerning an activity that they do not usually consider in quantitative terms. Still, any subjectivity problem ought to be constant over time; that is, growth rates should be unbiased.

Unfortunately, severe budget pressures caused a change in methodology in 1990. All the prior NPTS data had been collected using home interviews, but in 1990 they switched to telephone interviews based on a random-digit dialing. Inherently, random-digit dialing contacts a disproportionate number of high-income households: high-income households have several phones per household, while low-income households often share a phone with other households. Survey organizations use a variety of techniques to compensate for these biases, but sometimes the correction techniques are not sufficient.

Suppose the 1990 NPTS did over-sample high-income households. This would produce an overestimate of the average VMT level because high-income households travel more. Further, the effects of the upward bias in VMT level would be compounded by the change in survey methodology: To compute growth, one compares the high 1990 level to the 1983 level that was derived using the old survey methodology. That is, the change in survey methodology would account for the overestimate of VMT growth rates.

So, did the 1990 NPTS over-sample high income households? I cannot test this directly, but I devised a powerful indirect test. High-income households tend to own

VMT BY YEAR										
	1983	1984	1985	1986	1987	1988	1989	1990	1991	Growth Rate Over Time
NPTS Data (U.S)	10,315							12,458		2.7% ('83-'90)
	2.7%/year									
FHWA Data (U.S.)	9,655			9,995				10,633		1.4% ('83-'90)
	1.2%/year			1.6%/year						
RTECS Data (U.S.)	9,399		9,855			10,246			10,600	1.5% ('83-'91)
	2.4%/year		1.3%/year			1.1% per year				
California Data				9,925		10,238		10,585		1.6% ('86-'90)
				1.6%/year		1.6%/year				

TABLE 1

Vehicle–Miles Per Year (Average Vehicle)

newer cars than do low-income households. So I computed the age distribution (model-year) of vehicles in the NPTS sample and compared it to the correct age distribution based on complete state vehicle registration data. Figure 1 shows the results. The dark line shows the correct age distributions. The colored line shows the distribution of the vehicles sampled by the NPTS. Clearly, the NPTS sample includes too many young cars and too few old ones.[2]

What are the consequences of oversampling new vehicles in the NPTS? Figure 2 shows the relationship between vehicle age and yearly VMT: As vehicles age they are driven significantly less. Since the average car in the 1990 NPTS is newer than it ought to be, the 1990 NPTS will overestimate VMT per vehicle.

CONCLUSION

Table 1 summarizes the VMT estimates from the four data sets. The table shows the VMT per year estimates and the year to which they apply. On the right side of the table are the growth rates for the longest period applicable to each data set. Where intermediate points were available, they are shown, and the intermediate growth rates are also calculated.

The FHWA data, the RTECS data, and the California data are in close agreement on VMT per year: 10,633 miles/year, 10,600 miles/year, and 10,585 miles/year, respectively. These VMT estimates are well below the NPTS estimate of 12,458 miles/year. The FHWA, RTECS, and California estimates also give consistent estimates for overall VMT growth rates: 1.4%, 1.5%, and 1.6%, respectively. These growth rate estimates are about half the NPTS estimate.

But truth is not simply based on a three to one vote. The RTECS and California data sets are inherently higher quality than the NPTS because they collect objective odometer data. The NPTS is based on subjective VMT estimates and there was a critical change in sampling methods between 1983 and 1990. The 1990 NPTS survey used random-digit dialing, instead of home interviews, resulting in significant over-sampling of late-model, high-VMT vehicles.[3]

That is, there are a number of strong reasons to reject the apparent VMT jump in the 1990 NPTS. The best estimate of VMT growth for households in the 1983-1990 period is 1.4 to 1.6% per year. ◆

ACKNOWLEDGMENTS

Dan Near provided critical assistance with the California odometer data; Steve Gould and David Amlin provided encouragement and advice; and Phil Wilson provided the original inspiration. Dwight French and Ronald Lambrecht gave significant assistance with the RTECS data. Alan Pisarski, Susan Liss, Pat Hu, and Ami Glazer gave advice and support. Anita Iannucci provided invaluable computer assistance.

FURTHER READING

Charles Lave, "What Really is the Growth of Vehicle Usage?," forthcoming in *Transportation Research Record.*

2 Figure 1 plots only the distributions for cars. But we know that U.S. households also purchase large numbers of light trucks and that they use them in much the same way they use cars. Did the NPTS also over-sample young trucks? I don't have national registration data for light trucks, but I do have complete registration data for California's light trucks. I plotted a version of Figure 1 for actual California light trucks versus the NPTS sample of California light trucks. It shows the same age bias.

3 This sampling problem will not affect many other NPTS results. Comparisons of VMT between well-specified subgroups will be reasonable, as will be results on travel patterns, destinations, and characteristics.


Oakland
Highland Hospital
Lakeside Park & Fairyland
Lake Merritt
19th St BART
Greyhound
12th St BART
Laney College Lake Merritt BART
Oakland Medical Center
Oakland Hospital
US Coast Guard
Oakland Estuary
Jack London Square
Posey Tube
Webster Tube
Marina Village
Alameda
College of Alameda
Inner Harbor
Oakland West BART
MacArthur Blvd
Lake Park
Park Blvd
Lakeshore
Grand
Broadway
E 24th St
E 21st St
E 18th St
E 14th St
E 12th St
E 10th St
E 27th St
Foothill
8th Ave
14th Ave
23rd Ave
25th Ave
1st Ave
Fallon
Oak
Madison
Buena Vista
Clement
Lincoln
Santa Clara
Otis
9th St
Marina Village Pkwy

SmartMaps for Public Transit

BY MICHAEL SOUTHWORTH

Many people find the prospect of travel by public transit complex and unpredictable, rather than inviting. Riders must be able to read English, understand complex route maps and schedules, and figure out fares. Some must be able to use electronic ticket and information devices. These systems may seem simple, but many transit users have difficulty making sense of the transit information that's usually available. Most systems ignore the special needs of children, foreigners, and users who are illiterate, sight-impaired, hearing-impaired, or otherwise disabled.

Computer-aided traveler information systems could eliminate much of the guesswork for riders by providing information tailored to diverse users and their needs. If information systems could make transit less intimidating, they might also help to increase ridership. However, the design of traveler information systems must simplify a rider's transit experience, rather than add another layer of complexity.

We have studied the social and psychological characteristics of transit users in an effort to design effective information systems. Based on these findings, we offer some suggestions for "SmartMaps," systems that make transit riding more accessible to everyone.

Social Characteristics of Transit Users

The form of transit information is just as important as its content. Given the diversity of transit users and the complexity of transit systems, information must be carefully designed to communicate with major user groups rather than just a small group of expert travelers. Transit users differ in their familiarity with the system and with the town, city, and region. Their understanding of the system differs based on their age, education, location, cultural and language background, and literacy skills.

A high proportion of California's transit users are foreign-born, with limited English reading skills and minimal knowledge of their cities and regions. According to the Southern California Rapid Transit District 1986 On-Board Survey, most transit users in the region were in lower-income brackets, with 60.5 percent earning less than $15,000 annually. The majority of riders were Hispanic/Latino (44.2 percent) and African-American (23.2 percent). Most were under 35, with 37.6 percent of riders between 15 and 24 years old. Given the choice between an English or Spanish questionnaire, 28 percent of participants chose Spanish.

Another survey, the 1985 AC Transit On-Board Survey in the Bay Area, found similar traits. More than half the passengers were African-American, Asian-American, Hispanic, or Native-American; and nearly half had incomes under $20,000. Most depended on buses for transportation—over 80 percent of weekday passengers rode AC Transit buses at least four days a week. Almost 20 percent of weekday passengers were teenagers, while only about 10 percent were over 64 years old. ➢

Michael Southworth is professor of landscape architecture and of city and regional planning. He is Chair of the Department of City and Regional Planning at the University of California, Berkeley, CA 94720-1850.

Literacy Considerations in Designing Advanced Transit Information Systems

Available surveys suggest that many transit users are likely to have difficulty understanding both textual and numerical information, including maps, schedules, fares, and procedures required for using transit. To be comprehensible, transit information must communicate with people of varied language backgrounds and minimal literacy levels.

The 1992 *National Adult Literacy Survey* interviewed nearly 13,600 individuals in the United States, age 16 and older, to evaluate their prose literacy (ability to understand textual material), document literacy (ability to read bus maps and schedules, among other things), and quantitative literacy (ability to do mathematical operations).

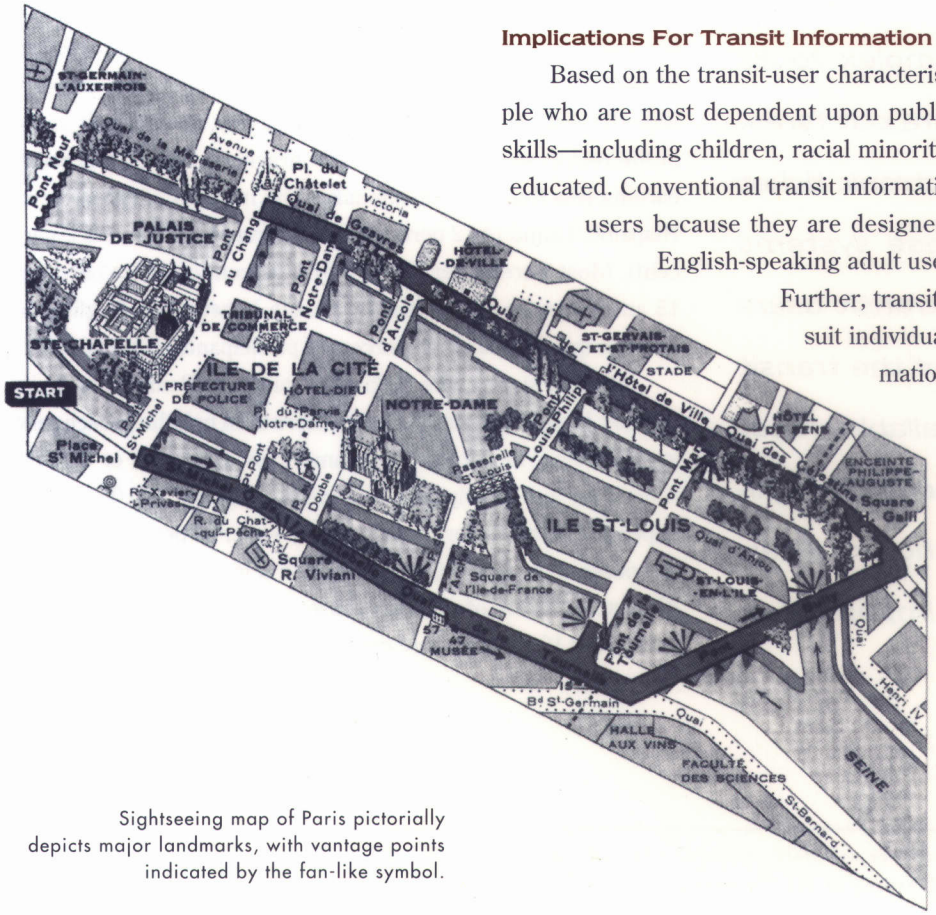
Results showed that 21 to 23 percent of adults surveyed performed at the lowest of five skill levels for each type of literacy, while another 25 to 28 percent performed at the next lowest level. Of those at the lowest level, one-fourth were immigrants who knew little English, two-thirds had not completed high school, and one-third were elderly. Thus, according to the survey, about half the adult population in the United States has very limited literacy skills, especially in document literacy. This finding has major implications for any organization involved in public communications and information.

African-American, Native-American, Hispanic, and Asian/Pacific Islander adults were more likely to have skills in the lowest two literacy levels than were white adults. Slightly over 40 percent of all adults at the lowest levels were living in poverty. Older adults demonstrated much lower literacy skills than younger adults, especially those past age fifty-five. This is probably because older adults have fewer years of formal education than younger adults.

Implications For Transit Information Systems

Based on the transit-user characteristics discussed above, we conclude that people who are most dependent upon public transit are also most deficient in literacy skills—including children, racial minorities, and the disabled, poor, elderly, and less educated. Conventional transit information systems fail to meet the needs of diverse users because they are designed primarily for middle-class, well-educated, English-speaking adult users.

Further, transit information tends to be generic and may not suit individual needs. Often, users receive too much information, becoming overwhelmed rather than enlightened. Maps and verbal directions don't clearly connect the transit system to the overall environment. The focus is on the transit system, not on understanding how the system fits into the surrounding urban and regional context.



Sightseeing map of Paris pictorially depicts major landmarks, with vantage points indicated by the fan-like symbol.

Cognitive Processes in Wayfinding

In addition to considering transit users' social characteristics, design of an effective traveler information system also requires an understanding of how people use maps and find their way to destina-

tions. Psychological research indicates that the cognitive processes of wayfinding are of two main types: (1) the sequentially arranged images and corresponding sets of decisions that help people find routes to destinations; and (2) "cognitive maps," or mental representations of overall spatial relationships.

While most researchers agree that people primarily use sequential information for wayfinding, cognitive maps can streamline the wayfinding process. Someone with a clear mental picture of a place tends to be more adept at finding routes and shortcuts within the area than someone with a less-developed cognitive map.

