



# Made for Walking

*Density and Neighborhood Form*



**Julie Campoli**





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**Julie Campoli**



**LINCOLN INSTITUTE**  
OF LAND POLICY  
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# Foreword

The image-rich urban design book *Visualizing Density*, coauthored by Julie Campoli and aerial photographer Alex S. MacLean, was an unusual “blockbuster” for the Lincoln Institute of Land Policy when it was published in 2007. It explored such topics as why we hate density and how we can come to love it, offered detailed guidance on ways to plan and design for density, and provided a density catalog with more than 1,000 aerial photographs representing a range of residential densities from less than one to more than 200 units per acre. The book included a compact disc of these images to encourage readers to use them in educational settings and at public meetings. It has been gratifying to learn that some development projects that, because of perceived density issues, initially encountered community opposition at planning and zoning hearings later gained approval following a viewing of comparable neighborhoods from the catalog.

Virtually from its launch, readers have called for an on-the-ground version of *Visualizing Density* that helps communicate people’s everyday experience of density. *Made for Walking* contains more than 450 street-level views of neighborhoods in North America, but it is more than a sequel to the earlier volume. In this new work, landscape architect and urban designer Julie Campoli takes us beyond simple measures of density to describe the characteristics of places that provide an alternative to the automobile-dependent suburb. This will interest all who are concerned about the high cost of energy, seek a more urban lifestyle, or want to reduce their annual vehicle miles traveled (VMT) as a way to reduce greenhouse gas emissions that affect climate change and the quality of our urban environment.

Providing more transportation options that encourage walking, biking, and transit will necessitate a shift in land use patterns and the way we locate and shape future development. We need to think about urban density conceptually as including the density of jobs, schools, and services, such as retail, community resources, and recreational facilities. Fitting more amenities into a neighborhood within a spatial pattern that invites walking

creates a built environment that offers real transportation options. Through her engaging text and dramatic photographs, Campoli challenges our notions of space and distance and helps us learn to appreciate and cultivate proximity.

Researchers who examine the impact of urban form on travel behavior identify specific characteristics of place that boost walking and transit use while reducing VMT. In the 1990s some pinpointed diversity, density, and design as the key elements of the built environment that, in specific spatial patterns, enable alternative modes of transportation. Later two other “Ds”—distance to transit and destination accessibility—were deemed equally important and together they became known as the “five Ds.” The addition of another key player, parking, brought the count to six attributes that have become useful as shorthand for defining and measuring compact form and, in the process, predicting how that form will affect travel and reduce VMT. They also correspond to characteristics of compact development touted by smart growth advocates. Lowering VMT by any significant measure will require integrating these attributes at a grand scale.

While thinking big is essential, this book visualizes a low-carbon environment in smaller increments by focusing on 12 urban neighborhoods, each covering a comfortable pedestrian walk zone of approximately 125 acres. Some are in familiar cities with historically dense land use patterns, intertwined uses, and comprehensive transit systems; others have emerged in unexpected locations, where the seeds of sustainable urban form are taking root on a micro level. The following 12 case studies are richly illustrated to show both their variety and their commonalities.

- LoDo and the Central Platte Valley, Denver, Colorado
- Short North, Columbus, Ohio
- Kitsilano, Vancouver, British Columbia
- Flamingo Park, Miami Beach, Florida

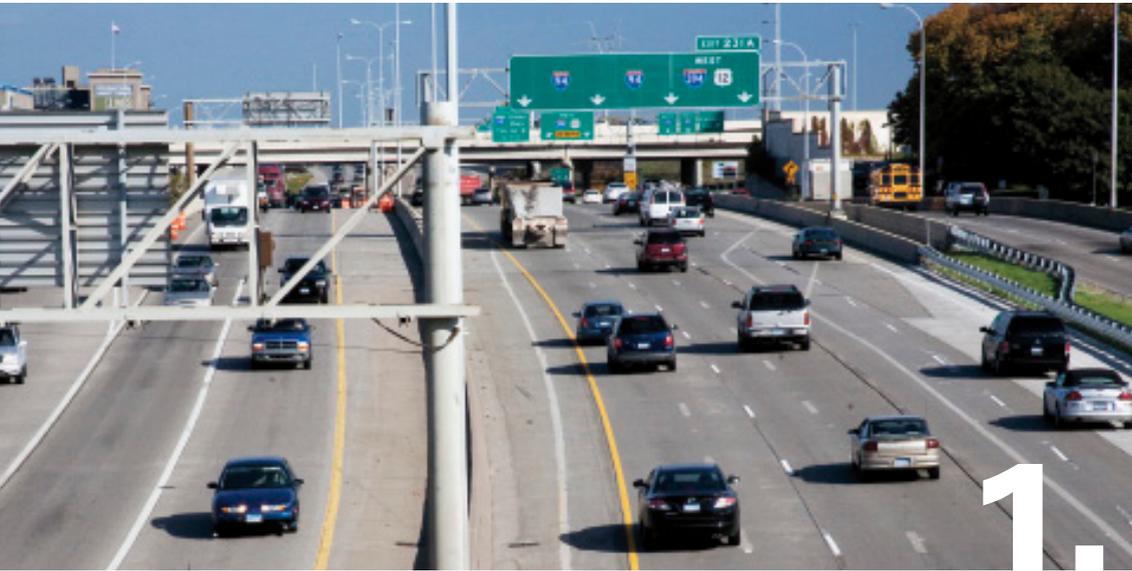
- Little Portugal, Toronto, Ontario
- Eisenhower East, Alexandria, Virginia
- Downtown and Reynolds Addition, Albuquerque, New Mexico
- The Pearl District, Portland, Oregon
- Greenpoint, Brooklyn, New York
- Little Italy, San Diego, California
- Cambridgeport, Cambridge, Massachusetts
- Old Pasadena, Pasadena, California

Each of these sites was selected because it offers choices: travel options, housing types, and a variety of things to do and buy. Their streets are comfortable, attractive, and safe for biking and walking. They all show how compact development can take shape in different regions and climates. Six specific qualities make them walkable—connections, tissue, densities of housing and population, services, streetscape, and green networks—all of which are measured and represented in a consistent series of graphic diagrams for easy comparison among the 12 neighborhoods.

Many of these places have shared a similar historical arc—bustling growth followed by decline and depopulation as a rail-based transportation system was superseded by one that dispersed economic energy in more diffuse patterns at the edges of cities. The bad years often took their toll, eating away at the intricately connected urban fabric. By the end of the twentieth century, however, the story was beginning to change as new urban dwellers discovered the attractions of these older neighborhoods.

In addition to the potential offered by existing downtown neighborhoods, we can apply lessons from these older places to new and infill development that emulates their “good bones”—human-scale buildings and networks of small blocks and connected streets. In the process we can create many more appealing neighborhoods that are made for walking.

Armando Carbonell  
Senior Fellow and Chair  
Department of Planning and Urban Form  
Lincoln Institute of Land Policy



# 1. Everything Is Somewhere Else

Everything in life is somewhere else, and you get there in a car.

—E. B. White (1982, 109)

## **THERE AND BACK**

Every weekday morning, Bill Hurst backs his Chevy Impala out of the garage and pulls away from his home in rural Venersborg, Washington. Cruising along the edge of the Cascade Mountains foothills, he passes through forests and fields peppered with farms and isolated homesteads. After several miles, the open landscape gives way to scattered houses and eventually to the subdivisions flanking Interstate 205 around Vancouver, Washington. Bill merges onto the beltway and works his way across the

Columbia River through rush-hour traffic to his office in downtown Portland, Oregon. He has traveled 22 miles.

