

Multimodal Transportation

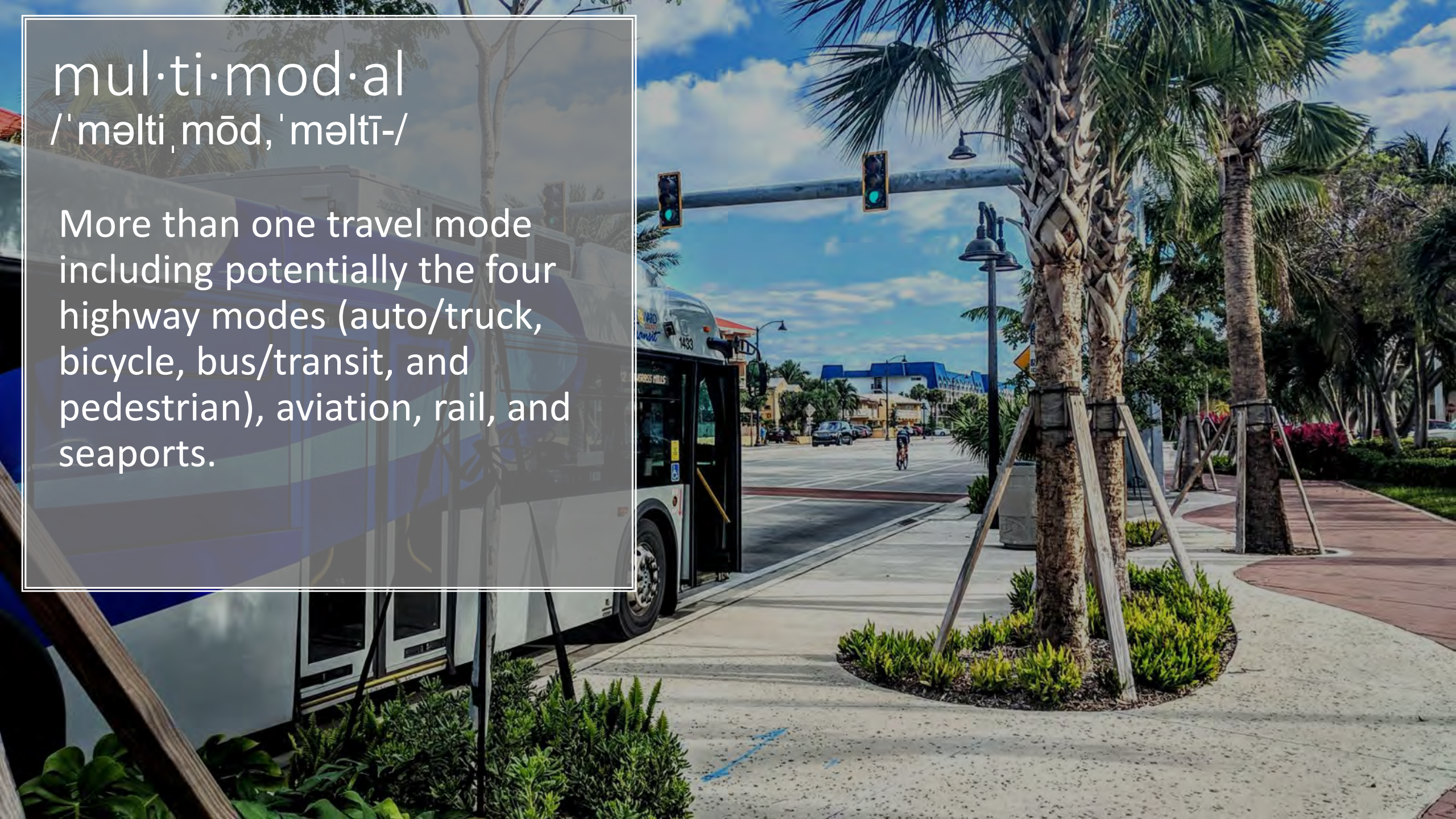
Emerging Thought, Trends & Practices



mul·ti·mod·al

/'mɛltiˌmɒd, 'mɛlti-/

More than one travel mode including potentially the four highway modes (auto/truck, bicycle, bus/transit, and pedestrian), aviation, rail, and seaports.