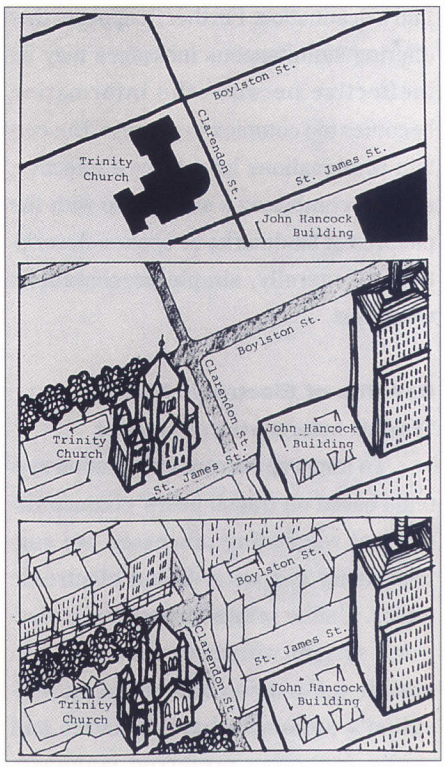
To develop an effective cognitive map that includes the route to a destination, one must be familiar with the location. But lack of familiarity can be remedied by using simulation techniques that can quickly familiarize newcomers with a complex environment—even more quickly than actually experiencing the same environment.

When encountering a new environment, individuals who have first been introduced to the environment through a form of simulation—for example, a map—feel more comfortable and secure than do those who are not familiarized beforehand. The most effective simulation procedure uses a combination of presentation methods.

A sequential, "walk-through" presentation—through animation or a series of still photographs—seems to be effective only if coupled with a bird's eye view of the area. This allows the mind to assimilate two kinds of information: spatial relationships (cognitive maps) and procedural information (network maps).

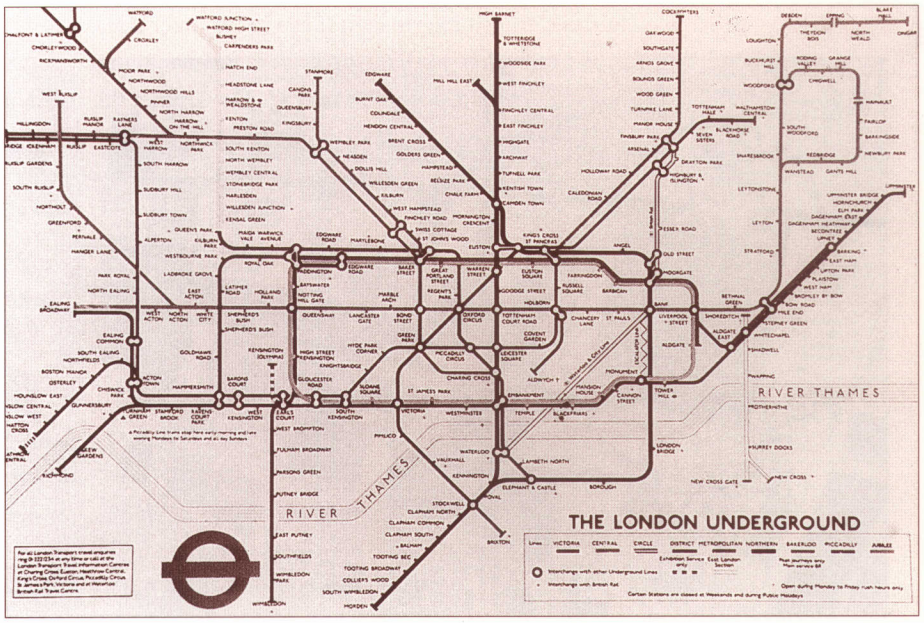
Viewers must learn to recognize specific elements in the urban setting—structures that are memorable and identifiable by their size and shape. In addition to landmarks, a simulation presentation should highlight the organizing features of the environment, such as its street pattern.

Studies show that people can process only limited amounts of information. Overly detailed pictorial maps can provide too much information and hinder one's ability to ➢



TYPES OF MAPPING

Two-dimensional footprint map (top); landmark map highlighting major buildings (middle); and fully pictorial map showing all buildings (bottom).



find a destination. Further, it appears that offering simultaneous messages may be ineffective because the information becomes too complex to process. But certain combinations have proved effective, such as combining a street map with the pictures of landmarks or spoken descriptions. Generally, simple presentations work best.

Benefits of Electronic Media in Transit Information Systems

To improve current information systems based on transit users' characteristics and wayfinding processes, we suggest using computer-based electronic media. Unlike printed material, an electronic system, with its vast memory, can provide information tailored to an individual's personal characteristics and needs, including preferred language, graphical or textual format, and content. It can simultaneously provide information in several media, instructing users in a more intuitive, immediate, and vividly communicative manner.

Electronic systems can engage users in an interactive give-and-take, permitting travelers to obtain the information they need, without extraneous information. Users receive information sequentially and with a level of detail suited to their needs.

Design Guidelines for Transit Information Systems

Based on our research, we suggest the following criteria for developing effective transit information systems:

1. Several levels of on-screen help should be available to accommodate different users' levels of expertise in using the information system. Skilled users should be able to bypass information they do not need. On-screen tutorials should be available for novices. In addition to different skill levels, the system should accommodate different levels of cognitive ability and perceptual orientation.

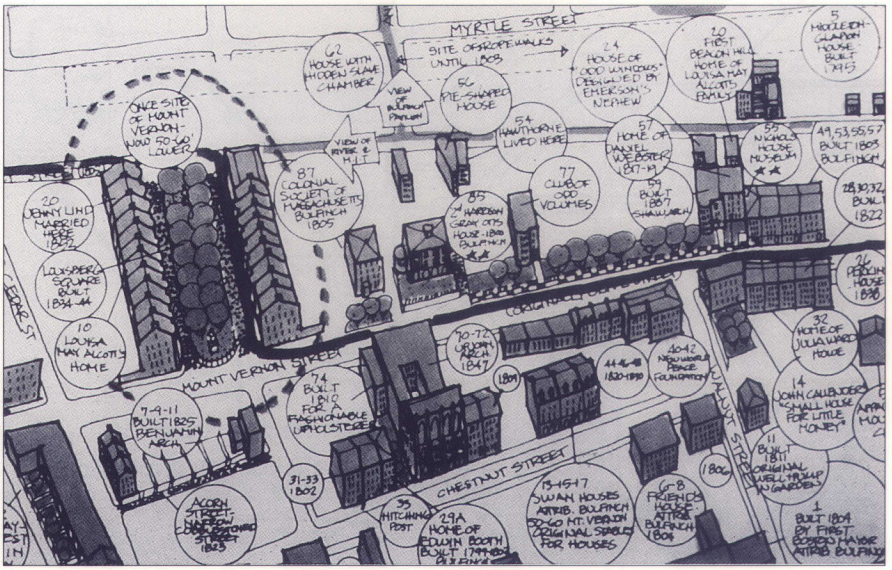
2. The system should be interactive, to allow users to make specific requests and avoid being confounded by extraneous information. Possible methods of user input are track balls, touch screens, joy sticks, and key pads.

3. Maps and aerial views should show the organization of streets and paths, properly aligned with the actual environment. This organization should not be obscured by unnecessary graphics such as insignificant buildings or text. The system should provide printed directions and a simple map of the route.

4. Maps should include recognizable images of landmarks and important places.

5. Sequentially arranged walk-through images of a route should be coupled with an overview of the environment, such as a map, an aerial view, or, preferably, a three-dimensional model. Full length videos of the route are unnecessary, time consuming, and too detailed. Selected walk-through images should include the points along the route where changes occur and should highlight important landmarks.

6. Graphically presented route information should be accompanied by written and spoken descriptions of the route to reinforce learning. Spoken descriptions are more accessible to the general population than written information.



This tourist map gives a cultural and architectural overview of Boston's Beacon Hill, using easy to understand graphics.

Conclusion

One reason people avoid transit is the lack of understandable information on routes, schedules, fares, and procedures. We can improve the communication of transit information by taking advantage of new electronic technology. But advanced information systems can create another layer of complexity if they don't accommodate the majority of users, especially the vast number of potential riders who have difficulty understanding directions and maps. An effective system must be designed for diverse users, especially transit-dependent persons who may lack literacy skills or be unfamiliar with the city's geography. ◆

Acknowledgments

Raymond Isaacs provided major research assistance, along with Glenn Gilbert, Joey Goldman, Gustavo Llavaneras, and Anthony Torres.

FURTHER READING

AC Transit, AC Transit *On-Board Survey* (Oakland: AC Transit, September 1985).

Donald A. Dixon, Merrill Vargo, and Davis W. Campbell, *Illiteracy in California: Needs, Services & Prospects* (Sacramento: California State Department of Education, 1987).

Irwin S. Kirsch, Ann Jungeblut, Lynn Jenkins, and Andrew Kolstad, Adult Literacy in America: *A First Look at the Results of the National Adult Literacy Survey* (Washington, DC: National Center for Education Statistics, 1993).

Southern California Rapid Transit District, *Southern California Rapid Transit District 1986 On-Board Survey* (Los Angeles: Market Research Associates, 1986).

Michael Southworth, "City Learning: Children Maps and Transit," *Children's Environments Quarterly*, Vol. 7, No. 2, 1990.

Michael Southworth and Susan Southworth, *Maps: A Visual Survey and Design Guide* (Boston: New York Graphic Society/Little Brown, 1982).

Michael Southworth and Susan Southworth, "Oakland Explorers: A Cultural Network of Places and People for Kids—Discovery Centers," (Berkeley: Institute of Urban and Regional Development, Working Paper 518, 1990).

Michael Southworth, "SmartMaps for Advanced Traveler Information Systems Based on User Characteristics," 1994. UCTC No. 236.

SMARTMAPS: CONCEPTUAL DESIGNS FOR NEW SYSTEMS

Applying the principles discussed above, we have designed SmartMaps, a transit information system that uses electronic technology to respond to users' needs. SmartMaps convey information through customized route maps, electronic advertisements, auditory maps, visual simulation maps, and conventional textual information. Here are some examples of SmartMaps technology.

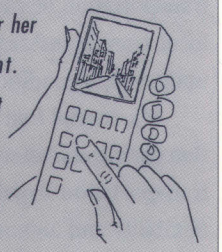
Walk-Through Transit Maps would let users navigate through computer-based representations of the transit environment, giving them a simulated preview of their prospective trip.

Example: An information kiosk containing a wide-screen computer stands near the ticket machines at every transit station. On the computer screen, prospective travelers may generate an eye-level view of any street in the city. By manipulating a joystick, they may simulate the sensation of walking down a selected street. Images unfold as they move forward: distant buildings and trees come smoothly into view, gradually enlarging while images nearby pass beyond the periphery.

Users can control their simulated tour by controlling the joystick and keyboard buttons to zoom, pan, tilt, rotate, or fly over the street. They become familiar with the street's landmarks, the general atmosphere of the area, and the appearance of their transit trip's destination. Further, the computer program can answer questions about transit services and schedules, providing information through on-screen and printed text and optional voice responses.

Hand-Held Transit Maps would provide portable information for people who have special transit needs, including visitors and newcomers to a city.

Example: A business traveler arrives in New York and needs to use transit to get to her hotel, meetings, and the airport for her return flight. When she first arrives, she stops at the SmartMaps information desk and rents a SmartPak, a hand-held computer that stores information about New York. She enters the name of her hotel into her SmartPak, and it tells her how to reach her hotel by transit. Later, she uses the device to take a simulated walking tour of the city and to find the nearest Thai restaurant accessible by transit. On her last day, she finds out which transit option can take her to the airport. ◆



DECISION-MAKING AFTER DISASTERS:

Responding to the Northridge Earthquake

BY MARTIN WACHS AND NABIL KAMEL

Many people seem to behave differently during emergencies than they do under ordinary circumstances. Feuding families unite to help each other when a tornado strikes their town, and neighbors who haven't spoken for years share a candlelight dinner after a hurricane knocks out their power. When faced with a disaster, people become more cooperative and humane, rising above their conflicts and aloofness.

But what happens among institutions? In particular, how do transportation institutions—from state highway departments to local transit authorities to private contractors—work together under crisis conditions?

It's crucial that the transportation system continue to function during and after a crisis. Thus it's important to know whether transportation organizations can collectively muster sufficient flexibility and ingenuity to respond effectively when stretched to the limit by earthquake, flood, hurricane, or tornado. Do organizations enjoy a period of mutual respect as people do in personal interactions, or do they respond as rivals, weighed down by bureaucracy? If they can adapt to crises, can they also improve their day-to-day functioning afterward?

In February 1994, the Northridge earthquake in Los Angeles provided an opportunity to ask these questions. Further, it was possible to compare that experience with reactions to the October 1989 Loma Prieta earthquake in the San Francisco Bay Area, which was studied at UC-Berkeley. We at UCLA reviewed the memos, technical documents, contracts, and agreements executed during the earthquakes, plus media reports and transcripts of hearings held by various legislative bodies. We also reviewed the literature on disaster response and preparedness, which goes far beyond specific transportation issues, and interviewed approximately forty people who played critical roles during California's two most recent major earthquakes.

DISASTER RESPONSE: AN OVERVIEW

A critical factor determining a community's response to disaster is the mitigation action—capital investments such as seismic upgrading of structures—taken to reduce harm. Also important are preparedness measures, including emergency procedures, evacuation plans, search and rescue training, and effective telecommunications systems.

For some types of disasters, it is feasible to work on prevention— for example, capital improvements aimed at flood control. Here, we don't deal with preventive measures because earthquakes can't be averted.

The effectiveness of a response also depends on the specific circumstances surrounding the particular disaster—its magnitude, location, and time of occurrence. The Los Angeles quake struck at 4:30 in the morning on a national holiday, which undoubtedly reduced losses (there was only one highway fatality) and affected governmental response.

Martin Wachs is professor of urban planning and director of the Institute of Transportation Studies, and Nabil Kamel is a doctoral student in urban planning, both at the University of California, Los Angeles, CA 90095-1656.