The Hurst's oldest child, Nicole, leaves home a half-hour later than Bill and drives much of the same route, diverting from her father's path only to enter Vancouver for her class at a local college 18 miles from home. Bill's wife, Darcy, has a shorter commute of about five and a half miles to her job in nearby Battle Ground, Washington. The only member of the Hurst family who does not begin her day alone in a car is the youngest, Jori. Leaving at 6:30 a.m., she is the first one out of the house. Jori walks to the end of the road to wait for the school bus to pick her up on its meandering nine-mile journey to Battle Ground High School.

In the afternoon, Darcy returns from work and waits for her daughter's bus, and they both climb into the car to take Jori to rugby practice eight miles away. Next Darcy travels six miles to a local park to enjoy a walk with friends. Even though the Hursts do most of their shopping and errands on the way to and from work, they often find themselves in Battle Ground on weekends, too. Darcy also makes a weekly 27-mile round trip to visit family.

All told, just for essential travel in 2011, the Hurst family drove roughly 627 miles each week (figure 1.1). And like most families, they added more miles to their odometers by making occasional trips for health care visits, family gatherings, summer vacations, visits to friends, college tours, and sporting events.

The Hursts' routine is familiar to most American families whose daily schedules send them off to work or school at different times and in different directions, usually in a car. Like the Hursts, they tend to drive farther than the average, and these families are what the U.S. Department of Transportation's National Household Travel Survey (NHTS) classes a high-mileage household (FHA 2009). They live in a single-family neighborhood in a low-density town, two family members' daily destinations are located 30 minutes from home, and all the places they visit regularly are beyond walking distance. They own several cars because that proves more time-efficient and convenient than sharing rides.

Since 1969 the NHTS has questioned Americans regularly about the details of their travel habits, their household demographics, and their living environments. It gathers information on the number of trips people take and the miles their vehicles travel. These data help guide decisions about transportation policy and provide a rough sketch of a nation devoted to and dependent on cars. Embedded in the 2001 tables are statistical profiles of uniquely American travel behavior (FHA 2004). Within a single day the average American makes roughly four car trips and spends an hour traveling a total of about 40 miles, usually alone. In 2009, 59 percent of households owned at least two cars, and 23 percent claimed three or more vehicles.

Americans rarely go anywhere without first reaching for their car keys. A tiny fraction of the population regularly climbs on a bus,



Figure 1.1 **Hurst Family Commute Zone.** With daily destinations extending over 80 square miles (their commute zone), the Hurst family drives a combined 627 miles each week for essential travel. The thickness of each blue band reflects the frequency of travel along a particular road segment. Source: Map data © OpenStreetMap contributors, CC-BY-SA.

and an even smaller number sets foot on a subway platform. Although we may stroll through a mall or around the block for exercise, only 8 percent of routine trips are on foot, and only 2 percent of workers walk to their job locations. We may pull our bikes out of the garage for a family vacation, but the number of people who pedal to work accounts for just 0.4 percent of the population—a figure so low it’s often lumped into that vague and insignificant statistical category “other” (Davis, Diegel, and Boundy 2010).

On an individual basis, this reliance on the car may be acceptable, depending on the traffic conditions or the price of gas, but the fact is that we have no choice. For most of us, there is no convenient bus and certainly no job within walking distance. In most of the places we live and work, we can take a walk, but we can’t walk to get somewhere because that somewhere is too far away. Most communities are designed with the assumption that distance is a virtue, that more space between neighbors and neighboring activities is better than less. Behind the wheel of a fast, comfortable car those distances are imperceptible. Without a car, however, all that excess space—the large lots, the buffers, the setbacks, the turning lanes, on-ramps, and clear zones—creates a huge barrier between us and the places we need to go.

Jori Hurst understood this implicitly. In the winter of 2011 she was counting the days to her sixteenth birthday, when she would trade in her learner’s permit for a driver’s license and claim the Ford Focus her sister left behind when she moved away for college. Jori was frustrated by her distance from her friends and was eager to gain control of her schedule by driving herself.

In this era of volatile energy prices and persistent congestion, an increasing number of Americans would prefer alternatives that are cheaper, faster, or more convenient than driving. In order to leave the car at home once in a while, they want to take a bus, walk, or ride a bicycle. But providing transportation options is more complex than creating a bus route, building sidewalks, or striping a bike lane. It’s not a problem that can be solved simply by greater transportation funding. It demands a shift in our land use patterns and the way we locate and shape future development. To make that change, we must

challenge our current notions of space and our obsession with distance and learn to appreciate and cultivate proximity.

When the price of gas spiked in 2008, the Hurst family made some changes. They shifted their schedules in order to share rides and eliminated unnecessary journeys into town by combining errands whenever possible. This was when they consolidated their major food shopping into two trips per month, and Darcy began stopping for produce on her way home from work. Bill got into the habit of keeping shopping lists handy and commuted in whichever car needed gas to avoid unnecessary trips just to fill the tank. Later, when gas prices declined, the family gave up these money-saving practices only to return to them a few years later when the pump price inched back toward four dollars per gallon.

The Hursts face a problem common to households all over North America—how to prevent the cost of filling their gas tanks from consuming too large a share of the family budget. They needed to drive less or, to use transportation planners’ lingo, to lower their VMT (vehicle miles traveled).

Researchers who analyze travel behavior with an eye toward lowering VMT have identified three separate components of travel: *trip frequency*—the number of times you go somewhere; *trip length*—how far you go; and *mode choice*—whether you travel by private vehicle, public transit, bicycle, or on foot. Trip frequency is affected more by a household’s personal circumstances than its built environment. Trip length depends more on the built environment and less on personal circumstances. Mode choice is influenced by both factors (Ewing and Cervero 2010).

When the price of gas goes up and the Hursts need to lower their household VMT, trip frequency is the only variable they can control. They reduce the number of times they drive by sharing rides and altering their routines. But the length of each trip is dictated by the built environment. They can’t choose a closer supermarket, hardware store, or athletic facility because there aren’t any. Their corner of Clark County, Washington, has a population density of 341 persons per square mile (ppsm)—too low to support more than a few widely scattered services. This dispersed development pattern also prevents the Hursts from choosing a different mode of travel.

According to comedian Steven Wright (2010), “Everywhere is walking distance if you have the time.” But no one living in exurbia has the kind of time it would take to walk to the places they need to go. The eleven-mile round-trip walk to Darcy’s job would add four hours to her workday. And getting to his job in downtown Portland without a car would take Bill five hours each way: a three-hour walk to the nearest Clark County transit (C-TRAN) stop plus two hours on four different bus routes. Their neighborhood doesn’t offer a large

enough pool of potential riders for C-TRAN to warrant extending the service. Biking would be faster than walking but, according to Darcy, they would not consider that option given the hilly terrain and the danger of biking on narrow roads with fast-moving cars.

While Mark and Sally Brown Russ of Houston, Texas, have similar personal circumstances—their family of five navigates a complex daily routine—their built environment provides more leeway for them to reduce the number of miles they drive. They live in a more densely built-up area, and because many destinations are within a few miles of their house, every week they travel half the distance the Hursts do. Mark commutes 23 miles each way from his Houston neighborhood to an exurban office park, but the rest of the family members’ trips are short—most under three miles—to nearby schools, sports fields, and grocery stores. The family’s weekly total is about 350 miles (figure 1.2). Like the Hursts they can share rides and combine errands to limit their trip frequency, but because they live in a place with a wider array of businesses and services, they also can opt to limit the length of their trips by choosing closer destinations.

The West U district of Houston, where Sally and Mark live, is subdivided into narrow parcels, most of them smaller than a third of an acre. The neighborhood consists entirely of detached single-family homes, but the tight arrangement of buildings on small lots results in a population density of 6,200 ppsm—about twice the density of the typical American suburb. Most of the family’s trips are a few miles long or less, and some destinations are as close as a quarter mile.