PRIVATE MOTOR VEHICLES
600–1,600/HR



MIXED TRAFFIC WITH FREQUENT BUSES
1,000–2,800/HR



TWO-WAY PROTECTED BIKEWAY
7,500/HR



DEDICATED TRANSIT LANES
4,000–8,000/HR

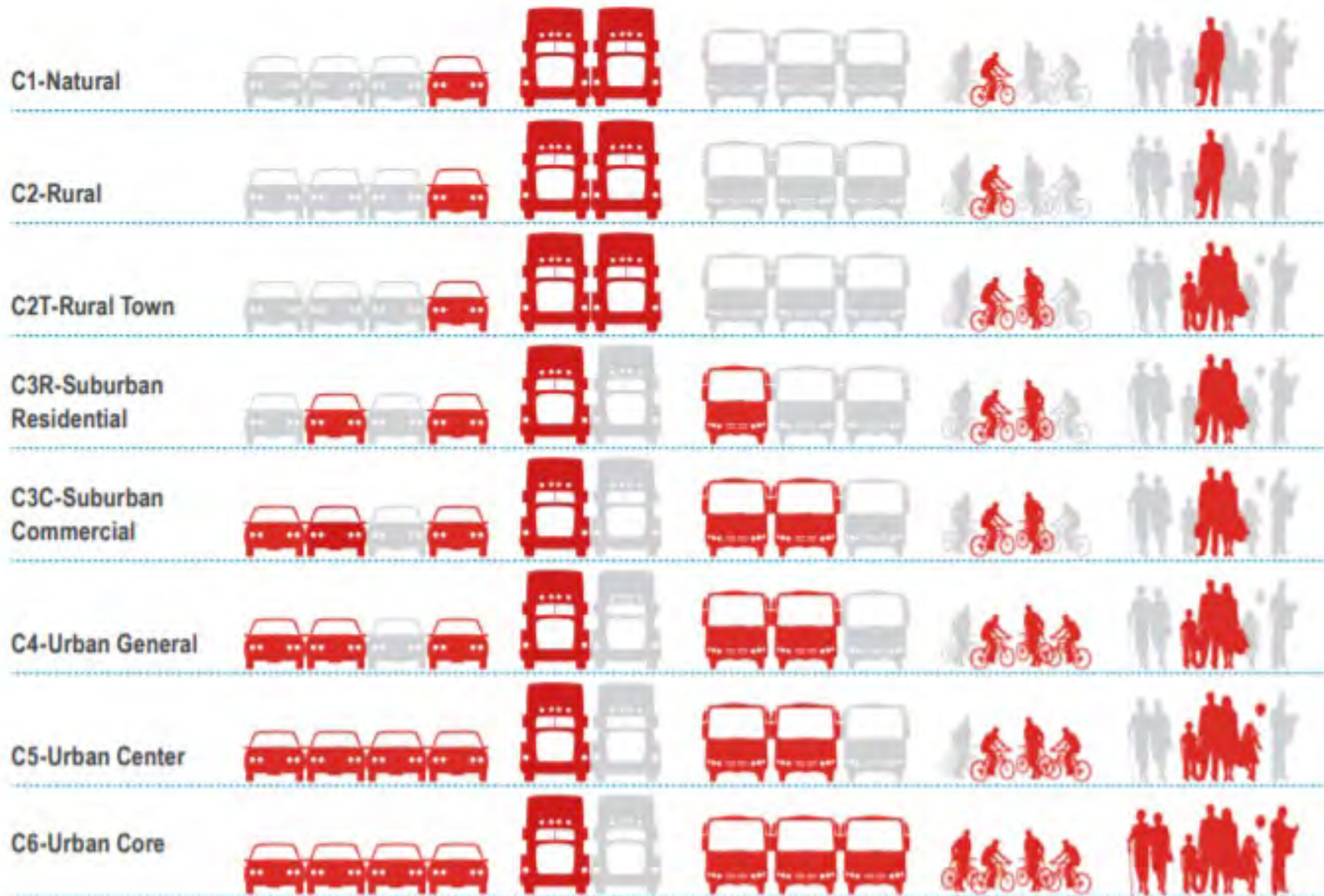


SIDEWALK
9,000/HR



ON-STREET TRANSITWAY, BUS OR RAIL
10,000–25,000/HR

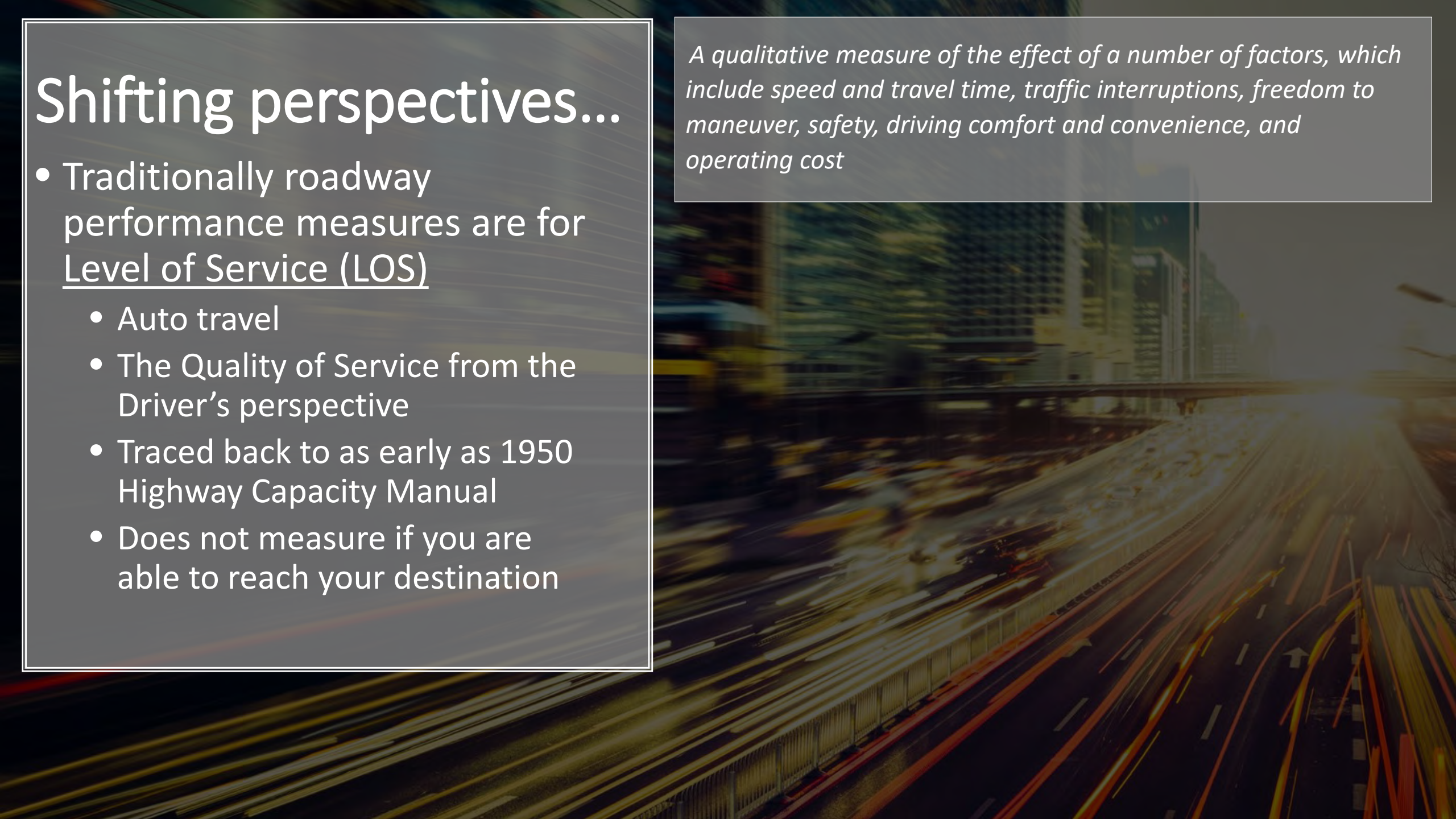
FIGURE 15 EXPECTED USER TYPES IN DIFFERENT CONTEXT CLASSIFICATIONS



Shifting perspectives...