A community's response to disaster also depends on the extent to which responsible organizations are "vertically" and "horizontally" integrated. Vertical integration is the degree of connection among local organizations and state and federal agencies. Vertical integration makes for open communication channels, resource exchange, common language of discourse, standard operating procedures, and agreed-upon ways of interacting. Effective response to disaster requires cooperation among all levels of government.

Horizontal integration is the degree of connection among local agencies—the extent to which they are linked through communication, shared resources, and similarity of practice. Numerous local agencies affect transportation decisions. So, it matters whether they can work together without bickering and impeding one another's progress. Cooperation among local agencies—those that are most directly involved with the affected community—is critical to successful response.

The extent of vertical and horizontal integration must be considered both before the disaster and during the period of response and recovery. Actions taken in the first hours or days after the disaster—*the period of emergency*—include assessing priorities for immediate action, removing dead and injured people, shoring up precarious structures, and clearing roads. The period of emergency gradually gives way to the *period of reconstruction,* during which detours may be marked and roads repaired or rebuilt. Finally comes the *period of recovery,* when the transportation system may resume normal functioning and efforts focus on recovering economic losses and analyzing the experience with the aim of improving the predisaster phase of future disasters. ➢

RESPONSES TO THE NORTHRIDGE EARTHQUAKE

Almost everyone we interviewed agreed that the organizations managing the Los Angeles transportation system responded very well to the Northridge earthquake. Further, while most studies of the 1989 Loma Prieta earthquake found the response there quite successful as well, we found clear evidence that lessons gleaned from the 1989 earthquake effectively improved the 1994 response.

VERTICAL INTEGRATION

Five hours after the earthquake, local and state officials had completed a reasonable inventory of damage, despite having to deal with a broken water main that flooded their emergency operations center. Transportation officials from several state agencies collaborated to develop a quick response plan. Los Angeles Mayor Richard Riordan activated the multiagency Emergency Operations Board, which met on the first day at 9:00 a.m. and 2:00 p.m.

That day, private contractors began demolition at four sites on damaged bridges. These companies worked on the basis of oral agreements with the California Department of Transportation (Caltrans), backed by the Federal Highway Administration. This work implemented "Project Bulldozer," a plan prepared in advance with the Associated General Contractors of California.

Throughout the period of emergency local and state officials worked together to mark detours, which in some cases were changed several times daily to accommodate changing conditions. City sign shops painted paper signs, later replaced by more durable signs, for facilities both inside and outside their jurisdiction.

Examples of vertical cooperation appeared at all governmental levels: The Governor declared a state of emergency; the President declared a national state of emergency; and the head of the Federal Emergency Management Agency, the Secretary of Transportation, and the Secretary of Housing and Urban Development flew to Los Angeles. These agencies followed preestablished procedures on emergency funding for transportation.

In contrast, the degree of vertical cooperation during the Loma Prieta quake was lower, reflecting tension among local, state, and federal officials over which agencies should take charge of operations. In Los Angeles, officials decided early on to let local institutions lead the effort, with other agencies playing facilitative and supporting roles. They based their decision on revised federal law concerning allocation of emergency funds, new operating procedures, and simple good judgment. Throughout the reconstruction period, a multiagency task force met regularly to avoid unwarranted

duplicative efforts and to insure that the region's numerous transportation agencies took mutually beneficial actions.

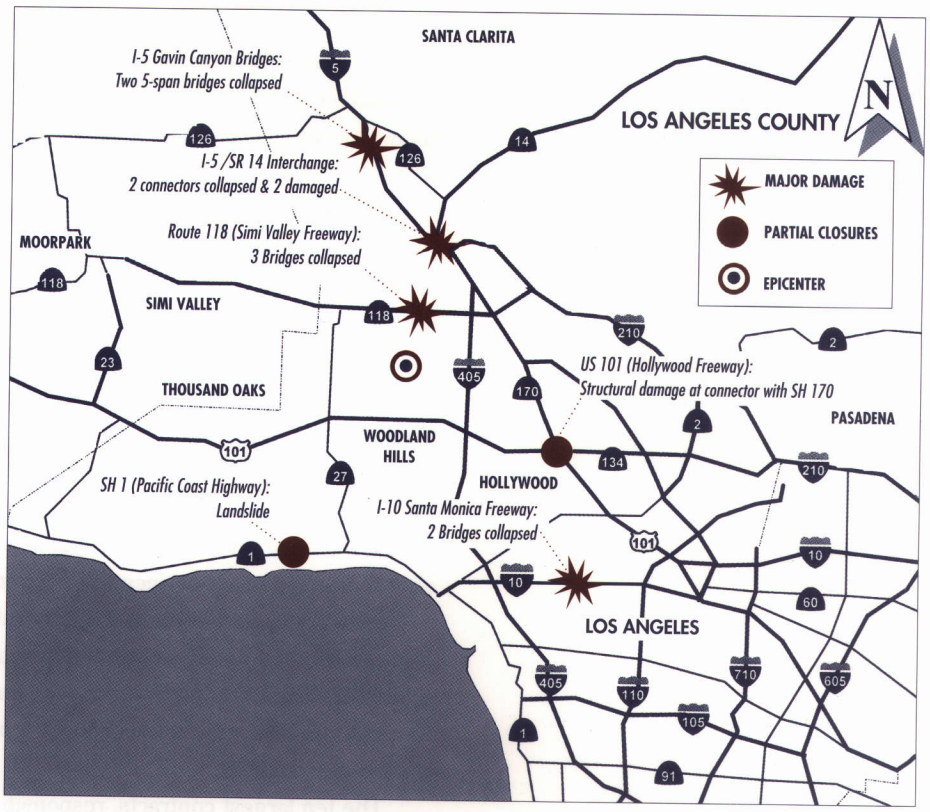
HORIZONTAL INTEGRATION

Immediately following the Northridge earthquake, local transportation agencies tended to be competitive with one another, making for a degree of horizontal integration that wasn't as great as the vertical integration.

However, local agencies have historically proved their capacity to cooperate under crisis conditions: for example, at times of civil unrest, floods, mudslides, brushfires, and during the 1984 Olympic Games. While local agencies normally vie against one another for funds, influence, and prestige—or ignore one another entirely—they can become horizontally integrated and work together effectively when it really matters.

After the Northridge quake, local agencies cooperatively reconstructed damaged highways. It should be noted that high levels of horizontal integration may have emerged in part because damage to the transportation system was localized. There was severe damage to a few bridges and high-capacity pavement sections, but no damage over an extensive portion of any roadway.

Because damage was localized, officials agreed that the only reasonable course of action was to rebuild highways as they previously existed—as quickly as possible and without discussion, debate, environmental reviews, or public comment. By the time demolition was completed, Caltrans had detailed design plans, done mostly in-house but with some contracted out because of limited staff. Some of the contracted work employed expedient "design-build" contracts, which saved time by assigning responsibility for all phases of design and construction at a site to a single contractor.



Major highways collapsed over a large part of the LA basin.

The Loma Prieta quake had created a different situation. While only a small section of the Bay Bridge failed—causing instant consensus, similar to that in Los Angeles, that it should be repaired quickly—the Cypress Freeway, an older double-deck freeway, failed over a considerable portion of its length, causing many fatalities. Rescue operations continued over several weeks before demolition started, and a study group began investigating the causes of failure.

Before the study was completed, citizens' groups that had opposed the freeway's construction decades earlier remobilized to oppose its replacement along the same alignment. Soon, a viable opposition arose, influencing local politicians to demand an entirely new route. Today, the freeway has not yet been completed at the new location. In comparison, breaks in the Los Angeles system were repaired within a year.

Similarly, the Embarcadero Freeway on the San Francisco waterfront, which was damaged in the Loma Prieta quake, was an extremely controversial structure that had never been finished. A ballot proposition to remove the Embarcadero Freeway was narrowly defeated in 1986 and communities remained deeply divided about its future. After the 1989 quake, it was torn down and a waterfront at-grade highway plan was adopted to replace the elevated freeway.

Los Angeles further revealed its horizontal integration when local agencies provided transit alternatives to automobile transportation during the reconstruction period. A regional commuter rail system, Metrolink, uses existing rail rights-of-way, including lines near several failed ➢

freeway bridges (two that stood in rugged terrain where few alternate highway routes existed). The county transportation commission, along with Metrolink and many other organizations, arranged for speedy expansion of rail service, borrowing railcars from as far away as Washington state, and extending service beyond pre-earthquake limits. Several cities built simple new rail stations, often complemented by publicly provided van and bus shuttles that traveled between stations and employment centers.

Local agencies augmented transit services in an amazingly short time—in just days or a couple weeks. Although increases in bus and rail patronage after the earthquake were rather small on some routes, or large but short-lived on others, the immediate changes showed the potential for effective local response.

Despite initial earthquake-related power failures, the city of Los Angeles ultimately used its Automated Traffic Signalization and Control (ATSAC) system to facilitate dramatic changes in traffic flows along arterial streets near some of the closed freeways. The ATSAC system monitors traffic flow through sensors buried in the pavement and alters traffic signal timing in response to changing traffic volumes. Its effectiveness after the earthquake convinced citizens and politicians of the system's vast capabilities.

In selecting and forming the 110 contracts for the engineering and construction of highway repairs, officials showed unusual flexibility. To spread the economic benefits of the reconstruction program widely, only one contract was permitted per contractor for each task. The city far exceeded its goal of hiring at least 20 percent minority or disadvantaged contractors.

The ten largest contracts, responsible for over 60 percent of the total dollar value of all contracts, employed an innovative "A+B" contract format, which proved very useful in this time-sensitive work. The "A" component involved a bid by the contractor for

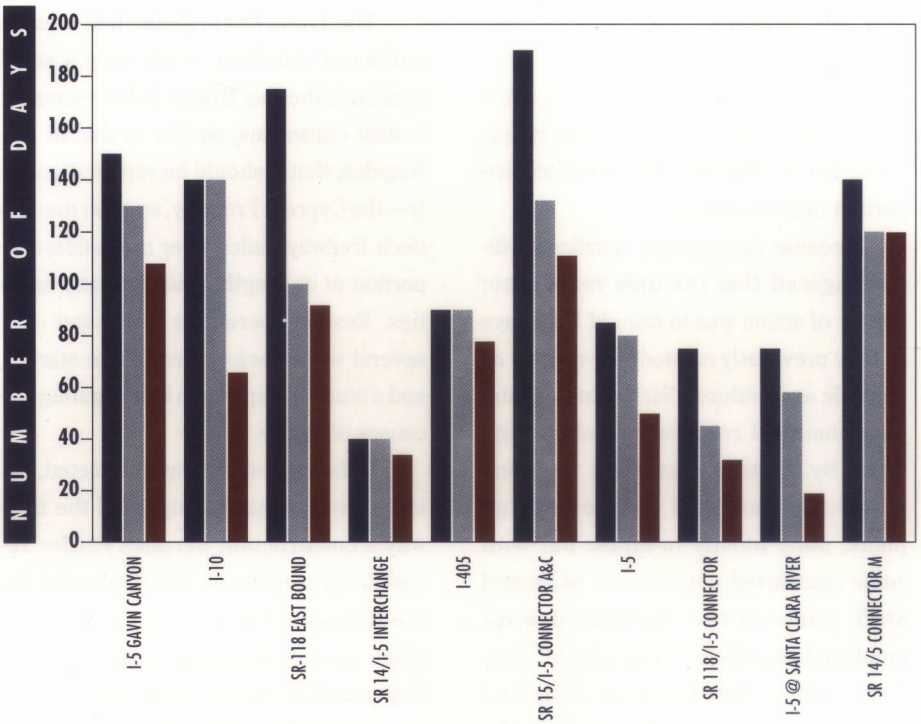


FIGURE 1

Maximum number of days allowed by the contracts compared to the days bid and to the actual days for the completion of all A+B contracts.

Source: Data from FHWA et al. 1995

materials and labor and specified a completion time. The "B" portion comprised specified bonuses the contractor would receive by completing the work earlier than the proposed time, as well as penalties the contractor would pay for each day of delay.

The value of the bonuses and penalties differed for each project based on the daily social value of having that highway link in operation—calculated by multiplying the pre-earthquake daily traffic volume by the time delay per user resulting from the disrupted facility, multiplied by an estimated value of travelers' time.

The "A+B" format resulted in some controversy. One contractor bid a very low "A" amount for reconstructing the Santa Monica Freeway (I-10)—probably well below the actual cost for materials and equipment—and won the contract. Subsequently, the contractor worked day and night, managing to rebuild the freeway in just 66 days, much faster than the 140 days specified in the contract. The bonus for early completion was $13,800,000. Some frugal politicians complained that taxpayers had been taken to the cleaners. Still, the Santa Monica Freeway was open to traffic months earlier than expected, presumably saving travelers the equivalent of $13,800,000 in the value of their time.

CONCLUSION

The Northridge earthquake tested the vulnerability of Los Angeles's transportation system both structurally and functionally. While transportation planners and engineers responded to this earthquake effectively, this was not the "big one" predicted to occur in Los Angeles within the next few decades. Should another major earthquake occur at a different time of day and at a different location, the resulting damage, injury, and disruption may be very different from the losses experienced in 1994.

After the Northridge quake, the City of Los Angeles Emergency Operations Board approved a modified "Recovery and Reconstruction Plan," containing policy statements and implementation plans that reflect lessons learned from the Northridge experience. It provides guidance, but the language is general and advisory, because a generic plan cannot precisely anticipate the best ways to deal with an earthquake of unknown magnitude, which may occur at any time and place.

