The New Transportation Planning Paradigm

Demographic and economic trends—and new community concerns—are changing the way that practitioners define transportation problems and evaluate potential solutions. A new paradigm expands the range of modes, objectives, impacts, and options considered in transport planning. This article discusses this paradigm shift and its implications for our profession.

BY TODD LITMAN

Introduction

A *paradigm* refers to the basic assumptions used to define a problem and to evaluate solutions.[1] A discipline's paradigm sometimes shifts, forcing practitioners to reexamine their basic assumptions and analysis methods. The Copernican revolution, which recognized that the earth revolves around the sun, and the theory of evolution, which explained biological change through natural selection, are well-known paradigm shifts.

Transportation planning is undergoing its own paradigm shift, and it is changing the way we define transportation problems and how we evaluate transportation system performance, the range of planning objectives and impacts considered when evaluating these options, and the types of solutions considered for solving transport problems.

The old paradigm evaluated transport system performance primarily on the speed, convenience, and affordability of motor vehicle travel—and so favored automobile-oriented improvements. The new paradigm is more comprehensive and multimodal. It considers a broader range of modes, objectives, impacts, and improvement options.

As a transportation professional, you are probably already involved in these changes. You may apply more comprehensive and multimodal analysis and implement more demand management solutions than was previously common.[2,3] These changes have been previously discussed in *ITE Journal*.[4] However, most previous discussions considered these changes individually. This article investigates their roots—the paradigm shift that is changing the way we think about transportation problems and solutions—and discusses why these changes are occurring, how they affect our work, how they fit together, and how they can help us better serve transport system users.

Why a New Paradigm

This is a timely issue. Motor vehicle travel grew steadily during the twentieth century, so it made sense to invest significant resources in building roadway systems. For example, in the 1960s, if a two-lane road started to experience congestion, it seemed rational to expand it to four or even six lanes. Maximizing capacity was considered "conservative" because it was cheaper to build extra capacity now than to add it later. There was little risk of overbuilding, as any extra capacity eventually would be used.

Motor vehicle travel has started to peak in most developed countries because of various demographic and economic trends, including aging populations, rising fuel prices, increasing urbanization, growing health and environmental concerns, and changing consumer preferences (Figure 1).[5,6]

These trends are increasing demand for alternative modes.[8] Motor vehicle travel is not expected to end—under most scenarios, automobiles will continue to have the largest mode share in most communities—but at the margin (that is, compared with their current travel patterns), many people want to drive less and rely more on walking, bicycling, and public transit, provided that those alternatives are convenient, integrated, comfortable, and affordable. Similarly, a growing portion of households want to locate in more accessible, multimodal communities.[9] Recent experience demonstrates there is latent demand for these modes: communities that implement active transport (that is, walking and cycling) and public transit improvements have experienced significant increases in their mode shares as well as reductions in automobile travel.[10] This trend indicates that multimodal planning better responds to consumer demands.

Accessibility and Multimodal Planning

The old transport planning paradigm was *mobility-based*: it assumed that the goal was to maximize the distances that people can travel within their time and money budgets and therefore maximized travel speed. The new paradigm recognizes that mobility is seldom an end in itself and, except for the small portion of travel that lacks a destination, the ultimate goal of most transport activity is *access* to services and activities.

Various factors can affect accessibility, including mobility, the quality of transport options (that is, the quality of walking, cycling, and public transport, plus mobility substitutes such as telecommunications and delivery services), transport network connectivity, and geographic proximity (that is, distances between destinations and, therefore, land use density and mix).[11] This is important because planning decisions often involve tradeoffs between different types of access. For example, wider roads with higher traffic speeds tend to increase automobile access, but by reducing walkability (and therefore public transit access, since most transit trips include walking links), restricting road network connectivity (fewer cross streets), and stimulating more dispersed development, they tend to reduce accessibility in other ways. It is important to consider all of these impacts when evaluating potential transport system changes.