- Traditionally roadway performance measures are for Level of Service (LOS)
 - Auto travel
 - The Quality of Service from the Driver's perspective
 - Traced back to as early as 1950 Highway Capacity Manual
 - Does not measure if you are able to reach your destination

A qualitative measure of the effect of a number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating cost



Levels of Service

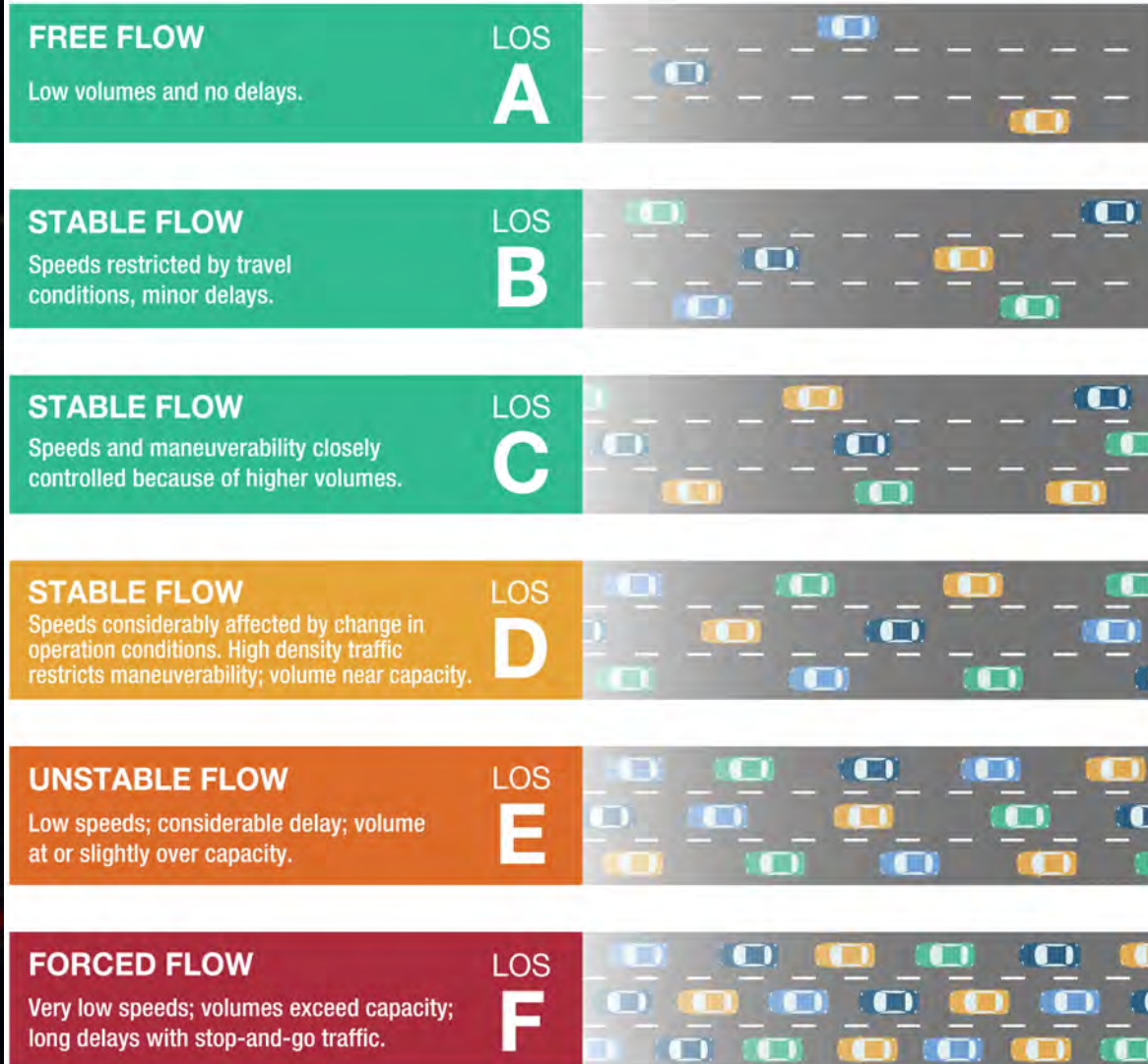


Figure 2 Total Lateral Clearance Adjustment Factor f_{TLC} Values (mph)

Four-Lane Highways		Six-Lane Highways	
TLC (ft)	Reduction in FFS, f_{TLC} (mi/h)	TLC (ft)	Reduction in FFS, f_{TLC} (mi/h)
12	0.0	12	0.0
10	0.4	10	0.4
8	0.9	8	0.9
6	1.3	6	1.3
4	1.8	4	1.7
2	3.6	2	2.8
0	5.4	0	3.9

Source: HCM 6th Edition, Exhibit 12-22.

Note: Interpolation to the nearest 0.1 is recommended.

The base FFS is taken to be the design speed (if available), or can be estimated as the speed limit plus 5 mph (for speed limits ≥ 50 mph) or the speed limit plus 7 mph (for speed limits < 50 mph). If the segment contains one or more horizontal curves with an advisory speed less than the speed limit, use the lowest advisory speed as the base FFS.

Highway free flow speed is considered to be the speed a driver chooses under low volume conditions when the interaction between vehicles and the influence of traffic control devices is minimal.