Despite the relatively high density and short distances, the Russes still drive almost everywhere they go. Sidewalks run the length of their tree-lined street, and the blocks around their house are quiet and pleasant, but the stores, schools, and most other places they go every day lie beyond these residential zones, strung along seven-lane highways and isolated by parking lots. Sally is weary of her role as family chauffeur, but the prospect of her children darting 90 feet from curb to curb in front of idling engines and then dodging around moving vehicles prevents her from letting them walk. And although she thinks she might benefit from the exercise of biking to the store

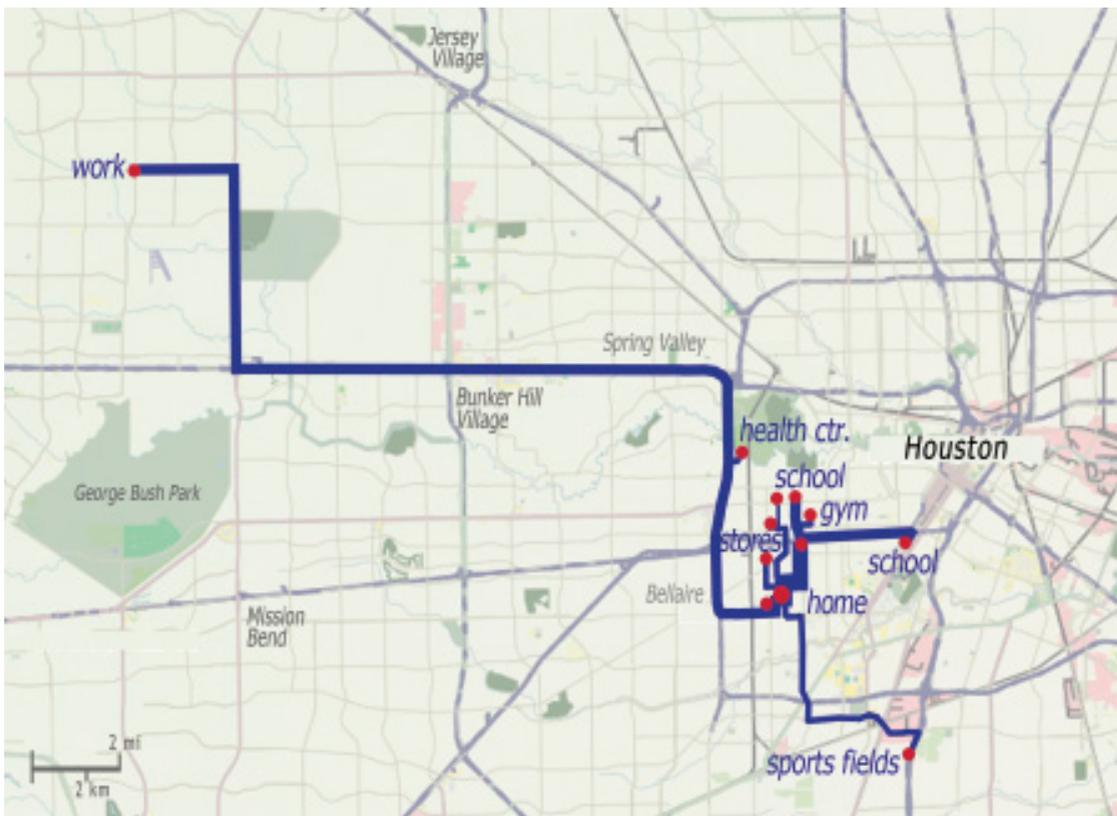


Figure 1.2 **Russ Family Commute Zone.** Despite Mark’s long commute to work, the rest of the Russ family’s routine travel is confined primarily to an area of roughly 20 square miles. The West U district of Houston, with a density of 6,200 ppsm, offers a wide variety of services, but walking to them is not easy.

Source: Map data © OpenStreetMap contributors, CC-BY-SA.

or gym, she rarely does so because it's simply not a pleasant experience. In transportation terms, their neighborhood offers short trips but little in the way of mode choice. The West U area is dense by the square mile but not by the foot. It lacks the kind of connected urban fabric that makes walking an attractive option.

## DENSITY BY THE FOOT

Density is often defined in terms of population per square mile, but such a crude measure makes it difficult to understand the relationship between density and transportation systems. We need to think about urban density in more complex ways, by including the density of jobs, schools, and services such as retail, transit, and recreational facilities in our consideration. Fitting more amenities into a neighborhood within a spatial pattern that invites walking will create the type of built environment that offers real transportation options. This requires planning at a pedestrian scale and designing an environment that is comfortable for a human being as she moves through it at a walking pace—building density measured not by the square mile but by the foot.

The best density—the kind found in urban places to which people become attached and cherish over time—is designed to be experienced on foot. Sidewalks are flanked by functional spaces such as entrances, window displays, small gardens, or public parks. Street frontage has a high value and every foot of it is maximized, with space divided in small increments. The scene varies with each step, unfolding invitations to look at and possibly enter a diversity of places along the way. Uses stack vertically, buildings share walls, and everything is nearby and connected by sidewalks, hallways, stairways, or elevators. Space is allocated in small, human-sized units. This quality can be found on the streets of the New York City borough of Manhattan as well as in communities of all sizes from Toronto, Ontario, to Savannah, Georgia, to Bisbee, Arizona.

With an average density of 18,000 ppsm, North American cities in 1910 were dense by the foot, and very few cars were on the streets. A century ago, urban neighborhoods offered the pedestrian most of the amenities, services, and destinations she would need

within walking distance. But over the course of the twentieth century, as we strove to accommodate the circulation and storage needs of the car, the increments of urban space mushroomed. Our sense of scale, which had been grounded in human footsteps, shifted to one measured in miles per hour.

As cities expanded outward, their densities shrank (Angel et al. 2011). Our notion of what fits within a given space is now very different. We no longer seem able to think small, which makes it difficult to create fine-grained urban environments. In fact, the failure to grasp pedestrian scale may be the biggest obstacle to replicating the patterns of our best-loved urban places. Eight decades behind the wheel have distorted our sense of distance and eroded our ability to divide urban space into increments that are comfortable for human beings. From a driver's perspective it is hard to believe that 60 feet could be an appropriate width between opposing building fronts. But when walking along a street between three-story buildings, 60-foot spacing feels just about right.

Plenty of neighborhoods are dense by the foot—real places in the United States and Canada where one can live well without spending much time in a car. Many of these places survive from the pre-automotive era, when they had been built around harbors, train stations, or streetcar lines. Their dense networks of homes and shops on small lots and narrow streets were designed to be traversed on foot.

The Boston, Massachusetts, neighborhood of Jamaica Plain, where Etty Padmodipoetro and her husband Joe Allegro live with their five children, is such a place. Like the Hursts and the Russes, their family performs a complex daily ritual of travel as its members disperse across a wide area. Unlike those two other families, however, Etty and Joe drive only about 150 miles a week. They and their children rely heavily on the T, Boston's public transit system, to get to work and school (figure 1.3). Apart from a weekly trip to an outer suburb for their son's science class, which doubles as a trip to the big box stores, their social lives, shopping, and children's activities take place in the dense network of institutions, shops, and homes in the vicinity of their street in Jamaica Plain, all of which

