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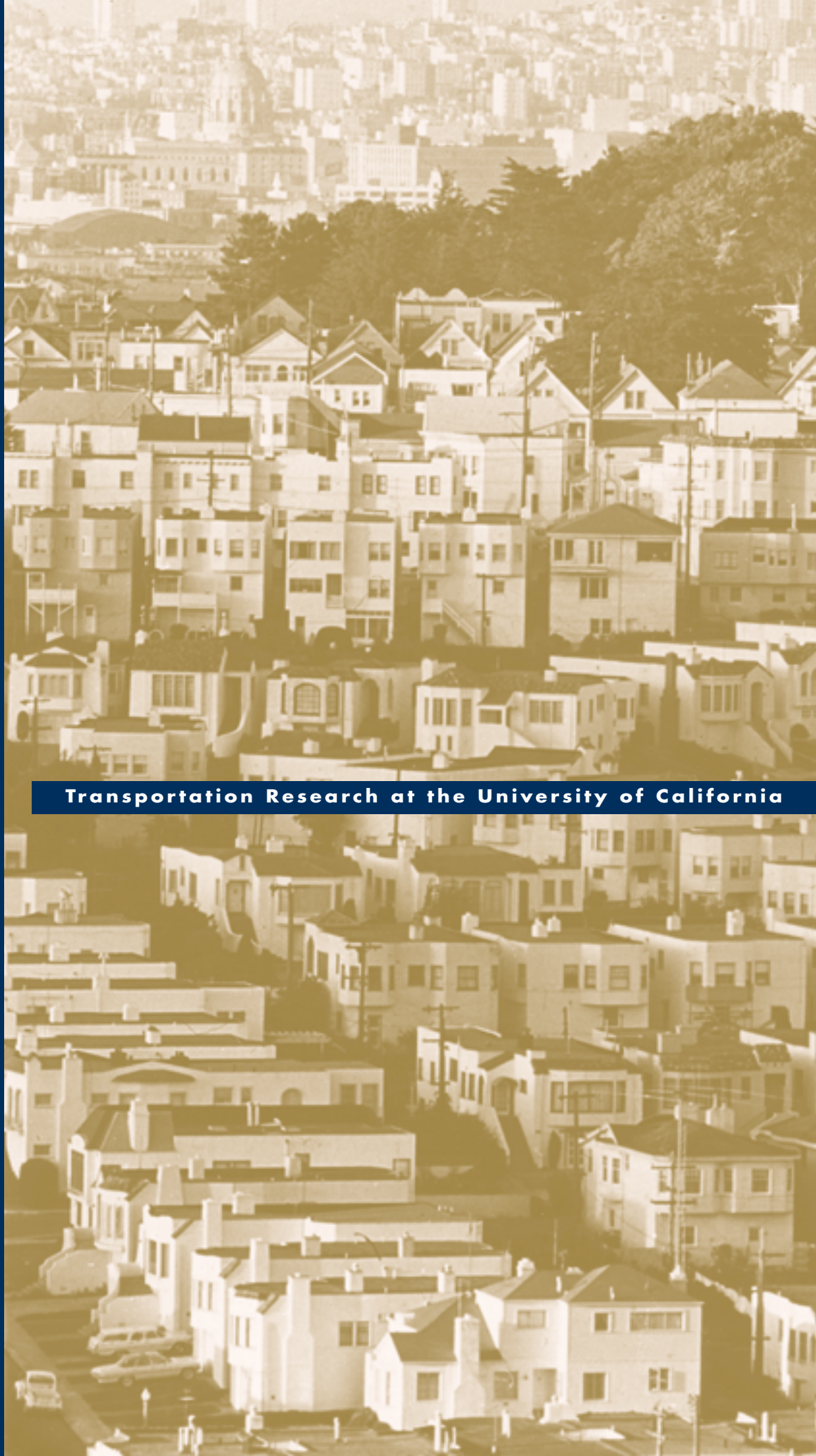
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The University of California Transportation Center, founded in 1988, facilitates research, education, and public service for the entire UC system. Activities have centered on the Berkeley, Davis, Irvine, Los Angeles, Riverside, and Santa Barbara campuses.

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Change Happens

IN A CONSTANTLY EVOLVING FIELD LIKE transportation, it's crucial for practitioners to be willing to shift perspective, or at least to rethink positions. What seems axiomatic in one period may change when new circumstances arise. Thus, for example, mid-twentieth-century advocacy of more roads to handle growing numbers of vehicles is being re-examined in the face of ever-increasing traffic congestion.

Meanwhile new vehicle types slowly replace older ones; new types of buses share streets with old yellow school buses as well as hybrid cars and light rail; and our cities experiment with bus rapid transit, car sharing, traffic calming, and bike lanes.

There is no one-size-fits-all solution to our transportation problems; we try on and test fixes small and large. Some may be rejected presently as unworkable; some may stick around, long past their usefulness, until a new idea is more successful. And some may seem at first the perfect solution, only to later reveal they have created new, unanticipated problems. Meanwhile, change continues.

It's hard for a modern citizen to believe, but the nineteenth century transportation mode of choice caused very serious congestion, pollution, and safety problems that seemed insurmountable. In these pages, Eric Morris details the remarkable consequences of using horses as the major means of transportation. Many readers will find his essay surprising. Parallels

between today's transportation and energy dilemmas and those of one hundred years ago will be easy to draw. Although society attacked the problems of horses on many fronts, the ultimate remedy seemed to come from nowhere: the modern motor car. A completely new transportation system transformed society in a relatively short time, and the woes of the horse-transport era were quickly a thing of the past.

Could solutions to current energy, pollution, and congestion problems come about in a similar way? Not having yet found any solutions, there's no way we can know. But we can keep working on as many fronts as we possible. Daniel Kammen, in the *Access Almanac*, gives a brief but cogent look at one area that needs attention: support for research and development in energy issues.

Donald Shoup is known to regular *Access* readers for explaining some of the repercussions of our parking systems over the years. He now has new information about how parking policies contribute to congestion—and by extension, to excess energy use and pollution—in our cities. Also in this issue, Sir Peter Hall ponders the future of transportation, his starting point firmly grounded in present day reality. Will buses, trains, or new technologies like private rapid transit eventually replace the automobile? And John Landis continues his sabbatical report, part two, with a look at Sydney's transportation dilemmas and some of the solutions Australians are trying out.

—*Melanie Curry*
Editor

From Horse Power to Horsepower

BY ERIC MORRIS

IN 1898, DELEGATES FROM ACROSS THE GLOBE gathered in New York City for the world's first international urban planning conference. One topic dominated the discussion. It was not housing, land use, economic development, or infrastructure. The delegates were driven to desperation by horse manure.

The horse was no newcomer on the urban scene. But by the late 1800s, the problem of horse pollution had reached unprecedented heights. The growth in the horse population was outstripping even the rapid rise in the number of human city dwellers. American cities were drowning in horse manure as well as other unpleasant byproducts of the era's predominant mode of transportation: urine, flies, congestion, carcasses, and traffic accidents. Widespread cruelty to horses was a form of environmental degradation as well.

The situation seemed dire. In 1894, the *Times* of London estimated that by 1950 every street in the city would be buried nine feet deep in horse manure. One New York prognosticator of the 1890s concluded that by 1930 the horse droppings would rise to Manhattan's third-story windows. A public health and sanitation crisis of almost unimaginable dimensions loomed.

And no possible solution could be devised. After all, the horse had been the dominant mode of transportation for thousands of years. Horses were absolutely essential for the functioning of the nineteenth-century city—for personal transportation, freight haulage, and even mechanical power. Without horses, cities would quite literally starve.

All efforts to mitigate the problem were proving woefully inadequate. Stumped by the crisis, the urban planning conference declared its work fruitless and broke up in three days instead of the scheduled ten.

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SADDLED WITH THE URBAN HORSE

The horse pollution problem was not a new one. Julius Caesar banned horse-drawn carts from ancient Rome between dawn and dusk in an effort to curb gridlock, noise, accidents, and other unpleasant byproducts of the urban equine. But conditions in the nineteenth century pushed the problem to new heights. First, America's urban population swelled by thirty million souls between 1800 and 1900. These new citizens needed to be fed, clothed, and sheltered using materials delivered by horse. Second, despite the fact that cities were expanding outward, the tidal wave of new residents sent density levels soaring; New York's rose from 39,183 per square mile in 1800 to 90,366 per square mile in 1900. Greater human crowding meant greater horse crowding as well, and problems that might have been tolerable in a sparsely populated rural region became unbearable in a densely packed urban one.

Not only was the absolute number of people rising; per capita reliance on the horse was rising as well. Living standards were skyrocketing—from 1800 to 1900, US per capita GDP rose from \$1,148 to \$4,676 (in 2000 dollars). This meant greater trade, and virtually all goods were, at some point in their journey, transported by horse. In ten major US cities, the number of teamsters rose 328 percent between 1870 and 1900, while the population as a whole rose only 105 percent.

At first glance, it might seem as if the railroad would have offered relief from the horse pollution problem. But in fact it exacerbated it. Railroads were as much a >



complement for horses as a substitute for them. Nearly every item shipped by rail needed to be collected and distributed by horses at both ends of the journey. So as rail shipments boomed, so did shipments by horse. Ironically, railroads tended to own the largest fleets of horses in nineteenth-century cities.

This situation was made even worse by the introduction of the horse into an area from which it had been conspicuously absent: personal intra-urban transportation. Prior to the nineteenth century, cities were traversed almost exclusively on foot. Mounted riders in US cities were uncommon, and due to their expense, slow speeds, and jarring rides, private carriages were rare; in 1761, only eighteen families in the colony of Pennsylvania (population 250,000) owned one. The hackney cab, ancestor of the modern taxi, was priced far beyond the means of the ordinary citizen.