Mobility-oriented planning favors hierarchical road networks that channel traffic from smaller, local streets onto wider, higher-speed arterials, as illustrated in Figure 2. This increases travel distances (Figure 3) and creates barriers to active transport.[12]

Recent research is improving our understanding of how these factors affect accessibility.[13] This research indicates that factors other than vehicle travel speed often have significant impacts on urban accessibility:

- In a major study of U.S. cities, Levine et al. found that "denser metropolitan regions have slower travel speeds but greater origin-destination proximity." A change in development density affects the number of jobs and services available within a given travel time about 10 times more than a proportional change in traffic speed.[14]
- Another major study measured the number of jobs that could

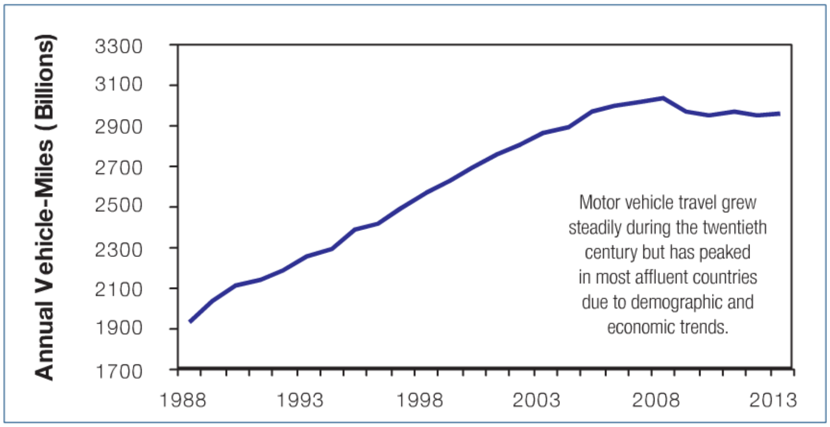
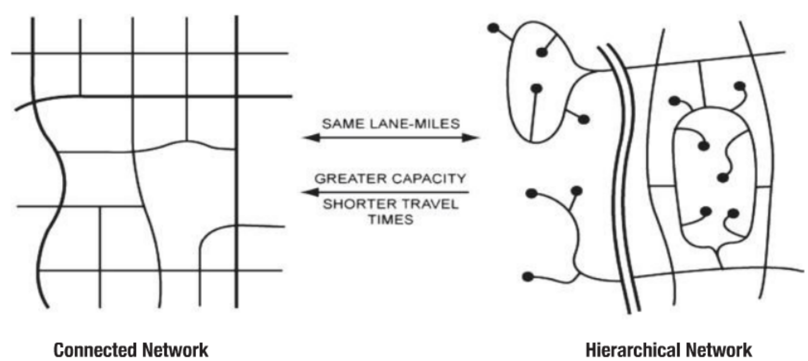
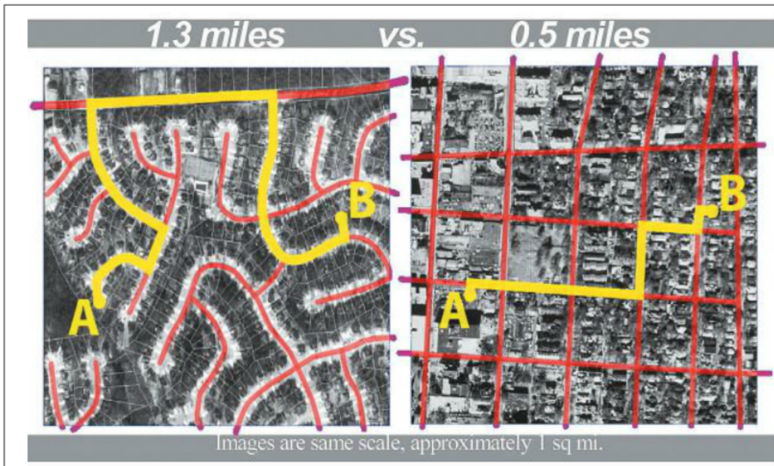


Figure 1. U.S. Annual Vehicles Mileage Trends[7]



Dense, connected road networks allow more direct travel to destinations, which reduces travel distances, increases active transport accessibility, and improves overall safety. Hierarchical road networks channel traffic onto higher speed arterials, which increases travel distances, congestion, and crashes.

Figure 2. Connected Versus Hierarchical Road Networks (Kelbaugh 2011)



Hierarchical road networks (left) have numerous dead-end streets that connect to higher-speed arterials. This lengthens trip distances and concentrates traffic on a few roads, which tends to increase congestion. A well-connected road network (right) offers multiple, direct routes between destinations, which reduces trip distances and distributes traffic. Well-connected road networks tend to have lower average speeds, but total travel times are generally less.

