STREET NETWORK MANAGEMENT STRATEGIES

T. Lethco, A. Durante & C. Jaynes
Arup, United States of America
trent.lethco@arup.com
anthony.durante@arup.com
carla.jaynes@arup.com

ABSTRACT

As populations shift towards urban areas, the planning and programming of streets to enhance livability and mobility become increasingly important. As cities grow, private automobiles, transit, bicycles and pedestrians will all continue to compete for limited road space. In addition to mobility needs, streets serve as places for commerce, leisure, dining and socialization. Often encompassing 25 to 30 percent of a city's developed land, streets represent a primary public space where people experience and enjoy their cities. [1]

An integrated, network-level street management approach can be applied in order to balance competing demands of multiple transportation modes and street functions. A network approach acknowledges streets as interconnected systems serving different functions and users and enables communities to think holistically about how their streets operate. This paper explores the network approach to street planning and management, identifying uses for and potential benefits from such an approach. The research examines five case studies to document the application and effect of street network management strategies.

1. INTRODUCTION

With over half the world's population living in cities for the first time in history [2], urban places and spaces have assumed greater importance than ever before. Streets in particular represent fundamental public spaces where people experience and enjoy cities. Recently, the functionality, use and design of streets have been reexamined in places such as New York City, Portland, Charlotte and London to address the mobility demands of expanding urban populations and enhance the livability of urban areas.

This type of planning, known as street management, assesses the programming of city streets and develops strategies for reallocating street space to enhance accessibility and create more livable and interconnected communities. As part of street management planning, a network or system approach can be utilized to holistically examine all streets in a given study area and their relationship to one another. According to the Institute for Transportation Engineers (ITE), "network planning establishes a framework for the transportation system and distinguishes the functions, modal emphasis and operational features of individual segments." [3] Such an approach allows planners, local officials and other invested parties to better understand how streets work and how they can be contextually managed to serve all users.

A network approach to street management reveals that streets are more than just a means of moving vehicles from "A" to "B;" they can act as transit corridors, pedestrian routes, shared spaces, commercial nodes, play areas, or gathering spaces. Indeed, certain types of streets work better for certain users. By viewing urban streets as part of collective, multimodal networks, rather than individual components, we can better inform future

infrastructure investments, consider the mobility needs of more user groups, improve safety, and enhance the quality of life in urban areas.

This paper presents five case studies to document the effect of street network management strategies on various outcomes including, but not limited to, mobility, quality of life and economic activity. The case studies include projects in:

- Brooklyn, New York, USA;
- New York, New York, USA;
- Portland, Oregon, USA;
- Charlotte, North Carolina, USA; and
- London, England, UK.

2. THE STREET NETWORK APPROACH

Often, streets are studied as isolated transportation corridors connecting two destinations, municipalities, etc. As a result, the critical interplay between and among streets can be lost. Analyzing streets as interrelated networks, however, represents a different approach to street planning and programming. A network approach embraces a broader transportation context and analyzes various interrelated streets, their roles and the effect they have on area mobility and community character. This, in turn, informs decision making with regard to street improvements, maintains established community goals and objectives, and evaluates how specific changes affect the wider network.

As stated in ITE's *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*, "network…planning sets the strategic direction and framework around which the network and various components will eventually be constructed." [4] With that in mind, a street network analysis should be undertaken early in the planning process. This allows time for community input as the network is defined and individual streets are characterized by function, use or other factors.

2.1. Street Typologies

The process often results in a hierarchical composition of streets classified to meet the needs of all user groups. Street classifications help to contextualize a city or study area. They create parameters for summarizing and presenting the complexities of street function, design and character. Classifications[*] can include freeways, arterials, local streets, or any other nomenclature developed through the planning process that can provide a picture of streets' characteristics. Used together, classified streets help to balance regional travel demand (higher capacity through trips) with local considerations (walkability, local trips, urban design) by employing multiple routes of varying functions or classes to disperse trips throughout the system. Sample street classifications or typologies can be seen in Figure 1.

Land use considerations are key to street classification and overall network planning. Narrow streets flanked by residential uses would be characterized by their context and designed to carry primarily limited, local vehicular, pedestrian and bicycle traffic. On the other hand, wide streets that serve a variety of land uses and connect major destinations or activity centers can support higher capacities, including transit, where feasible.

[*] Classifications can follow ITE's standard functional classification system or be customized to the given study area or audience.