Multimodal Level of Service

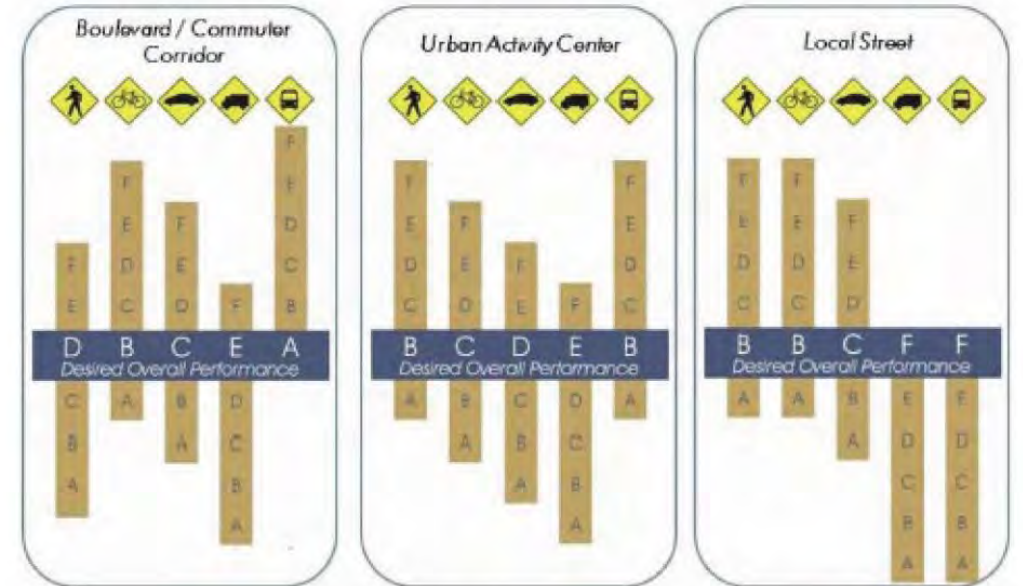
Developing the framework

- Goal to provide a well-rounded performance measure of the roadway and person throughput
- Growing interest and methods in practice and in development



Multimodal Level of Service

- Research states that a combined MMLOS may dilute results
- Instead, recommendations are to keep individual level of service evaluations for each mode

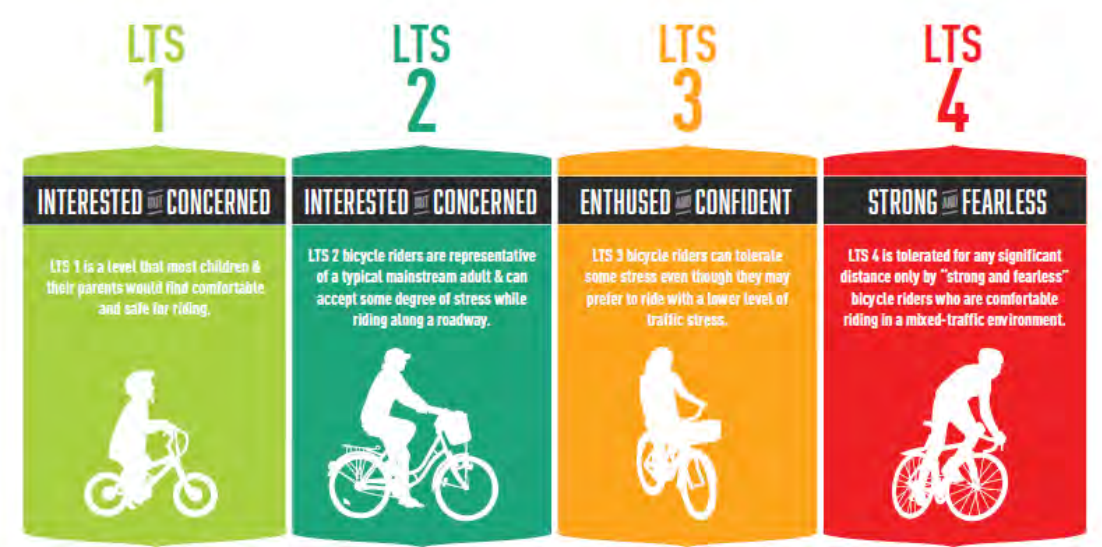


The identification of context-sensitive quality-of-service objectives for each mode of travel is one way to consider modal emphasis. Source: Institute of Transportation Engineers, 2014



Multimodal Level of Service

- Example: Bicycle Level of Traffic Stress- Bellevue, WA



Roadway Characteristics **Bicycle Facility Components:**
Guideline to Achieve Intended Level of Service/Level of Traffic Stress

Speed Limit (MPH)	Arterial Traffic Volume	No Marking	Sharrow Lane Marking	Striped Bike Lane	Buffered Bike Lane (Horizontal)	Protected Bike Lane (Vertical)	Physically Separated Bikeway
</= 25	<3k	1	1	1	1	1	1
	3-7k	3	2	2	2	1	1
	>/=7k	3	3	2	2	1	1
30	<15k	3	3	2	2	1	1
	15-25k	4	4	3	3	3	1
	>/=25k	4	4	3	3	3	1
35	<25k	4	4	3	3	3	1
	>/=25k	4	4	4	3	3	1
>35	Any	4	4	4	4	3	1



Multimodal Level of Service

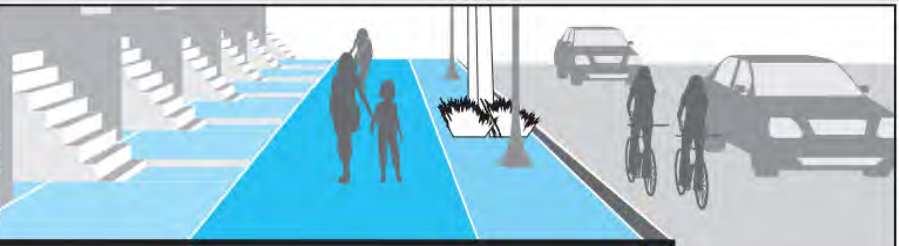
- Example: Pedestrian LOS

Pedestrian LOS	Metric	Implementation	How to Apply
Sidewalk & Landscape Buffer	Combined Width for sidewalk and landscape buffer	Frontage Improvements Capital Investment Program	Standard per Land Use Code and Transportation Design Manual
Intersection Treatment	Design Components	Frontage Improvements Capital Investment Program	Guideline
Mid-Block Crossings	Spacing of Crossings	Frontage Improvements Capital Investment Program	Guideline

Above: Bellevue, WA- PLOS example

Right: Boston, MA- guideline example

The width and design of sidewalks will vary depending on street typology, functional classification, and demand. Below are the City of Boston's preferred and minimum widths for each Sidewalk Zone by Street Type.