This changed with the introduction of the omnibus in the 1820s. Essentially large stagecoaches traveling fixed routes, these vehicles were reasonably priced enough to cater to a much larger swathe of the urban population. By 1853 New York omnibuses carried 120,000 passengers per day. Needless to say, this required a tremendous number of horses, given that a typical omnibus line used eleven horses per vehicle per day. And the need for horses was to spiral even further when omnibuses were placed on tracks, increasing their speeds by fifty percent and doubling the load a horse could pull. Fares dropped again, and passengers clamored for the new service. By 1890 New Yorkers took 297 horsecar rides per capita per year.

MAKING HAY: FEEDING THE URBAN HORSE

The consequences of the horse population boom were sobering. While the horse may be a charming and even romantic animal, when packed into already teeming and unsanitary cities its environmental byproducts created an intolerable situation.

Horses need to eat. According to one estimate each urban horse probably consumed on the order of 1.4 tons of oats and 2.4 tons of hay per year. One contemporary British farmer calculated that each horse consumed the product of five acres of land, a footprint which could have produced enough to feed six to eight people. Probably fifteen million acres were needed to feed the urban horse population at its zenith, an area about the size of West Virginia. Directly or indirectly, feeding the horse meant placing new land under cultivation, clearing it of its natural animal life and vegetation, and sometimes diverting water to irrigate it, with considerable negative effects on the natural ecosystem.

And what goes in must come out. Experts of the day estimated that each horse produced between fifteen and thirty pounds of manure per day. For New York and Brooklyn, which had a combined horse population of between 150,000 and 175,000 in 1880 (long before the horse population reached its peak), this meant that between three and four million pounds of manure were deposited on city streets and in city stables every day. Each horse also produced about a quart of urine daily, which added up to around 40,000 gallons per day for New York and Brooklyn.

The aesthetics of the situation require little editorial comment. Horse droppings were not only unsightly but their stench was omnipresent in the nineteenth-century city. Urban streets were minefields that needed to be navigated with the greatest care. "Crossing sweepers" stood on street corners; for a fee they would clear a path through the mire for pedestrians. Wet weather turned the streets into swamps and rivers of muck, but dry weather brought little improvement; the manure turned to dust, which was then whipped up by the wind, choking pedestrians and coating buildings. Municipal street cleaning services across the country were woefully inadequate.

Moreover, thanks to the skyrocketing horse population, even when it had been removed from the streets the manure piled up faster than it could be disposed of. Manure makes fine fertilizer, and an active manure trade existed in the nineteenth-century city. However, as the century wore on the surge in the number of horses caused the bottom to fall out of this market; while early in the century farmers were happy to pay good money for the manure, by the end of the 1800s stable owners had to pay to have it carted off. As a result of this glut (which became particularly severe in summer months when farmers were unable to leave their crops to collect the dung), vacant lots in cities across America became piled high with manure; in New York these sometimes rose to forty and even sixty feet. Needless to say, these were not particularly beloved by the inhabitants of the nineteenth-century city.

FILTH, FLIES, AND FATALITIES

The problem extended far beyond aesthetics. Though horse manure harbors tetanus spores, in and of itself it is not a major health risk. But a byproduct of it is. Horse manure is the favored breeding ground for the house fly, and clouds of flies hatched in it (one estimate is that three billion flies hatched in horse manure per day in US cities in the year 1900). ➤

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Flies are, of course, unsightly and annoying pests, and they are also potent disease vectors. Flies pick up bacteria and other pathogens on their feet, hairy appendages, and proboscides, then transmit them as they fly between filth and humans and their food. They also deposit germs through their feces and vomit. Flies transmit dozens of diseases, and studies have found that nineteenth century outbreaks of deadly infectious maladies like typhoid and infant diarrheal diseases can be traced to spikes in the fly population.

REIN OF TERROR: THE HORSE AND ACCIDENTS

Horses killed in other, more direct ways as well. As difficult as it may be to believe given their low speeds, horse-drawn vehicles were far deadlier than their modern counterparts. In New York in 1900, 200 persons were killed by horses and horse-drawn vehicles. This contrasts with 344 auto-related fatalities in New York in 2003; given the modern city's greater population, this means the fatality rate per capita in the horse era was roughly 75 percent higher than today. Data from Chicago show that in 1916 there were 16.9 horse-related fatalities for each 10,000 horse-drawn vehicles; this is nearly seven times the city's fatality rate per auto in 1997.

The reason is that horse-drawn vehicles have an engine with a mind of its own. The skittishness of horses added a dangerous level of unpredictability to nineteenth-century transportation. This was particularly true in a bustling urban environment, full of surprises that could shock and spook the animals. Horses often stampeded, but a more common danger came from horses kicking, biting, or trampling bystanders. Children were particularly at risk.

In addition, the vehicles themselves (especially the omnibus) presented safety hazards. They were difficult to brake, and the need to minimize friction meant that they required large wheels. These made for top-heavy, ungainly carriages prone to capsizing, a problem exacerbated by winding street layouts. Moreover, drivers had a reputation for recklessness.

CLATTER AND CONGESTION

Other byproducts of the urban horse were less deadly but unwelcome nevertheless. The clatter of horseshoes and wagon wheels on cobblestone pavement jangled nineteenth-century nerves. Many have blamed the noise created by iron horseshoes on hard pavement for the nervous disorders which seemed to plague cities far more than rural areas.

Congestion was another problem. Traffic counts indicate that traffic across the nation more than doubled between 1885 and 1905. Not only was the number of vehicles rising rapidly, but the nature of the vehicles themselves caused tremendous problems. A horse and wagon occupied more street space than a modern truck. Obviously, horse-drawn vehicles traveled at very slow speeds, and horses, especially those pulling heavy loads or hitched in teams, started forward very slowly, a great difficulty in stop-and-go conditions. Streets of the era were not adequate to handle the traffic, and hills caused problems.

In addition, horses often fell, on average once every hundred miles of travel. When this took place, the horse (weighing on average 1,300 pounds) would have to be helped to its feet, which was no mean feat. If injured badly, a fallen horse would be shot on the spot or simply abandoned to die, creating an obstruction that clogged streets and



brought traffic to a halt. Dead horses were extremely unwieldy, and although special horse removal vehicles were employed, the technology of the era could not easily move such a burden. As a result, street cleaners often waited for the corpses to putrefy so they could more easily be sawed into pieces and carted off. Thus the corpses rotted in the streets, sometimes for days, with less than appealing consequences for traffic circulation, aesthetics, and public health.

TAIL OF WOE: THE SAD LOT OF THE URBAN HORSE

Falls were not the only reason horses expired in the streets. One might think it would be in the interest of horse owners to keep their animals in good condition; a horse was a fairly large capital investment. But unfortunately, economics caused owners to reach quite the opposite conclusion. Due to the costs of feeding the animals and stabling them on expensive urban land, it made financial sense to rapidly work a small number of horses to death rather than care for a larger group and work them more humanely. As a result, horses were rapidly driven to death; the average streetcar horse had a life expectancy of barely two years. In 1880, New York carted away nearly 15,000 dead equines from its streets, a rate of 41 per day.

In addition to frequent whippings and beatings from drivers, urban horses faced another peril: the condition of the street surfaces. Paved streets were far more slippery than the dirt roads they replaced. They were especially slick when wet or frozen. Horses, shod in iron shoes providing poor traction, frequently lost their step and tumbled, often to their deaths. >

STABLE CONDITION

All of these problems—the filth, flies, disease, and cruelty—came to a head in the nineteenth-century stable. Stables were generally dark and lacked ventilation; some were rarely cleaned and reeked of excrement. Due to the expense of urban land, horses were crowded into them. This was not just uncomfortable; it was deadly as well, as it left horses open to the ravages of infectious disease. The Great Epizootic Epidemic of 1872 killed approximately five percent of the urban horses in the Northeast and debilitated many others. Transportation halted, food prices soared, goods piled up at the docks. Fire ravaged downtown Boston because there were not enough healthy horses to pull the fire trucks.

THE CAR BEFORE THE HORSE

Society eventually took action against the problem on numerous fronts. Henry Bergh founded the ASPCA in 1866 primarily to improve the lot of the urban horse. In the 1890s, Col. George E. Waring Jr. professionalized New York's street sweeping service with tremendous effect; his reforms were widely copied across the country. At the same time the electric streetcar usurped the horse's role as the primary mode for intra-urban personal transportation. At the turn of the 20th century, William Phelps Eno invented the rules of the road to reduce the number of accidents caused by horse-drawn vehicles; he is credited with devising the stop sign, the stop light, the yield sign, the crosswalk, the pedestrian island, the one-way street, the traffic circle, and the taxi stand. In addition, he codified driving on the right side of the road.

But it would take one more innovation to end the problem once and for all. In the 1890s improvements in the internal combustion engine, legal and political developments which severely restricted the power of cities to regulate the types of traffic on their streets (won by bicycle advocates), the aforementioned invention of traffic rules, and smooth new asphalt street surfaces paved the way for the private automobile.

Enticed by high speeds, point-to-point travel and the flexibility to roam across the urban landscape, the public adopted the new innovation in droves. Contemporary observers calculated that cars were cheaper to own and operate than horse-drawn vehicles, both for the individual and for society. In 1900, 4,192 cars were sold in the US; by 1912 that number had risen to 356,000. In 1912, traffic counts in New York showed more cars than horses for the first time. The equine was not replaced all at once, but function by function. Freight haulage was the last bastion of horse-drawn transportation; the motorized truck finally supplanted the horse cart in the 1920s.

As difficult as it may be to believe for the modern observer, at the time the private automobile was widely hailed as an environmental savior. In the span of two decades, technology eradicated a major urban planning nightmare that had strained governments to the breaking point, vexed the media, tormented the citizenry, and brought society to the brink of despair. Yet, given the environmental problems that the automobile has brought, it is worth asking: was this a Faustian bargain?