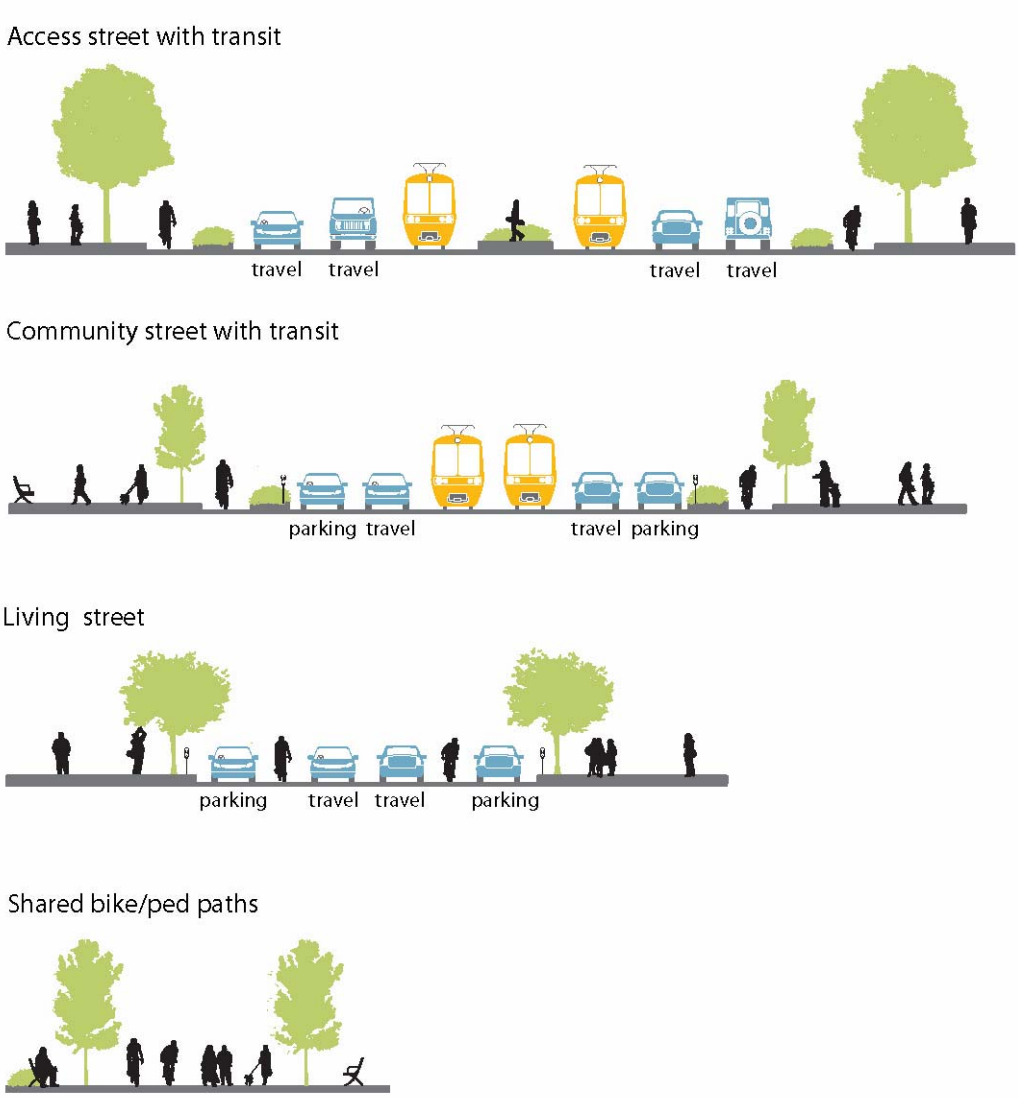

Figure 1: Cross sections of sample street typologies.

Quantifiable performance measures inform network planning so that classified streets are able to efficiently and effectively move the trips for which they are designed. For instance, it may be observed that a residential street is used more as a through street. Rather than propose isolated, street-specific solutions to prevent through traffic, regional strategies could be used to accommodate trips elsewhere, such as on a dedicated arterial, classified as such within the greater network. In any situation, performance measures can be applied to evaluate all modes so that the full transportation network is employed to manage total throughput demand along the most appropriate streets.

2.2. Planning for People First

Many cities and communities have recently taken steps to balance street and transportation networks to provide for other modal groups, especially pedestrians. As walking is the most sustainable and reliable form of transportation available, and pedestrians require the least amount of space and infrastructure to travel, they should be given priority when considering access and mobility issues (Figure 2). Almost all streets, where appropriate, can accommodate pedestrians through the provision of sidewalks, crosswalks, pedestrian signal heads, refuge islands, curb ramps, and street furniture, among others amenities.

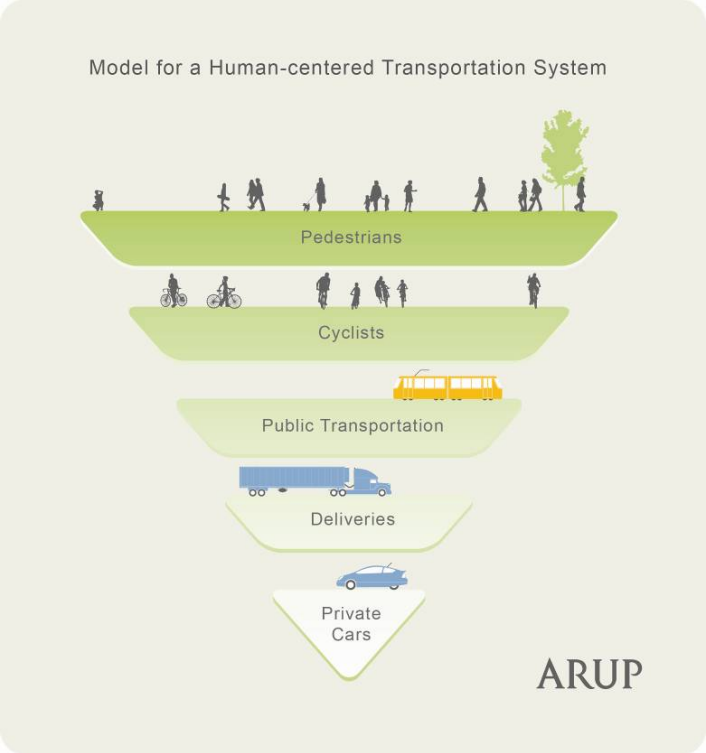

Figure 2: Graphic showing transportation planning priorities

In a similar vein, putting people first during the planning process gives the community an opportunity to learn and understand the different strategies being considered throughout the collective planning process. Residents, business owners, civic leaders and other stakeholders who live or work within the network study area can help identify issues and glean information on existing and future street characteristics and use. Shared goals and objectives, established early on, can set a vision for how the network should evolve over time to meet community needs. Public input of this kind is critical to generating consensus or "buy-in," so that street function is generally accepted. This can then streamline the approval of future street enhancements because everyone is in agreement with regard to the role of network streets and what improvements are needed to maximize their operation.

3. NETWORK OPTIMIZATION

Street improvement projects benefit greatly from a network approach to street management because network planning typically allows more thoughtful consideration of how street space should be allocated and enables informed decision-making on a wide range of projects designed to improve overall system mobility. Planned changes can then be made incrementally and systematically to the benefit of the network, rather than in a piecemeal fashion. [5] Changes can include:

- Physical changes – Context-sensitive treatments can support street function. For example, traffic calming elements such as neckdowns, chicanes or speed tables could be used on a local street to deter through traffic or speeding. Alternatively, the installation of dedicated bus lanes would reinforce a transit corridor.
- Operational changes – Coordinated or fixed-time traffic signals can be used on major thoroughfares to build network capacity, move traffic efficiently and attract trips from lesser routes.