An effective response will depend on thousands of specific acts by people in different agencies at many levels of government and in the private sector. Like individuals in our communities, institutions tend to abandon their prior patterns of conflict over resources and indifference toward one another, quickly becoming cooperating partners. The Loma Prieta and Northridge experiences suggest that transportation organizations possess far greater technical skill, organizational capability, and willingness to cooperate than are apparent in normal times. As with individuals, disasters seem to bring out the best in communities' capacities to cope. ◆

FURTHER READING

Barton-Aschman Associates, *Interstate 5/State Route 14 Recovery Report*, California Department of Transportation, District 7, Office of Operations, 1994.

Anna K. Bennett and David D. Little, *"Earthquake Effects on Employee Transportation,"* 1990. UCTC 152.

City of Los Angeles, *The Northridge Earthquake Recovery Report: How a Prepared City Responded*, 1995.

Elizabeth Deakin, *"Effects of the Loma Prieta Earthquake on Transbay Travel Patterns,"* 1991. UCTC 294.

Mark Hansen and Jacob Sutter, *"The Shake with Freight: The Impact of the Loma Prieta Earthquake on Bay Area Truckers,"* 1990. UCTC 151.

Mark Hansen and Sharon Weinstein, "East Bay Ferry Service and the Loma Prieta Earthquake," 1991. UCTC 162.

Nabil Kamel, Dulce Marie Leon, and Martin Wachs, "Transportation Decisionmaking Under Disaster Conditions," Institute of Transportation Studies, University of California, Los Angeles, 1995.

Cynthia A. Kroll, John D. Landis, Qing Shen, and Sean Stryker, *"Economic Effects of the Loma Prieta Earthquake: A Focus on Small Business,"* 1991. UCTC 154.

Peter May, *Recovering from Catastrophies: Federal Disaster Relief Policy and Politics* (New York and London: Plenum Press, 1986).

U.S. House of Representatives, Committee on Science, Space, and Technology, 103rd Congress, 2nd Session, *Lessons Learned from the Northridge Earthquake: Hearing Before the Committee on Science, Space, and Technology* (Washington, DC: U.S. Government Printing Office, March 2, 1994).

U.S. Department of Transportation, *The Lessons Learned from the Northridge Earthquake*, Federal Highway Administration/California Department of Transportation/Industry Task Force Report (Washington, DC: January 6, 1996).

Melvin M. Webber, *"Redundancy: The Lesson from the Loma Prieta Earthquake,"* Access No.1, Fall 1992.

Denis Wenger, "Community Response to Disaster: Functional and Structural Alterations," in E.L. Quarantelli, ed., *Disaster Theory and Research* (Beverly Hills, CA: Sage Publications, 1978).

PAPERS IN PRINT

Adler, Jeffrey L. and Michael G. McNally
"In-Laboratory Experiments to Investigate Driver Behavior Under Advanced Traveler Information Systems (ATIS)"
1993 UCTC 184

Adler, Jeffrey L., Michael G. McNally and Wilfred W. Recker
"Interactive Simulation for Modeling Dynamic Driver Behavior in Response to ATIS"
1993 UCTC 171

Adler, Jeffrey L., Thomas F. Golob and Michael G. McNally
"A Structural Model with Discrete-Choice Variables for Predicting Enroute Behavior Under ATIS"
1993 UCTC 174

Adler, Jeffrey L., Wilfred W. Recker and Michael G. McNally
"A Conflict Model and Interactive Simulator (FASTCARS) for Predicting Enroute Driver Behavior in Response to Real-Time Traffic Condition Information"
1992 UCTC 127

Adler, Jeffrey L., Wilfred W. Recker and Michael G. McNally
"In-Laboratory Experiments to Analyze Enroute Driver Behavior Under ATIS"
1993 UCTC 148

Adler, Jeffrey L., Wilfred W. Recker and Michael G. McNally
"Using Interactive Simulation to Model Driver Behavior Under ATIS"
1992 UCTC 126

Baer, Christopher T., Daniel B. Klein and John Majewski
"From Trunk to Branch: Toll Roads in New York, 1800-1860"
1992 UCTC 121

Barnett, Roger
"British Rail's InterCity 125 and 225," CalSpeed Series
1992 UCTC 114

Barnett, Roger
"Tilting Trains: The Italian ETR and the Swedish X-2000," CalSpeed Series
1992 UCTC 113

Barth, Matthew J. and Ramakrishna R. Tadi
An Automobile/Transit Emissions Evaluation of Southern California's Metrolink"
1995 UCTC 279

Bennett, Anna K. and David D. Little
"Earthquake Effects on EmployeeTransportation," Studies on the Loma Prieta Earthquake, No. 2
1990 UCTC 152

Bennett, Anna K. and David D. Little
"Earthquake Effects on Employee Transportation,"Studies on the Loma Prieta Earthquake, No. 2 Executive Summary
1990 UCTC 153

Berechman, J. and Kenneth A. Small
"Modeling Land Use and Transportation: An Interpretive Review for Growth Areas"
1988 UCTC 1

Blankson, Charles and Martin Wachs
"Preliminary Evaluation of the Coastal Transportation Corridor Ordinance in Los Angeles"
1990 UCTC 32

* **Boarnet, Marlon G.**
"Geography and Public Infrastructure"
1996 UCTC 305

* **Boarnet, Marlon G.**
"Highways and Economic Productivity: Interpreting Recent Evidence"
1995 UCTC 291

Boarnet, Marlon G.
"Highways and Intrametropolitan Employment Growth
1995 UCTC 85

* **Boarnet, Marlon G.**
"The Economic Effects of Highway Congestion"
1995 UCTC 292

Boarnet, Marlon G.
"Transportation Infrastructure, Economic Productivity, and Geographic Scale: Aggregate Growth versus Spatial Redistribution"
1995 UCTC 255

Boarnet, Marlon G. and Randall Crane
"L.A. Story: A Reality Check for Transit-Based Housing"
1995 UCTC 250

* **Boarnet, Marlon G. and Randall Crane**
"Public Finance and Transit-Oriented Planning: New Evidence from Southern California"
1995 UCTC 304

Brownstone, David
"Multiple Imputations for Linear Regression Models"
1991 UCTC 37

Brownstone, David and Thomas F. Golob
"The Effectiveness of Ridesharing Incentives: Discrete-Choice Models of Commuting in Southern California"
1991 UCTC 93

Brownstone, David, David S. Bunch and Thomas F. Golob
"A Demand Forecasting System for Clean-Fuel Vehicles"
1994 UCTC 221

Bunch, David S.
"Estimability in the Multinomial Probit Model"
1991 UCTC 71

Bunch, David S. and Ryuichi Kitamura
"Probit Model Estimation Revisited: Trinomial Models of Household Car Ownership"
1991 UCTC 70

Burns, Elizabeth K.
"Arizona's Metropolitan Travel Reduction Programs"
1992 UCTC 81

Burns, Elizabeth K.
"Employee and Student Trip Reduction: First Year Results from Metropolitan Phoenix"
1994 UCTC 226

Burns, Elizabeth K.
"Improving Traffic Congestion by Regulating Employee Travel: A Phoenix Survey"
1991 UCTC 22

Burns, Elizabeth K.
"Linking Geographic Information Systems and Trip Reduction: Limitations in a Pilot Application"
1994 UCTC 241

Burns, Elizabeth K.
"Linking Geographic Information Systems and Trip Reduction: Success and Failure in a Pilot Application"
1993 UCTC 143

Burns, Elizabeth K.
"Vance's Commuting Analysis Extended to the Suburban Southwest: Tempe Arizona"
1992 UCTC 67

Cervero, Robert
"Accessibility and Third World Rural Development: A Case Study of Sumatra"
1990 UCTC 108

* **Cervero, Robert**
"Commercial Paratransit in the United States: Service Options, Markets and Performance"
1996 UCTC 299

Cervero, Robert
"Congestion, Growth and Public Choices"
1991 UCTC 51

Cervero, Robert
"Jobs-Housing Balancing and Regional Mobility"
1989 UCTC 50

Cervero, Robert
"Land Market Impacts of Urban Rail Transit and Joint Development: An Empirical Study of Rail Transit in Washington, D.C. and Atlanta"
1992 UCTC 135

Cervero, Robert
"Land Uses and Travel at Suburban Activity Centers"
1991 UCTC 91

Cervero, Robert
"Land-Use Mixing and Suburban Mobility"
1988 UCTC 3

Cervero, Robert
"Paratransit in Southeast Asia: A Market Reponse to Poor Roads?"
1991 UCTC 90

Cervero, Robert
"Profiling Profitable Bus Routes"
1990 UCTC 92

Cervero, Robert
"Ridership Impacts of Transit-Focused Development in California"
1993 UCTC 176

Cervero, Robert
"Suburban Employment Centers: Probing the Influence of Site Features on the Journey-to-Work"
1991 UCTC 49

* *not previously listed*

PAPERS IN PRINT

Cervero, Robert
"Surviving in the Suburbs: Transit's Ultimate Challenge"
1993 UCTC 169

* **Cervero, Robert and Alfred Round,**
"Future Ride: Adopting New Technologies to Paratransit in the United States"
1996 UCTC 306

Cervero, Robert, Alfred Round, Carma Reed, and Brian Clark
"The All-Electric Commute: An Assessment of the Market Potential for Station Cars in the San Francisco Bay Area"
1994 UCTC 249

* **Cervero, Robert, Alfred Round, Todd Goldman, and Kang-Li Wu**
"BART @ 20: Rail Access Modes and Catchment Areas for the BART System"
1995 UCTC 307

* **Cervero, Robert, Carlos Castellanos, Wicaksono Sarosa, and Kenneth Rich**
"BART @ 20: Land Use and Development Impacts"
1995 UCTC 308

Cervero, Robert and Carolyn Radisch
"Travel Choices in Pedestrian Versus Automobile Oriented Neighborhoods"
1995 UCTC 281

Cervero, Robert and John Landis
"Suburbanization of Jobs and the Journey to Work"
1991 UCTC 83

Cervero, Robert and Mark Dunzo
"An Assessment of Suburban-Targeted Transit Service Strategies in the United States"
1993 UCTC 178

Cervero, Robert and Peter Bosselmann
"An Evaluation of the Market Potential for Transit-Oriented Development Using Visual Simulation Techniques"
1994 UCTC 247

Cervero, Robert and Val Menotti
"Market Profiles of Rail-Based Housing Projects in California"
1994 UCTC 242

Cervero, Robert, Michael Bernick and Jill Gilbert
"Market Opportunities and Barriers to Transit-Based Development in California"
1994 UCTC 223

Cervero, Robert, Thomas Kirk, Douglas Mount, and Carma Reed
"Paratransit in the San Francisco Bay Area: Providing Feeder Connections to Rail"
1995 UCTC 252

Chatti, Karim, John Lysmer and Carl L. Monismith
"Dynamic Finite-Element Analysis of Jointed Concrete Pavements"
1994 UCTC 283

Choy, Manhoi, Mei-Po Kwan and Hong Va Leong
"On Real-Time Distributed Geographical Database Systems"
1994 UCTC 216

Chu, Xuehao
"Endogenous Trip Scheduling: The Henderson Approach Reformulated and Compared with the Vickrey Approach"
1993 UCTC 199

Chu, Xuehao and Gordon J. Fielding
"Electronic Road Pricing in Southern California: Policy Obstacles to Congestion Pricing"
1994 UCTC 189

Cohn, Theodore E.
"Integration by the Human Eye: Implications for Warning Signal Design"
1993 UCTC 207

Cohn, Theodore E. and David J. Lasley
"Wallpaper Illusion: Cause of Disorientation and Falls on Escalators"
1990 UCTC 160

Crane, Randall
"Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning"
1994 UCTC 239

Crane, Randall
"On Form Versus Function: Will the 'New Urbanism' Reduce Traffic, or Increase It?"
1995 UCTC 266

Crane, Randall
"The Influence of Expected Suburbanization on Urban Form and the Journey to Work"
1994 UCTC 240

De Vany, Arthur and W. David Walls
"Network Connectivity and Price Convergence: Gas Pipeline Deregulation"
1993 UCTC 202

De Vany, Arthur and W. David Walls
"Pipeline Access and Market Integration in the Natural Gas Industry: Evidence from Cointegration Tests"
1993 UCTC 200

De Vany, Arthur and W. David Walls
"When Barriers to Markets Fall: Pipeline Deregulation, Spot Markets, and the Topology of the Natural Gas Market"
1992 UCTC 123

* **Deakin, Elizabeth**
"Effects of the Loma Prieta Earthquake on Transbay Travel Patterns"
1991 UCTC 294

Deakin, Elizabeth
"Land Use and Transportation Planning in Response to Congestion: The California Experience"
1989 UCTC 54

Deakin, Elizabeth
"Suburban Traffic Congestion, Land Use and Transportation Planning Issues: Public Policy Options"
1990 UCTC 57

Deakin, Elizabeth
"The United States"
1990 UCTC 66

Deakin, Elizabeth
"Toll Roads: A New Direction for U.S. Highways?"
1990 UCTC 56

Deakin, Elizabeth
"Transportation and Air Quality in California: A Policy Analysis"
1989 UCTC 55

Deakin, Elizabeth
"Transportation and Land Use Planning in California: Problems and Opportunities for Improved Performance"
1988 UCTC 53

* **Delucchi, Mark A.**
"Monetary Externalities of Motor-Vehicle Use"
1996 UCTC 318

* **Delucchi, Mark A.**
"Motor-Vehicle Goods and Services Priced in the Private Sector"
1996 UCTC 315

* **Delucchi, Mark A.**
"Payments by Motor-Vehicle Users for the Use of Highways, Fuels, and Vehicles"
1996 UCTC 327

* **Delucchi, Mark A.**
"Personal Nonmonetary Costs of Motor-Vehicle Use"
1996 UCTC 314