Street Type	Frontage Zone		Pedestrian Zone*		Greenscape/Furnishing Zone		Curb Zone	Total Width	
	Preferred	Minimum	Preferred	Minimum	Preferred	Minimum		Preferred	Minimum
Downtown Commercial	2'	0'	12'	8'	6'	1'-6"	6"	20'-6"	10'
Downtown Mixed-Use	2'	0'	10'	8'	6'	1'-6"	6"	18'-6"	10'
Neighborhood Main	2'	0'	8'	5'	6'	1'-6"	6"	16'-6"	7'
Neighborhood Connector	2'	0'	8'	5' (4')*	5'	1'-6"	6"	15'-6"	7'
Neighborhood Residential	2'	0'	5'	5' (4')*	4'	1'-6"	6"	11'-6"	7'
Industrial Street	2'	0'	5'	5' (4')*	4'	1'-6"	6"	11'-6"	7'
Shared Street	2'	0'	Varies	5' (4')*	N/A	N/A	N/A	Varies	Varies
Parkway	N/A	N/A	6'	5'	10'	5'	6"	16'-6"	10'-6"
Boulevard	2'	0'	6'	5'	10'	5'	6"	18'-6"	11'-6"

Notes

* 5' is the preferred minimum width of the Pedestrian Zone in the City of Boston. The Americans with Disabilities Act (ADA) minimum 4' wide Pedestrian Zone can be applied using engineering judgement when retrofitting 7' wide existing sidewalks where widening is not feasible.

Frontage Zone

- ▶ Where buildings are located against the back of the sidewalk and constrained situations do not provide width for the Frontage Zone, the effective width of the Pedestrian Zone is reduced by 1', as pedestrians will shy from the building edge.
- ▶ The preferred width of the Frontage Zone to accommodate sidewalk cafés is 6'.

Pedestrian Zone

- ▶ Based on engineering judgment in consultation with PWD and the Mayor's Commission for Person's with Disabilities, the ADA minimum 4' Pedestrian Zone (plus 5' of width every 200') may be applied.

Greenscape/Furnishing Zone

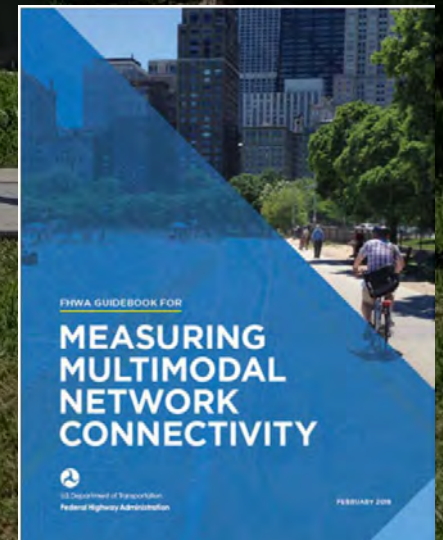
- ▶ The minimum width of the Greenscape/Furnishing Zone necessary to support standard street tree installation is 2'-6".
- ▶ Utilities, street trees, and other sidewalk furnishings should be set back from curb face a minimum of 18".

Curb Zone

- ▶ Although the typical width of the Curb Zone is 6", widths may vary; additional width beyond 6" should be calculated as a part of the Greenscape/Furnishing Zone.

Becoming Multimodal- Considerations

- Performance Measures- MMLLOS/MMQOS, Counts
 - Connectivity
- Safety and perceptions of safety
 - Vision Zero, Target Zero, Road to Zero
 - Speed Management
 - Managing conflict with other modes
- Roadway real estate/ curbside management
- Right-of-way, Easements
- Funding and Programming



Safety

- A big part of becoming truly multimodal is safety and creating the appeal for a mode shift
 - Perception of Safety
 - Real Safety
- Speed management-
 - Speed is the single greatest indicator of injury severity



Vision Zero

- Goal to eliminate all deadly and severe injury crashes
- Safety Program for all modes and all people
 - Emphasizes the vulnerable roadway users
 - Targets the High Injury Network
 - Equity



Vision Zero

- A shift in thinking

TRADITIONAL APPROACH

Traffic deaths are **INEVITABLE**

PERFECT human behavior

Prevent **COLLISIONS**

INDIVIDUAL responsibility

Saving lives is **EXPENSIVE**

VS

VISION ZERO

Traffic deaths are **PREVENTABLE**

Integrate **HUMAN FAILING** in approach

Prevent **FATAL AND SEVERE CRASHES**

SYSTEMS approach

Saving lives is **NOT EXPENSIVE**

Safe System Approach

Guiding Principles

1. The human body has a known and limited ability to tolerate crash forces.
2. People make mistakes that lead to crashes.
3. System designers share responsibility with road users for crash prevention.
4. All elements of the system should be strengthened to multiply their effects.



Safe System Approach +

• FDOT Strategic Highway Safety Plan, 2021

FLORIDA

STRATEGIC HIGHWAY SAFETY PLAN

TARGET ZERO
FATALITIES & SERIOUS INJURIES

MARCH 2021

USER BEHAVIOR: OCCUPANT PROTECTION

FOCUSED STRATEGIES

- EDUCATION** Develop and implement outreach and communication strategies focused on the demographics with low safety belt and child restraint use.
- INSIGHT INTO COMMUNITIES** Create safer communities by providing occupant protection and child passenger safety training, materials, resources, and child safety seat checks to all areas of the state and at-risk populations.
- INVESTMENTS AND POLICIES** Identify and support legislation to require all passengers in all seating positions to be properly restrained including occupants of pickup trucks or flatbed vehicles and the correct child restraint seats for the correct amount of time. Identify and support legislation or policies that require completion of a mandatory diversion program for first-time offenders of the child restraint law.
- ENFORCEMENT** Provide law enforcement officers training, tools, and resources to increase compliance with occupant protection and child passenger safety laws and increase seat belt use among officers. Combine focused high visibility enforcement with focused outreach and communication strategies to increase public awareness of the consequences of riding unrestrained.

SAFE SYSTEM: SAFE ROAD USER

CarFit Program
CarFit is an educational program where a team of trained technicians offers a safety check-up for vehicles of older drivers to ensure they fit their vehicle properly for maximum comfort and safety. A CarFit check-up is free and takes about 20-30 minutes.