- Functional changes – Streets that have developed patterns of use (or disuse) that seem to render their original purpose obsolete can be more suitably reclassified within the network planning framework. For instance, a commercial street that sees few auto trips but attracts many pedestrians could be re-categorized as a shared street where pedestrians and cyclists are given priority. Physical and/or operational changes can then be employed to formally establish the street's "new" role.

4. BENEFITS OF A NETWORK MANAGEMENT APPROACH

A network approach to street management that takes a holistic view of the multiple functions of streets enables planners to make key design decisions that support a range of community goals.

- Accommodation of all user groups – Ideally, the planning of an integrated network of streets proactively considers the needs of all potential users. In a network, multiple streets can accommodate a variety of users. People can be provided for first via local streets, shared streets, bike or transit corridors, then vehicles via through streets and arterials. (Refer to Figure 2 for a prioritization scheme.)

- Enhanced safety – In considering the needs of all users, the network approach can provide appropriate, mode-specific facilities and amenities at the outset to promote safe travel conditions for all. These can include dedicated bike lanes for cyclists or wide sidewalks and visible crossings for pedestrians.

- Improved mobility through connectivity – By holistically analyzing a network of streets, connectivity may be realized and used as a regional strategy to enhance mobility. Interconnected streets provide better access, improve circulation, and provide multiple route choices (Figure 3). "By providing…a high level of capacity on a [network] rather than a facility basis, roads…can be spared from...lane additions or straightening of alignments that would increase capacity at the expense of important context elements." [6] An interconnected and highly accessible network can also support multiple modes of transportation and intermodal connectivity.

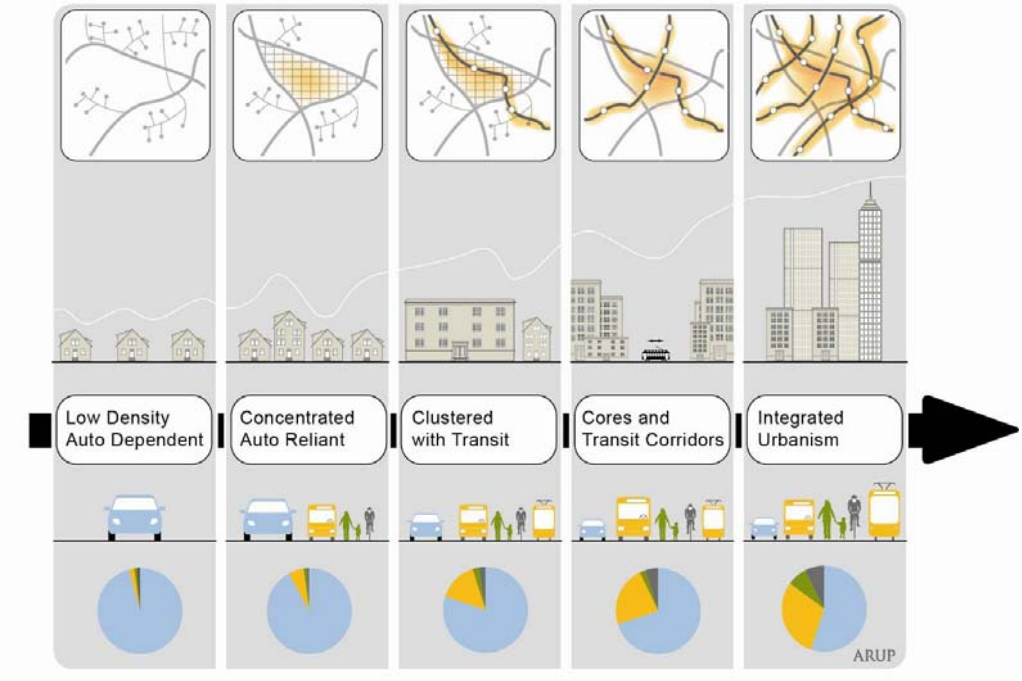

Figure 3: Spectrum of place types showing increasing levels of connectivity.

- Business improvement – When streets are tailored to users, businesses can benefit. As part of a street network analysis conducted by the New York City Department of Transportation (NYCDOT), it was discovered that pedestrians outnumber vehicles ten to one in Lower Manhattan's financial district. However, streets in the area were designed traditionally, with vehicles given priority. During the summer of 2010, four parking spaces on Pearl Street were converted as a pilot project into mini pedestrian plazas (dubbed "pop-up cafes"), and the two restaurants that funded the project not only saw a return on their investment, but a 14 percent increase in business following the installation of the cafes. [7]

- Community involvement – Members of the community should be engaged during any network planning activity. As the primary users of the network, the community can attest to its use and make insightful suggestions for future improvements. Public input in the planning and design process also fosters community ownership of the streets.

- Creation of great spaces – By categorizing streets within a network approach, their function and character can be better understood, and their potential as quality urban spaces can be realized. Design and engineering cues, including landscaping, signage and traffic calming elements can be used strategically to create a sense of place and greatly enhance the character of streets and the communities they serve.

- Enriched quality of life – Perhaps the ultimate outcome of street network planning is an enhanced quality of life. If some or all of the above outcomes are realized through a successful street network management program, users will be able to safely, efficiently and reliably travel through high-quality urban spaces, thereby greatly enhancing the quality of life for residents, businesses and visitors.

5. CASE STUDIES

The following case studies demonstrate network approaches to street management, how they've been applied, and resulting outcomes. In each instance, the network approach enabled context-sensitive design treatments to achieve local goals while maintaining overall network mobility and connectivity.

5.1. New York City

With a dense, urban environment and competing spatial demands from various modes of transportation, New York City has long struggled with allocating limited road space. A network approach to dealing with these complexities was proposed in the 1966 Lower Manhattan Plan, which recommended the designation of "traffic" streets, "service-emphasis" streets and "pedestrian-emphasis" streets. [8]

More recently, the City has undertaken projects that employ a network approach to inform decisions and enact change. The changes have aimed to improve the mobility of all modes, expand access to transit, reduce the impact of the automobile on communities, enhance the public realm, and boost the overall livability of the City. Two such projects are described herein: Downtown Brooklyn Traffic Calming and Green Light for Midtown.