* **Delucchi, Mark A.**
"Personal Nonmonetary Costs of Motor-Vehicle Use"
1996 UCTC 329

* **Delucchi, Mark A.**
"Some Conceptual and Methodological Issues in the Analysis of the Social Cost of Motor-Vehicle Use"
1996 UCTC 312

* **Delucchi, Mark A.**
"Summary of the Nonmonetary Externalities of Motor-Vehicle Use"
1996 UCTC 319

* **Delucchi, Mark A.**
"The Allocation of the Social Costs of Motor-Vehicle Use to Six Classes of Motor Vehicles"
1996 UCTC 320

* **Delucchi, Mark A.**
"The Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991: Summary of Theory, Methods, Data, and Results"
1996 UCTC 311

* **Delucchi, Mark A. and Don McCubbin**
"The Contribution of Motor Vehicles to Ambient Air Pollution"
1996 UCTC 326

Delucchi, Mark A. and J.M. Ogden
"Solar-Hydrogen Fuel-Cell Vehicles"
1993 UCTC 158

* **Delucchi, Mark A. and James Murphy**
"General Taxes Paid by Producers and Consumers of Motor Vehicles, Motor Fuels, and Other Motor-Vehicle Goods and Services"
1996 UCTC 328

Delucchi, Mark A. and James Murphy
"Motor-Vehicle Goods and Services Bundled in the Private Sector"
1996 UCTC 316

Delucchi, Mark A. and James Murphy
"Motor-Vehicle Infrastructure and Services Provided by the Public Sector"
1996 UCTC 317

* **Delucchi, Mark A. and James Murphy**
"U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles"
1996 UCTC 325

* **Delucchi, Mark A. and Shi-Ling Hsu**
"The External Cost of Noise from Motor Vehicles"
1996 UCTC 324

* **Delucchi, Mark A., James Murphy, Jin Kim, and Don McCubbin**
"The Cost of Reduced Visibility Due to Air Pollution from Motor Vehicles"
1996 UCTC 323

Delucchi, Mark A., Quanlu Wang and Daniel Sperling
"Electric Vehicles: Performance, Life-Cycle Costs, Emissions, and Recharging Requirements"
1989 UCTC 7

Murphy, James and Mark A. Delucchi
"Review of Some of the Literature on the Social Cost of Motor-Vehicle Use"
1996 UCTC 313

Fielding, Gordon J. and Daniel B. Klein
"High Occupancy / Toll Lanes: Phasing in Congestion Pricing a Lane at a Time"
1993 UCTC 179

Fielding Gordon J. and Daniel B. Klein
"How to Franchise Highways"
1992 UCTC 134

Gärling, Tommy, Mei-Po Kwan and Reginald G. Golledge
"Computational-Process Modelling of Household Activity Scheduling"
1993 UCTC 217

Gärling, Tommy, Mei-Po Kwan and Reginald G. Golledge
"Computational-Process Modelling of Travel Decisions: Review and Conceptual Analysis"
1991 UCTC 209

Garrison, William L. and Reginald R. Souleyrette II
"Relations between Transportation and Production"
1990 UCTC 45

Garrison, William L. and Reginald R. Souleyrette II
"The Relationship between Transportation and Innovation"
1994 UCTC 230

Giuliano, Genevieve
"Is Jobs-Housing Balance a Transportation Issue?"
1991 UCTC 133

Giuliano, Genevieve
"New Directions for Understanding Transportation and Land Use"
1989 UCTC 2

Giuliano, Genevieve and Kenneth A. Small
"Alternative Strategies for Coping with Traffic Congestion"
1994 UCTC 188

Giuliano, Genevieve and Kenneth A. Small
"Is the Journey to Work Explained by Urban Structure?"
1992 UCTC 107

Giuliano, Genevieve and Kenneth A. Small
"Subcenters in the Los Angeles Region"
1990 UCTC 39

Giuliano, Genevieve and Kenneth A. Small
"The Determinants of Growth of Employment Subcenters"
1994 UCTC 220

Giuliano, Genevieve and Martin Wachs
"Responding to Congestion and Traffic Growth: Transportation Demand Management"
1991 UCTC 86

Giuliano, Genevieve and Thomas F. Golob
"Using Longitudinal Methods for Analysis of a Short-Term Transportation Demonstration Project"
1990 UCTC 28

Giuliano, Genevieve, Keith Hwang and Martin Wachs
"Employee Trip Reduction in Southern California: First Year Results"
1993 UCTC 164

Giuliano, Genevieve, Keith Hwang, Diane Perrine, and Martin Wachs
"Preliminary Evaluation of Regulation XV of the South Coast Air Quality Management District"
1991 UCTC 60

Glazer, Amihai and Charles Lave
"Regulation by Prices and by Command"
1995 UCTC 276

Glazer, Amihai and Esko Niskanen
"Parking Fees, Congestion, and Consumer Welfare"
1991 UCTC 24

Glazer, Amihai and Esko Niskanen
"When Do Consumers Favor Price Increases: With Applications to Congestion and to Regulation"
1992 UCTC 193

Glazer, Amihai and Esko Niskanen
"Why Voters May Prefer Congested Public Clubs"
1992 UCTC 195

Glazer, Amihai and Kai A. Konrad
"Ameliorating Congestion by Income Redistribution"
1993 UCTC 192

Glazer, Amihai and Refael Hassin
"Governmental Failures in Evaluating Programs"
1994 UCTC 194

Glazer, Amihai, Daniel B. Klein and Charles Lave
"Clean for a Day: Troubles with California's Smog Check"
1993 UCTC 163

Glazer, Amihai, Daniel B. Klein and Charles Lave
"Clean on Paper, Dirty on the Road: Troubles with California's Smog Check"
1995 UCTC 275

Golledge, Reginald D.
"Defining the Criteria Used in Path Selection"
1995 UCTC 278

Golledge, Reginald G.
"Do People Understand Spatial Concepts: The Case of First-Order Primitives"
1992 UCTC 211

Golledge, Reginald G.
"Path Selection and Route Preference in Human Navigation: A Progress Report"
1995 UCTC 277

Golledge, Reginald G.
"Place Recognition and Wayfinding: Making Sense of Space"
1992 UCTC 212

Golledge, Reginald G.
"Time and Space in Route Preference"
1993 UCTC 213

Golledge, Reginald G., Mei-Po Kwan and Tommy Gärling
"Computational Process Modelling of Travel Decisions: Empirical Tests"
1991 UCTC 210

Golledge, Reginald G., Mei-Po Kwan and Tommy Gärling
"Computational-Process Modelling of Household Travel Decisions Using a Geographical Information System"
1994 UCTC 218

Golledge, Reginald G., Valerie Dougherty and Scott Bell
"Survey Versus Route-Based Wayfinding in Unfamiliar Environments"
1993 UCTC 214

Golob, Thomas F.
"Structural Equation Modeling of Travel Choice Dynamics"
1988 UCTC 4

Golob, Thomas F.
"The Dynamics of Household Travel Time Expenditures and Car Ownership Decisions"
1990 UCTC 26

Golob, Thomas F. and Jacqueline M. Golob
"Practical Considerations in the Development of a Transit Users Panel"
1989 UCTC 17

Golob, Thomas F. and Leo van Wissen
"A Joint Household Travel Distance Generation and Car Ownership Model"
1989 UCTC 8

Golob, Thomas F. and Michael G. McNally
"A Model of Household Interactions in Activity Participation and the Derived Demand for Travel"
1995 UCTC 287

* *not previously listed*

PAPERS IN PRINT

Golob, Thomas F., Mark A. Bradley and John W. Polak
"Travel and Activity Participation as Influenced by Car Availability and Use"
1995 UCTC 286

Golob, Thomas F., Seyoung Kim and Weiping Ren
"A Structural Model of Vehicle Use in Two-Vehicle Households"
1994 UCTC 224

Goulias, Konstadinos G.
"A Dynamic Microsimulator for Travel Demand Forecasting"
1992 UCTC 95

Goulias, Konstadinos G.
"Forecasting the Impact of Sociodemographic Changes on Travel Demand: Experiments with a Dynamic Microsimulation Model System"
1992 UCTC 94

Goulias, Konstadinos G. and Ram Pendyala
"Innovations in Transportation: The Case of Telecommuting"
1991 UCTC 72

Goulias, Konstadinos G. and Ryuichi Kitamura
"Analysis of Binary Choice Frequencies with Limit Cases: Comparison of Alternative Estimation Methods and Application to Weekly Household Mode Choice"
1991 UCTC 96

Goulias, Konstadinos G. and Ryuichi Kitamura
"Recursive Model System for Trip Generation and Trip Chaining"
1991 UCTC 40

Goulias, Konstadinos G., Ram M. Pendyala and Ryuichi Kitamura
"A Practical Method for the Estimation of Trip Generation and Trip Chaining"
1991 UCTC 62

Goulias, Konstadinos G., Ram M. Pendyala and Ryuichi Kitamura
"Updating a Panel Survey Questionnaire"
1991 UCTC 61

Guensler, Randall
"Data Needs for Evolving Motor Vehicle Emission Modeling Approaches"
1993 UCTC 74

Guensler, Randall and Daniel Sperling
"Congestion Pricing and Motor Vehicle Emissions: An Initial Review"
1993 UCTC 229

Hall, Peter, Brian Sands and Walter Streeter
"Managing the Suburban Commute: A Cross-National Comparison of Three Metropolitan Areas"
1993 UCTC 177

Hall, Peter, Daniel Leavitt and Erin Vaca
"High-Speed Trains for California. Strategic Choice: Comparisons of Technologies and Choice of Route," CalSpeed Series
1992 UCTC 104

Hall, Peter, Daniel Leavitt and Erin Vaca
"High-Speed Trains for California. Volume II: Detailed Segment Descriptions, Cost Estimates, and Travel Time Calculations," CalSpeed Series
1992 UCTC 105

Hall, Randolph W.
"Design for Local Area Freight Networks"
1991 UCTC 63

Hall, Randolph W.
"Pickup and Delivery Systems for Overnight Carriers"
1992 UCTC 106

Hall, Randolph W. and Wei Hua Lin
"LTL Trucking in Los Angeles: Congestion Relief through Terminal Siting"
1990 UCTC 43

Handy, Susan L.
"A Cycle of Dependence: Automobiles, Accessibility, and the Evolution of the Transportation and Retail Hierarchies"
1993 UCTC 233

Handy, Susan L.
"Regional versus Local Accessibility: Implications for Nonwork Travel"
1993 UCTC 234

Handy, Susan L.
"Regional versus Local Accessibility: Neo-Traditional Development and Its Implications for Non-Work Travel"
1993 UCTC 235

Hansen, Mark and Jacob Sutter
"The Shake with Freight: The Impact of the Loma Prieta Earthquake on Bay Area Truckers," Studies on the Loma Prieta Earthquake, No. 1
1990 UCTC 151

Hansen, Mark and Sharon Weinstein
"East Bay Ferry Service and the Loma Prieta Earthquake," Studies on the Loma Prieta Earthquake, No. 5
1991 UCTC 162

Hårsman, Björn
"Worker and Workplace Heterogeneity, Transport Access, and Residential Location: A Historical Perspective on Stockholm"
1995 UCTC 289

Hårsman, Björn and John M. Quigley
"The Spatial Segregation of Ethnic and Demographic Groups: Comparative Evidence from Stockholm and San Francisco"
1993 UCTC 149

Hedrick, J.K. and Kyongsu Yi
"The Effect of Alternative Heavy Truck Suspensions on Flexible Pavement Response"
1991 UCTC 46

Henderson, Dennis K., Brett E. Koenig and Patricia L. Mokhtarian
"Using Travel Diary Data to Estimate the Emissions Impacts of Transportation Strategies: The Puget Sound Telecommuting Demonstration Project"
1995 UCTC 265

Hsu, Shi-Ling and Daniel Sperling
"Uncertain Air Quality Impacts of Automobile Retirement Programs"
1994 UCTC 260

* **Huang, William S.**
"BART @ 20: Transit and Regional Economic Growth: A Review of the Literature"
1995 UCTC 310

Hwang, Keith and Genevieve Giuliano
"The Determinants of Ridesharing: Literature Review"
1990 UCTC 38

Jacobs, Allan B., Yodan Y. Rofé and Elizabeth S. Macdonald
"Boulevards: A Study of Safety, Behavior, and Usefulness"
1994 UCTC 248

* **Jacobs, Allan B., Yodan Y. Rofé and Elizabeth S. Macdonald**
"Multiple Roadway Boulevards: Case Studies, Designs, and Design Guidelines"
1995 UCTC 300

Jayakrishnan, R., Michael G. McNally and Michael I. Cohen
"Simulation of Advanced Traveller Information Systems (ATIS) Strategies to Reduce Non-Recurring Congestion from Special Events"
1993 UCTC 173

Jayakrishnan, R., Wei T. Tsai, Joseph N. Prashker, and Subodh Rajadhyaksha
"A Faster Path-Based Algorithm for Traffic Assignment"
1994 UCTC 191

Johnston, Robert A.
"The Evaluation of Multimodal Transportation Systems for Economic Efficiency and Other Impacts"
1994 UCTC 272

Johnston, Robert A.
"The Evaluation of Transportation and Land Use Plans Using Linked Economic and GIS Models"
1995 UCTC 268

Johnston, Robert A. and Caroline J. Rodier
"Critique of Metropolitan Planning Organizations' Capabilities for Modeling Transportation Control Measures in California"
1994 UCTC 271

Johnston, Robert A. and Raju Ceerla
"Effects of Land Use Intensification and Auto Pricing Policies on Regional Travel, Emissions, and Fuel Use"
1995 UCTC 269