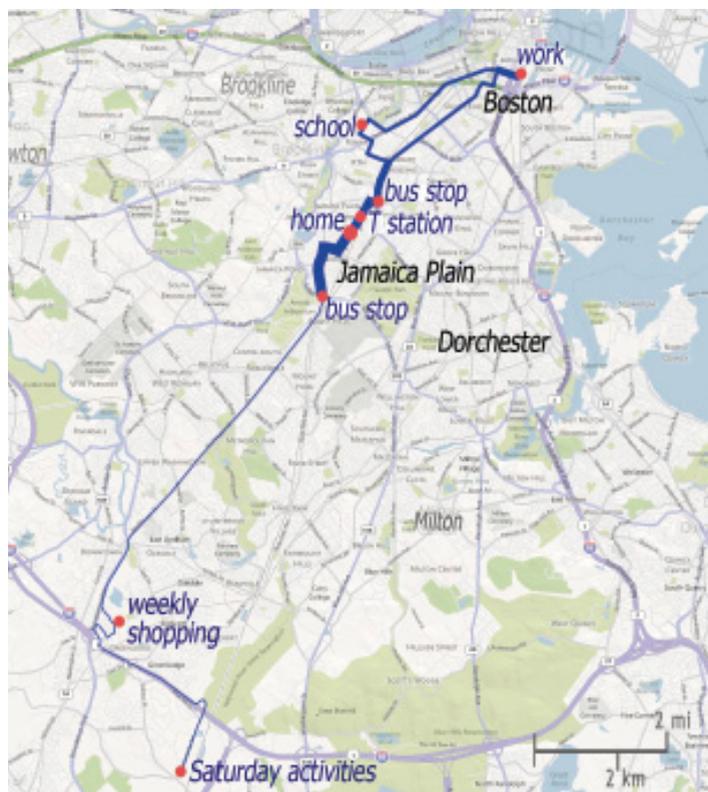


Figure 1.3 **Commute Pattern of the Padmodipoetro-Allegro Family.** Despite their busy schedules (two working parents and four children living at home), this family drives many fewer miles daily than the other two. They use school buses, the T, and walking to get to their daily destinations, all of which lie within two and a half miles of their home.  
Source: Map data © OpenStreetMap contributors, CC-BY-SA.

lie within a 15-minute walk. Short car trips include taking the children to the school bus stop or the T stop where, Etty admits, she often picks up her kids by car if it's late or cold or they're loaded down with bags. Otherwise the children, who are all at least eleven years old, depend on their feet or the T, rather than their parents, to get around.

Comparing these three families' commute patterns illustrates the range of conditions and challenges they and millions of other families face each day (figure 1.4). The Hursts' regular activities are spread across the broadest geographic area, most of the Russ's destinations are clustered around their inner-ring suburb, and the Padmodipoetro-Allegro family's weekly routines take them across the Boston metropolitan area, but few of this family's trips are made by car. Unlike exurban Battle Ground and the more auto-oriented Houston, Jamaica Plain's compact, public transit-oriented neighborhood offers alternatives.

Jamaica Plain gained its density in the late nineteenth and early twentieth centuries, when a trolley line from Boston connected this small, sleepy neighborhood to the city center. As the streetcar suburb grew, land within walking distance of the trolley held greater value. Developers maximized the parcels closest to the line by building at a high density and mixing uses. Many inner-ring suburbs in the Northeast and Midwest owe their walkable patterns to similar circumstances.

Over the last few decades other places outside central cities have grown denser, as multistory, mixed-use blocks have been developed around transit stops. Gangly suburbs and strip developments have matured into walkable neighborhoods, and once-withered urban industrial districts have been resuscitated by waves of new workers and residents. Buildings have been recycled and space repurposed, adding more intensive uses to create a fabric of proximity. Many features of these places—their density, mix of diverse uses, integrated transit, and the pedestrian quality of their streets—are the same elements that research shows help reduce VMT. These existing places can serve as models for more walkable neighborhoods of the future.

## THE CARBON CHALLENGE

Imagine purple clouds pouring from the tailpipes of cars everywhere. This was a fantasy of essayist Noel Perrin (1997), an environmentalist and early proponent of renewable energy. He drove an electric car across the United States in the early 1990s to promote interest in alternative-fuel vehicles. Frustrated by our failure to recognize the

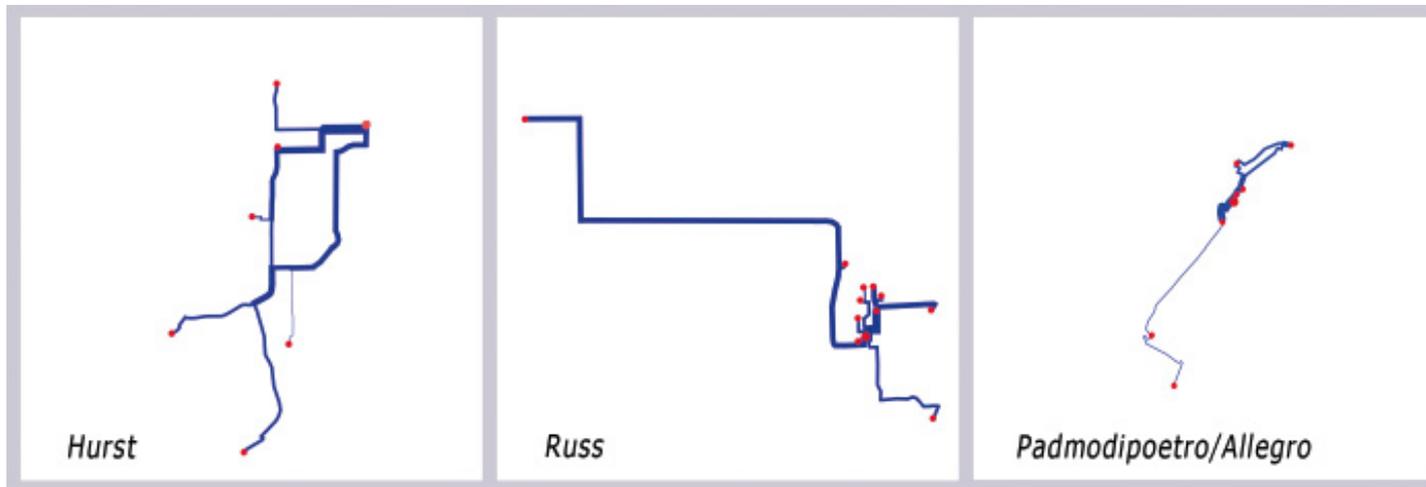


Figure 1.4 *Three Families' Commute Patterns at the Same Scale (20 x 20 miles).*

link between our personal driving habits and their consequences for society at large, he imagined a small pill that could be dropped into the gas tanks of cars to render their emissions a brilliant, highly visible, and impossible to ignore hue.

American household travel routines, combined with industrial and commercial transportation, add up to a lot of VMT. In 2009, the national odometer ticked up another 2.9 trillion miles—averaging almost 14,000 miles per licensed driver per year. The economic premium for that travel ranged from the small contributions by individuals—filling the gas tank and paying off the car loan—to massive public investment, such as underwriting military operations to defend oil supplies in foreign countries. Refining petroleum, building roads, maintaining bridges, and keeping the asphalt smooth and the parking lots plowed make up just the tip of an immense budgetary iceberg, and many costs will not emerge until years after the oil is spilled or burned. Americans have had at least 40 years to observe and catalog the economic, political, environmental, and public health consequences of our national driving habit, but so far we've been slow to make the necessary correction in our transportation system that will

achieve greater equilibrium between automobiles and other modes of transportation and lessen the impacts of travel.

In recent decades, we've become aware of another danger issuing out of the tailpipes of cars—one with which we may not be able to live—the carbon dioxide (CO<sub>2</sub>) accumulating in the atmosphere and altering the earth's climate. Carbon dioxide has always been present, but carbon-rich fossil fuels like petroleum have not, and the unprecedented rates at which they have been burned in recent decades is accelerating the greenhouse effect. The United States pumped 5,921 million metric tons of CO<sub>2</sub> into the atmosphere in 2008, about 20 percent of worldwide emissions—far more than our 4.5 percent share of the world's population warrants. A full third of that CO<sub>2</sub> is from energy used for transportation, and 60 percent of those emissions comes from automobiles (Davis, Diegel, and Boundy 2010). All the commutes, the leisure trips, the picking up and dropping off, and the daily errands of 208 million licensed drivers have added up to a significant contribution to climate change.