5.1.1 Downtown Brooklyn Traffic Calming

The Downtown Brooklyn Traffic Calming project, conducted by NYCDOT from 1999 to 2003, aimed to reduce the impact of through-traffic on Brooklyn communities by taking a network approach to physical and operational traffic calming measures. Although previous attempts had been made to reduce the impact of traffic on the community, interventions had been site-specific and isolated; the problem had yet to be examined holistically. The goal of the study was to establish a more equitable balance in the use of streets and to improve mobility for all modes without adversely impacting community access or shifting traffic problems to adjacent streets. Community input played a key role throughout the duration of the project.

The traffic calming strategy was achieved through the creation of a custom Street Management Framework (SMF). The SMF formed the basis for developing and evaluating an integrated and coherent area-wide traffic management strategy for Downtown Brooklyn. The SMF indicated how different streets should function, identified where streets function poorly, developed management strategies to improve the function of streets, and ensured that management measures were implemented in a coordinated manner. The SMF designated three different street categories based on both transportation functions and community needs: travel streets, community streets, and living streets. The classifications, described in Figure 4, take into account both existing characteristics of the street and a vision for how the street should function.

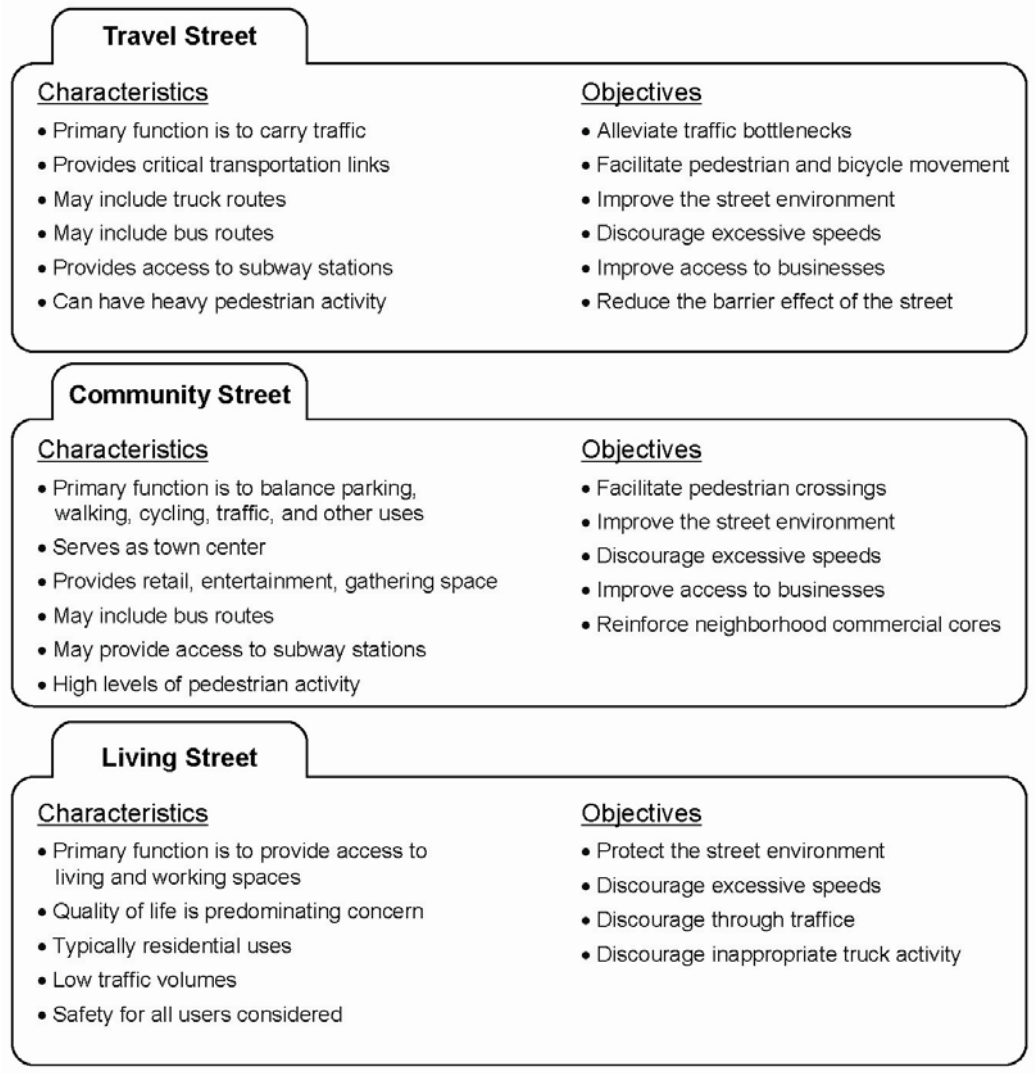

Figure 4: Downtown Brooklyn Street Types

Seven traffic management themes were developed to achieve more specific objectives within the overall goals for the area. Traffic calming tools were developed to meet each of the following themes:

- Providing pedestrian circulation and connectivity;
- Improving transit operations;
- Developing the bicycle network;
- Improving and managing truck access and routing;
- Managing through traffic;
- Ensuring local traffic permeability; and
- Providing emergency vehicle access.

Given the SMF, traffic management themes, and a toolbox of traffic calming treatments, coordinated action plans were developed for all streets within the study area. Community Boards and other stakeholders were engaged in the process of developing the action plans. The plans reflect the objectives for each street based on its street type designation. The SMF, generally, and the coordinated action plans, specifically, provided an agenda for the City to implement traffic calming in Downtown Brooklyn.

As traffic calming treatments were relatively new to New York City, a pilot program was used to monitor the effectiveness of several treatments including gateway treatments, all-pedestrian phases, neckdowns, a pedestrian refuge, a high-visibility cycling lane, a raised intersection, and a leading pedestrian interval. The pilot program explored issues related to the traffic calming measures and gauged impacts on safety, traffic operations and public perception. The program built confidence in the project team, local agencies and communities and demonstrated that traffic calming was practical for the study area.

