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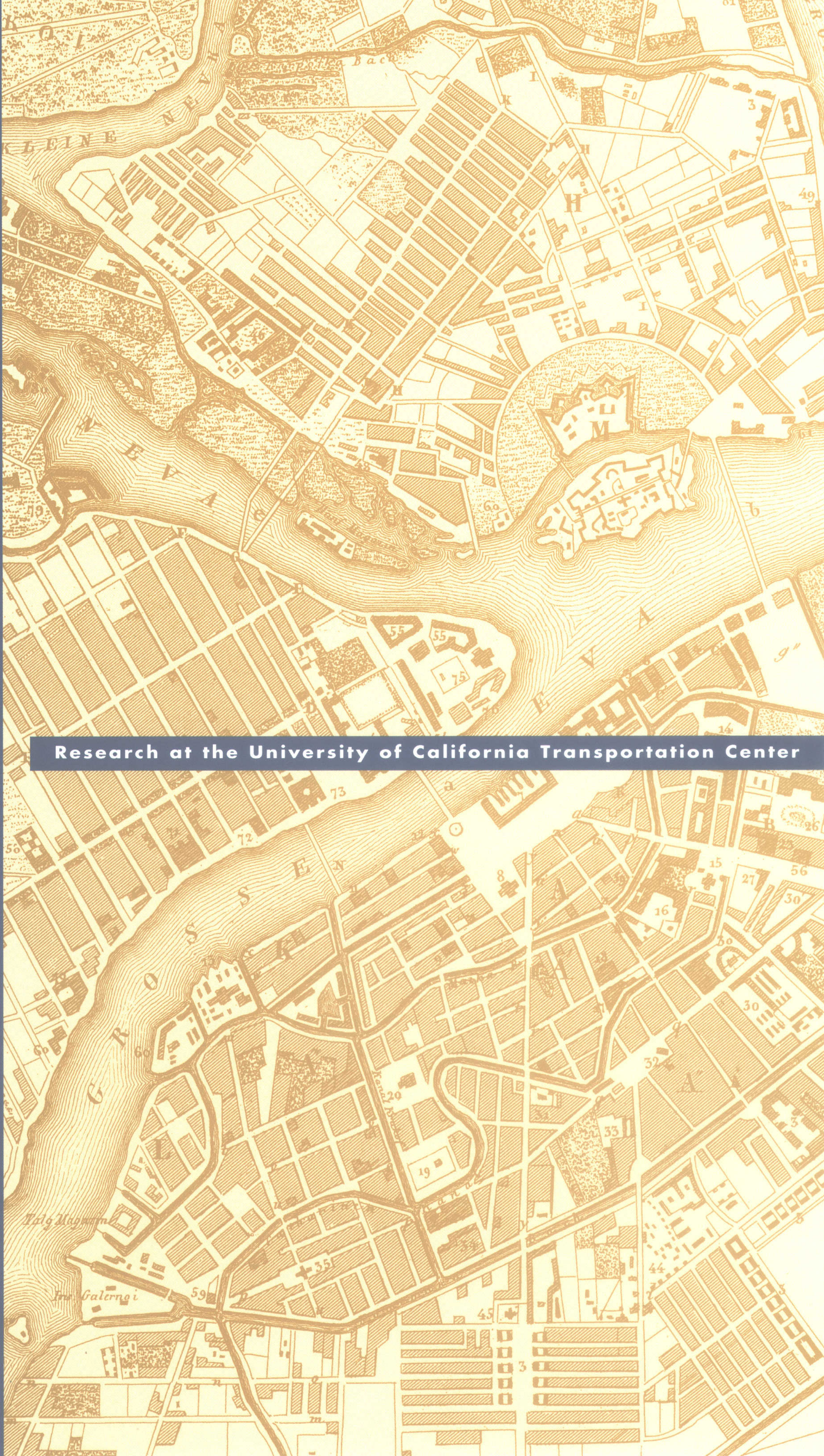

Research at the University of California Transportation Center

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The University of California Transportation Center, founded in 1988, facilitates research, education, and public service for the entire UC system. Activities have centered on the Berkeley, Davis, Irvine, Los Angeles, Riverside, and Santa Barbara campuses.

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Front Cover: St. Petersburg

Director's Comment

There is a need for competent and principled leadership in the field of transportation. The ongoing debate about reauthorizing ISTEA clearly illustrates the political pulls and tugs that characterize democratic decisionmaking. Each interest group voices its particular preferences, and legislators stake out claims for projects and programs that directly benefit their constituents. Real leadership involves breaking deadlocks like these through vision and compromise, but such leadership is rare. Beyond serving supporters' immediate aims for expensive projects, few seek to exploit transportation's potential for shaping the economy, environment, and public welfare.

Leadership is equally elusive at state and local levels where declining resources have increased tensions between suburbs and inner-city areas, where concerns for mobility clash with interests for environmental quality, and where rail-transit proponents challenge highway advocates. Some call for solutions that emphasize new land use patterns, others promote cleaner cars or alternative fuels, still others think "the answer" is to build rail systems and so forth.

Undoubtedly, we need a mix of policies. The real challenge, especially in the fishbowl of politics, is to find the right blend. The best mix for one region probably differs from that for another, although each may be tempted to mimic its neighbor's successes. Modern policymaking incorporates complex technologies, financing, and social and economic effects. Technical experts can help to clarify costs and benefits of different approaches and even to invent new ones. But, in the end, political leaders must select the best alternatives and implement them in fiscally responsible ways.

The University of California transportation community has a central responsibility in this complex policymaking ritual. Our research seeks to inform decisionmakers and to support them with dispassionate analysis — as well as with advocacy. Formal university teaching prepares many who will be among the next generation of experts and policymakers. In five, ten, and twenty years they'll face policy puzzles that we've not yet even identified. Our short courses, symposia, and research publications provide today's decisionmakers with information and ideas that address current problems.

In October the Berkeley campus hosted the fourth annual research conference of transportation graduate students from four UC campuses: Berkeley, Davis, Irvine, and Los Angeles. More than 100 students presented research findings to one another and debated the future of transportation policy. Having observed them in action, I've no doubt that those students are our most important contribution to future transportation policy. Their presentations were innovative, clear, and insightful. Their conference assured me that the current generation of graduate students is better prepared for future leadership roles than any earlier cohort.

At the conference we also enjoyed a dinner celebrating UCTC's tenth anniversary. We paid special tribute to Mel Webber, the Center's founding director, who also founded ACCESS magazine. His career reveals another window on leadership. Mel has consistently displayed the best leadership qualities to his students and colleagues. He is a principled person whose commitment to truth and excellence is unwavering. His scholarship has given us direction; his management of the Center has created new opportunities for students and faculty; and his modesty about his accomplishments is genuine.

Though frustrated by the shortage of real leadership in national, state, and regional transportation policymaking, I am heartened by the examples of these students and this senior professor. Together, they stand as exemplars for those in the surrounding policymaking community.

Martin Wachs

A New Agenda

BY DANIEL SPERLING

The hot issues of the 1970s and 1980s — energy conservation and air quality — are still hot. But they've been transformed and narrowed. Now we debate climate change, new propulsion technologies, and particulate emissions. Energy independence no longer is compelling, and efforts to reduce travel are politically weak.

The towering success story of the past three decades is the dramatic reduction of air-polluting emissions from new vehicles. Actual emission rates of gasoline vehicles have fallen by 70 to 90 percent, and the per-vehicle cost of lowering them has receded from a 1980 peak of about $1400 per vehicle (in today's dollars), when three-way catalysts and computer controls were first introduced, to about $800 in the early 1990s. And only now, with the promulgation of new, ultra-low emission standards, have costs begun rising.

Although some sources report that car emissions have improved by 99 percent, they are misleading. Only new cars tested under artificial conditions have achieved such figures, and only for hydrocarbon and carbon monoxide emissions. With real-world driving patterns, and taking into account deteriorating and malfunctioning vehicle-emission controls, actual reductions are about 70 percent for nitrogen oxides and 90 percent for hydrocarbon and carbon-monoxide emissions. Still, these are quite dramatic declines.

Even greater reductions in emissions from gasoline vehicles are now imminent, with a near-zero-emission gasoline car on the horizon. While it's unclear — many would say doubtful — whether such low emissions will be achieved in real-world driving, especially as cars age, there's no question that even cleaner gasoline cars will soon be available, each costing not more than about $200 extra.

The next challenge is to reduce fuel consumption. Technical fuel efficiency (defined as energy required to provide a fixed level of performance) has improved dramatically since the mid-1970s, a testament to impressive engineering advances. But recently these fuel-efficiency gains have not translated into improved fuel economy (measured as miles per gallon). The fuel economy of new vehicles is now lower than any year since 1981. The reason is clear: Improved fuel efficiency is being used not to improve fuel economy but to sell larger, heavier, more powerful, and more accessory-laden vehicles. New cars in 1996 were 8 percent heavier and 23 percent more powerful than they were ten years before. ➢

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And an increasing number have energy-consuming features such as four-wheel drive. Moreover, consumers are switching from cars to light trucks (pick-ups, vans, and sport-utility vehicles). The market share of light trucks has increased from less than the 15 percent in the 1970s to 44 percent in 1996. With federal fuel-economy standards for light trucks and cars both frozen, at 20.7 mpg and 27.5 mpg, respectively, overall fuel consumption is increasing steadily, in concert with increasing travel. These trends should come as no surprise in the US, where energy and CO_2 reduction receive little support, and per-mile fuel costs are lower than they've ever been.

EVOLUTION IN ENERGY AND ENVIRONMENTAL POLICY

During the past two decades we've developed a more sophisticated understanding of energy and environmental phenomena. We now recognize that the tens of billions of dollars invested in the 1970s in search of energy independence were misguided. We understand better the central role of economics and pricing. We know that early-1980s gasoline prices of $2.50 per gallon (in today's dollars) are unlikely to be replicated on a sustained basis, if ever; and we know that forecasts from that era of $4 per gallon gasoline, although accepted by industry and government, were plain wrong.

Concerns about energy use no longer reflect fears of oil depletion or energy dependence (though that may change in the coming decade). Instead, we're concerned about climate change and the greenhouse gases that cause it. About 25 percent of all human-generated greenhouse gases come from transportation, over half of that from light-duty vehicles. Unlike air pollutants, greenhouse gases from vehicles cannot be reduced easily or inexpensively with add-on control devices. The relationship between gasoline consumption and CO_2 emissions is fixed. CO_2 emissions may be reduced by improving fuel

Invasion of the SUVs.

economy, reducing vehicle travel, or switching fuels — none of which is as easy as reducing pollution from cars.

The political will to reduce petroleum consumption is weak. Fears of high gasoline prices and oil dependency have largely evaporated. Proven world oil reserves are at all-time highs. Only in the latter half of 1997 did the Clinton Administration begin to seriously address greenhouse-gas reduction. As recently as the summer of 1997, President Clinton was more willing to adopt stringent air-quality standards, despite protests from the business community and even many big-city mayors, than to consider European proposals to require controls on greenhouse gases.

Similarly, efforts to introduce alternative fuels have faltered. The transitory nature of alternative-fuel markets reflects shifting public attitudes toward environmental protection and energy security, as well as the petroleum industry's recent success in finding oil. Synthetic fuels of the late 1970s and early 1980s, made from coal and oil shale, failed for environmental and economic reasons; corn-based alcohol fuel, though expensive, has survived since the 1970s thanks to generous special interest subsidies; methanol has quietly disappeared; and environmentally attractive natural gas still accounts for less than 1 percent of the transportation fuels market, though it shows promise. Each captured the fancy of policymakers, but none has approached early expectations. The new entrant is battery-powered and other electric-drive vehicles. Interest in alternative fuels continues mostly because of air quality benefits.

The commitment to clean air is stronger than ever, and surveys report that 80 percent of Americans consider themselves environmentalists. But the growing popularity of environmental values has not spurred anti-car sentiments, as it has in parts of Western Europe. Continued tolerance for the negative effects of cars, even within the organized environmental community, probably reflects our country's ingrained dependence on automobiles. Cars are here to stay. The question is: in what form?