Car Seat Installation
Research shows that child safety seats reduce fatal injury by 71 percent for infants (under 1-year old) and by 54 percent for toddlers (1 through 3 years old) in passenger cars. Child safety seat inspection stations help to install or check the safety seats for children by nationally certified child passenger safety technicians free of charge in most cases.

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MEASURING OUR PROGRESS

To monitor progress, FDOT uses data-driven forecasting to provide projections for each measure including correlations between safety data and other variables such as VMT, gas prices, and the vehicle age. This statistical modeling process is conducted annually and final projections are reported for each measure in the SHSP, HSP, and HSP. In addition, the HSP, HSP, and each of the safety coalitions' strategic plans all include performance and progress indicators.

FDOT and the traffic safety coalitions regularly review data to monitor plan progress and to identify relationships between contributing factors, including time/day, demographics, driver behaviors, environmental and roadway conditions, high risk locations, and emerging issues.

In developing the SHSP, efforts were made to reach out to local governments and the state's 27 MPOs to provide information on ways to improve safety because the SHSP covers all public roads. For context, state roads account for 10 percent of all road miles yet 56 percent of total VMT and 62 percent of total fatalities and local roads account for 37 percent of roadway fatalities. To reach our vision of zero, a shared vision for safety and collaboration on key strategies is very important.

CENTERLINE MILES, VMT, AND FATALITIES BY ROAD TYPE (2019)

- 10% STATE: % OF TOTAL CENTERLINE MILES
- 90% FEDERAL & LOCAL
- 44% FEDERAL & LOCAL: % OF TOTAL VMT
- 56% STATE
- 62% STATE: % OF TOTAL FATALITIES
- 38% FEDERAL & LOCAL

SAFE SYSTEM: SAFE ROADS

While 95 percent of Floridians live in urban counties, nearly half of Florida's 67 counties are rural. Florida is committed to reducing crashes on all roadways, from those in congested urban areas to those in rural communities. Safety countermeasures for high risk rural areas are prioritized through collaboration with local governments and, where applicable, MPOs, and support targeted efforts for local road system improvements.

Rural road in Central Florida

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ROADWAYS: LANE DEPARTURES

Most fatal crashes occur because of lane departure. A lane departure crash occurs when a vehicle leaves its lane, possibly due to improper passing, wrong way driving, weaving or swerving, running off the road, or overcorrecting, and collides with other vehicles, structures, trees, or other objects, or other people. Driver behavior and roadway design affect the number and severity of lane departure crashes. A driver who is speeding, distracted, drowsy, or impaired is likely to have difficulty staying in the lane. Given all these factors, it is important to note that one fourth of all Florida crashes include a driver who leaves the scene.

Florida focuses its education efforts on the underlying driver behaviors that contribute to lane departures. A roadway that's slick and wet, an object that is too close to the road, or a shoulder or curve that's too narrow can also contribute to a lane departure crash. The FDOT Design Manual and the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual provide guidance to improve roadway conditions. Visual and audible cues to the driver, whether from the roadway or the vehicle, smartphones, or other technology, help mitigate lane departure crashes. Work zone crashes are often the result of lane departures. We continue to monitor work zone crashes and recognize them as an evolving emphasis area (see page 42).

LANE DEPARTURE FATALITIES AND SERIOUS INJURIES

Year	Fatalities	Serious Injuries
2015	4,382	1,570
2016	6,785	1,431
2017	6,331	1,827
2018	5,783	1,317
2019	5,408	1,319

Lane departures represent **34%** of all CRASHES yet result in **42%** of all DEATHS

SAFE SYSTEM: SAFE VEHICLES

Driver assistance technologies such as lane departure warning systems, lane monitoring support, warning of slippery roads, and adaptive cruise control help prevent drivers from unintentionally drifting out of their lanes or crossing the center median and reduce the likelihood of lane departure crashes. These systems lower rates of single-vehicle, sideswipe, and head-on crashes of all severities by 11 percent.

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OUR KEY STRATEGIES

INSIGHT INTO COMMUNITIES

Achieving zero fatalities and serious injuries requires more than addressing specific hazards and influencing individual decisions and behaviors. It also involves systemic approaches to reshape our transportation systems and communities to create a safer environment and a greater emphasis on more equitable access for people and all modes of travel. Florida will:

- Create safer communities through data-driven decisions that include partner and community member input, with the goal of more coordinated land use, design, planning, and traffic operations decisions that reflect the unique context, needs, and preferences of each community.
- Promote a broader range of safe transportation choices consistent with community visions including identifying more alternatives for safe travel.
- Reduce disparities in transportation safety risks among socioeconomic groups.

SAFE SYSTEM: SAFE SPEEDS

One proven way to reduce traffic fatalities and injuries is to adjust vehicle speeds to match the mix of users on a roadway. This might involve reducing target speeds or using speed management techniques to encourage drivers to operate at a safe speed that reflects the context of the community.

For example, in Volusia County, SR 430 (Oakridge Boulevard) is being redesigned to convert the existing three-lane facility to a two-lane roadway with a designated bicycle lane. This redesign provides for multiple road users including drivers, bicyclists, and pedestrians and encourages speed reduction for motor vehicles. Design features to manage speed on SR 430 include reduced lane width, horizontal deflection using curb bump outs, landscaping, and lane-repurposing to accommodate cyclists.

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Safe System Approach

- FAU Publications Examples



FLORIDA ATLANTIC
UNIVERSITY



Implementing Safe Systems in the United States: Guiding Principles and Lessons from International Practice

June 4, 2019

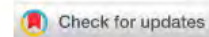
Eric Dumbaugh
Louis Merlin
Florida Atlantic University

Nail Sigot
Wen Kumbier
Seth Lakshminarayanan
Daniel Carter
University of North Carolina, Chapel Hill

Toward Safe Systems: Traffic Safety, Cognition, and the Built Environment

Eric Dumbaugh , Dibakar Saha, Louis Merlin 

First Published August 13, 2020 | Research Article



<https://doi.org/10.1177/0739456X20931915>

Complete Streets

- Complete Streets discussions are evolving
- Previously, generally described as livable streets designed for all users regardless of ability or mode of travel



Update Complete Streets Policies

- Increasing emphasis on Equity, Speed, Safety, Comfort, Public Health
- Complete Streets are streets for everyone.
 - designed and operated to prioritize safety, comfort, and access to destinations
 - are for all people who use the street,
 - addresses equity – race and ethnicity, ADA, vehicle ownership
- A Complete Streets policy can empower communities “to direct their transportation planners and engineers to routinely design and operate the entire right of way to prioritize safer slower speeds for all people who use the road, over high speeds for motor vehicles.”