HORSE POWER TO HORSEPOWER

In all probability the answer is no. Perhaps in total the negative externalities produced by the automobile are greater than the damage caused by the urban horse, but this is because the numbers of vehicles and the amount of travel have skyrocketed. Per vehicle and per mile, it seems highly likely that the environmental problems caused by the horse were far greater than those of the modern car. Horses even contribute to global warming: manure releases methane, a greenhouse gas eight times more potent than CO₂.

The environmental triumph of the private automobile sheds interesting light on modern problems of transportation and the environment. Today, many observers believe that only a drastic reduction of travel and/or a switch to slower and more inconvenient modes can mitigate transportation's negative externalities. But neither draconian regulations nor disincentives for travel were necessary to fix the horse pollution problem. Human ingenuity and technology (enabled by government, which provided infrastructure and regulations) did the job—and at the same time they brought a tremendous concurrent increase in mobility. Of course, the technological solution brought externalities of its own, and our solutions for those externalities will undoubtedly introduce a fresh set of unexpected problems. But with determination and inventiveness, perhaps one day the environmental consequences of the private car will be as dim a memory as the horse pollution crisis of the nineteenth century. ♦

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Beyond the Automobile?

BY SIR PETER HALL

There is growing international consensus that the world needs a successor to the motor car. A deluge of commentary in recent times has alerted us all to the hazards of air pollution, traffic congestion, petroleum consumption, and now global warming. The automobile is said to be the cause of it all. Some argue that decentralization of cities and low suburban densities force people to use cars. Transportation and urban planners everywhere have been looking for remedies, preferably by finding an alternative to the car such as the bus or train.

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The problem is that those densities—of residential areas, but also of employment zones—are generally too low to sustain either form of transit. There is some disagreement about precise numbers, but viable bus transit is alleged to be possible at a minimum density of ten to twenty dwelling units per acre. The lower densities seem to be enough for successful bus transit in Adelaide and Brisbane, Australia. In any case, numerous studies show that perfectly adequate family housing with private yard space can be provided at the higher density. Much of San Francisco, including highly desirable (and expensive) areas like Pacific Heights, is built at twenty units per acre. Note that this is still less than the minimum density necessary to support light rail, which is around 27 units per acre.

In addition to this, however, bus transit must combat a serious image problem. Margaret Thatcher famously said in 1986 that “A man who, beyond the age of 26, finds himself on a bus can count himself as a failure.” That idea seems to be supported by the research of Garrett and Taylor, reported in the *Berkeley Planning Journal* in 1999. Buses, they found, were used only by downtown commuters and what they called “transit dependents”: people who were too young, too old, or too poor to drive, who lived in inner cities, had low incomes, and lacked car access. The suburbs, providing fifty percent of workers in metropolitan areas, generated less than thirty percent of transit users. They concluded that current policies to increase the number of suburban riders are ineffective and inefficient.

But need they be? Experience from elsewhere in the world suggests otherwise. Even in the United States, there are some limited successes, chronicled by Robert Cervero and Michael Bernick in their book, *Transit Villages in the 21st Century*, where Rosslyn and Ballston in the Virginia suburbs of Washington, DC emerge as stars. These planned suburbs have higher-than-usual densities built around transit access, including heavy rail. But Rosslyn and Ballston are exceptional.

We seem to be left with an uncomfortable paradox. People like living in suburbs. And, increasingly, businesses like locating there. But most suburbs are designed for cars. Investment in rail-based transit tends to arrive long after patterns of auto dependence have become engrained. Bus-based systems could be viable, but are perceived as unsexy and down-market.

There are three ways to solve this seeming paradox, and they are complementary. First, try to identify what might change travel behavior by studying demand for transit. Second, and most important, find out how they do it successfully elsewhere, especially in places that look like American places, such as Great Britain and Australia. And third, consider how to use technology to resolve the problem—the traditional American way.

INFLUENCING BEHAVIOR

There is a plethora of recent work on demand for bus transit, much from Great Britain, some from the United States, from which a few basic conclusions can be extracted. Transit users, unsurprisingly, will take fewer trips when fares go up. Also, they will take more trips when service is improved, for example if buses arrive more frequently or drive longer routes. And, supporting the negative image of buses, as a person’s income goes up, the number of bus trips he takes goes down. >

*Bus-based cities
can and do work.
Their bus systems
deliver good service,
with high volumes,
at low cost.*



So to make a bus system viable, fares must be kept down and services must be as good as they can be. If the service is excellent and transfers seamless and easy, then the bus will appear to be a superior form of transit, which will counteract the problem of image. Some Latin American cities and other places like London and Toronto are showing how this can be done.

LOOKING ELSEWHERE: MODEL BUS CITIES

Singapore and Curitiba, Brazil are two cities widely noted globally for their well-conceived and carefully crafted planning of integrated transport and land use. Superficially, they have many features in common. But the technological basis is very different. Singapore depends on a conventional heavy rail metro system to support high urban densities around mixed-use urban cores at train stations, which also serve as interchanges with bus and light rail feeders. Curitiba achieves much the same effect with buses: high-density, mixed-use corridors are aligned along boulevards carrying express buses which travel on completely segregated busways and connect at selected stations with orbital services and local conventional bus lines.

When it began to plan the system, in the mid-1970s, Curitiba could not afford a metro system like those then being built in São Paulo and Rio de Janeiro. Its planners therefore settled for what they thought was a second-best solution. But the bus system has proved so successful, not least in its capacity for rapid expansion to serve the entire city, that it has come to seem a first-best solution—so much so that bus rapid transit (BRT) has begun to be widely implemented: in Bogotá, Quito, and elsewhere.

BRT systems appear to have been a major success story, for good reasons. First, they can achieve carrying capacities equal at least to light rail: 4,000 passengers per hour on segregated bus lanes using special shelters for rapid boarding and deboarding, against only 1,800 an hour on a conventional bus on conventional streets. Second, they achieve very high numbers of bus trips per capita: 1.02 per day in Curitiba, higher than any other major city. Third, they do so at a cost (in terms of dollars per mile) very much lower than either highways or rail rapid transit.

London has achieved a remarkable renaissance in bus travel without creating BRT—at least so far, though BRT networks are being planned in East London. London's bus riders number 5.4 million per day, up nineteen percent since 2000. How has this been achieved? When Margaret Thatcher deregulated the bus systems of British cities in the 1980s, even she did not dare extend the experiment to London. Instead—as, interestingly, in Curitiba—a franchise was created for private companies to operate routes for the public authority, Transport for London. New technologies such as the Oyster Card—a prepaid plastic card that charges fares via a card reader on the bus—have cut boarding times and hence overall transit times; in Central London, it is no longer possible to pay cash to board the bus. Currently, 983 dedicated bus lanes, extending over 155 miles, with priority at key junctions, speed journeys and make bus travel more reliable, especially at peak hours. Fares have been kept low, and in some cases reduced, especially for longer journeys.

LAND USE AND TRANSIT USE

However, in asking whether such successes could ever be replicated in American cities, we need to consider the critical question of land use—especially residential densities. In London, buses achieve their most intensive use in the inner and inner-middle

rings plus an area around Heathrow airport that has some inner-area characteristics; in the least dense outer suburbs that most closely approximate American suburbs, the car tends to dominate. And as discussed earlier, the minimum density needed to support adequate bus service may be in the range of ten to twenty dwellings per acre, well above the four per acre that characterize suburban development in much of the United States. (Even model examples of “New Urbanism” prove in practice to be built at around seven units per acre, far short of viability for bus transit.) Something can be achieved here with higher densities around bus stops and interchange stations. But there needs to be somewhat uniform moderate density if buses are to be viable; otherwise, car dependence will establish itself and may then be extremely difficult to modify, as some cities are finding.

In any event, what this means is that it will be best for American planners to study those cities that most resemble American ones in their suburbanization patterns. Here, the work of Paul Mees is particularly pertinent. Mees systematically compared two cities that had developed in the Anglo-Saxon suburban tradition: Melbourne, Australia and Toronto, Canada. He found that although car ownership is higher in Toronto, Toronto citizens make more than twice as many trips by public transport. For trips to work beyond walking distance, one-third in Toronto are by public transport; in Melbourne, less than one in five. Similar differences are reported for other types of trips. Mees then compared possible explanations, including one that is most often offered: that Toronto’s transit success arose from its land use planning, specifically the higher proportions of high-density, high-rise apartment development around stations and interchanges. But he found that statistical evidence failed to confirm this. The key factor proved to be simply quality of service. Toronto operates its transit twenty hours a day, seven days a week, attempting to guarantee seamless interchange between lines and different transit modes. Transit >



in Toronto is widely perceived as offering a real alternative to driving the car, in a way that is simply not true for Melbourne.

What can we conclude from the international evidence? First, bus-based cities can and do work. Their bus systems deliver good service, with high volumes, at low cost. There remains a question: can they do so everywhere—especially in the low-density suburban periphery? Can they cope with journey patterns that are less radial than orbital, with many origins and destinations, characteristic of the new polycentric city region? (One or two places, like Houston, Texas and Edmonton, Canada, have developed multiple hub-and-spoke bus routes specifically to handle such patterns, and with some success). Can American densities support viable bus service? The answer seems to be



that if cities as varied as Adelaide, Brisbane, and Toronto can in their different ways achieve it, then so can American cities. Polycentric mega-city regions with a series of strong urban cores, which seem to be an emerging urban form all over the world from America to China, may provide the concentrations to support a good transit system.

TECHNOLOGY TO THE RESCUE

The American answer to any problem has always been that technology will fix it. Ingenuity, harnessed to commercial application, will find a superior alternative. Just as the Model T replaced the horse and buggy, so we will find a replacement for the

automobile—which, we should remember, has been around in roughly its present form since 1885. And there is incentive enough, given the evidence of depleting global energy supplies and the challenge of global warming.