The commitment to clean air has played a pivotal role in a variety of environmental and public interest campaigns. Clean air and the strong regulatory institutions and enforcement procedures created to reduce pollution have been used by advocates not only to support alternative fuels and electric vehicles, but also to fight for other desired outcomes — land use management, community development, social equity, reduced investment in roads, and increased investment in transit. But as air quality improves, will it be possible to premise these energy, environmental, and social initiatives on clean air?

SHAPING THE FUTURE

Current public policy toward motor vehicles must be considered in light of three fundamental considerations:

1. Advances in Technology

The automotive industry is awash in new electronic, information, and materials technologies; and it is just now beginning to apply advanced energy-storage and conversion technologies. Most promising for dramatic energy and environmental improvements, but also most uncertain, are electric-drive powertrains — using electric motors and drivetrains, with electricity supplied either through a wallplug or generated onboard. These electric-drive propulsion systems may include various combinations of batteries, fuel cells, ultracapacitors, flywheels, and advanced electronics, as well as advanced combustion engines (including direct-injection gasoline and diesel engines, gas turbines, and ➢

Atkinson and Stirling engines). These technologies, combined with advances in lightweight materials and energy-conserving accessories and features, have the potential to significantly improve fuel economy and greenhouse-gas emissions and to eliminate air-polluting emissions, without compromising performance and perhaps without adding cost.

But these new propulsion and materials technologies face several obstacles. First, the marketplace does not reward consumers for buying more benign vehicles, nor companies for manufacturing them. Government must intervene to internalize environmental externalities. Second, existing companies are reluctant to invest in technologies dependent on government intervention, especially when such investment would probably require radical transformation of the worldwide automotive industry, including supplier and distribution networks. Third, the market for these new vehicles and fuels will likely take years to develop. Daunting market-entry barriers discourage even the most innovative companies from entering the automotive business, not only with new technologies such as electric drive, but even with conventional vehicles. At the same time, major automakers shy from investing in electric-drive technologies because of large sunk investments in factories, supplier relationships, and human resources; and outside companies are discouraged by the billions of dollars needed to create new manufacturing, distribution, and marketing capabilities. Daimler Benz invested a third of a billion dollars in Ballard to gain access to fuel-cell stack technology.

Prospects for electric-drive vehicles are further undermined by continuing improvements in gasoline-vehicle technology and by the prospect of near-zero-emission gasoline cars. The future of zero-emission mandates and other policies supporting sustainable technologies is tenuous: It rests on projected costs and performance of electric-drive vehicles, uncertain consumer preferences, and the resolve to reduce air pollution further. To be sustained, technology-forcing policies and rules now premised on air quality probably will soon have to be linked to climate change and, perhaps someday, to petroleum dependence.

2. Shifting Commitment to Clean Air

Since the 1960s air quality has been steadily improving almost everywhere in the US. Lead and carbon monoxide levels have dropped dramatically, and consistent progress has reduced ozone pollution. But particulate matter is a serious lingering health problem that may keep air pollution in the national consciousness — and place vehicles, especially diesels, under increasing scrutiny. Will the new focus on particulates have the effect of retaining air-quality rules and laws as the springboard for pursuing energy and greenhouse-gas goals, and new fuel-cell, hybrid, and battery-electric vehicles?

3. Failure of Behavior Reform

Because of the public backlash against efforts to alter driver behavior, especially marginal ridesharing and inspection-and-maintenance programs, air-quality regulators publicly acknowledge that they now invest most of their political capital in promoting new technology. This backlash coincided with the conservative political swing of the early 1990s and the longstanding reluctance of politicians to tax and inconvenience drivers.

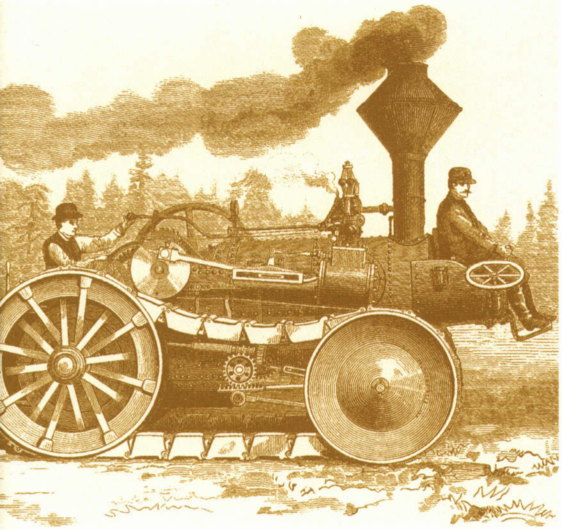
Is this retreat from behaviorial strategies appropriate? Many transportation and energy experts believe so. But is the cautiousness just a cyclical phenomenon? After all, from a historical perspective, consumer preferences and behavior are shifting faster than ever. Shouldn't government play an active role in altering market signals to incorporate market externalities and in nudging travelers toward ecologically benign behavior?

RECOMMENDED POLICY STRATEGIES

The US has developed a transportation system that may be environmentally and economically sustainable — but only if treated in isolation from the rest of the world. Our nation has the resources and resolve to nearly eliminate air-polluting emissions. But greenhouse-gas emissions pose a more stubborn global threat. As the world's largest consumer of oil and emitter of greenhouse gases, the US plays a central political, economic, and technological role in limiting global climate change. And a moral role as well. In light of the current situation, I recommend the following:

1. Encourage Diversity and Experimentation.

Today's transportation monoculture — as defined by our limited mix of vehicles, fuels, road infrastructure, and pricing and parking options — stymies diversification and change. Much greater effort is needed to identify and nurture desirable technologies, institutions, and practices. Certainly our transportation system can be more economically efficient and socially responsible. Technological revolutions in information and communications, materials, electronics, and energy storage and conversion are opening ➢



up vast new opportunties. We should be experimenting with transportation and land use arrangements, infrastructures, and markets to determine what works in which circumstances — to explore new and better options. Paper studies and surveys are a start, but they cannot accurately predict how people will respond to new methods of pricing, new road and vehicle types, or new paratransit modes. We need carefully evaluated field experiments.

2. Flexible regulatory approaches.

Regulation of vehicle emissions and energy should be more flexible and incentive-based. Except in California, every vehicle pollutant is regulated independently, and every vehicle is required to meet the same emissions standard. Fuel economy is regulated separately from vehicle emissions; greenhouse-gas emissions are ignored; and upstream emissions are dealt with independently. There is no procedure for making tradeoffs among different emissions and energy use goals, no method to account for upstream emissions, and little incentive to commercialize innovations ahead of regulatory deadlines. Industry and regulators are pitted in a game of "chicken," better known as technology forcing. The net effect is an economically inefficient regulatory process that is ill-suited to emerging fuel and technology options.

California regulators have taken a first step toward a more flexible, incentive-based system. They've adopted rules that allow limited averaging and banking of emissions, and they've encouraged trading of emission credits among manufacturers. California has also explored, but not adopted, emission standards that account for emissions over the full fuel cycle, known as "equivalent zero emission vehicle" standards. Full fuel-cycle standards are needed to guide the introduction of battery-electric, fuel-cell-electric, and hybrid-electric vehicles. These marketable-credit and fuel-cycle innovations should be pursued more aggressively and broadly.

California, though a leader in bringing more benign fuels and vehicles to market, suffers from a lack of authority to regulate CO_2 and energy use. California needs to work with the federal government to create procedures for trading off energy use and emissions, including greenhouse gases. Doing so would overcome a major shortcoming of today's system: automatic exclusion of any engine or fuel that cannot meet the standard for a single pollutant, even if it provides major improvements in other pollutants, energy use, or greenhouse gases. This is a wasteful practice that will likely exclude promising technologies, including lean-burn engine designs, advanced two-stroke engines, advanced diesel engines, and perhaps even some hybrid and fuel-cell designs.

3. CAFE Reform.

Two anachronistic rules governing corporate-average-fuel-economy standards need to be eliminated: (1) different rules for light trucks and cars, and (2) separate standards for imported and domestic cars. The former has no rational basis, and the latter distorts company behavior in economically inefficient ways. Further, companies should be allowed to trade fuel-economy credits. Many argue that companies would be too proud to buy credits from competitors — which may be true for large companies. But such economically irrational behavior will not constrain smaller companies, and will probably recede for larger companies under shareholder and other pressures.

A broader, more controversial policy would be a tightening of standards. Virtually everyone would benefit from modestly tighter standards, even automakers. Although companies may struggle to reconcile the desire for size and power within mandated fuel-economy standards, that obstacle would affect the whole industry rather than hurting only certain companies. These tighter standards would be more effective if accompanied by at least modest fuel-price increases.

4. Bully Pulpit

Government initiative and leadership is indispensable in addressing large-scale transportation, environmental, and energy challenges, for the simple reason that much of transportation is in the public sector, and environmental problems lie mostly outside the marketplace.

Informed, assertive leadership would be especially pivotal in promoting environmentally benign products. An automaker or oil company trying to sell a more benign car or fuel faces a credibility problem. Government must be more self-confident in supporting and rewarding innovative products and companies. The problem, however, is that government decision-making is becoming more difficult and circumscribed as many constituencies assert themselves in the political process, advocating the interests of local communities, underrepresented groups, businesses, and environmentalists.

5. Technology Transfer to Developing Countries.

It seems certain that the preponderance of greenhouse-gas emissions will eventually come mostly from China, India, and other large emerging nations. Given their less advanced technology and sparse energy and guideway infrastructure, it should be less expensive and easier to reduce emission rates in those countries by improving their energy efficiency and deploying leapfrog technology. The cost of eliminating one ton of emissions in China (below a business-as-usual baseline) would be far less than the cost of eliminating one ton in the US. Therefore it is wise to assist rapidly industrializing countries in slowing their production of greenhouse gases, with strategies ranging from education, training, and technical assistance, to major investments in leapfrog technologies such as electric-drive buses, cars, and bikes. These programs can be conducted by governments, universities, and businesses. Given our much higher emission rates and our high international profile, it is important that efforts to apply new and improved technology in other countries be seen as complementing, not substituting for, domestic efforts.

In the US, we must take a hard look at our current transportation system: at how the nation pursues technological progress, rallies around clean air and other public-interest goals, and brings the powers of government to bear. Given the crucial nature of these societal behaviors and the uncertainty of how they will be borne out, the future is largely unpredictable. It is for that reason that the linchpin of any policy strategy must comprise flexibility, experimentation, and harnessing of market forces. The US, with its large economy and high levels of energy use and greenhouse gas emissions, has a special responsibility to exert leadership in designing such energy and environmental strategies. ◆

This article was prompted by ideas presented at the 1997 Transportation-Energy Asilomar conference hosted by UC-Davis. A summary and detailed proceedings of conference, "Policies for Fostering Sustainable Transportation Technologies," is available from the Institute of Transportation Studies at UC Davis. (916) 752-6548 or jmiller@raphael.engr.ucdavis.edu

Hot Lanes:

Introducing Congestion-Pricing One Lane at a Time

BY GORDON J. FIELDING & DANIEL B. KLEIN

For years, economists have claimed that the only solution to highway congestion is to charge motorists for driving. But it's clear that congestion pricing still remains politically unpopular. People easily recognize the losses they'll incur by paying tolls. But they ignore the prospective benefits, including equitable distribution of driving costs, reduced congestion, efficient use of road capacity, increased public transit and ridesharing, and funding for highway upkeep and expansion.

We propose introducing congestion pricing gradually: by converting high-occupancy vehicle (HOV) lanes to high-occupancy/toll (HOT) lanes. HOV lanes have proven ineffective in reducing congestion, especially those that allow use by two-occupants. HOT lanes would give toll-free passage to three-occupant vehicles (HOV3s) but permit others to pay a peak-hour toll for access.

Existing HOV lanes can be converted to HOT lanes, and planned HOV lanes can be built as HOT lanes instead. Eventually all lanes can be converted to HOT lanes. By getting motorists accustomed to using the tolled lanes, they will see firsthand the benefits of differential road pricing and be more likely to accept full toll roads. Further, HOT lanes would generate revenue to finance their own construction, thereby allowing highway expansion with private capital.