The race against time to trim our travel-related CO<sub>2</sub> suggests two basic strategies. The first is to burn gasoline more efficiently so

that less carbon is emitted per mile. Developing low-emission vehicles, such as electrics and hybrids, and raising the minimum allowable miles per gallon (mpg) for new cars and trucks have dominated the national dialogue around climate change and transportation. In 2007, the U.S. Congress mandated an incremental increase in average mpg for new light trucks and sport utility vehicles (SUVs) that is to reach a minimum of 35 mpg for most vehicles by 2030. And very low-emission cars—first-generation electrics and plug-in hybrids—are now available.

Federal mandates improved fleet efficiency significantly in the late 1970s, when all classes of cars and light trucks began burning less gasoline and emitting less carbon for every mile driven. In 2009, the carbon footprint of a midsize car was 57 percent lower than it was in 1975. An SUV built in 2009 emits about 8 tons of CO<sub>2</sub> per year—more than most vehicles, but about half the amount spewed by its 1975 counterpart (Davis, Diegel, and Boundy 2010).

From a statistical perspective, however, that's only half the story. Each SUV packs less of a carbon punch than it once did, but many more of them are on the road. In the 1970s Chevy Suburbans and Toyota Land Cruisers were considered novelty cars for use primarily on ranches or in military convoys. Large SUVs held a mere 0.1 percent of the market. Now they are viewed as handy vehicles for commuting to work or transporting children. Almost a third of new cars on the road in 2009 were midsize or large SUVs, while the more fuel-efficient midsize car struggled to hold onto its modest 16 percent market share. Even more disturbing was the slumping popularity of the small car, which boasts the lightest carbon footprint of all classes (5.8 tons/year). It lost 21 percent of the market in 34 years, and in 2009 fewer than one in five American car buyers selected a fuel-sipping small car (Davis, Diegel, and Boundy 2010).

There are signs that this trend may be changing, however. As car makers transition to the higher federal efficiency standards, they're creating cars with smaller, more efficient engines, and Americans are buying them. Half the new cars and trucks sold in the the first part of 2012 featured four-cylinder engines rather than the energy-intensive V-8s popular for generations (AP 2012). Sales of large cars were

down 90 percent from June 2011 to June 2012, and many of the hottest sellers were hybrids and other low-emission vehicles (WSJ 2012). More efficient vehicles can play a role in lowering the national carbon output. But how will we use them? So far, the modest gains made in lowering the carbon output of individual engines have been wiped out by the much higher increases in miles traveled. Although we certainly had gas-guzzlers 40 years ago, we drove them 1.6 trillion fewer miles than today (FHA 2011).

Energy experts have seen a rebound effect accompany past gains in fuel efficiency. When the cost of fuel or power remains steady, greater efficiency leads to lower operating costs, which results in greater consumption. For example, if you replace your SUV with a hybrid, you'll be able to go farther for the same amount of money, which may encourage you to drive more. How significant the rebound effect might be remains a topic of discussion for economists, but it reveals the role that prices play in how we use energy and how we might hope to lower carbon emissions from burning gasoline (Small and Van Dender 2005).

Better efficiency through technology, the strategy that has commanded most of our attention to date, must be joined by a second one for lowering the number of miles we drive each year. Because our contemporary driving habits are based more on need than whim, changing driving patterns is easier said than done. It requires a major correction in how we develop land and fund transportation. First, we need to reverse a century-long decline in urban densities to make transit and other alternative transport modes viable again. In 1910, American cities held about 18,000 people per square mile, far more than the average of 3,700 ppsm in modern urban areas. This is well below the threshold of 7,000 ppsm for operating a minimal transit service and far from the 12,000 ppsm required to sustain a convenient and comprehensive system (Angel et al. 2011). Increasing the population density of urban areas is just a start, however, and accomplishing it is not simply a matter of adding more people. That requires creating a balance of housing, jobs, services, and institutions within shorter radii and fitting all these elements into a spatial pattern that accommodates and celebrates the experience of walking.

A more compact, transit-rich urban form will help reduce VMT by giving many more people alternative ways to move around. And when driving is necessary, we won't have to go quite as far on a daily basis. It will take many years to reach the point where we see the benefits of these changes, but within a generation we could cut our transportation-related emissions to levels that will align them with those of other developed nations.

## URBAN FORM MATTERS

It may seem obvious to anyone shuttling from their child's soccer game to the hardware store to the supermarket that a low-density land use pattern demands more time behind the wheel. But, would we drive less if we lived in denser cities, and would an altered urban landscape help slow climate change?

Three recent empirical studies analyzed the relationship between land use patterns and driving habits by measuring the impacts of a more compact urban form on VMT. *Growing Cooler* (Ewing et al. 2008), *Moving Cooler* (Cambridge Systematics 2009), and *Driving and the Built Environment* (Transportation Research Board 2009) all concluded that developing at higher population densities and mixing land uses will reduce the number of miles Americans drive each year. Locating jobs and people in close proximity would shorten trips, and people would be more likely to walk or ride a bike. Greater density also would make public transit possible by shifting more trips away from private vehicles and toward modes that emit fewer greenhouse gases.

The studies diverged on the question of how much difference such a density change would make, but all three focused on a target date of 2050. *Growing Cooler* envisioned a scenario in which we could be driving 20 to 40 percent fewer miles and lowering our greenhouse gas emissions by 18 to 36 percent (Ewing et al. 2008). The authors of *Moving Cooler* (Cambridge Systematics 2009) outlined various levels of reductions based on how aggressively we change our land use practices, estimating that expanding current best practices could achieve a 20 percent reduction. A maximum effort, including comprehensive growth boundaries, minimum required densities, and jobs/housing

balance, as well as nonland use strategies could reduce emissions by 60 percent. In *Driving and the Built Environment* the Transportation Research Board (2009) estimated a more modest reduction in the range from 1 to 11 percent.

The divergent opinions resulted from different assumptions about how likely we are to change our land use policies and how quickly our growth rate might alter the built environment through redevelopment. Critics of *Driving and the Built Environment* said the report underestimated the market appeal of compact development, and that changing demographics and rising gas prices will increase the potential for a shift toward denser urban forms (Ewing, Nelson, and Bartholomew 2009). Indeed, recent trends covered in chapter 6 indicate they may be right.

These three studies are not the final word, as research on the topic continues to show. A 2011 land use–transportation modeling analysis of the Charlotte, North Carolina, area found that long-term reductions of CO<sub>2</sub> emissions are possible by shifting to a more compact development pattern. Comparing a high-density, mixed-use, transit-oriented model with a low-density, auto-dependent pattern, the study determined that climate-warming carbon dioxide, along with the pollutants carbon monoxide, nitrogen oxides, and hydrocarbons, would be 5.5 to 7.1 percent lower overall in the dense transit model (Rodriguez et al. 2011). Combined with better fuel efficiency and alternative energy use, this shift could make a significant difference by 2050. The authors stress, however, that the scenario they modeled will not be sufficient. Since they expect population growth and the associated increase in travel to double CO<sub>2</sub> emissions over the next 40 years, an even more aggressive reduction in urban footprints must be paired with breakthrough automotive technologies to slow the build-up of greenhouse gases.

The most dramatic reductions in VMT would come from combining land use changes with other strategies that create economic incentives for driving less. Pay-as-you-drive auto insurance, congestion pricing, higher parking fees, intercity tolls, and other pricing policies can induce people to combine trips or leave a car at home (U.S. DOT 2010). In the absence of a higher gas tax, these

measures would place price more squarely at the center of individual travel decisions.

While adjusting the price of parking or car insurance can affect behavior immediately, modifying land use regulations and waiting for the existing housing stock to be redeveloped is another matter.

Unlike other carbon-reduction strategies, realization of a sufficiently compact pattern will take several decades to materialize, which is why most studies of the potential of compact development predict only minimal CO<sub>2</sub> reductions in the early years. Those who think it's

not worth doing, though, must consider that without density many other strategies will not be possible. Dense cities make public transit and intercity rail feasible.