There are two main lines of attack. First, to find a new energy source to replace the internal combustion engine: in the short term, though hybrid technology; in the medium or longer term, either fuel cells or the all-electric car, a serious contender in the early days of the automobile which may be due for a revival. Second, to inject more information technology into vehicles—something that has been happening progressively since the arrival of the microprocessor in the early 1970s—and into the highway.

These two lines of advance would eventually converge in the form of a new technology: the automated Personal Rapid Transit (PRT) system, which one could regard as a bus-taxi hybrid. There are a number of European competitors, such as ULTRA (Urban Light Transport), which is about to be introduced at London's Heathrow Airport to link peripheral parking lots with central terminals. Passengers will enter cars and book their destinations via smart cards, and the car will proceed autonomously along a guideway. The average journey at Heathrow will be one mile, covered in three minutes.

Within a controlled environment, such as an airport, downtown, shopping mall, or leisure complex, such PRT systems can be both effective and economic. They could also be applied in new residential areas, where they could connect homes with park-and-ride garages and longer-distance transit systems, both rail and bus. It is easy to envision them serving suburban developments around bus stations such as those in Brisbane and Adelaide.

If or when such a system comes into being, its implications for urban development could be complex and possibly paradoxical. It might well encourage long-distance commuting, since it would raise average highway speeds and lower average journey times proportionately. It could encourage a pattern of widespread regional dispersal with local concentrations served by PRT. In Europe, where good quality rail transit is widely available, rapid development of the high-speed train system—running at speeds from 125 to 220 miles per hour—is already beginning to produce similar effects, which could well multiply as the system spreads to connect all major cities within the next decade.

THE WAY FORWARD

The conclusion, surely, is that we should continue to work energetically to generate a successor to the automobile which would offer all the comfort and convenience of the current vehicle but without its malign consequences for congestion, pollution, and global warming. The prospects for a breakthrough in energy sources are promising, as the success of the Toyota Prius already demonstrates. The prospects for full automation are less certain. Meanwhile, we should seek to work with what we've got and what we know—including, most importantly, what other people know. Bus transit Latin American style or Australian style, including demand-responsive modes, is one realistic possibility. High-quality European style high-speed rail transit, used for longer-distance suburban commutes within widely spread polycentric mega-city regions, is another. We need to learn from best practice wherever it's to be found. That way lie the best prospects for civilized urban movement as part of civilized urban living. ♦

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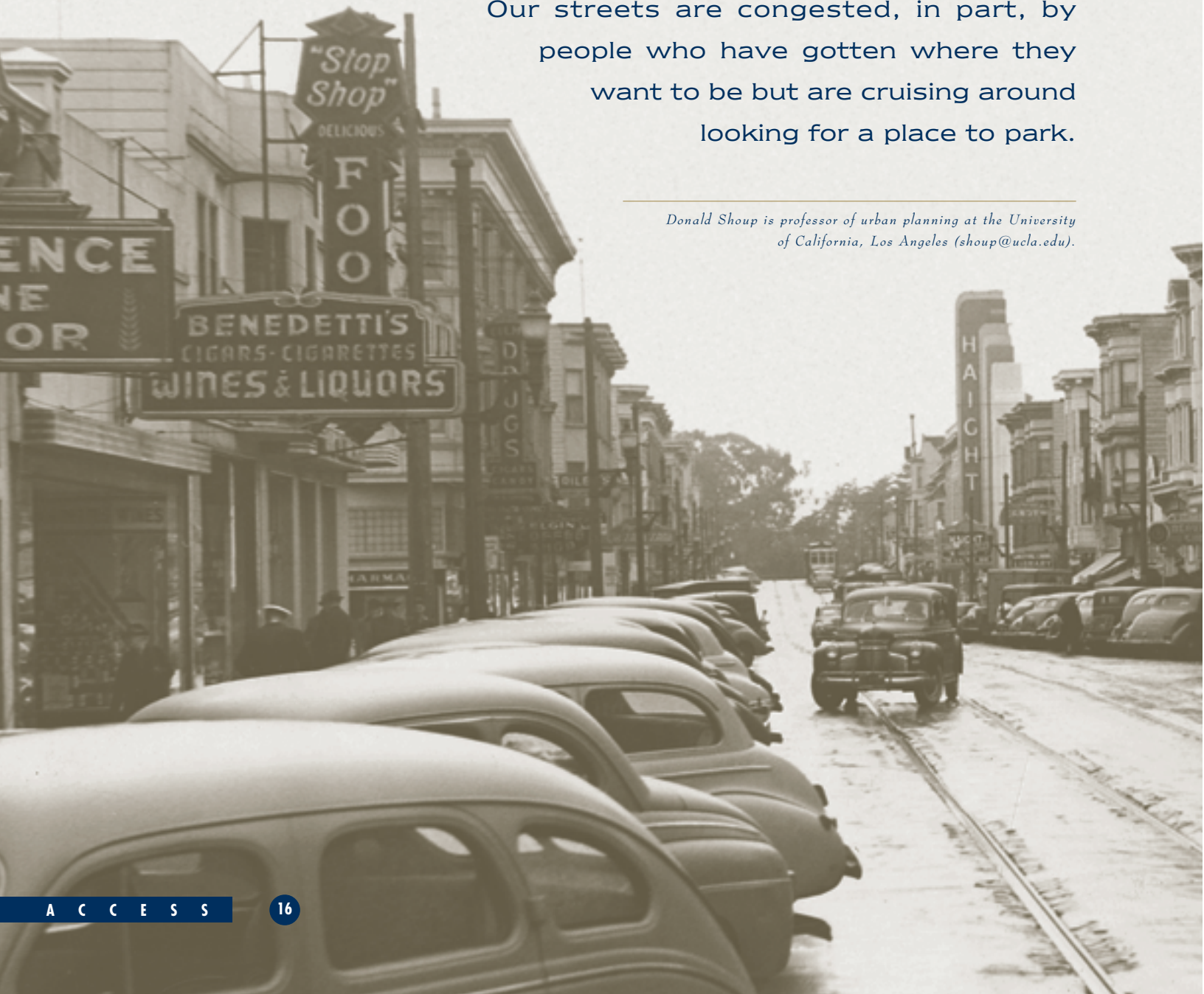
Cruising for Parking

BY DONALD SHOUP

My father didn't pay for parking, my mother, my brother, nobody. It's like going to a prostitute. Why should I pay when, if I apply myself, maybe I can get it for free?
—George Costanza

A surprising amount of traffic isn't caused by people who are on their way somewhere. Rather it is caused by people who have already arrived. Our streets are congested, in part, by people who have gotten where they want to be but are cruising around looking for a place to park.

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DRIVING IN CIRCLES

Perhaps because cruising is a disguised source of congestion, most transportation planners and engineers have ignored it. Cruising creates a mobile queue of cars waiting for curb vacancies, but cruisers are mixed with traffic that is going somewhere, so no one can see how many cars are in the cruising queue. Nevertheless, a few researchers have analyzed cruising by videotaping traffic flows, interviewing drivers who park at the curb, or driving test cars to search for a curb space. Sixteen studies of cruising behavior were conducted between 1927 and 2001 in the central business districts of eleven cities on four continents (see Figure 1). The average time it took to find a curb space was eight minutes, and about thirty percent of the cars in the traffic flow were cruising for parking. The data varied widely around these averages, however; on some uncrowded streets no cars were cruising, while on some congested streets most of the cars were cruising.

Cities have changed since these observations were made, and the data are selective because researchers study cruising only where they expect to find it. Nevertheless, cruising itself has not changed, and the studies show that cruising for parking has wasted time and fuel for many decades.

Even a small search time per car can create a surprising amount of traffic. Consider a congested downtown where it takes three minutes to find a curb space and the parking turnover is ten cars per space per day. For each curb space, cruising thus results in thirty extra minutes of vehicle travel per day (3 minutes x 10 cars). If the average cruising speed is ten miles an hour, cruising creates five vehicle miles traveled per space per day (10 mph x 0.5 hour). Over a year, this driving in circles amounts to 1,825 VMT for each curb space (5 miles x 365 days), greater than half the distance across the United States. >

YEAR	CITY	SHARE OF TRAFFIC CRUISING	AVERAGE SEARCH TIME (minutes)
1927	Detroit (1)	19%	—
1927	Detroit (2)	34%	—
1933	Washington	—	8.0
1960	New Haven	17%	—
1965	London (1)	—	6.1
1965	London (2)	—	3.5
1965	London (3)	—	3.6
1977	Freiburg	74%	6.0
1984	Jerusalem	—	9.0
1985	Cambridge	30%	11.5
1993	Cape Town	—	12.2
1993	New York (1)	8%	7.9
1993	New York (2)	—	10.2
1993	New York (3)	—	13.9
1997	San Francisco	—	6.5
2001	Sydney	—	6.5
	AVERAGE	30%	8.1

FIGURE 1

Twentieth-century cruising

Note: The numbers in parentheses after Detroit, London, and New York refer to different locations within the same city.

Sources: Simpson (1927), Hogentogler, Willis, and Kelley (1934), Huber (1962), Inwood (1966), Bus + Bahn (1977), Salomon (1984), O'Malley (1985), Clark (1993), Falcochio, Darsin, and Prassas (1995), Saltzman (1997), and Hensher (2001).



CHOOSING TO CRUISE

Suppose curb parking is free but all the spaces are occupied, so you have to cruise until you find a space being vacated by a departing car. Off-street parking is available but you have to pay the market price for it. How do you decide whether to cruise or to pay?

If off-street parking is expensive, many drivers will hunt for curb parking, an entirely rational response to prices. Thus, by underpricing their curb parking, cities create an economic incentive to cruise. To study this incentive, I collected data on the price of curb and off-street parking for an hour at noon at the same location—City Hall—in twenty cities throughout the United States. The average price of curb parking was only twenty percent of the price of parking in a garage. Cruising saved drivers the most money in New York, where the price of off-street parking was \$14.38 for the first hour, but curb parking was only \$1.50.