Advantages of HOT Lanes Over HOV Lanes

No one denies that increased ridesharing would help reduce traffic congestion, but most motorists find that ridesharing sacrifices the convenience, flexibility, and privacy of automobiles. Ridesharing has been declining nationwide and this trend is likely to continue.

Sometimes HOV lanes have successfully increased ridesharing. In Orange County, California, for example, two HOV lanes were added to State Route 55 in 1985, and average vehicle occupancy on all lanes increased from 1.17 to 1.26 in one year. Nevertheless HOV lanes are not the best means for increasing efficient use of roads.

During the shoulders of the peak periods, other lanes tend to be congested while HOV lanes are virtually empty. HOV lanes are effective only during the busiest commute hours.

Where two-occupant vehicles (HOV2) have access to HOV lanes, around 43 percent of carpoolers are members of the same household. Many of them would probably travel together even without an HOV lane. Vehicle occupancy can be deliberately increased if access to HOV lanes requires three travelers (HOV3) although this requirement can also reduce the overall number of vehicles using HOV lanes.

HOV lanes are expensive to construct. Adding HOV lanes to the Santa Ana Freeway in Orange County, California, cost an estimated $5 million per lane mile south of Santa Ana and may cost more than twice that much north of Santa Ana. HOV lane expansion is currently funded by fuel taxes and sales taxes, both of which are regressive and charged to everyone regardless of whether they'll receive any benefits.

Converting HOV lanes to HOT lanes would counter these problems. HOT lanes can give toll-free passage to HOV3s and let single-occupant vehicles (SOVs) buy in, thus serving a greater ➢

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➣ **HOT Lanes in the median of I-15 near San Diego.**

number of vehicles. By letting HOV3s pass free, ridesharing can still be promoted. Although HOV2s will have to pay, they'll still have an incentive to rideshare because they can split the cost and enjoy speedier travel. By varying tolls throughout the day, HOT-lane capacity can be kept at an efficient level. Drivers can pay through convenient electronic methods rather than costly manual toll collection. These tolls will pay for the cost of conversion and perhaps additional improvements.

All motorists can have the option of using HOT lanes. Most SOVs can probably use HOT lanes on occasion, depending on their time constraints and the toll cost at the time they're on the road. By having the option for faster travel when they need it, they will become accustomed to paying for highway travel and form a constituency for turning conventional lanes into toll lanes. Eventually complete retrofitting of all lanes might be possible.

Figure 1 shows the phases involved in converting a conventional freeway into a four-lane tollway, beginning with the conversion of a conventional lane into a HOT lane. Figure 2 shows the process of creating a five-lane tollway, beginning with the new *construction* of a HOT lane.

Examples of HOT Lanes in California San Diego I-15 Project

In 1988, Caltrans opened an 8-mile, two-lane, reversible HOV facility in the median of I-15, about ten miles north of San Diego, which gave free passage to buses, vanpools, and HOV2s. In 1991, the San Diego Association of Governments (SANDAG) implemented the three-year I-15 Transit Development and Congestion Pricing Demonstration Project, which permits SOV buy-ins to the HOV lanes. SANDAG was denied funding under ISTEA but received a grant from the Federal Transit Administration.

The first phase of the project, which began in December 1996, allows SOVs to buy a monthly permit that allows unlimited passage for a flat fee. Drivers with permits use a windshield sticker to enter the reserved lanes without stopping to pay tolls. The second phase will implement automated vehicle identification and electronic toll collection; the flat-rate monthly fee will be replaced by a pay-per-trip toll that will vary with the level of traffic congestion.

Initially SANDAG offered 500 monthly passes at $50 each. In February they increased the number of passes to 700. In March, they raised the price to $70 each, to assess how much commuters valued the time savings they received. Despite this price increase, only 16 percent of permit holders chose not to renew, and there were almost 400 applicants on the waiting list. In April, SANDAG increased the number of passes to 900, and cars still flowed smoothly in the reserved lanes.

With a $70 monthly fee, each round trip costs about $2.70 when the pass is put to maximum use. However surveys show that only 60 percent of permit holders commute regularly, and over 80 percent make fewer than five round trips per week using HOV lanes. Further, while some opponents of congestion pricing argue that charging for highway use discriminates against low-income drivers, half the survey respondents report annual incomes of $75,000 or more, but 29 percent have annual incomes of between $40,000 and $75,000, and 4 percent report incomes of less than $40,000.

State Route 91 Project

In 1991, the California Private Transportation Corporation (CPTC) obtained the right to plan, construct, and operate four tolled lanes in the median of State Route 91, the primary link between Orange and Riverside counties, for thirty-five years. The lanes opened in December 1995 and allow free passage to HOV3s, while requiring HOV2s and SOVs to pay tolls.

On January 1, 1997, the peak-period toll increased from $2.50 to $2.75, causing an increased rate of HOV3 formation. From January 1st until the third week of March, the number of HOV3 trips increased by more than 6,000/week, from 32,700 to 39,000 trips/week. In contrast, during the six months preceding the toll increase, the number of HOV3 trips increased by only 3,600 trips/week. This increase in ridesharing suggests that HOT lanes can produce the results that HOV2 lanes have failed to deliver.

Originally the California State Department of Transportation planned one HOV lane in each direction in the median but lacked enough money for construction. By creating HOT lanes instead, CPTC believes that the tolls will cover operating costs and provide a 17 percent return on investment. An additional 6 percent may be earned by meeting special targets for high levels of average vehicle occupancy; and any such excess income must be shared with the state.

HOT Lanes Are Hot

The federal government is showing increasing acceptance of HOT lanes. Now that the Federal Highway Administration encourages HOT lane proposals under the Congestion Pricing Pilot Pricing program, most of the program's available slots are supporting HOT-lane projects. Both the Clinton Administration and Congress plan to reauthorize ISTEA, which created the pilot program, increasing the number of HOT-lane opportunities on Interstate Highways and removing the longstanding federal ban on charging tolls on currently unpriced Interstates. Of course, the bills face opposition by motorist organizations that prefer to drive at the expense of the general taxpayer. ➢

FIGURE 1

Gradual HOT-Lane Conversion Process

STATUS QUO	C	C	C	C	4 Conventional Freeway Lanes
PHASE 1	HOV	C	C	C	
PHASE 2	HOT	C	C	C	
PHASE 3	HOT	HOT	C	C	
PHASE 4	HOT	HOT	HOT	C	
FINAL PHASE	HOT	HOT	HOT	HOT	Complete Retrofitting

This figure shows one direction of an existing four-lane freeway.

C = conventional Lane

FIGURE 2

HOT-Lane Construction Leading to HOT Lane Conversion

STATUS QUO		C	C	C	C	4 Conventional Lanes
PHASE 1	HOV	C	C	C	C	HOV Lane Added
PHASE 2	HOT	HOT	C	C	C	
PHASE 3	HOT	HOT	HOT	C	C	
PHASE 4	HOT	HOT	HOT	HOT	C	
FINAL PHASE	HOT	HOT	HOT	HOT	HOT	5-Lane Toll Highway

This figure shows one direction of an initially four-lane freeway.

Local governments are also warming to the idea of toll lanes. Six California counties are currently considering adding HOT lanes to congested freeways; six metropolitan areas elsewhere, including Phoenix, Houston, Dallas, Minneapolis, and Milwaukee, also have HOT lanes on their drawing boards.

Financial Feasibility of HOT Lanes

Surface-level HOV-lane additions, which generally involve new paving plus new signage and lane restripping, cost about $2 to 5 million per lane-mile. Elevated HOV facilities, built above existing freeways, cost about $19 to 23 million per lane-mile. If HOT lanes are built instead, they might be attractive to private sector investors.

To estimate possible revenues, we offer low and high hypothetical figures. In the low case, assume that congestion lasts six hours a day, five days a week, 52 weeks a year. During these hours, lower-occupancy vehicles pay 20 cents per mile to use the HOT lane, which carries 1,750 vehicles per hour per mile. Seventy percent of vehicles are lower-occupancy ones subject to the toll. Annual revenue per mile in this case is $382,200.

Alternatively, suppose congestion lasts seven hours a day, six days a week, 52 weeks a year. During these hours, the charge for lower-occupancy vehicles is 25 cents per mile to use the HOT lane, which carries 2,000 vehicles per hour per mile, and 70 percent of vehicles are lower-occupancy and pay the toll. Here, annual revenue per mile is $764,400.

To compare this range of revenues with costs, we again offer low and high hypotheticals. Assume that a surface-level HOT lane costs $5 million per lane-mile and that revenues equal the lower of our two estimates. In this case, gross revenues would return only 7.6 percent of construction costs per year to investors, which is not enough to attract debt or equity investments or to pay for operations and maintenance. If we use the high-revenue figure instead, the gross return is 15.3 percent of construction costs per year, a figure approaching a plausible market return but not accounting for operating and maintenance costs.

In a more optimistic scenario, assuming the low-end construction cost of $2.14 million per lane-mile and the high-end revenue figure of $764,400 per lane-mile, the gross return on investment is 35.7 percent. If annual operating and maintenance expenses equal 10 percent of construction costs (i.e., $214,000 per lane-mile per year), the net return on investment is 25.7 percent. This return is more than adequate to attract taxable debt and equity investment, and it exceeds the highest-allowable rates of return in the four existing Caltrans franchises for private toll roads, which range from 17 to 21.3 percent.

Financing elevated HOT lanes is much less feasible due to their extremely high construction costs. To obtain a 15 percent annual return on an investment of $20 million per mile would require unreasonably high rush-hour tolls of about $1 per mile.

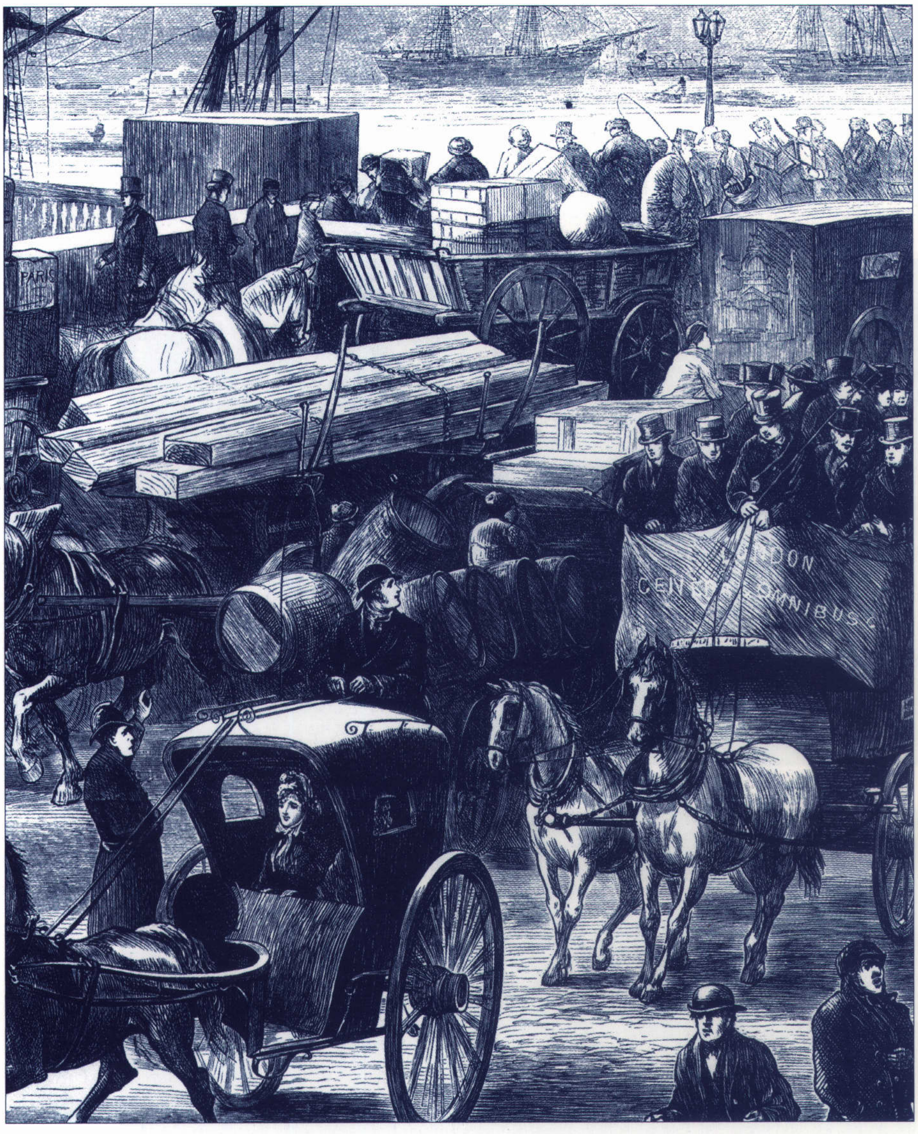
These hypotheticals indicate that some surface-level HOT lanes could be financially feasible as private-sector projects. If revenues are not sufficient to achieve the required commercial rates of return, e.g., in elevated HOT lanes, a public-private partnership as authorized under ISTEA would permit private capital to cover most of the cost. This means that California could build HOT lanes with a relatively small outlay of public funds.