Since the completion of the Downtown Brooklyn Traffic Calming study, NYCDOT has incrementally carried out many of the recommendations made in the report. The result has been a balance of modes at the network level that is responsive and sensitive to the context of individual streets. [9] The Downtown Brooklyn Traffic Calming study recognizes that streets are not only conduits of transportation but also public spaces that serve the community. As the study's final report states, managing streets through traffic calming "does not represent a radical new approach to managing streets, but a more balanced one…that reflects a clearer perception of broad community objectives." [10]

5.1.2 Green Light for Midtown

NYCDOT's Green Light for Midtown project did not utilize an established framework of street typologies but nonetheless represents a network approach to street management through its reallocation of street space. As part of a district-wide approach to improving mobility and safety in Midtown Manhattan, the project designated corridors for motorist and pedestrian mobility. Perhaps the most conspicuous pedestrian space created was from a swath of Broadway, including New York City's famous Times Square.

Times Square is one of the world's most recognizable places, attracting millions of tourists each year. The area is also home to 158,000 office employees and 33,000 residents. [11] In 2007, transit ridership at the five subway stations near Times Square came to approximately 235,000 people per day. [12] Although the area is constantly swarming with pedestrians, the two major avenues passing through Times Square – Seventh Avenue and Broadway – formed a complex roadway network and created conflicts between pedestrians and vehicles.

To remedy these issues, Mayor Michael Bloomberg and NYCDOT took drastic steps to balance road space and satiate competing demands from various users. Through the reallocation of road space and clearer separation between modes, the Green Light for Midtown project aimed to increase safety, improve mobility for multiple modes, and create a more pleasant public realm. The network approach taken by NYCDOT recognized that changes could not be made in isolation but as part of an overall transportation strategy for Midtown. Geometry modifications, signal changes, parking regulations and pedestrian improvements, including the road closures on Broadway, were simultaneously made in the summer of 2009 throughout Midtown to achieve area-wide change.

The City collected data to measure the project's effect on mobility, safety, pedestrian volumes and public perception. Mobility impacts to vehicles were measured using taxi global positioning system (GPS) data that tracked the speed and routes of approximately two million taxi trips. The results demonstrated that, by closing the Broadway segment in Times Square to vehicles and simplifying the geometry of intersections, northbound vehicle movements improved, and southbound vehicle movements were not greatly impacted. Impacts to bus travel times were less positive; the average time to complete a route increased for four of the five Metropolitan Transit Authority (MTA) bus lines that serve the area. For some of the routes, an increase in the length of the route or the number of turns required due to new roadway reconfigurations was likely the cause of the increased travel times. However, the severity of the impacts is countered, somewhat, due to abundant subway service in the area that can accommodate through trips. [13]

Comparison of crash data from previous years shows that the pilot project enhanced safety for both motorists and pedestrians. Injuries to drivers and passengers declined by 63 percent in Midtown, and injuries to pedestrians in Times Square declined by 40 percent. Furthermore, the new pedestrian-only space resulted in 80 percent fewer pedestrians walking in the roadway on Seventh Avenue between 45th and 46th Streets.

The project improved conditions for pedestrians by increasing the amount of usable space for circulation (sidewalks) and "staying" (plazas with seating and other amenities). Though the mobility and safety improvements are encouraging, the most visible change has been the impact to the public realm and the resulting increase in the space's use. Pedestrian volumes in Times Square jumped by 11 percent from the previous year, and the improvements elicited a particularly positive response from Times Square employees, who claimed that they are 26 percent more likely to leave the office for lunch following the pedestrianization initiatives. Plus, their overall satisfaction with Times Square increased from 43 percent to 74 percent from 2008 to 2009. [14]

Based on the improvements to mobility, safety and the public realm, the City decided to make the improvements permanent. The Green Light for Midtown project is an example of a district-wide approach to street management that balances vehicle and pedestrian mobility needs, promotes safety for all users, and recognizes streets as public spaces. Without the coordinated geometry and signal changes, the pedestrianization of Broadway could have wreaked havoc on Midtown traffic. Yet a more holistic approach was taken, and the City was able to create a world-class public space while maintaining vehicle mobility and improving safety for all modes.

5.2. Portland

Many urban areas lack street network management policies or a street typology framework to guide street planning and decision making. However, the greater Portland, Oregon,

area, a recognized leader in progressive planning in North America, claims three sets of street classifications from which to choose – one from the City of Portland; one from Portland Metro, the region's metropolitan planning organization (MPO); and one from the City of Gresham. Each work in tandem to improve regional mobility, promote sustainable forms of transportation and create quality public spaces.

5.2.1 City of Portland Street Classifications

Portland's Transportation System Plan (TSP), adopted by the City Council in 2007 as a long-term guide for transportation improvements, was developed to "provide transportation choices for residents, employees, visitors, and firms doing business in Portland, making it more convenient to walk, bicycle, take transit, and drive less to meet their daily needs." [15] A key chapter of the TSP, the Transportation Element, includes street classifications which "describe the types of motor vehicle, transit, bicycle, pedestrian, truck, and emergency vehicle movement that should be emphasized on each street." [16]

The classifications, a sampling of which can be seen in Table 1, are used to indicate desired street function. The TSP makes clear that all design treatments used for each type of street should support its modal emphasis and reinforce its classification, not its current use because a street may be used inappropriately over time. Importantly, the design treatments associated with each street also "achieve consistency…with [Portland] Metro's Regional Street Design Classifications" [17] (described in greater detail in the following section) thereby ensuring compatibility between systems. By investing in design improvements that strengthen street class within the network context, street use and space is maximized and the network itself is made more efficient.