Consider the high price of off-street parking in downtown Boston (\$11 for the first hour), which stems in part from the city's cap on the number of off-street parking spaces. This supply cap drives up the market price of off-street parking and produces an unintended outcome: the combination of low prices for curb parking and high prices for off-street parking increases the incentive to cruise. Boston limits the private off-street parking supply, but fails to charge the market price for its own public curb parking. A survey in 2006 found the average price for off-street parking in the Boston central business district was \$31 a day. In contrast, Boston charges a flat rate (\$1 an hour) for all metered parking spaces in the city.

Boston's off-street parking cap makes sense as a way to reduce congestion on routes *to* the city, but the failure to follow through with market prices for curb parking increases congestion *in* the city. Everyone would criticize off-street parking operators if long lines of cars regularly spilled into the streets and snarled traffic because the lots and garages were always full. Cities create the same result with underpriced curb parking, but the cruising cars are hidden in the general traffic flow.

CRUISING IN LOS ANGELES

To learn more about cruising, my students and I made 240 observations of how long it takes to find a curb parking space at four sites in Westwood Village, a commercial district next to the UCLA campus. Curb parking in metered spaces was only fifty cents an hour during the day and free in the evening, while the cheapest off-street parking was \$1 an hour. For each observation we drove to the site and then circled the block until we found a curb space. Because the curb spaces were occupied almost all the time, we rarely found a vacant space when we arrived. Instead, we usually searched until we found a parked car about to vacate a space, and then waited for it to leave.

Most drivers who are cruising for parking try to avoid following directly behind another car that appears to be cruising, so as to maximize the chance of being the first to see a vacant spot. Driving a car to measure cruising times may therefore influence the behavior being studied. To avoid this potential pitfall and to get some exercise, we decided to make most of the observations by bicycle. The average cruising speed by car in Westwood is only eight to ten miles an hour because every intersection has a stop sign or traffic light, so a cyclist can easily keep up with vehicle traffic. For the tests, we equipped each bicycle with a cyclometer to measure elapsed travel time, distance traveled, and average speed.

The average cruising time to find a curb space was 3.3 minutes, and the average cruising distance was half a mile (about 2.5 times around the block). The small distances cruised by individual drivers add up quickly, because the turnover rate for curb parking was seventeen cars per space per day. With 470 metered parking spaces in the Village, almost 8,000 cars park at the curb each day (17×470). Because so many cars park at the curb, a short cruising time for each driver creates an astonishing amount of traffic. Although the average driver cruises only half a mile before parking, cruising around the fifteen blocks in the Village creates almost 4,000 VMT every weekday ($8,000 \times 0.5$).

Over a year, cruising in Westwood Village creates 950,000 excess VMT—equivalent to 38 trips around the earth, or four trips to the moon. The obvious waste of time and fuel is even more appalling when we consider the low speed and fuel efficiency of cruising cars. Because drivers average about ten miles an hour in the Village, cruising 950,000 miles a year wastes about 95,000 hours (eleven *years*) of drivers' time every year. And here's another inconvenient truth about underpriced curb parking: cruising 950,000 miles wastes 47,000 gallons of gasoline and produces 730 tons of CO₂ emissions in a small business district.

THE RIGHT PRICE FOR CURB PARKING

When drivers compare the prices of parking at the curb or in a garage, they usually decide the price of garage parking is too high, but instead the reverse is true. The price of curb parking is too *low*. Underpriced curb spaces are like rent-controlled apartments: they are hard to find, and once you find a space you'd be crazy to give it up. This makes curb spaces even harder to find, and increases the time cost (and therefore the congestion and pollution costs) of searching for them. Like rent-controlled apartments, curb spaces go to the lucky more than to the deserving. One person might find a curb space and park there for days, while others are left to circle the block.

The left panel of Figure 2 shows a typical commercial block in Westwood where curb parking is underpriced and all the curb spaces are occupied. The block has ➤



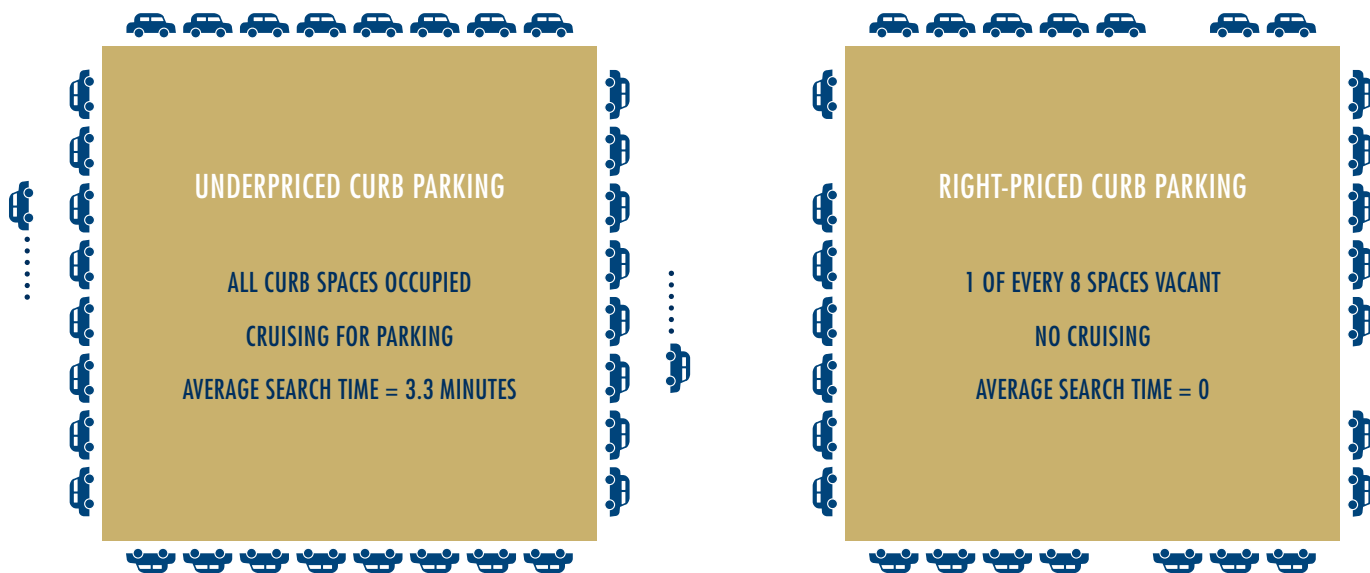
eight curb spaces on each side, the average cruising time to find a curb space is 3.3 minutes, and two cruisers are circling the block. In contrast, the right panel shows what happens if a city charges the lowest price that will produce a few vacant spaces. Drivers have no reason to cruise because they can always find a vacant curb space near their destination, search time is zero, and cruising cars do not add to traffic congestion.

Only trial and error will reveal the right price for curb parking. Initially, if all the curb spaces are always occupied, a city might periodically raise the meter rate by 25-cent increments until occupancy at some hours is about 85 percent. If spaces are still full during other hours, the city could continue to nudge meter rates upward during those times until the occupancy is about 85 percent all day. We can call this balance between the varying demand for parking and the fixed supply of curb spaces the Goldilocks Principle of parking prices: the price is too high if too many spaces are vacant, and too low if no spaces are vacant. When only a few spaces are vacant, the price is just right, and everyone will see that curb parking is both well used and readily available.

Pricing curb parking to ensure a few vacancies does not mean that travel will become unaffordable. Drivers can use several strategies to economize on curb parking without reducing their travel. They can (1) drive at off-peak hours when curb parking is cheaper, (2) park where prices are lower and walk farther to their destinations, (3) park for a shorter time, (4) park off-street, (5) carpool and split the cost of parking, or (6) take public transit, ride a bike, or walk all the way to their destinations. Diverting some trips to carpools, public transit, cycling, and walking will reduce *vehicle* travel without reducing *human* travel, and all real travel is by people, not cars.

FIGURE 2

Curb parking prices and cruising



CRUISING IN NEW YORK

In 2006, surveyors interviewed drivers stopped at a traffic signal in the SoHo district of Manhattan, and 28 percent reported they were cruising for curbside parking. A similar study in Brooklyn found that 45 percent of drivers were cruising. The same results might be found on many other streets in New York because off-street parking is generally far more expensive than on-street parking. In midtown Manhattan, for example, the price for the first hour of off-street parking is often about \$20, while curbside parking is only \$1. Parking for an hour at the curb saves \$19, but drivers first have to cruise to find a space on the street.

The high price of off-street parking in midtown Manhattan doesn't mean the right price for curbside parking is also \$20 an hour. Private operators can charge a disproportionately high price for short-term parking only because the curbside spaces are always full. If the city charges the lowest price for curbside parking that will yield a few vacant spaces everywhere, the price of short-term parking off-street will fall to compete with the curbside rate.

LOCAL REVENUE RETURN

In addition to its transportation and environmental benefits, right-priced curbside parking can yield ample revenue. If a city returns some of this revenue to pay for added public services on the metered streets, residents and local merchants will be more likely to support charging the right price for curbside parking. The added funds can pay to clean and maintain the sidewalks, plant trees, improve lighting, remove graffiti, bury overhead utility wires, and provide other public improvements.

Consider the case of a Business Improvement District (BID) in an older area where curbside parking is free and customers complain about a parking shortage. Suppose the city installs meters and charges the lowest prices that will produce a few vacancies. Everyone who wants to shop in the district can park quickly, and the meter money pays to clean the sidewalks and provide security. These added public services make the business district a place where people want to be, rather than merely a place where anyone can park free after they cruise long enough to find a space. No one can say this policy will drive customers away if almost all the curbside spaces are always occupied.