Conclusion

Changing public perception about highway pricing means upsetting the status quo. Drivers would come to appreciate the option of using a fast lane when they need it. Because most people recognize existing rather than prospective benefits, paying tolls for oncefree roads seems like only a loss. This opposition has prevented implementation of highway pricing, which many claim may be the only solution to congestion.

To introduce people to the benefits of highway pricing, we propose converting HOV lanes into HOT lanes. Some argue that HOT lanes will reduce ridesharing: Former HOV drivers might creating an influx of SOV buy-ins that reduces time savings in HOT lanes and causes former ridesharers to travel solo in conventional lanes. However, by increasing the ridesharing requirement in HOT lanes to three-occupant vehicles and by setting the toll at a sufficiently high level, travelers will have an incentive to form HOV3s to save both time and money.

Allowing drivers to buy into HOT lanes will improve use of reserved lanes, thereby reducing at least some of the congestion in conventional lanes. Drivers would realize the advantages of having an optional fast lane, grow accustomed to differential service in highways and, we believe, come to accept congestion pricing. ◆



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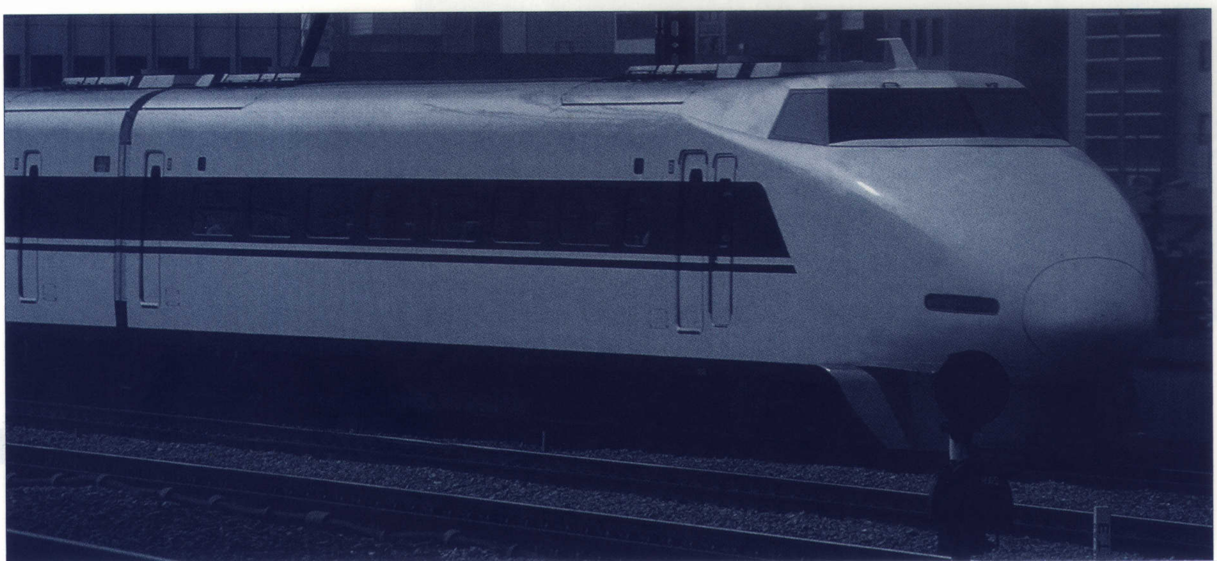
Balancing Act:
Traveling in the California Corridor

BY ADIB KANAFANI



On a flight from San Diego to San Francisco, I sat beside a woman who by coincidence was also returning from the August 1997 demonstration of automated highways. I expressed my enthusiasm for full automation to turn highway lanes into automated electronic railroads, with individual automobiles, akin to rail cars, hooked up electronically. Off the highway, these cars would revert back as individual automobiles to provide the ubiquitous local accessibility people expect from cars. The railroad analogy sparked the interest of my traveling companion, whom I'll call Mary Smith. She wondered why we shouldn't build a railroad instead, saying that automated highways would be costlier and would require higher subsidies.

I noted that costs and subsidies are different issues, and that one mode's higher costs do not necessarily mean higher subsidies. Subsidies occur only when costs are not fully internalized, that is, when they are not fully paid by users, but spread to society at large. Even if rail and automated highways were to cost the same to build, I said, rail would probably require larger subsidies. That's because most of the additional electronics in automated highways would be vehicle-borne and hence directly paid for by auto owners. Indeed, I added, automating highways might result in lower subsidies to the overall system because it would be designed to lower the externalities of noise and air pollution.

Even with today's technologies, high-speed rail (HSR) is not only costlier than its competitors in the California Corridor — highway and air — it also would require larger subsidies, I said. But I was reluctant to enter into a debate about the wisdom of building a high-speed railroad in California.

When she pressed me for details, however, I reached into my briefcase for a recent report that students and I had prepared on this very subject. It discusses air, highway, and rail costs for the California Corridor, then explains how these modes compare in terms of public outlays, user-paid revenues, and subsidies. Although we both agreed that financial analysis alone is not sufficient to determine public transportation policy, we entered into an engaging dialogue:

AK: Our research looked into the full costs of the three transportation modes in the California Corridor. We estimated HSR's at about 24¢ per passenger-kilometer, about the same as highway cost (23¢), but nearly twice that of air (13¢). To put these numbers in the California context, consider that the full cost of a 500-km trip is $120 by rail, $115 by highway, and $65 by air.

MS: Yes, but full costs include both internal and external costs. Rail may be most expensive to build, but it has advantages of lower external environmental costs.

AK: Look at Table 1. Rail is the most expensive infrastructure to construct, all right — nearly ten times the cost of highway or air transport. Its operating costs, including money and time costs, are comparable to air, but nearly half those of highway, where slower speeds and congestion make time costs so high. We've also estimated the social costs of accidents, noise, and air pollution. Here, rail is the cheapest mode. Its noise costs are similar to the other modes', but it generates negligible air pollution.

MS: It's also the safest mode.

AK: You're right! We assume zero accident cost for HSR, expecting a California system will be as safe as TGV and Shinkansen have been. As you can see, highways are by far the costliest in this category. But it's debatable whether to count accidents as external costs, since they're borne mostly by motorists. It's true that incident-management and health-care costs are borne by society at large, but they're difficult to disentangle.

MS: Your table says highway and rail are comparable in full cost. So why not build rail instead of expanding the highway system?

AK: The reason is the subsidies required by rail. We need to know which systems cover their costs, and which require public subsidies — and the question of whether subsidies are justified is another issue.

MS: You say that rail requires higher subsidies. What can you tell me about the subsidies now enjoyed by air and highway users ➢

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TABLE 1

Comparisons of Full Cost: Air, Highway, and High-Speed Rail

COST CATEGORY	¢ per passenger-km		
	AIR	HIGHWAY	HSR
Infrastructure Cost	1.82	1.20	12.9
Carrier or User Cost	9.46	8.60	6.0
Time Cost	1.31	10.46	4.4
Accident Cost	0.04	2.00	0.0
External Cost	0.52	0.71	0.40
Total	**13.15**	**22.97**	**23.70**

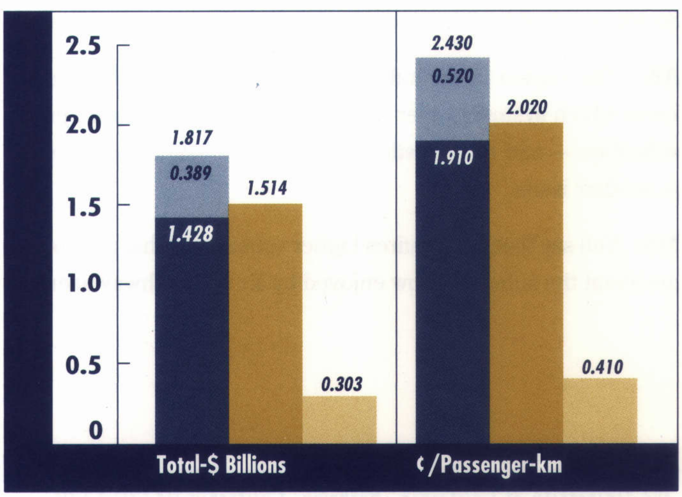
TABLE 2

Public Balance Sheet for Aviation in California, 1993

OUTLAY CATEGORY	$ MILLIONS	REVENUE CATEGORY	$ MILLIONS
Airport Development Outlays	159	Ticket & Other Taxes	729
ATC Burden	610	GA Fuel Taxes	8
State Grant Program	1	Local Airport Revenue	777
Acquisition & Development	3		
Loans	1		
Local Airport Expenses	654		
Total Outlays	**1,428**	**Total Revenues**	**1,514**

FIGURE 1

AIR: Costs, Revenues, Subsidies



in California? How do these compare with the subsidies you project for rail?

AK: To answer this question we constructed a balance sheet comparing public outlays with user-generated revenues. The difference represents a net surplus generated by the system and its users, or a subsidy received by them. External costs of noise and air pollution are public outlays in this balance sheet because they're essentially borne by society. Our research found that none of the three systems pays for itself. Air and highway cover their internal costs and pay only part of their social costs. Rail cannot cover even its internal costs.

MS: In other words, air and highway are actually being subsidized by the public because they don't cover the full cost of their noise and pollution. It would be useful to compare the balance sheets for each mode.

AK: We did that, conducting a different accounting for each of the modes, fitted to the way each is financed. For air transportation we considered the following outlays: airport development grants from the Aviation Trust Fund, local airport expenses for operations and maintenance, and locally funded development. We also considered the cost of air-traffic control (ATC) services, by allocating the costs of these services to flights on the basis of the amount of flight activity generated in California.

MS: What about revenues generated by the airport system?

AK: These are ticket and freight-waybill taxes paid directly to the Trust Fund; general aviation fuel taxes that go to the state; and local airport revenues paid back to local governments. The balance of these revenues and outlays is shown in Table 2.

MS: Your figure shows that the revenues exceed the costs for a surplus of about $86 million. So the airport system is more than paying for itself.

AK: That's because Table 2 doesn't include the external costs of noise and air pollution. These are estimated from Table 1 and total $389 million for California. The balance sheet changes, and the air transport system in California ends up $303 million in the red. That translates to a subsidy of 0.4¢ per passenger-km. The results are summarized in Figure 1.

MS: So, when considering social costs, the air system is being subsidized — the costs of noise and pollution aren't recovered from the users.

AK: They're partly recovered and partly internalized. For example, the aviation trust-fund makes grants for noise abatement, which means that we're recovering some of these social costs by direct ticket and freight-waybill taxes. But this recovery is limited, and unfortunately we weren't able to find reliable figures of its magnitude for California.

MS: How can we then fully recover these costs?