Figure 3. Hierarchical Versus Well-Connected Road Networks

Table 1. Consideration of Accessibility Factors in Transport Planning[18]

Factor	Consideration in Conventional Planning	Required for Comprehensive Planning
Motor vehicle travel conditions—traffic speed, congestion delays, vehicle operating costs, and safety.	Usually considered using indicators such as roadway level of service, average traffic speeds, congestion costs, and crash rates.	Impacts should be considered per capita (per capita vehicle travel time, vehicle operating costs, and crash casualties) to take into account the distances people must travel to reach destinations.
Quality of transport options—convenience, comfort, safety, and affordability of walking, cycling, ridesharing, public transport, plus mobility substitutes such as telecommunications and delivery services.	Considers public transit speed but not comfort; active transport modes often receive little consideration.	Multimodal transport system performance indicators that account for convenience, comfort, safety, affordability, and integration.
Transport network connectivity—density of connections between paths, roads, and modes, and therefore the directness of travel between destinations.	Traffic network models consider major regional road and transit networks. Local streets, active transport networks (paths and sidewalks), and connections between modes are often ignored.	Fine-grained analysis of sidewalk, path, and road network connectivity, and of connections between modes, such as the ease of walking and biking to public transit terminals.
Land use accessibility—development density and mix, and therefore the distances people must travel between common destinations.	Often ignored; some integrated models consider some land use factors.	Fine-grained analysis of how land use factors affect accessibility by various modes.

Conventional planning evaluates transport system performance primarily on automobile travel speed and operating costs. New methods are needed for more comprehensive accessibility evaluation.

be reached by automobile within certain time periods for the 51 largest U.S. metropolitan areas.[15] It found that that many of the cities that ranked among the *best* for automobile employment access (Los Angeles, San Francisco, New York, Chicago, San Jose, Washington, DC, and Boston) rank among the *worst* in traffic congestion intensity[16] because their shorter commute distances more than offset their lower peak-period traffic speeds.

- Analysis in Phoenix, Arizona, indicates that roads in more compact neighborhoods experience considerably less traffic congestion than do roads in less compact, suburban neighborhoods because of shorter trip distances, more connected streets, and better travel options, which more than offset the higher trip generation rates per square mile.[17]

This suggests that commonly used transportation performance indicators, such as roadway level of service and vehicle traffic speeds, are not very useful for evaluating urban accessibility. In some cases, planning decisions that increase traffic speeds may reduce accessibility overall if they reduce transport options or roadway connectivity, or stimulate more dispersed development.

Conventional transportation modeling overlooks and undervalues many of these factors. Table 1 summarizes factors that affect accessibility, the degree to which they are considered in conventional transport planning, and analysis methods for more comprehensive evaluation of their accessibility impacts. New planning tools allow more comprehensive accessibility evaluation. For example, the new *Highway Capacity Manual* includes multimodal level-of-service ratings that can be used to quantify walking, cycling, and public transit travel conditions, and fine-grained traffic modeling can indicate how neighborhood streets affect local accessibility.

Comprehensive Analysis

The old planning paradigm was *reductionist*: individual problems were assigned to individual agencies with narrowly defined responsibilities. Transportation agencies were responsible for reducing congestion; environmental agencies were responsible for reducing pollution emissions; and social agencies were responsible for improving accessibility options for nondrivers. This approach can result in those agencies rationally implementing solutions to problems within their responsibility that exacerbate other problems facing society, and it tends to undervalue solutions that provide modest but multiple benefits.

For example, with conventional planning, transport agencies often expand roads, but by inducing additional vehicle travel, which, in turn, increases total fuel consumption and pollution.[19,20] Similarly, environmental agencies impose fuel-efficiency standards, which, by reducing vehicle operating costs, can also increase total vehicle travel and therefore traffic congestion.[21] The new paradigm applies more comprehensive analysis. It considers a wider range of planning objectives (things that a community wants to achieve) and impacts (benefits and costs), and so can identify *win-win* solutions, which provide multiple benefits. For example, comprehensive evaluation can identify the congestion reduction strategies that also help reduce parking problems and pollution emissions, and improve accessibility for nondrivers.

Tables 2 and 3 illustrate this concept. Roadway expansion reduces traffic congestion but provides few other benefits. Similarly, increasing vehicle fuel economy, for example, through fuel-efficiency standards, provides energy savings and air pollution emission reductions but few other benefits. Transportation demand-management strategies—which improve transport options, more efficiently price vehicle travel, or create more accessible communities—tend to achieve multiple planning objectives and so can be considered win-win solutions.