When meter revenue goes into a city's general fund rather than going back to the BID or neighborhood that generated it, the city can be careless about collecting it. In downtown San Francisco where the curbside spaces always seem full, an audit in 2006 found that drivers paid for less than an hour a day per meter. A similar audit in Los Angeles in 2002 found that 96 percent of the vehicles parked at expired meters did not receive citations. If every BID received a share of the meter revenue it generated, business leaders would pay closer attention to enforcement. Consistent parking enforcement will create a culture of compliance with parking regulations.

Some cities have begun to charge performance-based prices for curbside parking and return the meter revenue to its source. In Redwood City, California, for example, the city sets meter rates to achieve an 85 percent occupancy rate for curbside parking downtown; the rates differ by location and time of day, depending on demand. The city returns the >





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revenue for added public services in the metered district, and downtown Redwood City will receive an extra \$1 million a year to pay for increased police protection and clean sidewalks. The merchants and property owners all supported the new policy when they learned the meter revenue would pay for added public services in the downtown business district, and the city council adopted it unanimously. Performance-based prices create a few curb vacancies so visitors can easily find a space, the added meter revenue pays to improve public services, and these public services create political support for the performance-based prices.

Most cities keep their meter rates constant throughout the day and let occupancy rates vary in response to demand. Instead, cities can charge different prices at different times of day to keep occupancy at about 85 percent. In Redwood City, the meter rates are higher in the central spaces because demand is higher there. The goal is to balance supply and demand everywhere, all the time.

Most cities also limit the length of stay at meters so long-term parkers won't monopolize the underpriced curb spaces. But after Redwood City adjusted meter rates to guarantee the availability of curb spaces, it removed the time limits at meters. This unlimited-time policy has turned out to be popular with some drivers, who can now park for as long as they are willing to pay. The demand-determined meter rates create turnover at convenient curb spaces, and most long-term parkers tend to choose cheaper spaces in off-street lots.

PARKING INCREMENT FINANCE

Most cities now put parking meter revenue into the city's general fund. How can a city return meter revenue to business districts without shortchanging the general fund? The city can keep all the *existing* meter revenue and return a share of the subsequent *increment* in meter revenue—above and beyond the current meter revenue—that arises from right-priced curb parking. We can call this arrangement *parking increment finance*. More meters, higher rates, longer hours of operation, and better enforcement will increase the parking revenue in business districts. The added public services paid for by increased parking revenue will promote business activity, and the increased demand for parking will further increase meter revenue.

GET THE PRICES RIGHT

Where curb parking is underpriced, drivers cruise for a curb space rather than pay to park off-street. Charging the right price for curb parking can eliminate this cruising and all its harmful side effects. Because city governments set the prices for curb parking, they choose whether drivers will cruise.

Because its curb parking is underpriced, Westwood Village generates almost a million miles of cruising every year. And because its curb parking is value-priced, Redwood City will generate \$1 million a year for added public services. Which is the better policy? If cities want to reduce congestion, clean the air, save energy, reduce greenhouse gas emissions, improve neighborhoods, and do all this quickly, they should charge the right price for curb parking and spend the resulting revenue to improve local public services. Getting the price of curb parking right will do a world of good. ♦



DISPATCH FROM SYDNEY

Transport in the Land of Oz

BY JOHN LANDIS

AUSTRALIA—OR OZ AS IT IS KNOWN COLLOQUIALLY—IS INSTANTLY recognizable to visiting Americans, even those like myself who had never been there before. As in the US, most of Australia’s population lives in metropolitan areas within twenty miles of the coast. A majority of Australians live in suburban communities, and single-family homes are the dominant housing form. Australia’s home ownership rate stands at seventy percent, slightly above the US rate.

The transportation picture also looks familiar, at least at first glance. GM (through its Holden Division), Ford, and Toyota are Australia’s biggest auto manufacturers, and four-wheel drives, minivans, and SUVs (known locally as “utes” and “soft-roaders”) are popular among suburban households. Urban and suburban traffic congestion is LA-like in its severity, especially in and around Australia’s two largest cities, Sydney and Melbourne. After years of under-investment, Australia’s urban transit systems are facing widening revenue shortfalls. In terms of new investments, light rail is popular with local elected officials, while transit professionals generally favor bus rapid transit. Support is also growing for transit-oriented development to combat auto dependence and better coordinate public transportation investments with private land use decisions.

Early twentieth-century land use patterns in Australia’s major East Coast cities—Sydney, Melbourne, and Brisbane—were shaped by a combination of privately and publicly developed streetcar systems. As a result, the inner ring of older suburban neighborhoods in all three cities is compact and walkable. Sydney dismantled its tram system in 1962 to promote private vehicle use, followed by Brisbane in 1969. Melbourne still operates an extensive 150-mile, 500-tram streetcar system carrying more than 400,000 riders every day. Billed as the largest tram network in the English-speaking world, most Melbourne trams share street space with local auto traffic.



FOR WANT OF URBAN FREEWAYS

Perhaps the biggest difference between US and Australian transportation systems is in how major intrametropolitan expressways were planned and developed. Whereas the US interstate and intrametropolitan freeway system was planned, developed, and mostly paid for by the federal government in the 1950s and 1960s, in Australia the construction of major expressways and tollways had to wait until the 1990s, and went without national funding.

The implications of this difference are enormous. Without the benefit of freeways as an organizing skeleton, Australia’s postwar suburbs developed individually and willy-nilly. Whereas America’s postwar suburbs sprawl contiguously outward along recognizable freeway spines, Australian suburbs just sprawl. Leapfrog development, which has mostly been eliminated from American metropolitan areas, is still commonplace in Australian suburbs. Instead of locating along freeways or expressways where they are easy for regional shoppers to get to, Australia’s suburban malls are located in suburban centers and along connecting arterials, where they conflate regional and local

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traffic congestion. If there is a good side to the lack of suburban freeway capacity it is that many of Australia's major employers have remained downtown—where they can be served by public transit—instead of migrating to suburban office parks. But this too is now changing. Sydney's most recent metropolitan development plan, known as the Metropolitan Strategy, foresees and indeed encourages job decentralization to multiple suburban job centers.

When Australia's three largest state governments (New South Wales, Victoria, and Queensland) finally did embark on a program of metropolitan freeway building in the 1990s, they faced additional costs and difficulties. Because the suburban landscape was already substantially developed, right-of-way acquisition was extremely expensive. The engineering and design challenges of linking new facilities to existing regional transportation facilities like Sydney's Harbor Bridge and downtown Cahill Expressway proved daunting. Residents of established suburban neighborhoods were none too happy about having regional roadways cut through their communities. The national government in Canberra was no help. Instead of using its financial capacity to help state governments build a seamless, nationally connected transportation system, Canberra eschewed debt-financed infrastructure construction altogether. In terms of planning and financing new transportation projects, this left state and local governments on their own. ➤



THE RISE (AND OVERREACH?) OF PPPs

Local governments solved this dilemma by enlisting the help of the private sector in a series of arrangements that came to be known as PPPs, or Public-Private Partnerships. Similar to the Build-Operate-Transfer model of infrastructure construction used in the developing world, PPPs work as follows: the public sector—in Australia’s case, a state government—contracts with a private-sector consortium made up of a building contractor, a maintenance company, and a bank lender to build, operate, and maintain a particular facility. The consortium raises investment capital, operates the facility, and collects user fees—or in the case of roadways, tolls. At the end of the contract period (usually between twenty and thirty years) the facility may or may not revert to government ownership. From the government’s perspective, PPPs have many advantages. They benefit from the private sector’s experience in managing development risk and its ability to mobilize private investment capital, and they keep financing costs off the government’s ledger. The private sector consortium receives up-front development and financing fees from the government, as well as a portion of ongoing toll payments. Most of the toll revenue goes to repay investors. (A similar model was used in Orange County to develop the SR91 tollway.)

The PPP Model was introduced in Australia in 1986 by the New South Wales government to build the Sydney Harbor Tunnel, which connects North Sydney to the

Sydney Central Business District (CBD) underneath the iconic Sydney Harbor Bridge. Subsequent PPPs were used to build a host of expressways and tunnels throughout metropolitan Sydney. The PPP model has also been used in Melbourne to construct two new freeways, the Western Link (running north-south and connecting Melbourne's western suburbs), and the Southern link (running east-west through and under Melbourne's central area).

Controversy over the PPP-tollway model has focused on two points. The first is whether the public sector could have developed similar facilities at a lower cost. The second focuses on whether the tolls are higher than need be, given that returns paid to investors have been consistently higher than the government's borrowing costs. These disagreements aside, there is little doubt that the PPP approach has proved to be a workable model for retrofitting desperately needed freeways into Sydney and Melbourne's existing metropolitan fabric.

When used to build tunnels, PPPs have been a mixture of good and bad. On the good side of the ledger is the Sydney Harbor Tunnel connecting the Warringah Freeway in North Sydney and the Cahill Expressway in the Sydney CBD. Opened in 1992, the Sydney Harbor Tunnel was initially criticized for its half-billion dollar construction cost, its unusual immersed modular tube construction, and the fact that it guaranteed returns based on projected traffic volumes rather than actual use. Now the Tunnel is an integral component of Sydney's cross-harbor transportation system, carrying about 85,000 inbound vehicles per day—about half the traffic of the nearby Sydney Harbor Bridge, but more than twice the average daily ridership of the Sydney Ferry system. The additional vehicle capacity afforded by the Sydney Harbor Tunnel enabled the Sydney Harbor Bridge to convert one of its automobile lanes to a dedicated bus lane, and today, according to government statistics, peak-hour buses crossing the Sydney Harbor Bridge carry thirty percent more commuters than the Bridge's other seven traffic lanes combined.