Johnston, Robert A., Jay R. Lund and Paul P. Craig
"Capacity-Allocation Methods for Reducing Urban Traffic Congestion"
1995 UCTC 270

Jovanis, Paul P., Tetsuya Kaneko and Tzuoo-Din Lin
"Exploratory Analysis of Motor Carrier Accident Risk and Daily Driving Patterns"
1991 UCTC 73

Kaneko, Tetsuya and Paul P. Jovanis
"Multiday Driving Patterns and Motor Carrier Accident Risk: A Disaggregate Analysis"
1991 UCTC 59

Keeler, Theodore E.
"Highway Safety, Economic Behavior, and Driving Environment"
1993 UCTC 65

* **Kim, Jin, James Murphy, Mark A. Delucchi, and Don McCubbin**
"The Cost of Crop Losses Caused by Ozone Air Pollution from Motor Vehicles"
1996 UCTC 322

Kim, Seyoung
"After the Resolution: Excess Commuting for Two-Worker Households in the Los Angeles Metropolitan Area"
1993 UCTC 144

Kim, Seyoung
"Gender Differences in Commuting: An Empirical Study of the Greater Los Angeles Metropolitan Area"
1994 UCTC 190

Kirchstetter, Thomas W., Brett C. Singer and Robert A. Harley
"Impacts of Oxygenated Gasoline Use on California Light-Duty Vehicle Emissions"
1995 UCTC 280

Kitamura, Ryuichi
"Panel Analysis in Transportation Planning: An Overview"
1990 UCTC 68

Kitamura, Ryuichi and David S. Bunch
"Heterogeneity and State Dependence in Household Car Ownership: A Panel Analysis Using Ordered-Response Probit Models with Error Components"
1990 UCTC 52

Kitamura, Ryuichi, Jack M. Nilles, Patrick Conroy, and David M. Fleming
"Telecommuting as a Transportation Planning Measure: Initial Results of California Pilot Project"
1991 UCTC 58

Kitamura, Ryuichi, Patricia L. Mokhtarian, Ram M. Pendyala, and Konstadinos G. Goulias
"An Evaluation of Telecommuting as a Trip Reduction Measure"
1991 UCTC 5

Klein, Daniel B.
"The Voluntary Provision of Public Goods? The Turnpike Companies of Early America"
1990 UCTC 18

* **Klein, Daniel B. and Adrian T. Moore**
"A Property Rights Framework for Transit Services"
1995 UCTC 303

* **Klein, Daniel B. and Adrian T. Moore**
"Schedule Jockeying and Route Swamping: A Property Right Interpretation of British Bus Deregulation"
1995 UCTC 302

* **Klein, Daniel B. and Chi Yin**
"The Private Provision of Frontier Infrastructure: Toll Roads in California, 1850-1902"
1994 UCTC 238

Klein, Daniel B. and Gordon J. Fielding
"Private Toll Roads: Learning from the 19th Century"
1992 UCTC 118

Klein, Daniel B. and John Majewski
"Economy, Community and Law: The Turnpike Movement in New York, 1797-1845"
1991 UCTC 76

Klein, Daniel B. and John Majewski
"Plank Road Fever in Antebellum America: New York State Origins"
1994 UCTC 243

Klein, Daniel B. and John Majewski
"Promoters and Investors in Antebellum America: The Spread of Plank Road Fever"
1991 UCTC 75

Klein, Daniel B. and Pia Maria Koskenoja
"The Smog-Reduction Road: Remote Sensing Versus the Clean Air Act"
1996 UCTC 301

Kroll, Cynthia A., John D. Landis, Qing Shen, and Sean Stryker
Economic Impacts of the Loma Prieta Earthquake: A Focus on Small Business," Studies on the Loma Prieta Earthquake, No. 3
1991 UCTC 154

Kurani, Kenneth S., Thomas Turrentine and Daniel Sperling
"Demand for Electric Vehicles in Hybrid Households: An Exploratory Analysis"
1994 UCTC 232

Kwan, Mei-Po and Reginald G. Golledge
"Contributions of GIS to ATIS"
1994 UCTC 215

Kwan, Mei-Po and Reginald Golledge
"Integration of GIS with Activity-based Model in ATIS"
1995 UCTC 254

Landis, John D.
"The California Urban Futures Model: A New Generation of Metropolitan Simulation Models"
1994 UCTC 244

* **Landis, John D. and David Loutzenheiser**
"BART @ 20: Access and Office Building Performance"
1995 UCTC 309

Landis, John D. and Ming Zhao
"Pilot Study of Solano and Sonoma Land Use and Development Policy Alternatives"
1994 UCTC 245

Landis, John D., Subhrajit Guhathakurta and Ming Zhang
"Capitalization of Transportation Investments into Single Family Home Prices: A Comparative Analysis of California Transit Systems and Highways"
1994 UCTC 246

Landis, John D., Subhrajit Guhathakurta, William Huang, and Ming Zhang
"Rail Transit Investments, Real Estate Values, and Land Use Change: A Comparative Analysis of Five California Rail Transit Systems"
1995 UCTC 285

Lasley, David J., Russell D. Hamer, Robert Dister, and Theodore E. Cohn
"Postural Stability and Stereo-Ambiguity in Man-Designed Visual Environments"
1991 UCTC 157

Lave, Charles
"Measuring the Decline in Transit Productivity in the U.S."
1991 UCTC 159

Lave, Charles
"State and National VMT Estimates: It Ain't Necessarily So"
1994 UCTC 231

Lave, Charles
"The Demand Curve Under Road-Pricing and the Problem of Political Feasibility"
1992 UCTC 136

Lave, Charles
"Things Won't Get a Lot Worse: The Future of U.S. Traffic Congestion"
1990 UCTC 33

Lave, Charles and Patrick Elias
"Did the 65 Mph Speed Limit Save Lives?"
1993 UCTC 69

Leavitt, Dan, Sean Ennis and Pat McGovern
"The Cost Escalation of Rail Projects: Using Previous Experience to Re-Evaluate the CalSpeed Estimates," CalSpeed Series
1993 UCTC 156

Leavitt, Daniel, Erin Vaca and Peter Hall
"Revenue and Ridership Potential for a High-Speed Rail Service in the San Francisco / Sacramento - Los Angeles Corridor" Calspeed Series
1994 UCTC 185

Leavitt, Daniel, Peter Cheng, Erin Vaca, and Peter Hall
"Potential for Improved Intercity Passenger Rail Service in California: Study of Corridors," Calspeed Series
1994 UCTC 222

Lem, Lewison Lee, Jian-Ling Li and Martin Wachs
"Comprehensive Transit Performance Indicators"
1994 UCTC 225

* *not previously listed*

PAPERS IN PRINT

Lipman, Timothy E., Kenneth S. Kurani and Daniel Sperling (editors)
"Proceedings of the Neighborhood Electric Vehicle Workshop: A Policy, Technology, and Research Conference"
1994 UCTC 258

Loukaitou-Sideris, Anastasia
"Retrofit of Urban Corridors: Land Use Policies and Design Guidelines for Transit-Friendly Environments"
1993 UCTC 180

Loukaitou-Sideris, Anastasia and Tridib Banerjee
"Form Follows Transit? The Blue Line Corridor's Development Potentials"
1994 UCTC 259

Majewksi, John, Christopher T. Baer and Daniel B. Klein
"Market and Community in Antebellum America: The Plank Roads of New York"
1991 UCTC 47

Majewski, John, Christopher Baer and Daniel B. Klein
"Responding to Relative Decline: The Plank Road Boom of Antebellum New York"
1993 UCTC 267

Mannering, Jill S. and Patricia L. Mokhtarian
"Modeling the Choice of Telecommuting Frequency in California: An Exploratory Analysis
1995 UCTC 282

* **McCubbin, Don and Mark A. Delucchi**
"The Cost of the Health Effects of Air Pollution from Motor Vehicles"
1996 UCTC 321

McNally, Michael G.
"Regional Impacts of Neotraditional Neighborhood Development"
1993 UCTC 172

McNally, Michael G. and Sherry Ryan
"A Comparative Assessment of Travel Characteristics for Neotraditional Developments"
1992 UCTC 142

McNally, Michael G. and Sherry Ryan
"Accessibility of Neotraditional Neighborhoods: A Review of Design Concepts, Policies, and Recent Literature"
1992 UCTC 141

Meurs, Henk, Leo van Wissen and Jacqueline Visser
"Measurement Biases in Panel Data"
1989 UCTC 9

Miller, Vincent P. and John M. Quigley
"Segregation by Racial and Demographic Group: Evidence from the San Francisco Bay Area"
1989 UCTC 14

Mokhtarian, Patricia L.
"A Typology of Relationships Between Telecommunications and Transportation"
1990 UCTC 82

Mokhtarian, Patricia L.
"An Empirical Analysis of the Transportation Impacts of Telecommuting"
1991 UCTC 131

Mokhtarian, Patricia L.
"An Empirical Evaluation of the Travel Impacts of Teleconferencing"
1988 UCTC 132

Mokhtarian, Patricia L.
Defining Telecommuting"
1992 UCTC 80

Mokhtarian, Patricia L.
"Telecommuting and Travel: State of the Practice, State of the Art"
1991 UCTC 79

Mokhtarian, Patricia L. and Ilan Salomon
"Modeling the Choice of Telecommuting 2: A Case of the Preferred Impossible Alternative"
1995 UCTC 263

Mokhtarian, Patricia L. and Ilan Salomon
"Modeling the Choice of Telecommuting 3: Identifying the Choice Set and Estimating Binary Choice Models for Technology-Based Alternatives"
1995 UCTC 264

Mokhtarian, Patricia L. and Ilan Salomon
"Modeling the Choice of Telecommuting: Setting the Context"
1993 UCTC 147

Mokhtarian, Patricia L. and Ilan Salomon
"Modeling the Desire to Telecommute: The Importance of Attitudinal Factors in Behavioral Models"
1994 UCTC 284

* **Mokhtarian, Patricia L. and Ilan Salomon**
"Modeling the Preference for Telecommuting: Measuring Attitudes and Other Variables
1995 UCTC 293

Monismith, C.L., J. Lysmer, J. Sousa, and J.K. Hedrick
"Truck Pavement Interactions: Requisite Research"
1988 UCTC 48

Munshi, Kaivan and Edward C. Sullivan
"A Freight Network Model for Mode and Route Choice"
1989 UCTC 25

Novaco, Raymond W.
"Aggression on Roadways"
1989 UCTC 16

Novaco, Raymond W.
"Automobile Driving and Aggressive Behavior"
1990 UCTC 42

Novaco, Raymond W. and Cheryl Collier
"Commuting Stress, Ridesharing, and Gender: Analyses from the 1993 State of the Commute Study in Southern California"
1994 UCTC 208

Novaco, Raymond W., Daniel Stokols and Louis Milanesi
"Objective and Subjective Dimensions of Travel Impedance as Determinants of Commuting Stress"
1990 UCTC 30

Novaco, Raymond W., Wendy Kliewer and Alexander Broquet
"Home Environment Consequences of Commute Travel Impedance"
1991 UCTC 77

O'Regan, Katherine M.
"Space and Poverty: The Effect of Concentrated Poverty"
1992 UCTC 150

O'Regan, Katherine M. and John M. Quigley
"Family Networks and Youth Access to Jobs"
1992 UCTC 128

O'Regan, Katherine M. and John M. Quigley
"Labor Market Access and Labor Market Outcomes for Urban Youth"
1991 UCTC 84

O'Regan, Katherine M. and John M. Quigley
"Teenage Employment and the Spatial Isolation of Minority and Poverty Households"
1995 UCTC 290

Ong, Paul
"Work and Car Ownership Among Welfare Recipients"
1995 UCTC 19

Parker, John K.
"Meeting Land Transportation Needs of the Ports of Long Beach and Los Angeles"
1990 UCTC 35

Parker, John K.
"The Consolidated Transportation Corridor: Surface Access to the Ports of Long Beach and Los Angeles" Final Report
1990 UCTC 137

Pendyala, Ram M., Konstadinos G. Goulias and Ryuichi Kitamura
"Impact of Telecommuting on Spatial and Temporal Patterns of Household Travel"
1992 UCTC 111

Prosser, Neil A. and Stephen G. Ritchie
"Real-Time Knowledge-Based Integration of Freeway Surveillance Data"
1990 UCTC 89

Ritchie, Stephen G.
"A Knowledge-Based Decision Support Architecture for Advanced Traffic Management"
1990 UCTC 31

Ritchie, Stephen G. and Neil A. Prosser
"A Real-Time Expert System Approach to Freeway Incident Management"
1990 UCTC 88

Rodier, Caroline J. and Robert A. Johnston
"Incentives for Local Governments to Implement Travel Demand Management Measures"
1995 UCTC 251

Rosenbloom, Sandra and Elizabeth Burns
"Gender Differences in Commuter Travel in Tucson: Implications for Travel Demand Management Programs"
1993 UCTC 273

Rosenbloom, Sandra and Elizabeth Burns
"Why Working Women Drive Alone: Implications for Travel Reduction Programs"
1994 UCTC 274

Rubin, Jonathan D. and Catherine Kling
"An Emission Saved is an Emission Earned: An Empirical Study of Emission Banking for Light Duty Vehicle Manufacturers"
1993 UCTC 253

Ruud, Paul A.
"Restricted Least Squares Subject to Monotonicity and Concavity Constraints"
1995 UCTC 288

Sampath, Srikanth, Somitra Saxena and Patricia L. Mokhtarian
"The Effectiveness of Telecommuting as a Transportation Control Measure"
1991 UCTC 78

Sands, Brian D.
"InterCity Express: A Technical and Commercial Assessment," CalSpeed Series 1
992 UCTC 101