AK: The subsidy according to our calculations is 0.4¢ per passenger-km. This could be recovered by a ticket surcharge on the order of $2.25 for a typical California Corridor air trip. It's easy to assume that such a surcharge will not appreciably affect the demand for air trips, which means that air transportation system in California can be made to fully cover its costs.

MS: Does this mean we're each receiving a $2.25 subsidy from taxpayers for this flight to San Francisco?

AK: Each way!

MS: What about highways? Taxpayers must be subsidizing them heavily.

AK: The outlay and revenue categories are different, but the accounting is similar. The numbers are summarized in Table 3, which shows total outlays in California of about $8.6 billion, and revenues of $12.4 billion.

MS: Do you mean that highways are generating a surplus of nearly $4 billion on an investment of $8.6 billion in California alone? Highways look like a good business.

AK: Not really. The highway system looks like good business only because of the unrecovered social costs. If we add these, the balance sheet turns upside down. Using the numbers in Table 1, we estimated social costs for California at $4.57 billion, which wipes out the surplus generated by the system and leaves us with the balance shown in Figure 2. The deficit is $800 million.

MS: And to recover these costs?

AK: It shouldn't be difficult to recover this implied subsidy, because it totals to only 0.12¢ per passenger-km. At prevailing auto occupancies and vehicle mileage this subsidy can be recovered with a mere 4¢ per gallon additional gas tax. Such a surcharge wouldn't have a significant impact on demand for auto trips. I don't think a $2.25 surcharge on air tickets and a 4¢ gas tax surcharge would deter people from these two modes in the California Corridor.

MS: But suppose your estimates of social costs are too low. What if we double your numbers? Could air and highways still recover their costs with manageable surcharges?

TABLE 3

Public Balance Sheet for Highways in California, 1993

OUTLAY CATEGORY	$ MILLIONS	REVENUE CATEGORY	$ MILLIONS
Capital Outlays	5,504	Taxes & Tolls	5,952
Traffic Management	2,761	License Fees	4,486
Interest & Other	347	Interest Income	1,951
Total	**8,612**	**Total**	**12,389**

AK: If we double the estimated social costs, then the gas tax surcharge would jump to about 35¢ per gallon. The airline ticket surcharge would jump to about $5 per trip. It's clear that the highway figures are more sensitive, because social costs represent a higher proportion of the total for highway than for air.

MS: But such surcharges might alter demand.

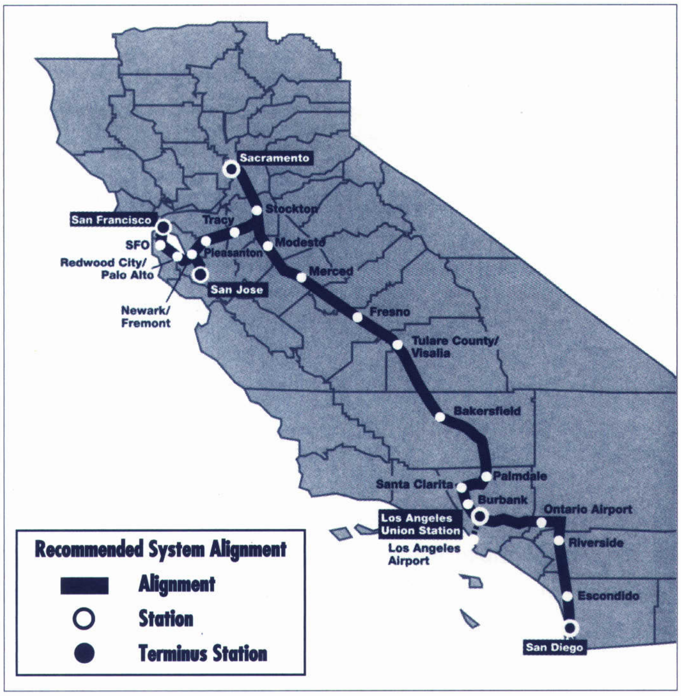
Me. Probably by diverting more highway traffic to air, which in itself will reduce social costs of the overall system!

MS: Hmm! Now what can you say about high-speed rail? Can it pay for itself with a manageable and competitive fee and tax structure? What subsidies do you estimate for a California TGV?

AK: Here we had to do a different accounting, because we don't have an existing system to furnish empirical data. We used estimates of capital and operating costs for a system linking the California Corridor that were prepared by the California High-Speed Rail Commission. Commission studies also estimate market share and consider the revenue potential of the system. Current estimates foresee a very-high-speed train, running at over 300 kph, connecting the Corridor from Sacramento to San Diego, and generating about 20 million passenger-trips and about 10 billion passenger-kilometers annually by the year 2015. We converted the Commission's estimates to the following equivalent annual costs in 1993 dollars: $595 million in revenues, and $1.5 billion in costs, of which $43 million are in external costs. This is shown in Figure 3.

MS: These numbers are quite dramatic. This is a deficit of nearly $900 million, not too much higher than the highway system deficit of $800 million. Surely we can recover these from fares, just as you suggest for air and highways.

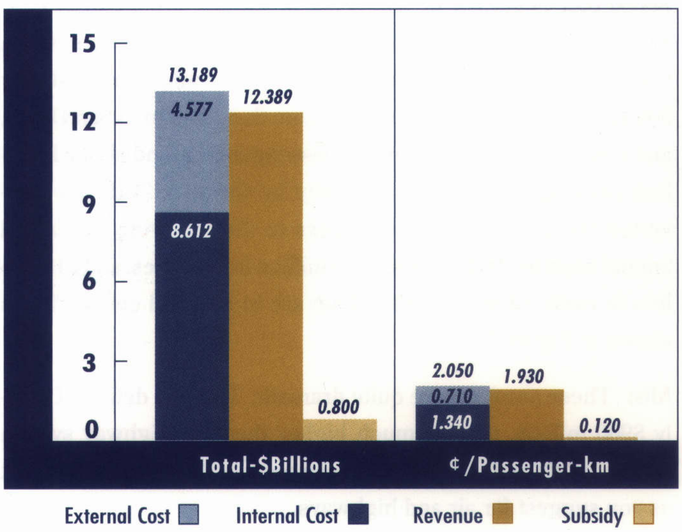
AK: But this deficit amounts to 9¢ per passenger-km. To balance the books and recover this would mean a fare surcharge ➢



Route through California Corridor recommended by the California Intercity High Speed Rail Commission.

FIGURE 2

HIGHWAY: Costs, Revenues, Subsidies



on a SF-LA trip of about $45. Compare this to the $2.25 surcharge on air fares. Such a large fare surcharge most likely will seriously affect rail ridership. Current estimates are based on rail fares that are maintained at 30 percent less than average air fares, resulting in a market share for HSR of about 50 percent. These estimates are already rather optimistic. Recall that Commission studies estimate nearly 20 million annual HSR trips in 2015, which is about the same as rail traffic in the whole of the Northeast corridor today. It's therefore quite unlikely that an equilibrium can be found with such a large surcharge and that the books can be balanced without subsidy.

MS: Are there other possible sources of revenue?

AK: Yes, we can count on revenues generated at HSR stations. We estimated $777 million in local airport revenue. About half is from aeronautical charges such as landing fees. The other half is commercial revenue from concessions and parking. It's fair to assume that HSR stations will have a similar revenue-generating potential.

MS: That's a fairly good assumption. Would it avoid a subsidy?

AK: Assuming a revenue potential of $350 million annually, the deficit would drop by about a third; and so too would the subsidy. The necessary ticket surcharge would drop to $28, still too high to maintain both the market share and sufficient rail traffic to generate these commercial revenues at rail stations.

MS: It may be easier to balance the books for highways and air, but sometimes we use subsidies as instruments of policy or as means of mitigating social costs, such as environment impacts or traffic accidents. Suppose people value air quality much more than current estimates of social costs suggest?

AK: Based on our sensitivity analyses we found that even with a ten-fold increase in the value of environmental quality, the deficit for high-speed rail would still be twice that for air and highways. Are people willing to pay such high surcharges to balance the books? And if they're not, should the state do it for them through taxation?

MS: Perhaps we should build more highway and air transportation facilities, since they generate surplus relatively easily.

AK: What would you do with the surpluses generated?

MS: Finance the high-speed rail system, of course! According to your tables, an additional 3¢ of highway gas tax would cover the deficit of the rail system. You estimate 4¢ of gas taxes to cover the highway system. If we charge only the 3¢ needed to finance the rail system we would still be subsidizing highway users by 1¢ for each passenger-km. This seems a good deal to me. I mean you must consider all the advantages of rail which your financial analysis ignores. Consider the local accessibility and the economic-development effects of a rail line going down the California Corridor. Consider the jobs created by building the rails and all the trains that have to run on them for decades to come.

* * *

I wanted to remind my flight companion that she was overlooking air transportation in this comparison. But we'd just landed in San Francisco and, perhaps fortunately, I had no opportunity to comment further, other than to agree that the subject deserves further discussion. ◆

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FIGURE 3

RAIL: Costs, Revenues, Subsidies

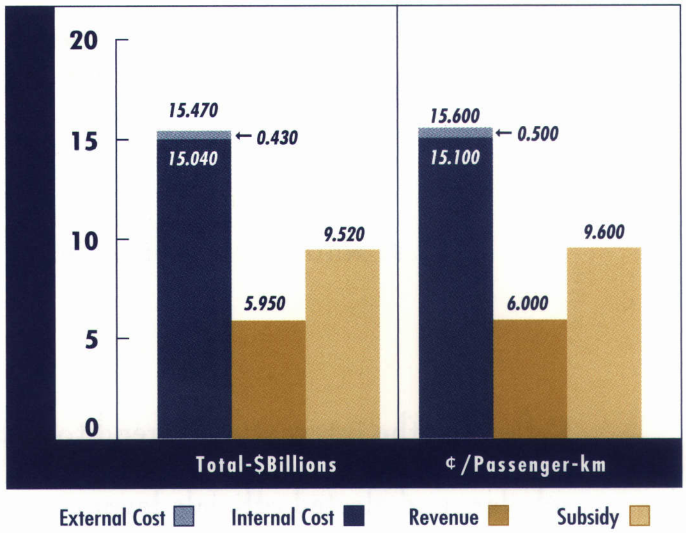
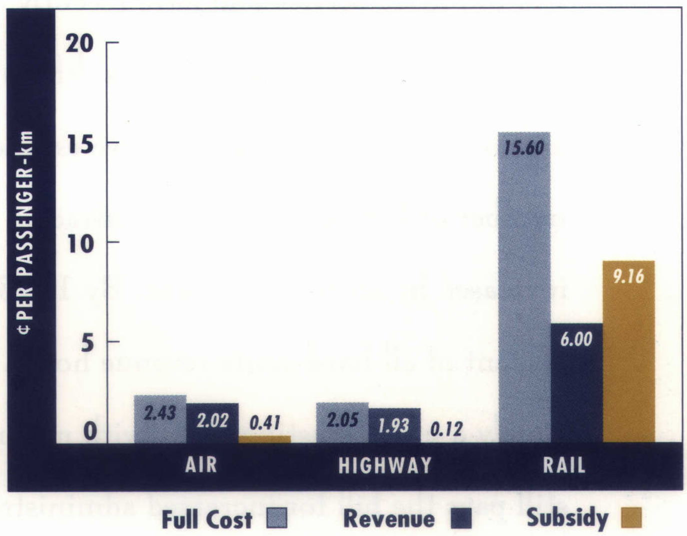


FIGURE 4

COMPARISON OF ALL THREE MODES



Does Contracting Transit Service Save Money?

BY WILLIAM S. MCCULLOUGH, BRIAN D. TAYLOR, & MARTIN WACHS

Reflecting the international trend toward privatizing government services, many scholars and elected officials favor contracting out public transit services. During the 1980s many states and the federal government implemented policies that explicitly favored private-sector participation in the provision of transit service. Proponents continue to argue that contracting will bring dramatic cost savings and improved service and have recently convinced many transit agencies to switch to contracted service. It is difficult to know precisely how many services are contracted nationwide, but we estimate that between 1989 and 1993 the number of US agencies that contracted out their fixed-route motorbus services increased by about 27 percent. By 1993 contracted bus service made up about 6 percent of all fixed-route revenue hours. Opponents claim that contracting is simply a union-busting tactic with minimal net savings because the public sector still pays the bill for increased administrative and management costs, while receiving lower-quality service.