Not all PPP experiences have been so positive. Opened in August 2005, the 1.2 mile Cross-City Tunnel, which connects Sydney's eastern and western neighborhoods, is proving far more controversial. As part of the contract awarded to the Cross-City Tunnel Consortium (a partnership of an Australian construction company and investors from Hong Kong and the US), the New South Wales (NSW) government agreed to close competing surface streets. Initial projections were that the Tunnel would carry 85,000 vehicles per day. One month after its opening, fewer than 25,000 vehicles were using the Tunnel and surface street traffic congestion was worse than ever. With Sydney's newspapers accusing the New South Wales government of incompetence and Tunnel investors growing increasingly nervous, speculation arose that the NSW government would be forced to buy out the Consortium's financial interest at a \$300 million premium. This was denied vigorously by both parties, who insisted that tunnel usage would eventually rise and that they were "in it for the long haul." To attract more users and assuage growing public anger, the Consortium announced in March 2006 that the toll would be cut in half for three months, and that some existing road closures would be reversed. Two days prior to the end of the half-price toll period, NSW Premier (i.e., Governor) Morris Iemma summarily ended negotiations with the Consortium without an agreement, and in contravention to the original contract, announced the reversal of several road closures. Where things go from here will depend on the results of NSW state elections, which were held on March 24, 2007. ➤

There is little doubt that the PPP approach has proved to be a workable model for retrofitting desperately needed freeways into Sydney and Melbourne's existing metropolitan fabric.

OFF THE ROADS AND ON THE BUS: THREE APPROACHES TO BRT

Australia has also emerged as an international leader in the construction of bus rapid transit (BRT) systems, with four BRT routes now in operation and two more under construction. Australia's first BRT system was developed in the 1970s to link several suburban towns around Canberra, Australia's capital.

Far better known is Adelaide's O-bahn system, which was completed in 1986. Built in place of a freeway extension and as a more flexible and less costly alternative to light rail, the 7.5-mile O-bahn system was conceived in partnership with Daimler Benz (now DaimlerChrysler). It is unique in that buses run on a specially built track that cannot be used by cars or other private vehicles. The O-bahn's one station and two interchanges allow regular local buses to enter and exit the system as part of their normal suburban routes. O-bahn buses run up to sixty miles per hour with one-minute headways during the weekday peak and three- to five-minute headways during non-peak periods. During its first ten years of operation, O-bahn patronage increased seventy percent, while its service area population increased by twenty percent. Patronage levels declined somewhat during the late 1990s as a result of fare increases. Current O-bahn patronage levels are on the order of 20,000 riders per day, forty percent of whom previously drove. Its ridership appeal notwithstanding, according to a 2003 TRB study comparing Australian BRT systems, the Adelaide O-bahn has had little effect on urban development patterns or on nearby property values.

Brisbane's ten-mile long South East Busway has had much greater ridership, mode share, and property value impacts. Opened in two phases in 2000 and 2001, the busway connects Brisbane's CBD to the city's southern suburbs, and is used by approximately 70,000 riders everyday. With a dedicated bi-directional right-of-way in an expressway median, and ten easy-on/easy-off stations, the South East Busway is used by 117 separate bus routes. Headways range from thirty seconds near the CBD to three minutes at the suburban terminus.

The South East Busway has clearly made transit use in Brisbane faster and more convenient, but has it lured drivers from their cars? While a precise answer to this question will have to await the next national census, one survey puts the share of Busway riders who previously drove at 26 percent. The same 2003 TRB study that found Adelaide's O-bahn system to have had no impact on property values concluded that the South East Busway has led to a twenty percent gain in nearby property values, and that homes within six miles of the Busway increased in value two to three times as fast as more distant properties.

The Sydney region is taking a different approach to bus rapid transit. Instead of connecting the Sydney CBD to its western suburbs—a service provided by commuter trains—the 18.5 mile long Liverpool-Paramatta Transitway (LPT) connects several of the region's fast-growing suburban centers. Opened in February 2003, the LPT includes twelve miles of bus-only right-of-way located in the median or adjacent to existing arterials, and 35 stations spaced at approximately 800-meter intervals. In contrast to Adelaide and Brisbane, use of the LPT is not open to local buses. Articulated buses powered by compressed natural gas run every ten minutes during peak periods and every fifteen to thirty minutes during the off-peak. Fares are assessed zonally, and are comparable to other suburban bus routes.





While peak-period buses often run full, in what seems to be an endemic problem for all Sydney area transportation projects, patronage has been much less than originally forecast. A 2005 review of the LPT conducted by the New South Wales Audit Office concluded that although customer satisfaction was quite high, final construction costs had exceeded initial estimates threefold, and that, even allowing for further patronage increases, the system would continue to operate in the red.

HOW NOT TO RUN A RAILROAD, AND OTHER POLITICAL OBSERVATIONS

Sydney relies on its public transit system more than any other Australian city, and without it, the Sydney metropolitan area would be unlivable—a seventeen-day rail strike in 1983 brought the city to its knees. These days, most of the 186,000 commuters who daily swell the ranks of Sydney's CBD arrive by bus or rail. Altogether, metropolitan Sydney's transit systems carry nearly two million passengers each weekday. Public transit is Sydney's lifeblood, yet by common agreement, the quality of transit service in Sydney—especially its rail service—has grown steadily and noticeably worse since the 2000 Sydney Olympics.

Sydney's eleven commuter rail lines and four inter-city lines are run by CityRail, a subsidiary operator of RailCorp, the government agency responsible for all passenger rail services in New South Wales. CityRail operates a fleet of more than 1,500 double-decked transit cars over 1,300 miles of trackbed serving 302 separate stations. >



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All CityRail services (as well as the independently-operated Metro Tram light rail service) converge at Sydney's Central Station, which is located about a half-mile south of the Sydney CBD.

CityRail service suffers from three types of problems. The first is simple age. In the build-up to the 2000 Sydney Olympics, CityRail devoted most of its capital resources to system expansion and not to replacing equipment. As with any aging vehicle fleet, reliability is on the decline. CityRail's second problem is that traincar operators are leaving or retiring faster than they can be replaced. Its third and most serious problem is that because so many different lines share a common trackbed, breakdowns and delays on any one line quickly cascade throughout the entire system.

CityRail's own benchmarks stipulate that at least 92 percent of peak-period trains should keep to within five minutes of their designated arrival timetables. As of 2004, every major CityRail line missed its performance benchmarks, in some cases by as much as thirty or forty percent. CityRail's problems reached a crisis point in January 2003 when a train operator's deadman's brake failed to slow a commuter train after the operator was incapacitated by a heart attack. The resulting derailment killed seven passengers and injured many more. An official inquiry into the accident attributed some of the blame to CityRail's "underdeveloped safety culture."

In response, and without any immediate hope of meeting its own benchmarks, in September 2005, CityRail lowered its sights by reducing train speeds, increasing headways and station dwell times, and reducing the number of weekday trains in service by an average of twenty percent. Depending on the route, these changes added between five and twenty minutes to typical commuter trip times. They did have the desired effect, however, and on-time performance improved, although not to the level of CityRail's 92 percent benchmark. A 2005 investigation into CityRail's problems by the NSW Auditor General identified numerous internal management and operations problems, and also criticized CityRail for not doing a better job informing passengers about severe train delays.

To an outsider like myself, CityRail's problems seem to go deeper. And they are symptomatic of a pervasive and fundamental problem: the lack of political accountability. The Labor Party government's usual response to declining public service quality is to switch mid-level managers and hope for the best. The notion that top-level public servants should be more accountable to the public than to party leadership has withered away. Missing from electoral politics in Australia is a sense of outrage—and the expectation that things can and should be better. ♦

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The Incredible Shrinking Energy R&D Budget

BY DANIEL M. KAMMEN AND GREGORY F. NEMET

THE FEDERAL GOVERNMENT AND PRIVATE INDUSTRY ARE BOTH REDUCING their investments in energy research and development (R&D) at a time when geopolitics, environmental concerns, and economic competitiveness call instead for a major expansion in US capacity to innovate in this sector. The 2005 federal budget reduced energy R&D by eleven percent from 2004. The American Association for the Advancement of Science projects a decline in federal energy R&D of eighteen percent by 2009. Meanwhile, investments in energy R&D by US companies fell by fifty percent between 1991 and 2003.

This decline occurred despite numerous calls from expert groups for major new commitments to energy R&D. A 1997 report from the President’s Committee of Advisors on Science and Technology and a 2004 report from the bipartisan National Commission on Energy Policy both recommended that federal R&D spending be doubled.

A comparison with the pharmaceutical industry is revealing. In the early 1980s, energy companies were investing more in R&D than were drug companies; today, drug companies invest ten times as much in R&D as do energy firms. Total private sector energy R&D is less than the R&D budgets of individual biotech companies such as Amgen and Genentech. The nation’s ability to respond to the challenge of climate change, and to the economic consequences of disruptions in energy supply, has been significantly weakened by the lack of attention to long-term energy planning.