Table 1: City of Portland Street Classification Matrix

Modal Emphasis	Intent	Sample Street Classifications
Traffic	• Support the movement of motor vehicles for regional, interregional, interdistrict and local trips	• Regional Trafficways • Traffic Access Streets • Neighborhood Collectors
Transit	• Support the movement of transit vehicles for regional, interregional, interdistrict and local trips	• Regional Transitways • Community Transit Streets • Local Service Transit Streets
Bicycle	• Serve all bicycle users and all types of bicycle trips through a system of bikeways	• City Bikeways • Off-Street Paths • Local Service Bikeways
Pedestrian	• Serve all types of pedestrian trips, particularly those with a transportation function	• Pedestrian Districts • Pedestrian-Transit Streets • City Walkways
Freight	• Support local, national and international distribution of goods and services with a system of truck streets and intermodal freight facilities	• Regional Truckways • Priority Truck Streets • Local Service Truck Streets

A key policy of the Transportation Element strategically supports the City's multimodal network planning approach by focusing on transportation education. Objectives include:

- Publicize…the availability of resources and facilities that promote a multimodal transportation system;
- Implement educational programs that recognize the need for developing and maintaining a multimodal transportation system;
- Increase public awareness of…available resources and facilities; and
- Educate citizens and businesses about Green Streets and how they can serve…to enhance, improve, and connect neighborhoods. [18]

Overall, the street management and design policies in Portland's TSP transparently support the network approach and promote a balanced and interconnected multimodal system of streets that emphasize specific modes over others, distribute trips throughout the City and improve regional connectivity.

5.2.2 Portland Metro Street Design Classification

Portland Metro's long-range plan, the Region 2040 Growth Concept Plan, was created by the regional planning agency to guide growth in the greater Portland area, identify the location of future land uses and activity centers and ensure a reliable, accessible, multimodal transportation system that moves people and goods throughout the region.

"Within the framework of the Growth Concept is a network of multi-modal corridors and regional through routes…that allow choices of how to travel in the region…and encourage the use of alternatives to the auto." [19] As part of this network, designated street classifications and detailed street design guidelines were created that enhance the conventional classifications used by Portland and Gresham.

Often, the conflicting roles of many streets – such as arterials used for both local, retail-oriented trips and regional through trips – inhibit mobility and present real challenges to transportation planners, designers and engineers. To address these complexities, Portland Metro's street classifications consider both land use and multimodal functions. [20] Portland Metro identifies five classifications of streets based on transportation mode and function: Throughways, Boulevards, Streets, Roads, and Local Streets. Boulevards and Streets are further broken down into Community and Regional categories so that the design appropriately reflects their function and character. [21]

Table 2: Portland Metro Street Design Classification

Street Type	Description
Throughway	• Emphasize vehicle travel • Connect major activity centers, industrial areas and intermodal facilities
Boulevard	• Emphasize public transportation, bicycle and pedestrian travel • Balance travel demands • Serve major activity centers
Street	• Serve transit corridors, main streets and neighborhoods • Integrate multiple modes of travel • Allow for ease of pedestrian, bicycle and public transportation travel
Road	• Integrate all modes, but are primarily traffic-oriented
Local Street	• Carry local traffic • Serve neighborhoods and complement the regional system

Implementation of these design guidelines and similar network street management measures enable streets throughout the Portland region to accommodate multiple modes of transportation, support non-auto transportation choices and improve area connectivity. One example is the Rockwood Town Center Redevelopment Plan in Gresham, Oregon, where a street management framework was utilized to design streets that are permeable and integrated with the surrounding development and modify existing infrastructure that serve as barriers to connectivity. Construction is currently underway to develop streetscapes that will improve pedestrian connections and enhance access to two local MAX light rail stations. [22]

5.2.3 City of Gresham Functional Street Classification System

The City of Gresham, located just to the east of Portland in Multnomah County, has experienced rapid growth since the 1980s and is now the second largest city in the Portland metropolitan area. City residents rely heavily on the car – which accounts for approximately 85 percent of all trips – despite the presence of several MAX light rail stations and bus routes. [23]

To meet the City's goals of establishing a multimodal transportation system, reducing reliance on the automobile, upgrading conditions for walking and cycling, and improving neighborhood connectivity, Gresham produced a Transportation System Plan (TSP) in 2002.* Key policies and strategies of the TSP relate directly to the creation of a citywide, hierarchical network of interconnected streets, including:

- Development of a functional classification of streets that serve all modes of travel;
- Establishment of a hierarchy of street types that balance trips in the network;
- Street design standards that support land uses; and
- Improvement of pedestrian conditions by providing connectivity, street furniture and trees, underground utilities, and ample lighting, among other measures. [24]

To further these policies, "the [TSP] provides a network of arterial routes to serve regional destinations and accommodate large amounts of through volumes and high frequency transit service as well as a system of collector, community, and local streets to accommodate and distribute local travel." [25] A sampling of specific street types can be seen in Table 3.

Table 3: City of Gresham Street Classification System (not exhaustive)

Street Type	Characterization	Travel Lanes	Volume
Freeway	High speed, high volume	4 to 8	60,000+ vpd
Principal Arterial	High speed, high volume	4 to 6	35,000 to 50,000 vpd
Arterial	Moderate speed, high volume	4	15,000 to 30,000 vpd
Boulevard	Moderate speed, moderate volume	4, with 2 parking	15,000 to 30,000 vpd
Collector	Provide access bet. neighborhoods and the arterial system	2, with 2 parking	10,000 to 15,000 vpd
Community Street	Facilitate travel within neighborhoods and serve adjacent land uses	2, with 2 parking	3,500 to 10,000 vpd
Local Street	These make up the largest percentage of road mileage in Gresham.		
Transitional Street	Low volume, low speed	2, with 2 parking	<1,000 vpd
Queuing Street	Low volume, low speed, two-way	1, with 2 parking	< 800 vpd
Lane	Provide local access to homes	2	< 200 vpd
Alley	Provide access to properties; Can be used for service vehicles	1	Very low

To ensure regional cohesion with Portland's street management policy, the TSP makes clear that "Gresham works with Portland to coordinate development of transportation facilities connecting the two cities and to address common transportation issues." [26]

As laid out in Gresham's Vision 2020 Plan, specific improvements to individual streets and the collective network have been prioritized through the next decade. By 2020, a more robust interconnected network of thoughtfully planned and designed streets should be in place to help the City establish a more sustainable and user-friendly transportation system.