Sands, Brian D.
"The Development Effects of High-Speed Rail Stations and Implications for California" Calspeed Series
1993 UCTC 115

Sands, Brian D.
"The Transrapid Magnetic Levitation System: A Technical and Commercial Assessment" Calspeed Series
1992 UCTC 183

Schipper, Lee, Maria Josefina Figueroa, Lynn Price, and Molly Espey.
"Mind the Gap: The Vicious Circle of Measuring Automobile Fuel Use"
1993 UCTC 228

Scott, Allen J. (editor)
"Electric Vehicle Manufacturing in Southern California: Current Developments, Future Prospects"
1993 UCTC 170

Shaw, John
"Transit-Based Housing and Residential Satisfaction: Review of the Literature and Methodological Approach"
1994 UCTC 262

Shaw, Peter L.
"New Federal Transportation Financing and Legislative Directions: No New Taxes or $31 Billion a Year?"
1990 UCTC 36

Shaw, Peter L.
"Seaport-Surface Transportation Access and Air Quality"
1993 UCTC 181

Shaw, Peter L.
"Seaport-Surface Transportation Access and Urban Transportation Congestion"
1992 UCTC 116

Shaw, Peter L.
"Setting the State for National Transportation Policy to the Year 2020: The Surface Transportation and Uniform Relocation Assistance Act of 1987"
1989 UCTC 13

Shaw, Peter L.
"Surface Transportation Policy and Seaports" Final Report
1990 UCTC 138

Shoup, Donald C.
"Cashing Out Employer-Paid Parking"
1992 UCTC 140

Shoup, Donald C.
"Cashing Out Employer-Paid Parking: A Precedent for Congestion Pricing?"
1993 UCTC 205

Shoup, Donald C.
"Cashing Out Employer-Paid Parking: An Opportunity to Reduce Minimum Parking Requirements"
1994 UCTC 204

Shoup, Donald C. and Richard W. Willson
"Commuting, Congestion and Pollution: The Employer-Paid Parking Connection"
1992 UCTC 120

Shoup, Donald C. and Richard W. Willson
"Employer-Paid Parking: The Problem and Proposed Solutions"
1992 UCTC 119

* **Singer, Brett C. and Robert A. Harley**
"A Fuel-Based Motor Vehicle Emission Inventory"
1996 UCTC 296

Small, Kenneth A.
"Economics and Urban Transportation Policy in the United States"
1993 UCTC 219

Small, Kenneth A.
"Real Costs of Transportation and Influence of Pricing Policies"
1993 UCTC 187

Small, Kenneth A. and Camilla Kazimi
"On the Costs of Air Pollution from Motor Vehicles"
1994 UCTC 237

Small, Kenneth A. and Shunfeng Song
"Population and Employment Densities: Structure and Change"
1993 UCTC 161

Small, Kenneth A. and Shunfeng Song
"Wasteful Commuting: A Resolution"
1992 UCTC 87

Song, Shunfeng
"Does Generalizing Density Functions Better Explain Urban Commuting? Some Evidence from the Los Angeles Region"
1994 UCTC 197

Song, Shunfeng
"Modelling Worker Residence Distribution in the Los Angeles Region"
1993 UCTC 196

Song, Shunfeng
"Monocentric and Polycentric Density Functions and Their Required Commutes"
1992 UCTC 198

Song, Shunfeng
"Spatial Structure and Urban Commuting"
1992 UCTC 117

Song, Shunfeng
"The Distribution of Population in a Contemporary Metropolitan Area: The Case of Orange County [A Replication]"
1991 UCTC 44

Southworth, Michael and Raymond Isaacs
"SmartMaps for Advanced Traveler Information Systems Based on User Characteristics" Final Report
1994 UCTC 236

Sperling, Daniel
"Gearing Up for Electric Cars"
1994-95 UCTC 146

Sperling, Daniel
"Prospects for Neighborhood Electric Vehicles"
1994 UCTC 261

Sperling, Daniel and Mark A. Delucchi
"Alternative Transportation Energy"
1993 UCTC 256

Sperling, Daniel and Mark A. Delucchi
"Is Methanol the Transportation Fuel of the Future?"
1989 UCTC 10

Sperling, Daniel and Mark A. Delucchi
"Transportation Energy Futures"
1989 UCTC 11

Sperling, Daniel, Winardi Setiawan and David Hungerford
"The Target Market for Methanol Fuel"
1995 UCTC 168

Streeter, Walter C.
"The French Train à Grande Vitesse: Focusing on the TGV-Atlantique," CalSpeed Series
1992 UCTC 100

Swan, D.H., B.E.Dickinson and M.P. Arikara
"Proton Exchange Membrane Fuel Cell Characterization for Electric Vehicle Applications"
1994 UCTC 257

Taniguchi, Mamoru
"High Speed Rail in Japan: A Review and Evaluation of Magnetic Levitation Trains," CalSpeed Series
1992 UCTC 102

Taniguchi, Mamoru
"High Speed Rail in Japan: A Review and Evaluation of the Shinkansen Train," CalSpeed Series
1992 UCTC 103

Taylor, Brian D.
"Unjust Equity: An Examination of California's Transportation Development Act"
1991 UCTC 64

* *not previously listed*

Taylor, Brian D. and Paul M. Ong
"Racial and Ethnic Variations in Employment Access: An Examination of Residential Location and Commuting in Metropolitan Areas"
1993 UCTC 175

Tsuchida, Pamela and Linda Wilshusen
"Commute Behavior in Santa Cruz County," Studies on the Loma Prieta Earthquake, No. 4
1991 UCTC 155

Turrentine, Thomas and Daniel Sperling
"Theories of New Technology Purchase Decisions: The Case of Alternative Fuel Vehicles"
1992 UCTC 129

Turrentine, Thomas, Martin Lee-Gosselin, Kenneth Kurani, and Daniel Sperling
"A Study of Adaptive and Optimizing Behavior for Electric Vehicles Based on Interactive Simulation Games and Revealed Behavior of Electric Vehicle Owners"
1992 UCTC 130

Uhlaner, Carole J. and Seyoung Kim
"Designing and Implementing a Panel Study of Commuter Behavior: Lessons for Future Research"
1993 UCTC 145

Vaca, Erin
"Intercity Rail Ridership Forecasting and the Implementation of High-Speed Rail in California," Calspeed Series
1993 UCTC 182

Vaca, Erin, Thomas Bordeaux, Daniel Leavitt, and Peter Hall
"Revenue and Ridership Potential for a High-Speed Rail Service in the San Francisco / Sacramento - Los Angeles Corridor: Technical Appendix" Calspeed Series
1994 UCTC 186

van Wissen, Leo J.
"A Model of Household Interactions in Activity Patterns"
1991 UCTC 15

van Wissen, Leo J. and Thomas F. Golob
"Simultaneous Equation Systems Involving Binary Choice Variables"
1990 UCTC 20

van Wissen, Leo J., Thomas F. Golob and Hank J. Meurs
"A Simultaneous Dynamic Travel and Activities Time Allocation Model"
1991 UCTC 21

Wachs, Martin
"Learning from Los Angeles: Transport, Urban Form, and Air Quality"
1993 UCTC 166

Wachs, Martin
"Policy Implications of Recent Behavioral Research in Transportation Demand Management"
1991 UCTC 165

Wachs, Martin
"Regulating Traffic by Controlling Land Use: The Southern California Experience"
1990 UCTC 12

Wachs, Martin
"Transportation Demand Management: Policy Implications of Recent Behavioral Research"
1990 UCTC 23

Wachs, Martin and Genevieve Giuliano
"Employee Transportation Coordinators: A New Profession in Southern California"
1992 UCTC 99

Wachs, Martin, Brian D. Taylor, Ned Levine, and Paul Ong
"The Changing Commute: A Case Study of the Jobs/Housing Relationship over Time"
1993 UCTC 167

Walls, W. David
"A Cointegration Rank Test of Market Linkages with an Application to the U.S. Natural Gas Industry"
1993 UCTC 201

Walls, W. David
"Competition and Prices in the Deregulated Gas Pipeline Network: A Multivariate Cointegration Analysis"
1993 UCTC 203

Walls, W. David
"Competition in a Network of Markets: The Natural Gas Industry"
1992 UCTC 122

Wang, Quanlu and Mark A. Delucchi
"Impacts of Electric Vehicles on Primary Energy Consumption and Petroleum Displacement"
1991 UCTC 6

Wang, Quanlu, Catherine Kling and Daniel Sperling
"Light-Duty Vehicle Exhaust Emission Control Cost Estimates Using a Part-Pricing Approach"
1993 UCTC 206

Wang, Quanlu, Catherine Kling and Daniel Sperling
"Marketable Credits for Light-Duty Vehicle Emission Control in California"
1992 UCTC 109

Wang, Quanlu, Daniel Sperling and Janis Olmstead
"Emission Control Cost-Effectiveness of Alternative-Fuel Vehicles"
1993 UCTC 227

Wang, Quanlu, Mark A. Delucchi and Daniel Sperling
"Emission Impacts of Electric Vehicles"
1990 UCTC 41

* **Washington, Simon P. and Randall Guensler**
"Carbon Monoxide Impacts of Automatic Vehicle Identification Applied to Electronic Vehicle Tolling
1994 UCTC 297

* **Washington, Simon P. and Randall Guensler**
"Modeling Air Quality for Conformity, Current Deficiencies, and New Directions"
1994 UCTC 98

* **Washington, Simon P. and Troy M. Young**
"'Modal' Activity Models for Predicting Carbon Monoxide Emissions from Motor Vehicles"
1995 UCTC 295

Washington, Simon P., Randall Guensler, and Daniel Sperling
"Assessing the Emission Impacts of IVHS in an Uncertain Future
1993 UCTC 298

Webber, Melvin M.
"The Joys of Automobility"
1991 UCTC 110

Willson, Richard W.
"Estimating the Travel and Parking Demand Effects of Employer-Paid Parking"
1992 UCTC 139

Willson, Richard W. and Donald Shoup
"Parking Subsidies and Travel Choices: Assessing the Evidence"
1990 UCTC 34

Willson, Richard W. and Elham Shirazi
"Transportation Demand Management: Policy Implications of Recent Behavioral Research" Symposium Summary
1991 UCTC 29

Yi, Kyongsu and J.K. Hedrick
"Active and Semi-active Heavy Truck Suspensions to Reduce Pavement Damage"
1989 UCTC 27

Yi, Kyongsu, Margaret Wargelin and J.K. Hedrick
"Dynamic Tire Force Control by Semi-Active Suspensions"
1992 UCTC 97

Yim, Youngbin
"Shopping Trips and Spatial Distribution of Food Stores"
1993 UCTC 125

Yim, Youngbin
"The Effects of Transportation Services on the Scale of Food Retailing"
1992 UCTC 112

Yim, Youngbin
"Travel Distance and Market Size in Food Retailing"
1992 UCTC 124

Ph. D. DISSERTATIONS

Dissertations have not been reprinted, owing to their length. However, copies are avaiable for $15, payable to UC Regents.

Abdel-Aty, Mohamed Ahmed
"Investigating the Factors Influencing Route Choice: New Approaches in Data Collection and Modeling"
1995 Diss 27

Adler, Jeffrey L.
"An Interactive Simulation Approach to Systematically Evaluate the Impacts of Real-Time Traffic Condition Information on Driver Behavioral Choice"
1993 Diss 18

Ben-Joseph, Eran
"Subdivision Guidelines and Standards for Residential Streets and their Impact on Suburban Neighborhoods"
1995 Diss 29

Blankson, Charles
"A Study of the Los Angeles Coastal Transportation Corridor Specific Plan"
1989 Diss 10

Chatti, Karim
"Dynamic Analysis of Jointed Concrete Pavements Subjected to Moving Transient Loads"
1992 Diss 9

Chu, Xuehao
"Trip Scheduling and Economic Analysis of Transportation Policies"
1993 Diss 16

Dahlgren, Joy W.
"An Analysis of the Effectiveness of High Occupancy Vehicle Lanes"
1994 Diss 25

Delucchi, Mark A.
"Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity"
1991 Diss 6

Du, Yafeng
"Fleet Sizing and Empty Equipment Redistribution for Transportation Networks"
1993 Diss 11

Goulias, Konstadinos G.
"Long Term Forecasting with Dynamic Microsimulation"
1991 Diss 21

Guensler, Randall
"Vehicle Emission Rates and Average Vehicle Operating Speeds"
1994 Diss 19

Handy, Susan L.
"Regional versus Local Accessibility: Variations in Suburban Form and the Effects on Non-Work Travel"
1992 Diss 5

Kim, Seyoung
"Commuting Behavior of Two-Worker Households in the Los Angeles Metropolitan Area"
1993 Diss 22

Kurani, Kenneth Stuart
"Application of a Behavioral Market Segmentation Theory to New Transportation Fuels in New Zealand"
1992 Diss 15

Kwan, Mei-Po
"GISICAS: A GIS-Interfaced Computational-Process Model for Activity Scheduling in Advanced Traveler Information Systems"
1994 Diss 24

* **Lee, Richard W.**
"Travel Demand and Transportation Policy Beyond the Edge: An Inquiry into the Nature of Long-Distance Interregional Commuting"
1995 Diss 30

Levine, Jonathan Charles
"Employment Suburbanization and the Journey to Work"
1990 Diss 12

O'Regan, Katherine M
"Social Networks and Low Wage Labor Markets"
1990 Diss 3

Pendyala, Ram Mohan
"Causal Modeling of Travel Behavior Using Simultaneous Equations Systems: A Critical Examination"
1993 Diss 14

Rubin, Jonathan D.
"Marketable Emission Permit Trading and Banking for Light-Duty Vehicle Manufacturers and Fuel Suppliers"
1993 Diss 13

Shaw, John
"Transit, Density, and Residential Satisfaction"
1994 Diss 28

Smith, James E.
"A Comparative Study of Entrepreneurial Strategies among African-American and Latino Truckers in the Los Angeles and Long Beach Ports"
1993 Diss 23

Song, Shunfeng
"Spatial Structure and Urban Commuting"
1992 Diss 8

Souleyrette, Reginald R. II
"Transportation Services and Innovation in the Housing Industry: A Study of the Relations Between Transportation and Production"
1989 Diss 7

Taylor, Brian D.
"When Finance Leads Planning: The Influence of Public Finance on Transportation Planning and Policy in California"
1992 Diss 1

Turrentine, Thomas
"Lifestyle and Life Politics: Towards a Green Car Market"
1995 Diss 26

* **van Hengel, Drusilla**
"Citizens Near the Path of Least Resistance: Travel Behavior of Century Freeway Corridor Residents"
1996 Diss 31

Walls, W. David
"Open Access Transportation, Network Competition, and Market Integration in the Natural Gas Pipeline Industry"
1992 Diss 17

Wang, Quanlu
"The Use of a Marketable Permit System for Light-Duty Vehicle Emission Control"
1992 Diss 2

Willson, Richard W.
"Employer Parking Subsidies, Mode Choice, and Public Policy"
1991 Diss 4

Yim, Youngbin
"The Relationship between Transportation Services and Urban Activities: The Food Retail Distribution Case" 1990 Diss 20

BOOKS

UCTC does not distribute books. Please contact a bookstore or the publisher.