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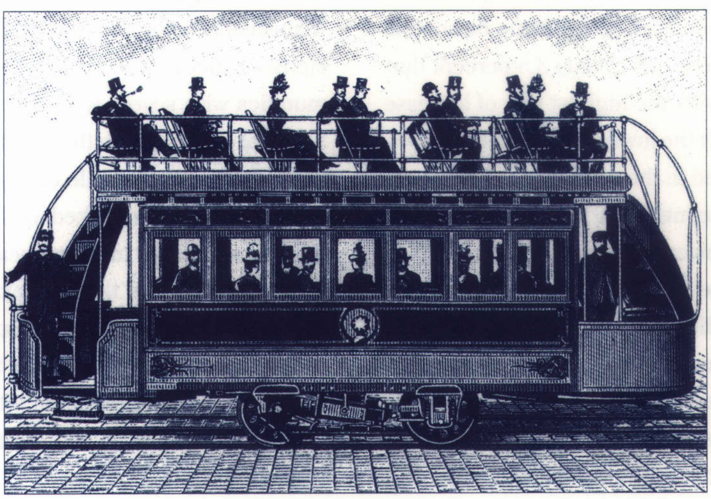
In presenting their cases, both sides often dispute basic data, making it difficult to assess the efficiency of contracted transit service. When the Los Angeles County Transportation Commission analyzed the effects of contracted bus services in the suburban Foothill Transit Zone in the late 1980s, they claimed savings in operating costs of 48 percent. But the Southern California Rapid Transit District, the regional operator that formerly operated the services, hired another consultant who reported no significant savings at all. A third report by an independent evaluator concluded that both were wrong, and that actual savings ranged from 24 to 34 percent.

The Federal Transit Administration estimated that service contracting can produce operating-cost savings, per revenue-vehicle-hour of transit service, of between 25 and 30 percent. A Denver study found savings from contracting ranged between 15 and 30 percent; and a study in Yolo County, California, showed savings to be about 35 percent. But Eliott Sclar of Columbia University, a vocal critic of transit contracting, claims that these figures are grossly overstated. He cites examples from Denver, New Orleans, New Jersey, and Westchester County, New York, in which contracted services are found to be more expensive than publicly operated ones.

Proponents of contracting often claim that public agencies cannot operate efficiently and generate higher costs because of wasteful bureaucracy, bungling, and fraud. Research clearly shows, however, that the vast majority of savings from contracting transit service results from reduced labor expenses. Private contractors pay their workers lower wages and fewer fringe benefits, and they are less often bound by restrictive work rules. Every private contractor who bid to operate LA's Foothill Transit service proposed bus-driver wages well below $10 per hour, while the Southern California Rapid Transit District, the former governmental operator, paid drivers $14.69 per hour. When the Bay Area Rapid Transit District accepted bids on feeder bus service to their train stations in 1989, every private bid had wage rates below $9.10 per hour, while the sole public competitor, AC Transit, submitted a proposed wage rate of $11.01 per hour. Similar patterns have been reported in studies of Houston, Denver, and San Diego.



Further, union contracts usually require public transit agencies to pay overtime penalties when drivers work "split shifts" — driving during morning and afternoon rush hours with a break between. To avoid these costs, private transit companies tend to increase the proportion of part-time drivers who work during only one peak period per day. Government transit agencies don't have this option because their labor agreements usually limit the proportion of employees who can be part-timers.

We tried to make sense of the divergent data and to perform our own statistical analyses to determine the costs and benefits of contracting transit services. The vast majority of previous studies looked at single cases and compared small, single-mode contracted service providers with large regional operations with extensive service responsibilities and political obligations. In contrast, we examined a national sample of 142 bus transit services, including some operators with fewer than 25 buses and others with more than 1,000. Some operators in our study contracted out all service, others contracted-out none, and many contracted for part of their service while directly operating the rest. Most previous studies compared transit-service costs in a single year, but we examined trends over a five-year period.

IS CONTRACTING A BARGAIN?

Contrary to expectations, we found the lowest operating costs per hour of bus service among those that did no contracting at all, and the highest rates among those that contracted out some of their services. Those that contracted out all their services had intermediate values (See Figure 1). The 87 transit operators that did no contracting had average hourly costs in 1993 of $45.74 per hour; the 29 operators that contracted-out all of their services had average hourly costs of $47.71; the 25 operators that contracted out some but not all of their services experienced hourly bus operating costs averaging $66.84.

Apparently, contracted transit service is not always cheaper than directly operated services, and there is no clear-cut general rule on when contracting will work. In all likelihood, agencies that choose to contract for some of their services do so precisely because they are located in high-cost areas and have an incentive to try new ways to reduce costs. They may experience cost ➢

savings through contracting even though their hourly rates are highest among the three groups. Similarly, agencies that don't contract for any of their services may have no reason to consider contracting because they happen to be in lower-cost service areas.

Interestingly, between 1989 and 1993, agencies that did no contracting experienced cost increases of 14.6 percent, while agencies that contracted for all of their services experienced increases of 9.5 percent. Those contracting out some but not all their service experienced cost increases of only 3.5 percent during the same period. In other words, the highest rate of increase in costs occurred in the group with the lowest hourly-service cost, while the lowest increase occurred in the group with the highest service cost. It appears, then, that contracting helped slow the rate of increase in high-cost areas. However, between 1991 and 1993, costs for contracted services rose faster than costs for non-contract operators. Our research thus suggests that most of the improvements in cost efficiency occurred soon after services were contracted, and that in time these gains began to slow down.

We further tested the effects on hourly bus operating costs of fourteen factors that we hypothesized may contribute to cost differences among transit companies across the US. Besides the extent of contracting, we studied various relevant characteristics of transit companies and their service areas. We looked at population density because higher density may be more favorable to efficient transit than lower densities. We examined cost of living differences between different regions to account for wage differences and other operating expenses. We included fleet size because larger fleets are reported to have higher operating costs than smaller ones. We considered measures of snowfall and precipitation because it probably costs more to run buses in communities with severe weather than in milder climates. We studied local traffic congestion because slow vehicle speeds produce high labor costs per mile of transit service.

Our findings shocked us. Transit contracting, a much-hyped public policy issue in recent years, had far less influence on transit operating costs than we expected. In fact, the presence or absence of contracting had a smaller effect on costs than any of the thirteen other variables. By far the variable most influential to cost efficiency is the ratio of total vehicle-hours to revenue-vehicle-hours — which measures the proportion of time that a bus is actually carrying passengers when on the road. If a bus company operates a far-flung network with routes located far from the garage, buses must cover many nonservice miles. This "deadheading" adds greatly to operating costs. This factor was 78 times as influential in determining the cost of transit operations as was contracting. Whether operated directly or by contractors, services that require much deadheading are much more expensive than those that do not.

Another variable influential in determining the hourly cost of bus service was the ratio of drivers' pay-hours to total bus-hours, which measures the efficiency of labor. It is important to note that drivers often get paid for hours when they are not actually driving and carrying passengers. For example, suppose a bus company wants to operate extra service during rush hours, from 6:00 to 10:00 a.m. and from 4:00 to 8:00 p.m., totalling eight revenue hours. Labor contracts with unions often require that drivers who work both rush-hour periods be paid for the six hours in between, although they are not driving during that time. Most contracts even require payment of overtime wages for work time in excess of eight consecutive hours. So a driver who works the two rush-hour periods may be paid for seventeen pay hours (6:00 a.m. to 8:00 p.m., plus time-and-a-half wages for the six hours exceeding eight consecutive hours) even though the bus is in revenue service for only eight hours. To avoid these payments, companies may wish to hire part-time drivers, but most labor contracts also restrict the number of part-time workers.

Of course, we don't mean to imply that transit contracting is insignificant. In fact, contracting, or even the threat of contracting during contract negotiations with unions, can make a big difference depending on the circumstances. For example, if a transit operator has routes that entail substantial deadheading, it may attempt to solve that problem directly: by locating garages nearer to routes, by eliminating unproductive suburban routes, or by making bus routes more efficient. Or, it may contract out some of its service. Similarly, if a transit operator ends up paying for inefficient labor, transit managers may consider new labor agreements, or they may consider contracting out services. Contracting offers one tactic for reducing costs, but it should not be considered the only solution.

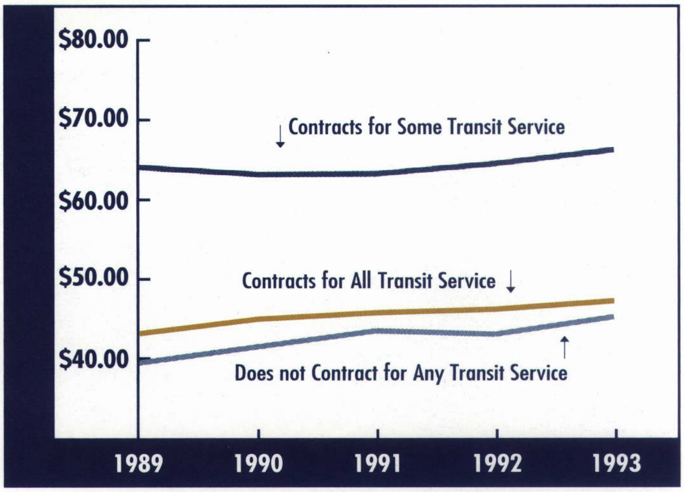
Contracting may also be used to quickly start or expand services. This is particularly true for public agencies that have little experience in transit operations. It is important, however, that a competitive environment be developed so that one contractor cannot monopolize transit service in a region.

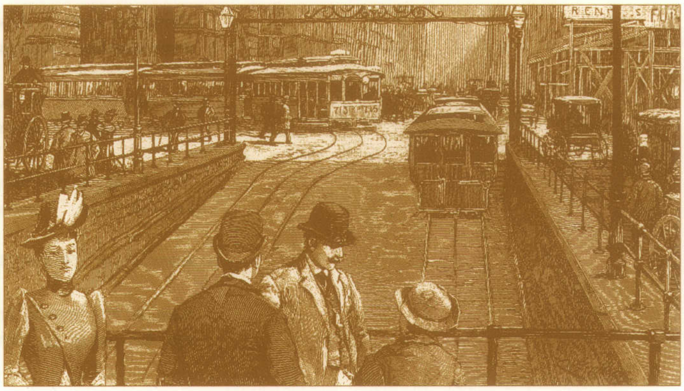
CONCLUSION

So, does contracting save money? It depends. Transit services operated by private contractors are not always less expensive or more efficient than services directly operated by transit ➢

FIGURE 1

Operating Expense per Reveue Hour by Type of Fixed-Route Transit Operator





agencies. At the same time, contracting for transit services is not unimportant. We found that a complex set of conditions influences transit operating costs and efficiency. Often these conditions include unfavorable operating rules, service to distant communities, and high wage rates. In some cases contracting for service may be the best way to achieve cost-effective operations; in others the problems causing high costs are best addressed by other strategies. Contracting is a viable option for many transit systems, but it is certainly not a panacea. ◆

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Tracking Accessibility

BY ROBERT CERVERO

Much of transportation planning and engineering today aims at reducing average delays, increasing passenger throughput, and in general keeping traffic flowing smoothly and safely. These are the field's principal measures of performance. But is a quick, uncongested trip indicative of a well-planned, accessible community?

It is axiomatic, yet worth repeating, that the physical act of traveling is a *derived* behavior. People travel to engage in activities at other places — work, recreation, shopping, worship, health care, and so on — not because they wish to ride a car or bus. We must distinguish between accessibility, which relates to people's opportunities to get where they want to go, and mobility, which relates to the ease of actually traveling between two or more points. Accessible neighborhoods are those within easy reach of desired destinations either because they are located nearby or because transit and highway connections are fast and direct. Improvements in accessibility should focus on *people, places, and social activities,* not the transportation system itself.