Update Complete Streets Policies

- 4' or 5' bike lanes are not appropriate for all roadways
- Direct routes vs Low Stress Routes
- Integration of greenways and neighborhood greenways or bicycle boulevards
- There are many different methodologies to assess connectivity



Emerging Micro-Mobility

Emerging Mobility – Disruptors:

- Serve as First – last mile solutions and remove vehicular trips
- Personal Devices, or
- Mobility as a Service (MaaS)
 - Bikeshare- standard and e-assist bikes
 - E-scooters
 - Docked and Dockless



Emerging Micro-Mobility

- For example, Fort Lauderdale E-Scooter Dockless Mobility:
 - Regulated by local ordinance
 - E-scooter estimated average trip length less than 2 miles.
 - Average ride duration 27.78
 - Averaged over 100k trips per month
 - 75% of riders reported that their e-scooter ride replaced a vehicular trip
 - Personal car or TNC (e.g., Uber, Lift, Taxi)



Emerging Micro-Mobility

MaaS has had their own challenges

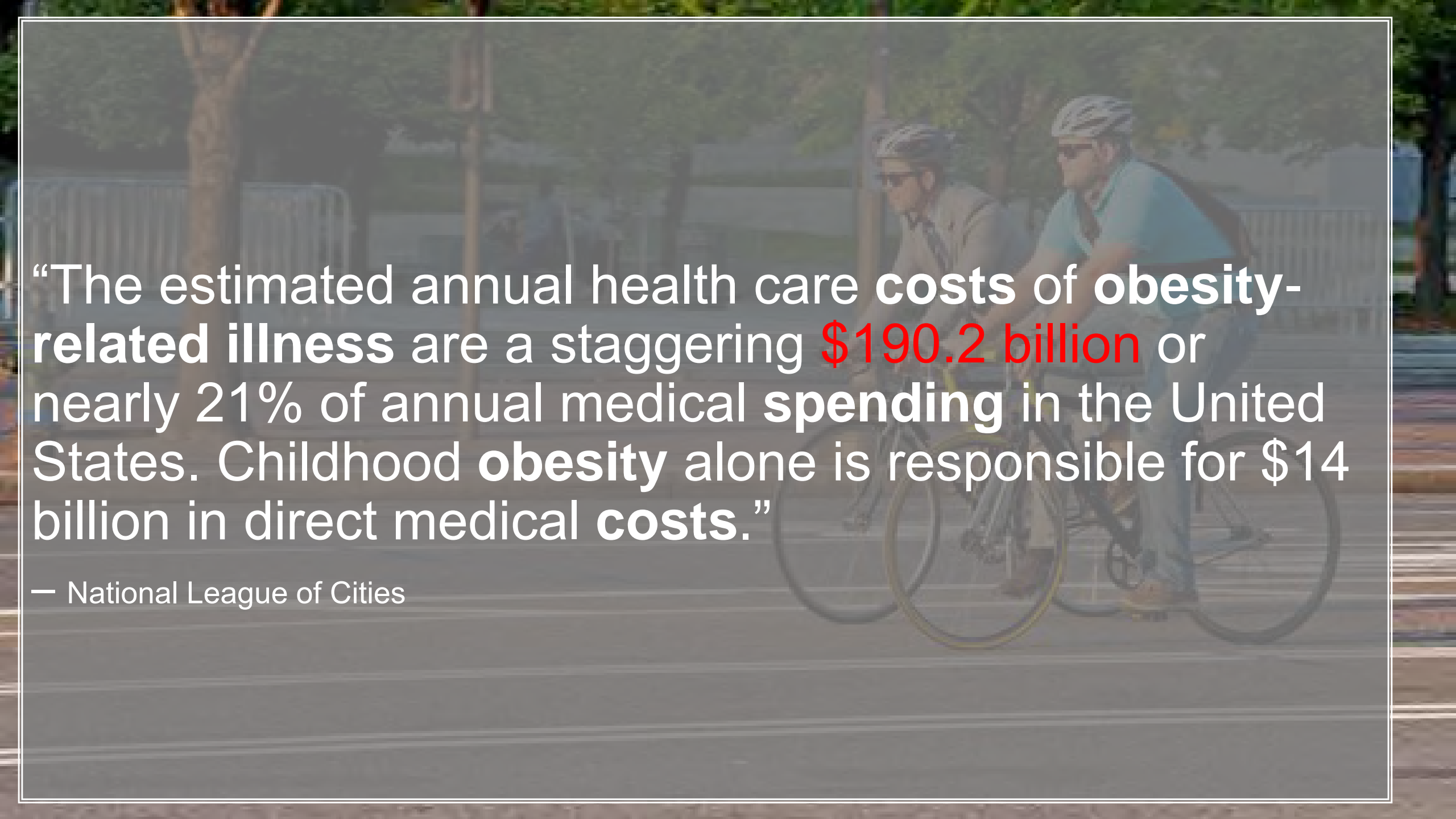
- Curbside management
- Safety- increase in injuries
- May expose a lack of safe and connected infrastructure-
 - Highlight and justify the need for greater bike lane/facilities to be rebranded as micro-mobility
 - Highlights the imperfections in pavement or uneven surfaces- the need for smooth seamless infrastructure or a required design change for technology itself
- Parking
 - Although less than 25% of scooters were found to be mis-parked in Fort Lauderdale's study, it is often cited as a nuisance