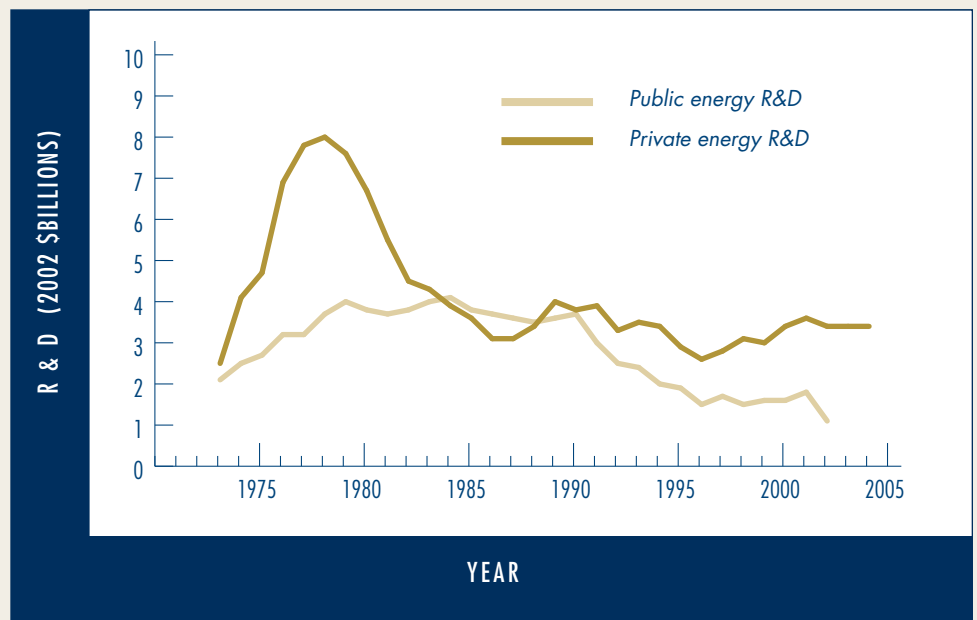
Comparison to previous major government research programs suggests that a serious federal commitment to energy R&D could yield dramatic results. Using emissions scenarios >

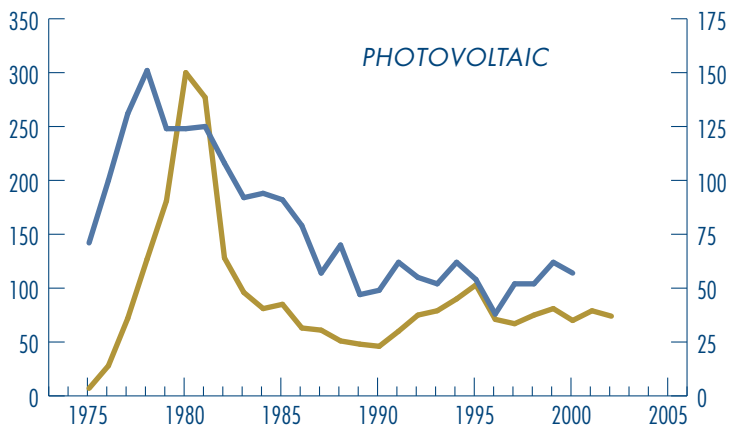
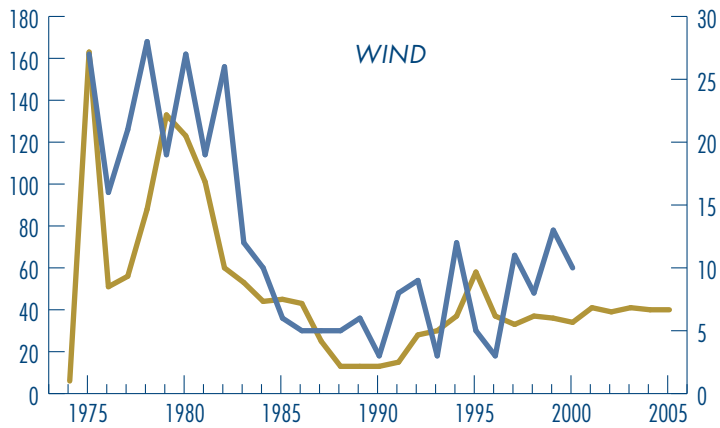
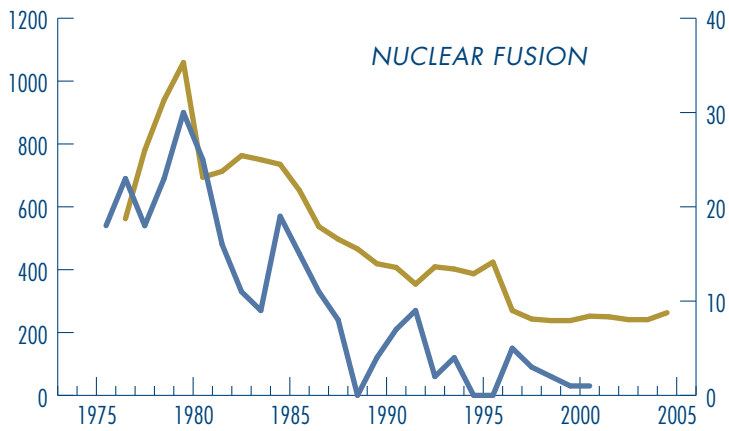
FIGURE 1

Declining energy R&D investment by public and private sectors

Since 1980, energy R&D as a percentage of total US R&D has fallen from ten percent to two percent. Since the mid-1990s, both public and private sector R&D spending has been stagnant for renewable energy and energy efficiency, and has declined for fossil fuel and nuclear technology.

Sources: Raymond M. Wolfe, *Research and Development in Industry* (National Science Foundation, Division of Science Resources Statistics, 2004); M. Jefferson, et al., *Energy Technologies for the 21st Century* (World Energy Council, 2001); Ronald L. Meeks, *Federal R&D Funding by Budget Function: Fiscal Years 2003–05*, NSF 05-303 (National Science Foundation, Division of Science Resources Statistics, 2004); Robert Margolis and Daniel M. Kammen, “Underinvestment: The Energy Technology and R&D Policy Challenge,” *Science*, No. 285, 1999.





YEAR

FIGURE 2

Correlations and declines in patenting and federal R&D

Patenting provides a measure of the outcomes of innovation. We use records of successful US patent applications as a proxy for the intensity of innovative activity and find strong correlations between public R&D and patenting. Since the early 1980s, all three indicators—public sector R&D, private sector R&D, and patenting—exhibit consistently negative trends. The data include only US patents issued to US inventors. Patents are dated by their year of application.

Source: US Patent and Trademark Office patent database.

— Public R&D
— Patents

from the Intergovernmental Panel on Climate Change and a framework for estimating the climate-related savings from energy R&D programs developed by Bob Schock from Lawrence Livermore National Laboratory, we calculate that energy R&D spending of \$15 to \$30 billion/year would be sufficient to stabilize CO₂ at double pre-industrial levels. This five- to ten-fold increase in spending from current levels is not a “pie in the sky” proposal; in fact it is consistent with growth seen in several previous federal programs, such as the Apollo Program, which took place in response to clearly articulated national needs. In the private sector, US energy companies could increase their R&D spending by a factor of ten and would still be below the average R&D intensity of US industry. Past experience indicates that higher investments would be repaid several times over in technological innovations, business opportunities, and job growth. The recent \$500 million agreement between British Petroleum and several universities, which established the Energy Biosciences Institute at UC Berkeley, is a step in the right direction. But it falls far short of the level of funding that’s both needed and possible.

R&D investment is an essential component of a broad innovation-based energy strategy that includes transforming markets and reducing barriers to the commercialization and diffusion of nascent low-carbon energy technologies. The economic benefit of such a bold move would repay the country in job creation and global economic leadership, building a vibrant, environmentally sustainable engine of new economic growth. ♦

Figures and text are drawn from Kammen, Daniel M. and Nemet, Gregory, “Reversing the Incredible Shrinking Energy R&D Budget,” Issues in Science and Technology, Fall 2005.

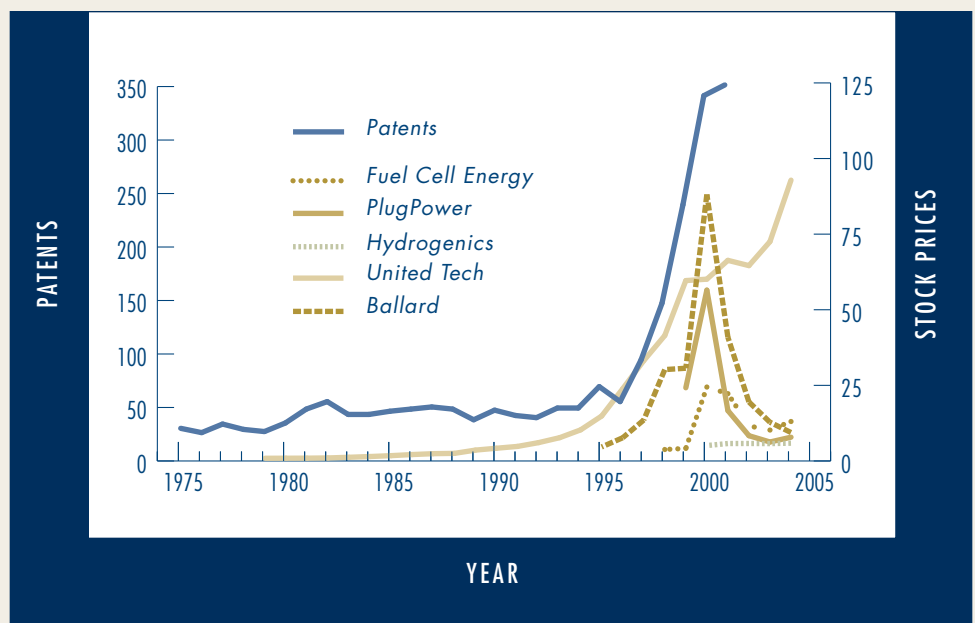
Daniel M. Kammen (kammen@berkeley.edu) is professor in the Energy and Resources Group and in the Goldman School of Public Policy at the University of California, Berkeley, where he is also co-director of the Berkeley Institute of the Environment. Gregory F. Nemet (gnemet@wisc.edu) is assistant professor at the Gaylord Nelson Institute of Environmental Studies, and at the LaFollette School of Public Affairs at the University of Wisconsin at Madison.

FIGURE 3

Fuel cell patenting and stock prices

One bright spot in the nation’s energy innovation system is increased investment and innovation in fuel cells. Despite a seventeen percent drop in federal funding, patenting activity intensified by nearly an order of magnitude, from 47 in 1994 to 349 in 2001, with much of the activity driven by private sector investment fuelled by rising stock prices. The relationship between fuel cell company stock prices and patenting is stronger than that between patenting and public R&D. The five firms shown account for 24 percent of fuel cell patents from 1999 to 2004. Almost 300 firms received fuel cell patents in those years, reflecting participation both by small and large firms.

Source: US Patent and Trademark Office patent database.



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