People often misunderstand the concept of "accessibility," which may partly explain why expanded access is seldom an explicit objective in transportation planning. In contrast, mobility, or the lack thereof, is something that we all regularly experience firsthand.

The term "accessibility" has various meanings depending on one's scale of analysis. Within a metropolitan context, accessibility relates to opportunities to reach places across a region. Those preparing long-range metropolitan transportation plans deal with *regional accessibility.* But at a micro-level, *site accessibility* refers to the relative ease of gaining entry to a specific destination. For example, a road with multiple curb cuts provides ready access to adjacent parcels, thereby increasing site accessibility; at the same time, such a road decreases mobility, since frequent ingress-egress maneuvers often interfere with traffic. Transportation modes and facilities themselves also affect site accessibility. Thus, traffic engineers distinguish highways that have limited access, such as those restricted to grade-separated interchanges, from those having unconstrained access. All federally funded transit projects must be fully accessible to disabled persons under the Americans with Disabilities Act, which means providing accommodations such as low-floor buses and rail stations with ramps and elevators.

In this article I'm using the term accessibility in its regional context, that is, residents' opportunities to reach major destinations across a metropolis. Today, few if any American metropolitan areas are systematically tracking trends in regional accessibility and it remains unclear whether decisions on resource allocation — e.g., whether to expand a road's capacity, where to site a major new shopping center — are helping to improve transportation efficiency. It is also unclear how different socio-economic groups are affected by investment decisions: Who gains or loses access to job opportunities following construction of a new rail system? When big companies change work locations, are various groups affected differently?

Some scholars argue that a root cause of joblessness and persistent poverty is the increasing physical isolation of inner-city residents, especially African-Americans, who lack transportation ➢

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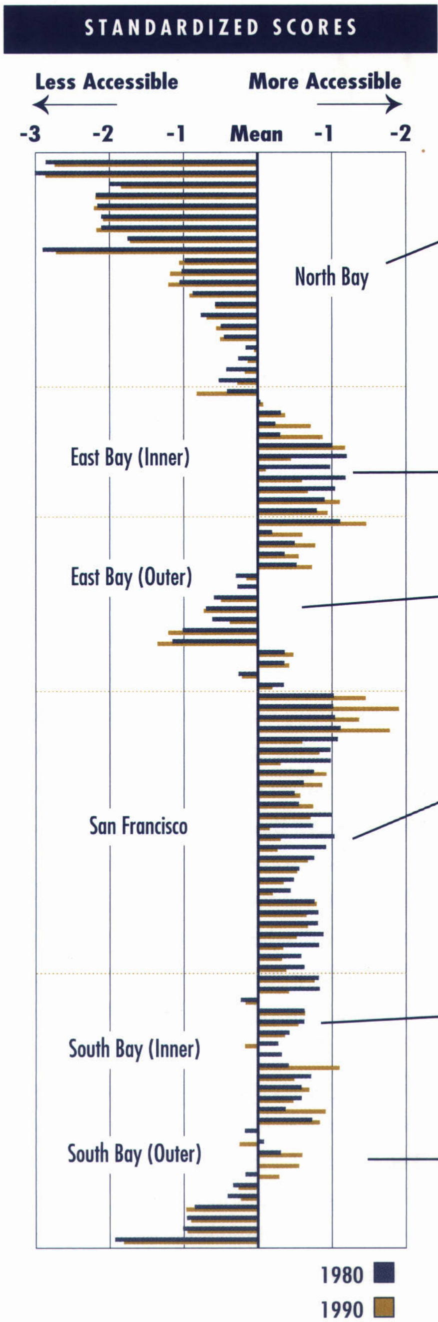

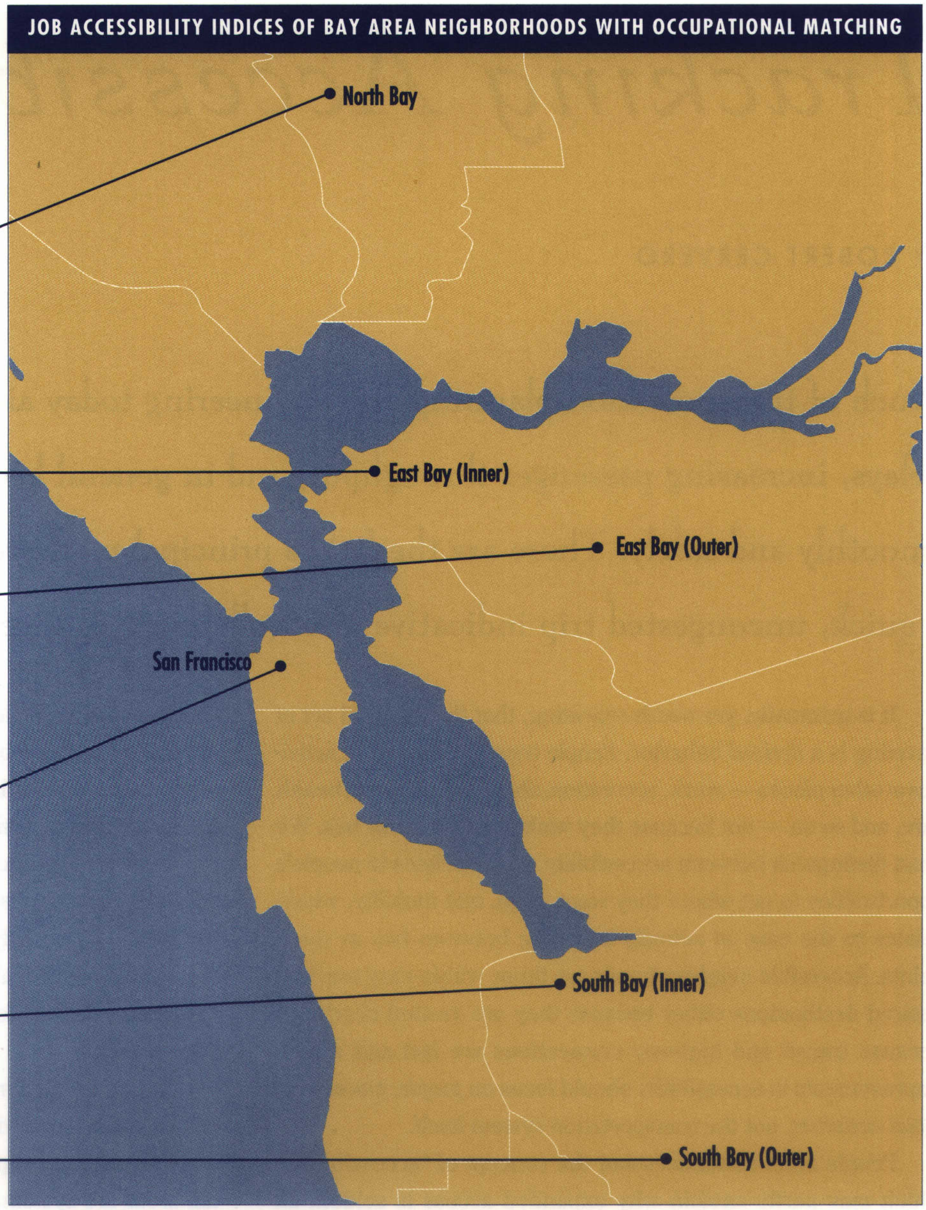

to job opportunities in the suburbs. They call this the "spatial mismatch" problem. These concerns prompted the federal government to initiate the "Bridges to Work" program in 1996, a welfare-to-workfare movement in which reverse-commute van services link tens of thousands of inner-city residents to suburban jobs in Baltimore, Milwaukee, and about a dozen other US cities.

JOB ACCESSIBILITY IN THE SAN FRANCISCO BAY AREA

As part of a study designed to operationalize the use of accessibility as a measure of transportation performance, students at UC-Berkeley and I examined trends in regional accessibility within the San Francisco Bay Area. We examined only one type of destination — the workplace. Our study traced changes in regional accessibility to jobs between 1980 and 1990 across a sample of 100 neighborhoods in the nine-county Bay Area. We hoped to demonstrate how different measures of job accessibility can be used to track system performance in long-range transportation-land use planning. We also sought to assess whether the spatial mismatch hypothesis holds in the Bay Area.

Using Census data, we developed job-accessibility indices that weighed the relative distances, expressed in miles, of working-age residents in each of 100 sampled neighborhoods to regional job opportunities, assuming trips were made by car over the regional highway network. We did not study accessibility by transit, nor did we adjust for variability in car ownership since over 92 percent of households in the surveyed census tracts owned one or more cars.

We refined in our study to account for the degree to which the occupational backgrounds and skills of residents matched up with the kinds of jobs available in each of the Bay Area's 1382 Census tracts. The resulting "accessibility scores" were standardized so that job-accessibility of each neighborhood could be compared to the regional average. An accessibility score of +2, for example, indicates that a neighborhood is considerably more accessible to job opportunities, accounting for the degree of occupational matching, than that of the average working-age Bay Area resident.

In both 1980 and 1990, the neighborhoods most accessible to jobs, were those located in central areas: San Francisco, the older parts of the East Bay (Oakland and Berkeley), and northern Santa Clara County, around the Silicon Valley. Most of these neighborhoods averaged job-accessibility scores of 0.7 to 1.5, well above the regional average of zero. Peripheral neighborhoods, specifically those in Santa Rosa and Vacaville in the North Bay and Morgan Hill in the far South Bay, tended to be the least job-accessible. Their accessibility scores were in the range of -2 to -3. Figure 1 maps the 1980 and 1990 scores for all 100 sampled neighborhoods. The real value in these numbers lies in their comparisons with other neighborhoods' scores. The Bay Area's more centralized neighborhoods are three to four times more accessible to job opportunities than peripheral ones.

Underlying these fairly straightforward findings, however, are two alarming patterns. *First,* disparities widened during the 1980s. Between 1980 and 1990, the most job-accessible (i.e., central) neighborhoods experienced the greatest gains in accessibility, while the least job-accessible (i.e., peripheral) ones suffered the largest losses. This occurred despite rapid suburbanization of jobs during the 1980s. *Second,* well-to-do neighborhoods were generally much more accessible to jobs for which their residents were qualified than were poorer neighborhoods. Thus, our measure of "match effect" — the relative importance of occupational matching toward a high job-accessibility score — was strongly associated with income and race. In 1990, the ten neighborhoods with the highest match effect averaged annual household incomes of over $80,000, well above the regional average. The same ten neighborhoods averaged an unemployment rate of less than 3 percent, compared to a regional 7 percent average. In contrast, the greatest job-opportunity mismatches were in the region's poorest neighborhoods — San Francisco's Tenderloin and Mission districts, East Oakland, and East Palo Alto.

These findings likely reflect several dynamics. Many service-industry, manufacturing, and back-office jobs left central cities during the 1980s. The well-educated, high-salary workers could more easily move to neighborhoods reasonably close to desirable jobs for which they were qualified. For example, Russian Hill in San Francisco, which recorded the highest match effect in 1990, attracted hundreds of executives and highly paid young professionals seeking both urbanity and close proximity to front-office jobs in downtown San Francisco. Also, leading Bay Area firms tended to locate near potential pools of professional and executive workers during the 1980s. However, because of ➢

factors such as exclusionary zoning and housing discrimination, poorer households stuck in often declining inner-city neighborhoods found it increasingly difficult to access jobs for which they were qualified during the 1980s.

UNEMPLOYMENT: RACE VERSUS SPACE

The spatial mismatch hypothesis is highly controversial because empirical evidence is inconsistent. A late-1980s study in Los Angeles found that job accessibility accounted for 30 to 50 percent of the difference in employment rates among black and white teenagers. Others counter that overt racial discrimination, not accessibility, largely explains inner-city unemployment. In an influential study of black households in Chicago, David Ellwood of Harvard's Kennedy School found comparably high unemployment rates among blacks with similar education levels regardless of whether they resided on the southside, away from job opportunities, or west of the city near the booming Interstate 88 employment corridor. He concluded that "race, not space" was the chief reason for chronic unemployment among blacks.