The Health Benefits of Multimodal Planning & modal shift adoption

Active Transportation vs. Sedentary forms of transportation

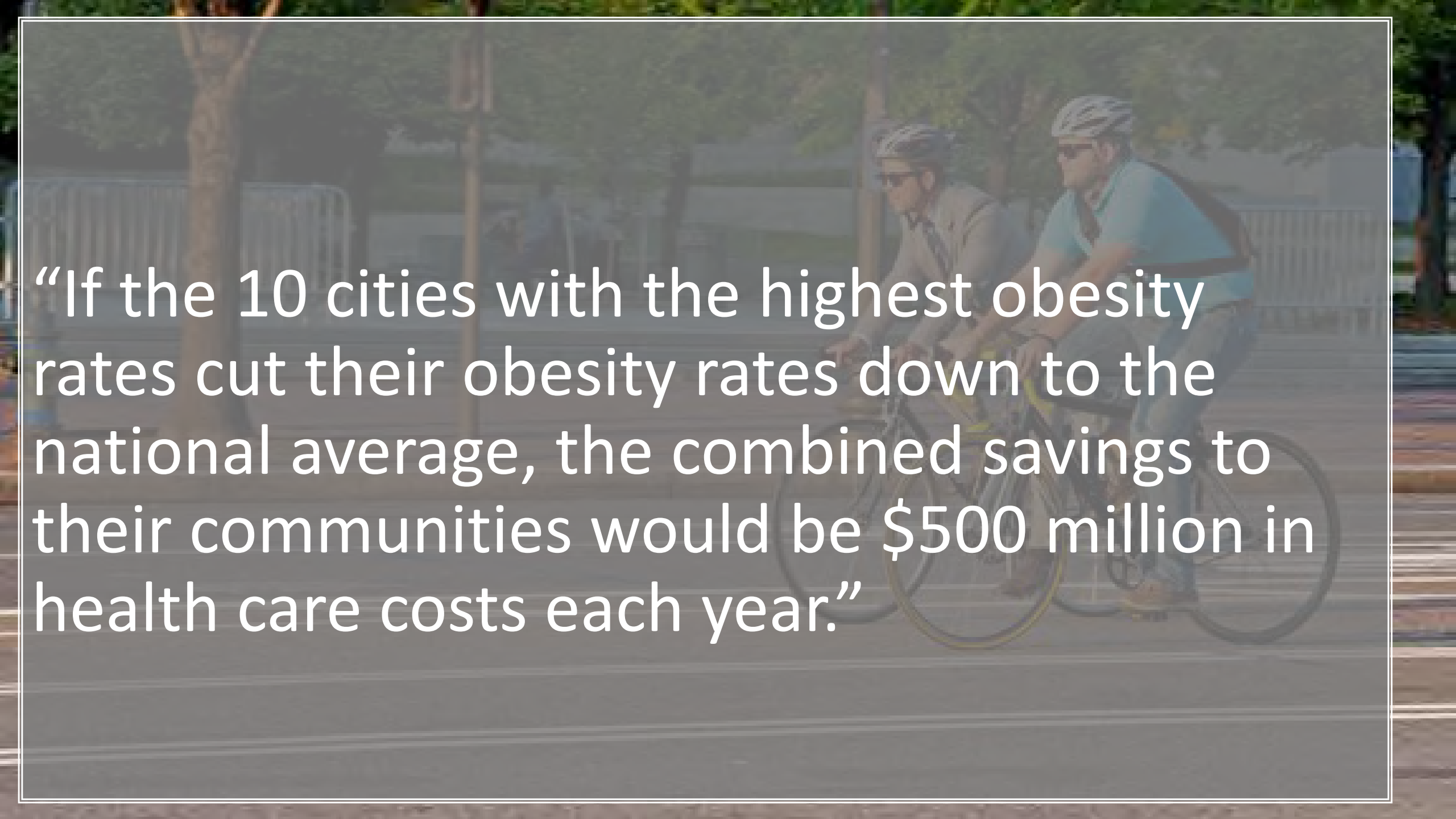
- Sedentary forms of transportation- requires little energy expenditure and is primarily sitting
- Active Transportation is most closely related to Alternative Transportation
 - Walking, Biking, Transit Use
 - Active transportation can play a role on fighting our obesity epidemic and promote health behaviors



A background image showing two men riding bicycles on a paved road. The man in the foreground is wearing a light blue shirt and a white helmet, while the man behind him is wearing a grey shirt and a white helmet. They are both wearing sunglasses and appear to be in motion. The background is slightly blurred, showing trees and a fence.

“The estimated annual health care **costs of obesity-related illness** are a staggering **\$190.2 billion** or nearly 21% of annual medical **spending** in the United States. Childhood **obesity** alone is responsible for \$14 billion in direct medical **costs.**”

— National League of Cities

A photograph of two men riding bicycles on a city street. The man in the foreground is wearing a light blue polo shirt, dark pants, a white helmet, and sunglasses. The man behind him is wearing a grey suit jacket, a white shirt, a dark tie, a white helmet, and sunglasses. They are riding on a paved road with a metal fence and trees in the background. The image is semi-transparent, allowing the text to be overlaid.

“If the 10 cities with the highest obesity rates cut their obesity rates down to the national average, the combined savings to their communities would be \$500 million in health care costs each year.”

The Health Benefits of Multimodal Planning

A background image showing two cyclists riding on a paved path. The cyclist in the foreground is wearing a light blue shirt and a backpack, while the one behind is in a grey shirt. They are both wearing helmets and sunglasses. The path is lined with trees and a fence in the background.

- For each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity.(Frank et al, 2004)
- Each additional kilometer spent walking was correlated with a 4.8% reduction in the likelihood of obesity. (Frank et al, 2004)
- Americans who use transit spend a median of 19 minutes daily walking to and from transit; 29% achieve ≥ 30 minutes of physical activity a day solely by walking to and from transit (Besser and Dannenberg, 2009)
- Encouraging people to use public transportation increases physical activity and reduces sedentary time (Bista, Debache, Chaix, 2020)

The Health Benefits of Multimodal Planning & modal shift adoption

A background image showing two cyclists riding on a paved path. The cyclist in the foreground is wearing a light blue shirt and a grey helmet. The cyclist behind is wearing a grey shirt and a grey helmet. They are both wearing backpacks and riding on a paved path with trees and a fence in the background.

- Designing for multimodal infrastructure to facilitate accessibility and mobility to destinations can help us improve the health of our communities and increase the productivity of our transportation system.
- Land use and zoning play a big role in the urban fabric of our communities
- Diet and nutrition share a great proportion of the impacts on health and a healthy weight
 - Access to healthy foods
 - Decreasing food deserts

Questions, Comments, Discussion

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