This analysis is even more dramatic if it considers rebound effects, that is, the additional vehicle travel induced by wider roads and more fuel-efficient vehicles. For example, see Table 3.

Table 4 illustrates the scope of accessibility factors and objectives considered in a planning process. The old paradigm evaluates transport system performance primarily on automobile travel speeds (dark blue) and may give some consideration to a few other impacts (light blue), but it ignores most other factors and impacts (white). For example, the old paradigm generally ignored the impacts that active transport (for example, neighborhood walkability and bikability), roadway connectivity, and smart-growth land use policies have on parking costs, consumer affordability, and public fitness. The new paradigm considers these impacts.

Table 2. Comparing Strategies[22]

Planning Objective	Roadway Expansion	More Fuel-Efficient Vehicles	Transportation Demand Management
Congestion reduction	✓		✓
Roadway cost savings			✓
Parking cost savings			✓
Consumer savings/affordability	✓		✓
Improved traffic safety			✓
Improved accessibility for nondrivers			✓
Energy conservation		✓	✓
Pollution reduction		✓	✓
Physical fitness and health			✓
Land use objectives			✓

Roadway expansions and increased vehicle fuel economy achieve few objectives. Transportation demand-management (TDM) strategies, which reduce total vehicle travel, help achieve a wider range of objectives.

Table 3. Comparing Strategies—Considering Induced Travel Impacts[23]

Planning Objective	Roadway Expansion	More Fuel-Efficient Vehicles	Transportation Demand Management
Motor Vehicle Travel Impacts	*Increased*	*Increased*	*Reduced*
Congestion reduction	✓	×	✓
Roadway cost savings	×	×	✓
Parking cost savings	×	×	✓
Consumer savings/affordability		✓/×	✓
Improved traffic safety	×	×	✓
Improved accessibility for nondrivers	×		✓
Energy conservation	×	✓	✓
Pollution reduction	×	✓	✓
Physical fitness and health			✓
Land use objectives	×	×	✓

(✓ = Achieve objectives × = Contradicts objective) By inducing additional vehicle travel, wider roads and more fuel-efficient vehicles may exacerbate other problems, such as congestion, accidents, and sprawl. TDM strategies tend to achieve a wide range of planning objectives and so are considered win-win solutions.

Redefining Transport System Efficiency

This paradigm redefines transport system efficiency. *Efficiency* refers to the ratio of benefits (outputs) to costs (inputs). The old paradigm evaluated roadway efficiency primarily on vehicle traffic speeds, so increased transport system efficiency meant faster vehicle travel. The new paradigm considers other impacts; it can therefore reach very different conclusions about transport system efficiency.

- *Traffic network analysis* evaluates efficiency based on travel distances as well as speeds. This recognizes that a lower-speed but more-connected road network may allow motorists to reach destinations faster than a higher-speed but less-connected hierarchical road network that has longer trip distances.
- *Multimodal transport planning* recognizes that not everybody can drive and that walking, cycling, and public transport are more efficient than driving. From this perspective, transport systems are most efficient if they allow system users to select the most appropriate mode for each trip, such as walking and cycling for local errands, public transit and rideshare vehicles for travel on major corridors, and automobile travel when it is truly most resource efficient overall.
- *Accessibility-based transport planning* recognizes the various factors that affect accessibility, including mobility, the quality of transport options, transport network connectivity and land use accessibility. From this perspective, a transport system is most efficient if it optimizes all of these factors in order to minimize the total resource costs required to access services and activities.
- *Economic efficiency* refers to the degree to which a system maximizes the value of goods and services provided.

Table 4. Scope of Accessibility Factors and Objectives Considered in Planning

← Planning Objectives →	← Accessibility Factors → Mobility (Auto Travel)	Transit Quality	Active Transport Quality	Roadway Connectivity	Land Use Proximity
Congestion reduction					
Roadway cost savings					
Parking cost savings					
Consumer savings/affordability					
Improved traffic safety					
Accessibility for nondrivers					
Energy conservation					
Pollution reduction					
Physical fitness and health					
Land use objectives					

The old transport planning paradigm considers a limited scope of accessibility factors and objectives. It focuses on vehicle travel speeds (dark blue) and may consider a few other objectives (light blue), but it ignores most other factors and objectives.