* An update to the TSP with a horizon to 2035 is currently underway.

5.3. Charlotte

In the past decade, the City of Charlotte, North Carolina, has taken steps to reverse the auto-oriented land use and transportation patterns that have dominated local development. As part of a set of policies to implement smart growth, the City developed the Urban Street Design Guidelines (USDG). The USDG identify design and planning guidelines for five street types (Table 4) that serve as overlays to the City's existing street classification system. This overlay process enables the City to apply design guidelines based on factors beyond mobility that are also sensitive to the functions of individual streets as part of a larger network. Considerations such as land use, street function, safety, pedestrian and cyclist comfort, community character, connectivity, transit use and roadway allocation are all built into the guidelines, thus enabling a different approach to street design not previously available in the City's practice. The USDG provide a "framework of integrated planning, through context-sensitive street design, and a process for creating streets that increases transportation choices." [27]

The USDG strive to reflect the following three goals for the City's growth and development:

- Support economic development and quality of life by providing increased capacity and more user-friendly streets;
- Provide more and safer transportation choices by creating a better-connected network that supports a variety of mode choices; and
- Better integrate land use and transportation by creating the right combination of uses and streets to facilitate planned growth.

Table 4: Charlotte Urban Street Design Guideline Street Types

Street Type	**Description**
Parkways	• Primary function is to efficiently move vehicles • Connect destinations in the metropolitan area • Design emphasizes automobile priority
Boulevards	• Designed to carry large volumes of vehicles • Connect destinations in different areas of the city • Accommodate pedestrians and cyclists, with adequate buffers from traffic • Development set back further from street
Avenues	• Provide access from neighborhoods to commercial areas • Provide access between intercity destinations • Provide transportation choices with a balance of all modes of transport • Provide high-quality pedestrian access • Provide high levels of transit access • Provide bicycle accommodations, including bike lanes
Main Streets	• Destination streets, centers of civic, social and commercial activity • Provide access to fronting land uses • Provide a high level of comfort, security and access for pedestrians • Mixed-use and pedestrian-oriented development
Local Streets	• Provide access to districts • Encourage low vehicle volumes and low vehicle speeds • Provide a safe and comfortable environment for pedestrians and bicyclists • Further classified by residential, commercial and industrial

The USDG provide a six-step implementation process for applying the guidelines to streets. Whether applied to a single street or a collection of streets, the implementation

steps should take an area-wide approach, recognizing that “individual street segments do not exist or function in isolation from the surrounding street network and land uses.” [28] An important part of this process is the examination of trade-offs among competing uses of limited right-of-way space and the recognition that any one street cannot meet the needs of all users. By analyzing trade-offs at both the street and network level, the City is able to make context-sensitive decisions for each street, balancing choices made on some streets with those made on others in the network. For instance, vehicle and transit mobility may be a primary concern on some streets while historic preservation and pedestrianization may be important to other streets. The guidelines recognize the trade-offs involved and present a framework for making informed choices.

A draft of the USDG was adopted as City policy in 2007, and the design guidelines were formally adopted for implementation by the City Council in December 2010. [29] Before full implementation of the guidelines, the City of Charlotte applied the USDG on a range of projects including thoroughfares, streetscape projects, road conversions, rebuilt intersections and sidewalk projects. The most comprehensive approach to applying the USDG has been in area plans; to date, the guidelines have been used in twelve area plans to select street classifications and cross-sections based on anticipated land uses. As the City now moves towards full implementation of the USDG, it hopes to realize a “well-connected network of complete streets that function well for all users and complement and preserve the communities and neighborhoods they connect.” [30]

5.4. London Red Routes

In the past two decades, London has taken innovative steps in managing the street network of its central city. Beginning with Red Routes that prioritized mobility on key corridors, and expanding to bus priority corridors, bike corridors, and congestion charging, London has been able to manage streets in a way that reduces congestion and allows for improvements in public transportation and non-motorized modes.

Conceptualized in the early 1990s and implemented over the past two decades, London’s Priority Red Routes designate corridors that prioritize vehicle and transit movements in an effort to facilitate flows of people and goods, reduce congestion, improve transit service, promote roadway safety, and improve the local environment. [31] For example, time-of-day curbside stopping and parking restrictions were placed on the Routes, and loading and unloading are only permitted in designated loading bays during specified times.

The Red Routes were not implemented in isolation but were complemented by added bicycle facilities, improved pedestrian crossings, an enhanced public realm [32] and bus priority measures such as dedicated bus lanes and signal prioritization. [33] Studies indicate that the Red Routes have improved private vehicle and bus journey times and reduced the amount of illegal parking without having a negative impact on local businesses. Vehicle and bus journey times were reduced by 20 percent and 10 percent, respectively, and bus reliability increased by 27 percent. Through stringent enforcement and increased provision of legal parking spaces, handicapped spaces and loading zones, illegal parking has been reduced by 75 percent. [32] The principles of network management have allowed the City of London to optimize performance on designated priority transit and vehicular streets without detracting from adjacent communities.

London’s Red Routes were a precursor to congestion charging implemented in 2003. The central city congestion charge aimed to reduce congestion, improve bus service and vehicle journey time reliability, and distribute goods and services more efficiently. [34] Any driver entering the designated congestion charge zone from 7:00 AM to 6:30 PM is

required to pay a daily fee. When the charge was first introduced, the required fee stood at £5 and was increased to £8 and £10 in 2007 and 2011, respectively. [35]

By law, net revenues from the first ten years of the scheme must be reinvested in transportation improvements. To date, the majority of net revenues – 80 percent in 2007/2008 – have been put towards bus improvements. [36] In the 2009/2010 fiscal year, £148 million were raised through the congestion charge to be used towards additional bus network improvements, road safety measures, and pedestrian and bicycle facilities. [37]

Though reduced congestion was an initial result of the charging scheme, congestion levels have now risen above pre-charging levels. [38] Transport for London contends that congestion would be worse without the charge and points to construction activity and additional traffic management measures as sources of added congestion. Though reallocation of street space may have resulted in decreased capacity, these efforts have provided for pedestrian, cyclist and bus priority measures as well as public realm improvements. [36] Without an initial reduction in congestion created by the charge, these provisions for non-auto modes may not have been possible.