Increasing densities to levels near or exceeding those typical of cities in 1910 by concentrating housing, jobs, schools, stores, parks, and population is the best way to shrink commute zones from 80 or 20 square miles to ones as small as two and a half square miles. If we hope to enter a low-carbon age, we must create fewer Battle Grounds and Houstons and a lot more Jamaica Plains.



## Five Ds and a P

As researchers delve into the question of how urban form affects travel behavior, they're identifying specific characteristics of place that boost walking and transit use while reducing VMT. In the 1990s some pinpointed diversity, density, and design as the key elements of the built environment that, in specific spatial patterns, enable alternative transportation (Cervero and Kockelman 1997). After a decade of successive studies on the topic, these “three Ds” were joined by two others deemed equally important—distance to transit and destination accessibility—and together they are now known as the “five Ds.” Added to the list is another key player: parking, which inconveniently bears neither a D initial, nor a synonym beginning with D (Ewing 2010). The Ds have evolved into a handy

device for defining and measuring compact form and, in the process, predicting how that form will affect travel and reduce VMT. Research models demonstrate that places that combine the Ds to a high degree enjoy lower driving rates than those that don't.

Essentially, the five Ds have the same characteristics of compact development as those touted by smart growth advocates, but transportation researchers renamed them to highlight their effects on travel behavior. Like all research tools that are discussed and cited frequently, it helps to put them into a real-life context and show how they look in existing places.

## DIVERSITY

Diversity, or the mix of uses, creates a dense texture of destinations (Ewing et al. 2011). Residents can find more of the products and services they need in the neighborhood, so they don't need to drive to get them. The degree of diversity, or how many uses coexist in a place and how close together they are, matters. Types may be mixed—housing next to retail alongside commercial—but how many iterations of each use overlap or intermingle? A high level of diversity would include apartments and townhouses mixed with single-family homes. Restaurants, drugstores, supermarkets, banks, hair salons, coffee shops, day care centers, fitness studios, software companies, and law, dental, and insurance offices all can be closely spaced along the street or in upper stories (figure 2.1). Greater diversity creates a higher number of services within a small area that employees as well as the residents of the neighborhood can reach on foot or by bike. With a broad mix of businesses comes a greater potential for employment, and a sufficient mix of housing units means many people can work close to home (figure 2.2).

**Urban Convenience.** You can get your clothes cleaned, take an art class, buy plantains, a gallon of paint, a bouquet of flowers, and a new outfit, send a fax, and get your computer fixed all without walking more than 120 feet along this stretch of Queen Street in the Beaches neighborhood of Toronto, Ontario. The diversity continues in upper-floor offices and apartments.

## DENSITY

Density usually refers to population (in persons per acre or hectare, square mile, or square kilometer) and housing (dwelling units per acre or hectare). Population density is sometimes combined

with a count of the number of jobs in a given area to calculate an activity density (Ewing and Cervero 2010). As a measure that can be applied to anything in the urban environment—housing, parking, jobs, floor space, intersections, bus stops, food outlets, crosswalks, bike racks—density reveals the intensity of a particular element or activity.

Planners have long considered population density to be the key to lowering VMT. Recent studies show, however, that density is only one of several necessary ingredients. Alone, it does not make a big difference. You may live in a high-rise building, but if the neighborhood is remote, unpleasant to walk in, and cut off from transit, you will drive often and far. In fact, living close to a downtown or other center of activity matters more. Places with the best destination accessibility have the lowest rates of VMT (Ewing and Cervero 2010).

## DISTANCE TO TRANSIT

When faced with the opportunity to take a bus or train, people tend to weigh their options: How long will I have to wait? Will it be crowded or uncomfortable? Can I count on getting there on time? Would it be cheaper than driving? These are concerns that transit providers must address to make public transportation the more appealing option. Research shows that in the calculus of decision making, the biggest question is, How far away is the bus stop?

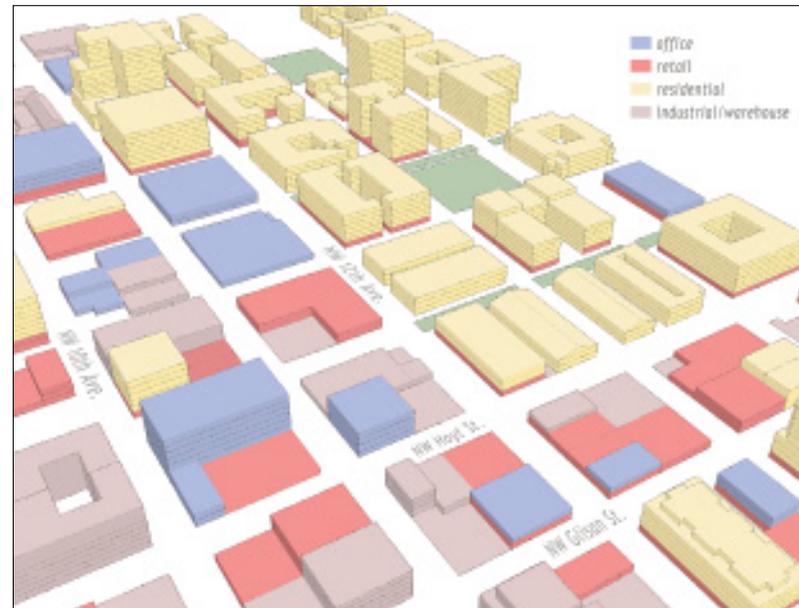




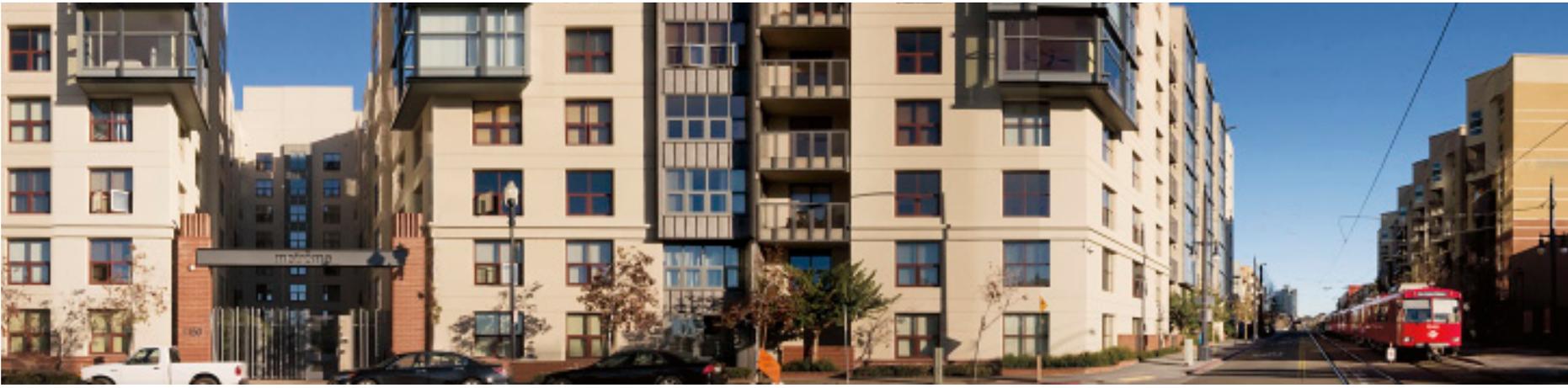
**Beyond the Minimart.** Developers are incorporating large food markets into the ground floors of infill housing developments. Built into the ground floor of a midrise apartment complex, Ralph's supermarket in downtown Los Angeles, California, provides the basics that people need every day.



**Diversity on the Street.** In Seattle, Washington's Belltown neighborhood, ground-floor uses include a wide range of everyday services.



**Multistory Diversity.** In Portland, Oregon's Pearl District, residential, commercial, industrial, and retail uses are woven into the neighborhood both horizontally and vertically. All manner of retail services can be found on the ground floor, while the upper levels hold a mix of businesses, homes, and even rooftop green spaces.