Our data allows us to address the "race versus space" controversy for the Bay Area. Using a statistical technique called path analysis, we explored how the racial composition of a neighborhood affects unemployment rates, accounting for job-accessibility, occupational matching, educational level, and automobile ownership.

Ideally we'd have found the correlation between race and unemployment spurious. We hoped to find little difference in joblessness among racial groups. That is, if race doesn't matter, employment rates would be comparable among 100 African-Americans and 100 whites with similar educational backgrounds and car ownership levels, who live in neighborhoods with similar levels of job accessibility.

We found a statistical correlation of +0.757 between percent of households that are African-American and civilian unemployment rates for the 100 sampled Bay Area neighborhoods. Only 4 percent of the association was attributable to blacks being less accessible than whites to jobs, while not having access to a car explained just 5 percent of the association. A larger part of the association, 33 percent, could be explained by the lower average-level of educational attainment among African-Americans. But race directly accounted for 58 percent of the correlation. Thus while "space," or job accessibility, does matter in explaining black unemployment in the San Francisco Bay Area, race and educational attainment appear to matter much more. These findings clearly side with "race" more than with"space" in explaining joblessness in the region, at least among African-Americans.

ELEVATING ACCESSIBILITY IN PLANNING PRACTICE

While our findings suggest that inaccessibility to jobs is not a major factor in explaining Bay Area black unemployment, this does not diminish the importance of measuring and tracking accessibility over time. We were able to isolate the relative statistical importance of race in explaining black unemployment only by having a refined measure of accessibility that controlled for occupational matching. We had to control for the effects of "space" to understand the effects of "race." Moreover, our analysis traced only one dimension of accessibility — regional access to jobs.

Tracing trends in access to hospitals and medical clinics might reveal, for instance, whether new transit investments and changing urbanization patterns are making certain groups, like seniors, more or less accessible to available health-care services. Longitudinal studies of shifting levels of regional accessibility might prove valuable in other policy realms. By associating shifts in regional accessibility to changes in VMT per capita, air-quality planners could determine the importance of land-use management in reducing mobile-source emissions.

To date, the Netherlands has progressed furthest in reforming regional transportation planning to emphasize both accessibility and mobility. Dutch planners draw mobility profiles for new businesses, defining the amount and type of traffic likely to be generated. They classify various locations within a city according to their accessibility levels. For example, locations that are well-served by public transit, that are connected to nearby neighborhoods by bike paths, and that have a variety of retail shops receive high accessibility marks. Thus they are targeted for land uses that generate steady traffic streams, e.g., college campuses, commercial plazas, public offices. More remote areas that can be conveniently reached only by motorized transport tend to be assigned land uses that need not be easily accessible by the general public, e.g., warehouses and factories.

One reason accessibility issues have failed to garner much political attention elsewhere may be that those who are least accessible also wield the least political clout. Accessibility also does not resonate as a particularly important political issue because it is not an easy concept for laypeople to grasp. Further, the sparsity of empirical research and evidence linking accessibility to broader social agendas probably reflects a built-in resistance to changing methodological approaches. This undoubtedly impedes the evolution of accessibility as a performance measure.

Traditional performance indicators fail to reflect the vital role of land-use patterns in making cities and regions more accessible. Accessible regions are those that allow more time to be spent at desired destinations than on the road. This might be accomplished by bringing activities closer together, by designing walkable communities, or by promoting tele-work. Only by tracking changes in accessibility over time will we be in a position to gauge whether unfolding patterns of urban growth are working to make destinations easier or more difficult to reach. Expanding the use of accessibility as a performance indicator and making clear connections between accessibility and real-world problems, I conclude, are important challenges that the transportation planning profession must be prepared to take on. ◆

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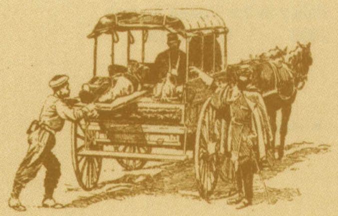

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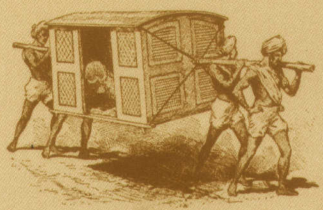

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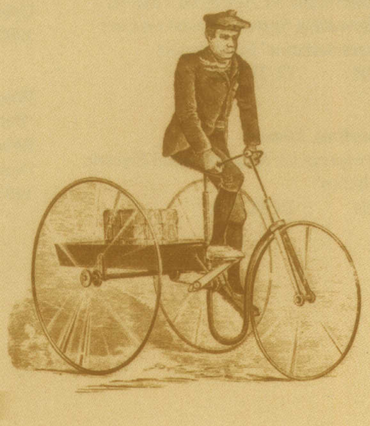

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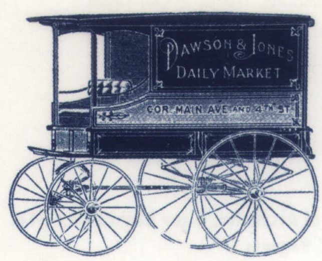

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THE PEDIGREE OF A STATISTIC

BY DONALD C. SHOUP

Have you ever wondered how much urban land is devoted to streets and parking? I realize there are many problems inherent in calculating this sort of statistic. For example, it's not clear whether a driveway alongside a house should be counted as a street or as parking, or maybe as neither, because some driveways serve primarily as open space between adjacent houses and are rarely used by cars. Nevertheless, it would be good to have even a rough estimate of the share of urban land in streets and parking.

I found the answer to my question in a wonderful new book by Michael Southworth and Eran Ben-Joseph (1997). They say (pp. 4-5), "In the urban United States, the automobile consumes close to half of the land area of cities; in Los Angeles the figure approaches two thirds." Southworth and Ben-Joseph cite Hanson (1992) and Renner (1988) for this information, and I traced the references to their source. Here is what I found.

Mark Hanson (1992, p. 66) says, "In US cities, close to half of all urban area goes to accommodating the automobile, while in Los Angeles the figure reaches two-thirds." For this Hanson cites Michael Renner (1988, p. 46), who says, "In American cities, close to half of all the urban space goes to accommodate the automobile; in Los Angeles, the figure reaches two-thirds." For this, Renner cites Kirkpatrick Sale (1980, p. 253), who says, "It [the car] demands enormous amounts of space, both in the countryside, where it has so far caused 60,000 square miles of land to be paved over, and in the cities, where roughly half of all the land (in Los Angeles 62 percent) is given over to its needs." Sale did not cite his source, and despite repeated telephone calls, I have been unable to reach him.

Meanwhile, others also have been on the trail. Stephen Marshall at University College London posted a message on the Internet, citing the questionable statistic quoted from Southworth and Ben-Joseph, and asking for similar information about other cities. Marshall summarized the responses, and has made them available on the Internet.

Among the responses Ray Brindle reports, "The glib citing of such 'data' is nonsense, of course. Many years ago, as a planning student, I tried to calculate the figure for Melbourne — and found that in older areas of Melbourne (with many wide boulevards and ninety-nine-foot local road reserves) the figure was approaching one third — but that was largely because of the generous colonial pre-auto allocation of space to 'streets.' We discovered that the figure for modern suburbs was well below 25 percent, suggesting paradoxically that urban areas designed for car use in fact devoted less land to roads and streets."

Herman de Wolff reports that the share of land devoted to streets and railways is 7.1 percent in Amsterdam and 6.5 percent in Rotterdam. Murali Krishnan reports that the share of land in Indian cities devoted to transportation (all modes) is between 10 and 15 percent. Others report the shares of land in streets as Bangkok (11 percent), Paris (11 percent), Hong Kong (13 percent), and Tokyo (13 percent).

The share of urban land devoted to streets is not, however, the same as the share "consumed by automobiles." Because streets existed before automobiles, perhaps the share of land "consumed by automobiles" is only the increase in the share of land devoted to streets and parking since the automobile arrived. The share of land devoted to parking has increased far more than the share of land devoted to streets, which may even have declined. Unfortunately, there are no data on the share of urban land devoted to parking. I'm tempted to invent them.

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If you want to read Stephen Marshall's summary on the share of urban land devoted to transportation, see our web site. http://socrates.berkeley.edu/~uctc

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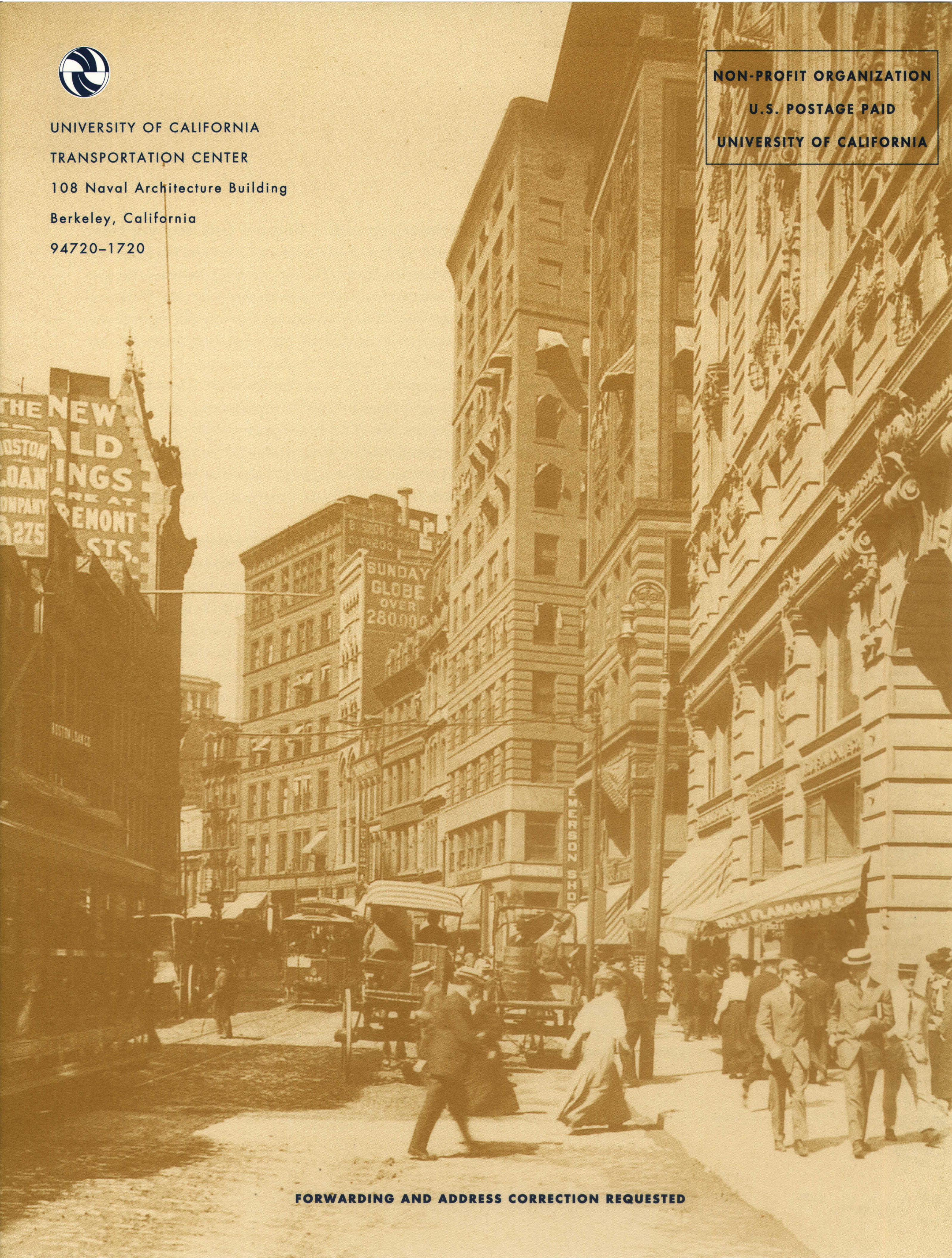

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