London's most recent street management initiative is the introduction of bicycle "superhighways" designed to provide safer and more direct bicycle routes to the central city. Two pilot routes were introduced in 2010, and the City and its partner, Barclays, plan to install the remaining ten routes in coming years. [39]

CONCLUSION

As the global trend towards urbanization continues, cities must recognize streets as some of the most complex and versatile of all urban spaces. As aptly stated by Allan Jacobs in *Great Streets*, "The people of cities understand the symbolic, ceremonial, social, and political roles of streets, not just those of movement and access." [40] Indeed, few other urban public spaces have the potential to concurrently act as travel conduits, plazas, gathering places, transit facilities, cafes, play areas, open spaces and more. Given the significance of streets, their function and use should be carefully analyzed, planned and managed to meet increasing mobility demands, accommodate all modes of transportation, improve safe travel conditions, and enhance community character and quality of life.

Street planning, design and management is often most effective through an integrated network approach that acknowledges streets as interconnected systems, recognizes their myriad functions, and balances the competing demands of multiple transportation modes. Network-level street management strategies enable communities to think innovatively and holistically about the ways in which streets interact with one another and with the surrounding environment. The case studies presented in this paper represent but a few examples of how such street network management approaches have been applied to great effect in communities around the world.

REFERENCES

1. Jacobs, Allan B. (1993). Great Streets. Cambridge: MIT Press, p 6
2. United Nations Population Fund (May 2007). Urbanization: A Majority in Cities. http://www.unfpa.org/pds/urbanization.htm
3. Institute of Transportation Engineers (2006). Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities. p 26
4. Ibid., p. 25

5. Institute of Transportation Engineers (2006). Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities. p 25
6. Dock, Fred and Ellen Greenberg (2003). Design Guidance for Great Streets: Addressing Context Sensitivity for Major Urban Streets. p. 10
7. Solomonow, Seth and Scott Gastel (4 November 2010). NYCDOT Accepting Applications for Innovative Pop-Up Café Pilot Program. Press Release # 10-055
http://www.nyc.gov/html/dot/html/pr2010/pr10_055.shtml
8. Willis, Carole Ed. (2002). The Lower Manhattan Plan: The 1966 Vision for Downtown New York. Chapter 11. New York: Princeton Architectural Press.
9. New York City Department of Transportation (2006). Calming Clinton Street with the Traffic Engineering Toolbox. Presentation for the ITE Technical Conference. San Antonio
10. New York City Department of Transportation. (2004). Downtown Brooklyn Traffic Calming Project Final Report
11. Times Square Alliance (Accessed February 2011). Employee and Residential Demographics.
http://timessquarenyc.org/facts/facts_economic_demo.html
12. Times Square Alliance (Accessed February 2011). Subway Ridership in Times Square 1980-2007.
http://timessquarenyc.org/facts/documents/Subway_Daily_Ridership_1980-2007.pdf
13. Grynbaum, Michael M. (2010). "Times Square Plazas Slow Many Bus Trips." New York Times
14. New York City Department of Transportation (2010). Green Light for Midtown Evaluation Report
15. Portland Bureau of Transportation (2007). Transportation System Plan.
http://www.portlandonline.com/transportation/index.cfm?c=52495
16. Portland Bureau of Transportation (2007). Transportation System Plan. Chapter 2, Transportation Element. p. 2-5
17. Ibid., p. 2-18
18. Ibid., p. 2-4
19. City of Gresham (2002). Gresham Community Development Plan. Volume 4: Transportation System Plan. p. 12
20. Dock, Fred and Ellen Greenberg (2003). Design Guidance for Great Streets: Addressing Context Sensitivity for Major Urban Streets. p. 13
21. Portland Metro (2000). 2000 Regional Transportation Plan. Adopted by Metro Council, August 10, 2000. (Ordinance No. 00-869A)
22. City of Gresham, Gresham Redevelopment Commission (2005). Rockwood Town Center Design and Redevelopment Plan Final Report
23. City of Gresham (2002). Gresham Community Development Plan. Volume 4: Transportation System Plan.
24. Ibid., Chapter 4 – Policies and Strategies
25. Ibid., p. 133
26. Ibid., p. 14
27. Newsome, Tracy, Norm Steinman and Reid Ewing. (2003). Charlotte's Urban Street Design Guidelines: A Context-Sensitive Decision-Making Method. 2nd Urban Street Symposium
28. City of Charlotte. (2007). Draft Urban Street Design Guidelines. Chapter 1. p. 53
29. Stabley, Susan. (2010). Charlotte Approves Street Design Rules. Charlotte Business Journal
30. City of Charlotte. (2007). Draft Urban Street Design Guidelines. Chapter 1. p. 11
31. Transport for London (Accessed 23 February 2011). London Freight Matters.
http://www.tfl.gov.uk/microsites/freight/parking_and_loading.aspx
32. West Midlands, United Kingdom (2006). West Midlands Local Transport Plan.
http://www.westmidlandsltp.gov.uk/2006/appendices/chapter_29.html
33. Transport for London (2006). Bus Priority at Traffic Signals Keeps London's Buses Moving
34. Transport for London (2007). Central London Congestion Charging Impacts Monitoring Fifth Annual Report. p. 1
35. Transport for London. (2011). http://www.tfl.gov.uk/roadusers/congestioncharging/17094.aspx#charge
36. Transport for London (2008). Central London Congestion Charging Impacts Monitoring Sixth Annual Report
37. Transport for London (2011). What Do You Need to Know About Congestion Charge.
http://www.tfl.gov.uk/roadusers/congestioncharging/6723.aspx
38. Transport for London (2011). Benefits of Congestion Charge.
http://www.tfl.gov.uk/roadusers/congestioncharging/6723.aspx
39. Transport for London (2010). Barclays Cycle Superhighways FAQs. p. 4
40. Jacobs, Allan B. (1993). Great Streets. Cambridge: MIT Press, p 5