**Hand in Glove.** Urban mobility depends on a snug fit between density and transit. Several blocks along San Diego, California’s light rail line have filled in with multistory housing. The many residents of this East Village apartment complex have easy access to transit. A trip to the rail stop is not much farther away than an elevator ride.



**Figure 2.3 Transit Workhorse.** Light rail and streetcar modes generate excitement, but buses make transit work. They are affordable, flexible, and available to towns and cities with emerging density. In Albuquerque, New Mexico, for just one dollar—thirty-five cents if you’re a student or a senior—you can travel through about 350 square miles of the greater metropolitan area. The map shows only a portion of the system, which includes several “rapid-ride” routes. Fewer stops and quicker loading shorten travel time and make bus travel more convenient.

Distance to transit, or transit accessibility, is the key to luring more passengers. A dense network of routes and stops insures that transit users don’t have long walks tacked onto the beginning or end of their transit rides (figure 2.3). And this is where density comes back in—many people close together within a tight web of access points. It’s the “virtuous cycle” of density and transit. Concentrating people and jobs next to transit feeds the system with riders, which helps upgrade and extend service and in turn makes transit more attractive and useful and the city more livable (Angel et al. 2011). The key is locating everything together.

**DESIGN**

Every trip by bus, subway, streetcar, or train begins and ends on foot. Shortening that walk and furnishing it with a visually rich, comfortable streetscape increases the likelihood that people will choose public transportation. A pleasant streetscape also makes walking and biking appealing alternatives for shorter trips. To lower VMT, urban designers should focus on two strategies: connecting streets, which

will shorten trips; and making them pedestrian- and bicycle-friendly, which will improve the quality of the journey.

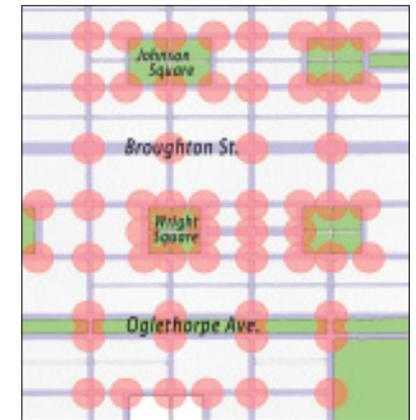
An interconnected street system gives pedestrians what they want—a more direct path and a choice of routes. It's easy to measure connectivity: just count the intersections. Neighborhoods with smaller, rectilinear blocks have more intersecting streets than places with large blocks and curvilinear networks (figure 2.4). Intersection density has been identified as one of the most crucial ingredients of the built environment for reducing VMT (Ewing and Cervero 2010). A doubling of intersection density results in about a 44 percent increase in walking.

Among the D variables, streetscape design is a critical player, but it is more complex and difficult to measure than the other four. It involves altering the space within the public right-of-way—narrowing streets; widening sidewalks; and adding crosswalks, street trees, and bus shelters—as well as defining its built edges to make the space more appealing for people on foot or bicycle. A pedestrian-oriented street combines many basic urban design concepts that once came naturally to city builders: enclosure, human scale, architectural diversity, transparency, and permeability. In our automotive age,

incorporating these qualities into development projects requires deliberate and sustained efforts by planners, landscape architects, and developers. The details of creating pedestrian-friendly design, defining the main concepts, and illustrating how they are employed in real places are examined in chapters 4 through 6.

### DESTINATION ACCESSIBILITY

The D most strongly associated with lowering VMT is destination accessibility—how closely a place is located to the destinations to which people travel most regularly. This variable may be measured in the distance to a central business district (CBD) or by how many jobs or attractions are within a three-minute drive or a fifteen-minute walk (Ewing and Cervero 2010). Places close to downtowns have easy access to the jobs and services concentrated there. Trips into and out of the CBD can be made on foot or by bike or transit, and car trips tend to be short. Destination accessibility is highest when a development is located close to a CBD that offers a full array of regional employers and attractions. But local accessibility—a commercial corridor or intersection hosting a smaller range of local and neighborhood services—also helps reduce VMT (figures 2.5 and 2.6).



**Figure 2.4 Savannah's Historic Street Grid.** The historic district of Savannah, Georgia, has a street network made for walking. Small, one-acre blocks are laid out in a rectilinear grid, which ensures a high density of intersections, many of which are four-way. Pedestrians arrive at a corner every 125 or 350 feet. Small lots with narrow frontages dictate a human-scale building pattern. Greens bisected by public walkways are interspersed among the blocks of Savannah.

**Pedestrian Heaven.** The small blocks, narrow streets, and checkerboard pattern of historic buildings and green spaces, combined with a leafy canopy, make walking across Savannah a pleasure.



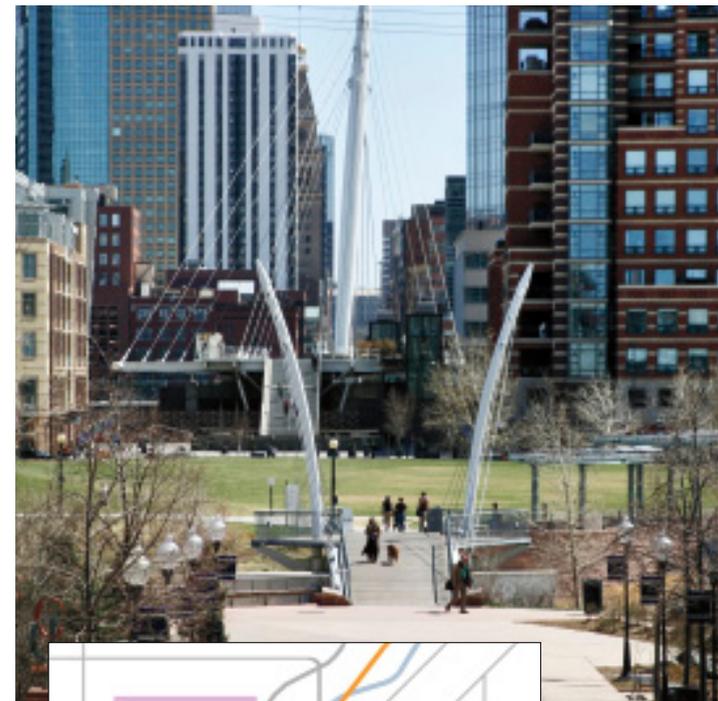


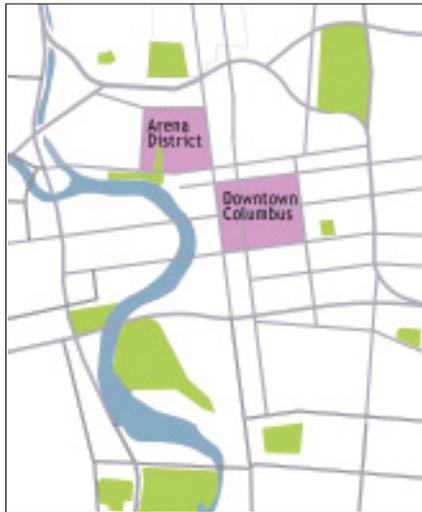
**Optimal Streetscape.** Wide sidewalks lined with shop entrances and window displays hug the perimeter of Shaker Square in Shaker Heights, Ohio. The landscaping along the opposite edge encloses a space worth spending time in.



**Intimate Streets.** Vancouver, British Columbia, has built pedestrian-friendly streetscapes throughout the city by stepping its “skinny” high-rise towers back and setting them atop lower buildings (podiums) that fit the scale of the street. Along the sidewalk in Coal Harbor, the atmosphere is intimate, despite the block’s high density. From this perspective one sees a row of two-story townhouses fronted with gardens rather than the thirty-story towers behind them.