From this perspective, a transport system is most efficient if it is managed to favor higher-value trips and more resource-efficient modes over lower-value trips and less efficient modes. This can justify priority for commercial vehicles (which tend to have high value) and public transit vehicles (which tend to be space efficient), and efficient pricing of roads and parking facilities. In this way, higher-value trips and more efficient modes can outbid lower-value trips and more space-intensive modes for scarce road space and parking facility use.

- *Planning efficiency* refers to the degree of planning process integration so that short-term decisions support strategic, long-term goals. From this perspective, transport systems are most efficient if planned and managed to support strategic objectives—for example, if transport, land use, environmental objectives, and social and economic development planning are effectively integrated.

Example

If a school experiences traffic and parking congestion because more students are being driven, then the old paradigm considers roadway expansion to be the preferred solution. However, wider roads and increased vehicle traffic create a barrier to walking and cycling access, which contributes to a self-reinforcing cycle as more parents feel that their children cannot safely walk and bike to school—so they drive them, which exacerbates the problem.

The new paradigm recognizes the inefficiencies that result if students who live close to schools are driven because of poor walking and cycling conditions. This new perspective considers other congestion-reduction strategies, such as Safe Routes to Schools programs[24] and *complete streets* policies[25] that improve walking and cycling conditions, support ridesharing and public transit travel, and encourage students to use more active modes whenever possible.

Such programs have proven successful at shifting modes, which reduces local traffic and parking congestion, and provides other benefits, including household financial savings (from reduced vehicle travel), improved safety (from local pedestrian and cycling improvements, and reduced vehicle travel), improved public fitness and health (from more walking and cycling activity), and environmental benefits (from reduced vehicle traffic).[26] This may require policy reforms to allow demand-management programs to be funded whenever they are most cost effective overall.[27]

This illustrates the new paradigm:

- Redefine the problem, from inadequate capacity to excessive vehicle trips due to poor walking and cycling conditions.
- Expand the range of solutions considered to include demand-management strategies, which may include walking and cycling improvements, roadway redesigns, plus education and encouragement programs. It could even include pricing reforms—parking fees for the most convenient parking spaces and subsidized student public transit fares—and choosing school locations to favor walking and cycling over automobile access.
- Expand the range of objectives and impacts considered in the evaluation process to include consumer savings, improved public fitness and health, and environmental protection in addition to traffic and parking congestion reductions.
- Make transportation funding that was previously dedicated to road and parking facility expansion available for demand-management programs.

The old paradigm didn't entirely ignore transportation demand management, but it did tend to treat them as solutions of last resort, to be implemented only where facility expansion was infeasible. The new paradigm reverses these priorities: it applies demand-management solutions first and only expands facilities if they prove to be inadequate.

Summary

Our profession is changing the way we define transportation problems and evaluate solutions. Our new paradigm expands the modes, objectives, impacts, and options considered in the planning process. Table 5 compares the old and new paradigms.

This shift is an opportunity for transportation practitioners to redefine our roles and activities in order to better serve our communities. It requires new approaches, skills, tools, and data. This is an exciting time to be a transportation professional. ■

Table 5. Changing Transport Planning Paradigm

	Old Paradigm	New Paradigm
Definition of Transportation	*Mobility* (physical travel).	*Accessibility* (people's overall ability to reach services and activities).
Modes considered	Mainly automobile.	Multimodal: Walking, cycling, public transport, automobile, telecommunications, and delivery services.
Planning objectives	Congestion reduction; roadway cost savings; vehicle cost savings; and reduced crash and emission rates per vehicle-kilometer.	Congestion reduction; road and parking cost savings; consumer savings and affordability; improved access for disadvantaged people; reduced crash, energy consumption and emission rates per capita; improved public fitness and health; strategic land use objectives (reduced sprawl).
Impacts considered	Travel speeds and congestion delays; vehicle operating costs and fares; and crash and emission rates.	A variety of economic, social, and environmental impacts, including indirect impacts.
Performance indicators	Vehicle traffic speeds, roadway level of service, and distance-based crash and emission rates.	Multimodal level of service; multifaceted accessibility modeling, which calculates the time, monetary costs, comfort, safety, security, and environmental impacts required to access services and activities.
Favored transport improvement options	Roadway capacity expansion.	Improve transport options (walking, cycling, public transit, etc.); transportation demand management; pricing reforms; and more accessible land development.
Planning scope	Limited; transport planning is separated from other planning issues.	Integrated and strategic planning; individual, short-term decisions should support strategic, long-term planning goals.

The new paradigm expands the range of modes, objectives, impacts, and options considered in planning.

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