Cervero, Robert and Michael Bernick
Transit Villages for the 21st Century
(New York: McGraw Hill, 1996)

Cervero, Robert
Paratransit in America: Jitneys, Vans, and Minibuses
(Westport, CT: Praeger Press, 1996)

Garrett, Mark and Martin Wachs
Transportation Planning on Trial: The Clean Air Act and Travel Forecasting (Beverly Hills: Sage Publications, 1996)

Jacobs, Allan B.
Great Streets
(Cambridge: MIT Press, 1993)

Klein, Daniel B., Adrian T. Moore, and Binyam Reja
Property Rights Transit: A Framework for Competition and Entrepreneurship
(forthcoming)

Sperling, Daniel
Future Drive: Electric Vehicles and Sustainable Transportation
(Washington, DC: Island Press, 1995)

VIDEOS

Jacobs, Allan B., Yodan Y. Rofé and Elizabeth S. Macdonald
"Boulevards: Good Streets for Good Cities" (20 min.)
1995 Video 1

Turrentine, Thomas
"Clean Car Alternatives" (15 min.)
1994 Video 2

* *not previously listed*

ACCESS BACK ISSUES

Access No. 1, Fall 1992

Cars and Demographics, *Charles Lave*

Compulsory Ridesharing in Los Angeles, *Martin Wachs and Genevieve Giuliano*

Redundancy: The Lesson from the Loma Prieta Earthquake, *Melvin M. Webber*

Environmentally Benign Automobiles, *Daniel Sperling, et al.*

Pavement Friendly Buses and Trucks, *J. Karl Hedrick, et al.*

Commuter Stress, *Raymond W. Novaco*

Access No. 2, Spring 1993 (Out of Print)*

Cashing Out Employer-Paid Parking, *Donald C. Shoup*

Congestion Pricing: New Life for an Old Idea?, *Kenneth A. Small*

Private Toll Roads in America—The First Time Around, *Daniel B. Klein*

Investigating Toll Roads in California, *Gordon J. Fielding*

Telecommuting: What's the Payoff?, *Patricia L. Mokhtarian*

Surviving in the Suburbs: Transit's Untapped Frontier, *Robert Cervero*

Access No. 3, Fall 1993

Clean for a Day: California Versus the EPA's Smog Check Mandate, *Charles Lave*

Southern California: The Detroit of Electric Cars?, *Allen J. Scott*

The Promise of Fuel-Cell Vehicles, *Mark Delucchi and David Swan*

Great Streets: Monument Avenue, Richmond, Virginia, *Allan B. Jacobs*

Why California Stopped Building Freeways, *Brian D. Taylor*

Access Almanac: Trends in Our Times, *Charles Lave*

Access No. 4, Spring 1994

Time Again for Rail?, *Peter Hall*

No Rush To Catch the Train, *Adib Kanafani*

Will Congestion Pricing Ever Be Adopted?, *Martin Wachs*

Cashing in on Curb Parking, *Donald C. Shoup*

Reviving Transit Corridors and Transit Riding, *Anastasia Loukaitou-Sideris*

Access Almanac: Love, Lies, and Transportation in L.A., *Charles Lave*

Access No. 5, Fall 1994

Highway Blues: Nothing a Little Accessibility Can't Cure, *Susan Handy*

Transit Villages: From Idea to Implementation, *Robert Cervero*

A New Tool for Land Use and Transportation Planning, *John D. Landis*

It Wasn't Supposed to Turn Out Like This: Federal Subsidies and Declining Transit Productivity, *Charles Lave*

The Marriage of Autos and Transit: How To Make Transit Popular Again, *Melvin M. Webber*

Access Almanac: The CAFE Standards Worked, *Amihai Glazer*

Access No. 6, Spring 1995

The Weakening Transportation–Land Use Connection, *Genevieve Giuliano*

Bringing Electric Cars to Market, *Daniel Sperling*

Who Will Buy Electric Cars?, *Thomas Turrentine*

Are HOV Lanes Really Better?, *Joy Dahlgren*

Access Almanac: Slowdown Ahead for the Domestic Auto Industry, *Charles Lave*

Access No. 7, Fall 1995

The Transportation–Land Use Connection Still Matters, *Robert Cervero and John Landis*

New Highways and Economic Growth: Rethinking the Link, *Marlon G. Boarnet*

Do New Highways Generate Traffic?, *Mark Hansen*

Higher Speed Limits May Save Lives, *Charles Lave*

Is Oxygen Enough?, *Robert Harley*

** Photocopies of Access No. 2 can be made for $10, payable to UC Regents.*

ORDER FORM

UCTC #	AUTHOR	TITLE	QUANTITY

UCTC Papers, Videos, and ACCESS back issues are free, but please limit your request to subjects of genuine interest to you.
Ph.D. Dissertations are available for $15, payable to UC Regents.
If you would like to be added to our mailing list to receive future issues of ACCESS, please check here ❑

NAME _____

ORGANIZATION _____

ADDRESS _____

_____

PHONE _____

Send to:
Publications, University of California Transportation Center
108 Naval Architecture Building, University of California, Berkeley, CA 94720-1720
Telephone (510) 643-5454 Fax (510) 643-5456
access@uclink.berkeley.edu

ADDRESS CORRECTION

Please attach your incorrect mailing label here.
Then mail or fax us this page.

❑ **Delete this name from the ACCESS mailing list.**

❑ **New address is provided on the order form above.**

ACCESS NUMBER 8
SPRING 1996

Director: Melvin M. Webber
Editor: Luci Yamamoto
Design: Beth Loudenberg
Manager: Briggs Nisbet

University of California Transportation Center

Printed on recycled paper.

Photo Credits

Pg.2, 3, and 4: Reprinted with permission of the American Automobile Manufacturers Association

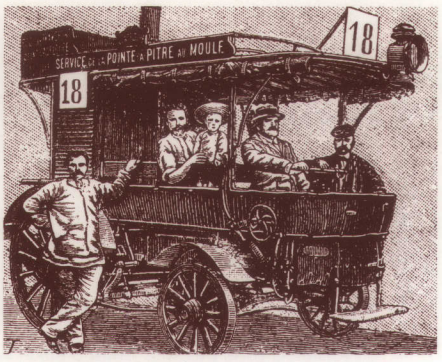
Pg.5: Daniel Klein

Pg.15: Reprinted with permission of The Society for the Preservation of New England Antiquities

Pg.18: AC Transit

Pg.20, 21, and 22: Southworth and Southworth, *Maps*, 1982

Pg.25 and 26: Reprinted with permission of the *Los Angeles Times*



The Access Almanac:

AUTOS SAVE ENERGY

The October 1973 oil price shock made everyone realize how much energy Americans use for transportation—over a quarter of total U.S. energy use (Table 1). By 1993 energy consumption for transportation reached 22.83 quadrillion BTU (British thermal units), of which over 70 percent was used for passenger travel. Not surprisingly, automobile travel accounted for over 40 percent of all energy expended for transportation (Table 2).

Something has to be done. Many believe we'd conserve energy if more people would use transit. The American Public Transit Association estimates that, in terms of fuel efficiency, one bus with only seven passengers equals one auto. One full bus equals six autos, and one full rail car equals fifteen autos! Transit's potential to save energy seems promising. But there is one problem: how to fill those buses and rail cars with passengers. People have to be lured out of their comfortable automobiles. So, buses and trains have been fitted with air conditioning and other amenities that use extra energy but make them more attractive. Still, not enough riders are coming. Thus the number of passengers in each transit vehicle is falling, making transit less energy efficient.

In 1975 Congress set corporate average fuel economy (CAFE) standards to make new cars sold in the United States more energy efficient. While transit failed to get more passengers on board, the CAFE standards worked to reduce gallons of fuel per passenger mile of automobile travel. Now cars are more energy efficient than transit (Table 3). In 1980 the U.S. Department of Energy found that automobiles used an average of 4,782 BTU of energy per passenger mile—1.7 times more than buses and 1.6 times more than rail. But by 1993 the average auto consumed only 3,593 BTU per passenger mile. Compare this with buses, which used 4,374 BTU per passenger mile, and rail, at 3,687 BTU per passenger mile.

So, should government now encourage people to use cars to save energy? Or is there a way to reverse the trend toward single-occupant automobiles and attract more passengers into transit?

—Sharon Sarmiento

TABLE 1

YEAR	TOTAL (quad BTU)	TRANSPORTATION (quad BTU)	% of total	PASENGER TRAVEL (quad BTU)	% of transport
1980	75.96	19.70	25.9	13.9	70.6
1981	73.99	19.51	26.4	13.7	70.2
1982	70.85	19.07	26.9	13.6	71.3
1983	70.52	19.13	27.1	13.8	72.1
1894	74.14	19.80	26.7	14.1	71.2
1985	73.98	20.07	27.1	14.4	71.7
1986	74.30	20.81	28.0	15.0	72.1
1987	76.89	21.45	27.9	15.2	70.9
1988	80.22	22.31	27.8	15.5	69.5
1989	81.33	22.56	27.7	15.7	69.6
1990	81.27	22.54	27.7	15.8	70.1
1991	81.12	22.12	27.3	15.4	69.6
1992	82.14	22.46	27.3	15.9	70.8
1993	83.96	22.83	27.3	16.3	71.4

Source: Transportation Energy Data Book, U.S. Department of Energy, 15th Edition, Table 2.6, p. 2-12; Table 2.19, p. 2-31.

TABLE 2

MODE	1992 Tril. BTU	1992 % share	1993 Tril. BTU	1993 % share
AUTOMOBILES	9240.5	40.9	9,392.6	40.7
MOTORCYCLES	23.8	0.1	24.7	0.1
TRANSIT BUSES	81.0	0.4	87.8	0.4
OTHER BUSES	93.2	0.4	94.1	0.4
TRUCKS	7538.5	33.3	7925.2	34.4
OFF HIGHWAY	665.2	2.9	706.5	3.1
AIR MODES	1970.8	8.7	1995.9	8.7
FREIGHT RAIL	425.1	1.9	381.6	1.7
TRANSIT RAIL	40.9	0.2	42.2	0.2
COMMUTER RAIL	22.0	0.1	21.4	0.1
INTERCITY RAIL	17.4	0.1	17.8	0.1
TOTAL TRANSPORT	22,2609.3	100.0	23,051.7	100.0

Source: Transportation Energy Data Book, U.S. Department of Energy, 15th Edition, Table 2.9, p. 2-16.

TABLE 3

YEAR	AUTOMOBILES BTU per vehicle mile	AUTOMOBILES BTU per passenger mile	TRANSIT BUSES BTU per vehicle mile	TRANSIT BUSES BTU per passenger mile	RAIL TRANSIT BTU per passenger mile
1980	8,130	4,782	36,553	2,813	3,008
1981	7,894	4,644	37,745	3,027	2,946
1982	7,558	4,446	38,766	3,237	3,069
1983	7,314	4,302	37,962	3,177	3,212
1894	7,031	4,136	37,507	3,204	3,732
1985	6,880	4,047	38,862	2,421	3,461
1986	6,853	4,031	39,869	3,512	3,531
1987	6,530	3,841	38,557	3,542	3,534
1938	6,275	3,598	39,121	3,415	3,585
1989	6,095	3,809	36,583	3,711	3,397
1990	5,983	3,739	36,647	3,735	3,453
1991	5,767	3,604	36,939	3,811	3,710
1992	5,738	3,586	37,071	3,970	3,575
1993	5,748	3,593	39,081	4,374	3,687
AVERAGE ANNUAL PERCENTAGE CHANGE					
1980-83	-3.5	-3.5	1.3	4.2	2.3
1984-93	-2.4	-1.7	0.3	4.4	1.6

Source: Transportation Energy Data Book, U.S. Department of Energy, 15th Edition, Table 2.15, p. 2-25 (series not continuous between 1983 and 1984 because of a change in American Public Transit Association data source).

UNIVERSITY OF CALIFORNIA TRANSPORTATION CENTER
108 Naval Architecture Building
Berkeley, California 94720-1720

FORWARDING AND ADDRESS CORRECTION REQUESTED

NON-PROFIT ORGANIZATION
U.S. POSTAGE PAID
UNIVERSITY OF CALIFORNIA