▼ **Figure 2.5 Bridging the Gap.** In Denver, Colorado, the Highland neighborhood is less than a mile from the city’s CBD. In recent years, redevelopment of industrial land between the two areas has brought them closer together. New streets, parks, and footbridges spanning the Platte River and an interstate highway have created a seamless pedestrian connection. Recognizing good destination accessibility when they see it, developers have filled in the wedge of land closest to downtown with a mix of housing and neighborhood commercial uses in four- and five-story buildings.





*Figure 2.6 In on the Action.* Columbus, Ohio, located its new Nationwide Arena adjacent to downtown, then surrounded it with six-story buildings filled with offices, restaurants, shops, and apartments. In the process the city reduced the travel distance between two major destinations to a short walk and bestowed the gift of accessibility on every new resident of the Arena district.

## THE Ds IN CONCERT

The five Ds make the biggest impact when they work together. Density, for example, plays a crucial supporting role by shoring up the other Ds. It feeds diversity by supplying customers and workers to businesses. And it creates a deeper pool of transit riders that can support a comprehensive system with many routes and access points, thus shortening the distance to transit. Better transit accessibility makes density possible. It can also attract a greater diversity of uses, which in turn improves destination accessibility with a critical mass of population, housing, and jobs in close proximity.

The extent to which the D variables are combined in a neighborhood or city determines whether residents choose to make trips in a car or by another mode. It also affects the length of those trips. Using various iterations of the five Ds, Reid Ewing and his colleagues (2011) analyzed household travel data from hundreds of mixed-use developments across the country and found that neighborhoods with the most Ds have lower VMT. They also concluded that each variable

has its own distinct effect. In a place with a high diversity of uses, people take more of their trips within the neighborhood. In one that has a dense network of transit stops, people are more likely to walk and take transit. And in centrally located places that are accessible to many destinations, car trips tend to be short.

## PARKING

If you want to understand why so many North American cities are low in density, sit in on a development review meeting at your local town office and keep a tally of the number of minutes devoted to the topic of parking. Unless you live in a very densely populated place, the conversation will most likely linger over that particular subject. When discussion moves to other topics, such as building design or stormwater discharge, it may well veer back to issues of parking and circulation—the number of spaces, vehicle entrance and exit, turning radii, lighting, and maintenance of parking lots. More than any other aspect of a development project, parking is what we seem to care



*Minneapolis, Minnesota.*

about most. Like gasoline, it's an essential component of an auto-dominated transportation system, and our dependency on cars puts it at the center of decisions about development and land use.

Parking is a feature of the built environment that has a considerable impact on travel behavior, yet its role is often overlooked, perhaps because it is so pervasive and widely embraced as a necessity. Parking lots—especially garages—increase the cost of a

development project, but this reality is hidden from drivers, who pay little or nothing to use them. Since only 5 percent of employees nationwide pay for parking at their workplaces, it's not surprising that most commuters drive alone (U.S. DOT 2010). Local governments play Santa Claus by providing curbside parking spaces along city streets and requiring developers to construct off-street facilities. This two-pronged strategy not only keeps the supply high, it sustains the illusion in the minds of the driving public that parking is cheap, if not free.

Under this system, developers are forced to allocate roughly 10 percent of their budgets to meeting zoning standards. They bundle the cost of parking facilities into the sale of commercial space or living units. Buyers and tenants pay for the spaces, whether they want them or not, just as taxpayers underwrite the costs of paving, sweeping, and plowing on-street parking spaces, whether they use them or not. We all pay for parking, but if we're not handing over money at the lot or curb, we think of it as free. Compared to transit, which requires an out-of-pocket purchase for each trip, driving appears to be the more affordable option.

At the heart of municipal parking policies lay certain assumptions that feed a cycle of auto dependency: the car is the best way to get around; parking should be free; and there is no alternative. Cheap and abundant parking holds down the cost of driving, which in turn encourages greater car use, spurs auto-oriented design, degrades the pedestrian environment, and discourages trips by foot. Parking consumes a disproportionate amount of space that doesn't serve active human uses because it lowers densities, forces destinations apart, and renders transit inefficient (Weinberger, Kaehny, and Rufo 2010).

The notion that parking is an entitlement is so deeply ingrained in our thinking that it is rarely challenged. A few cities, however, have recognized the disadvantages of flooding their downtowns with cheap parking and have begun to align their parking policies and zoning regulations with their goals for a more integrated transportation system. Boston, Massachusetts; Chicago, Illinois; Jersey City, New Jersey; and a few others have upended long-held attitudes toward parking by limiting rather than boosting the supply.



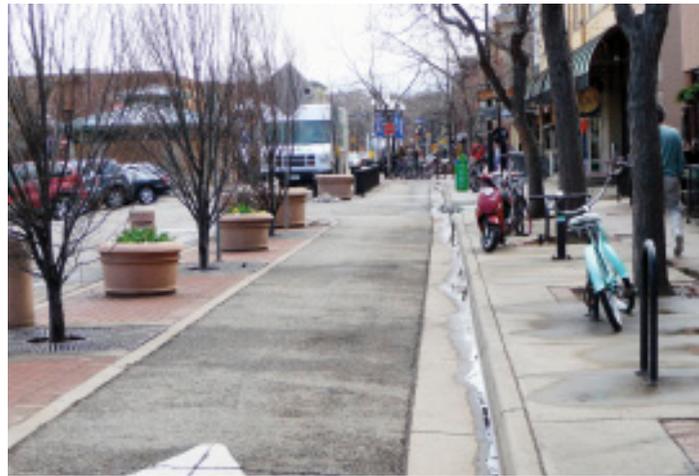
Philadelphia, Pennsylvania.

Portland, Oregon, has taken a leading role in this direction. Instead of *requiring* parking, the city *allows* it and sets a maximum rather than a minimum number of parking spaces for development downtown, in neighborhood commercial districts, and around transit stops. The city also permits bike parking to substitute for automobile parking. Developers pass savings along to those tenants who don't want parking and charge a higher market-driven rate to those who do. Urban space that might have gone to parking is used for housing, commercial, or other uses that increase densities and feed the transit system (Weinberger, Kaehny, and Rufo 2010).

In addition to zoning changes, some cities are taking an innovative approach to curbside parking. Instead of giving it away, they let value dictate price. More desirable locations command higher meter fees making motorists pay for the convenience of leaving their cars at the curb. In San Francisco, California, "smart" meters adjust the price of parking up or down depending on the current demand. At moments when many spaces are in use, the price rises, discouraging driving downtown while raising revenues. This stationary version of

congestion pricing controls the flow of parking and allows those who benefit the most to shoulder the cost burden.

Parking fees are a disincentive to driving, and in cities that manage parking carefully they can create an incentive to walk. Boulder, Colorado's downtown Parking Benefit District collects revenues from on-street meters and city-owned garages that it then channels into alternative transportation. Parking money goes to pedestrian and bike-friendly streetscape improvements and buys free transit passes



**Public Parking.** Boulder's downtown parking structures are set back from the street behind multistory retail and office buildings (below). Revenues from these municipally owned garages are used to subsidize bike lanes and pedestrian-friendly streetscapes (left).



for downtown employees. A wave of suburbanites enter Boulder every day, but there is no free parking downtown. The city controls the cost of parking, tweaking the prices to encourage short-term shopping trips while discouraging single-occupancy commuters (Weinberger, Kaehny, and Rufo 2010).

How we manage parking—whether we make it cheap or charge its true cost—has an impact on travel choices. Local governments can nudge people out of their cars and into other modes by limiting the supply and shifting the cost of parking directly to the motorists

who use it. Rather than feeding auto-dependency, smarter parking policies help initiate a cycle of urban pedestrianism. Fewer parking lots and garages free up space for housing, employment, and recreation, which brings more people who live nearby to support transit, which in turn makes more frequent service possible and parking less necessary. Replacing surface lots and street-level garages with homes or businesses improves the quality of the street and encourages trips by bike or on foot.