Assessing Level of Service Equally Across Modes

White Paper

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Project Manager: Martin Guttenplan

Prepared by

Center for Urban Transportation Research
College of Engineering
University of South Florida

Philip L. Winters
Francis Cleland
Edward Mierzejewski, Ph D., P.E.
Lisa Tucker

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Dale Eacker, Florida Department of Community Affairs
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Assessing Level of Service Equally Across Modes

Introduction

Transportation investments are influenced by level of service ratings of the current and expected system performance. According to the Highway Capacity Manual, Level of Service (LOS) is a "quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience." LOS for a roadway facility or mode falls into six letter grade levels with "A" describing the highest quality and "F" describing the lowest. LOS for automobiles, transit, pedestrian and bicycle modes are based on a variety of criteria and, therefore, calculated on a different basis. For automobiles, LOS is measured using average stopped delay for intersections, average speed for arterials and density for freeway segments. Automobile LOS "F" implies traffic is at a near standstill. For bicycles, LOS is a function of the typical roadway conditions, bicycle facilities, and safety perceived by users. Unlike automobiles where LOS "F" represents too many users, bicycle LOS "F" is just the opposite - only those who absolutely have to bike will do so, probably due to safety concerns or lack of facilities all together. LOS for pedestrians is similar to that for bicyclists. For fixed route transit, LOS measures access to transit routes based on population within walking distance to bus routes and service frequency.

Unfortunately, the current classification schemes make the total transportation system performance and multimodal tradeoff decisions difficult to assess. For automobile travel, most users would consider LOS "D" or "E" conditions as satisfactory. However, LOS "D" or "E" for bicyclists is poor enough to deter all but skilled bicyclists or those with no other mode choice from making the trip. Furthermore, the measures don't reflect expectations (i.e., do travelers interpret LOS "D" the same under all conditions?) or system reliability/volatility (i.e., how does LOS fluctuate over time? How sensitive is the system to disruption?). Thus investments are not optimized to provide the efficient and balanced transportation system that communities envision.

These concerns were expressed in Florida House Bill 17 of the 2000 Legislative session, referred to as the Urban Infill and Redevelopment Act or Growth Policy Act (GPA). This legislation was amended to include the development of alternate LOS techniques to measure multi-modal performance.

During the past several years, the Florida Department of Transportation (FDOT) has taken a leadership role nationally in the development of analytical tools and processes to assist local governments and Metropolitan Planning Organizations (MPOs) in understanding facility, corridor and system levels of service for these alternative modes. More specifically, FDOT has funded the following activities:

- A national literature search of multimodal level of service methodologies to determine
    - the best approach for Florida and
    - an areawide application.
- The application and validation of a methodology for assessing both bicycle and pedestrian quality of service and to measure the performance of roadway segments in all FDOT districts.
- The application and testing of the new Highway Capacity Manual (HCM) performance measures for transit in all FDOT districts.
- The development of areawide multimodal level of service measures to be used for the evaluation of multimodal transportation districts.
- The development of the Transit Level of Service software for detailed operational analysis of transit availability.
- Expert Review of FDOT's multimodal level of service measures by members of TRB's Highway Capacity and Quality of Service Committee.
- Test applications for corridor multi-modal LOS techniques.

The primary focus of this research is to assess the need for the development of a Level of Service (LOS) system that can be assessed equally for the motor vehicle, bicycle, pedestrian, and transit modes. If a need for a common LOS system is identified, are there methodologies that FDOT can use to develop a common LOS system? In addition to the development of a common LOS system, this research is also examined how stakeholders currently use LOS measures to make decisions and how they would like to use them to make decision in the future.

Method

The approach used to address these objectives were: (1) to gather information known about how the automobile, bicycle, pedestrian, and transit modes are measured; (2) to assess how stakeholders use the measures and/or want to use the measures to make decisions; (3) to generate alternatives for applying or aligning current or proposed LOS measurement systems through a series of brainstorming/creative thinking sessions with an advisory committee of transportation experts; (4) to have the advisory committee identify the values, feasibility and benefits of each of these alternatives; (5) have the advisory committee identify the difficulties and cautions associated with each of the alternatives; and (6) recommend (an) approach(es) to FDOT for a pilot study.

Literature Review and Interviews

The first two tasks were to gather information about how the current systems are measured and assess how stakeholders use the measures to make decisions. Under these tasks, the project team reviewed FDOT's Multimodal Level of Service literature searches performed under FDOT's contracting with University of Florida (UF) and Reynolds Smith &Hill (RS&H); contacted agencies utilizing multimodal LOS analysis techniques; and assessed how stakeholders want to use the measures to make decisions in the future. Interviewees were queried about their use of multimodal LOS analysis techniques to assess the issues surrounding multimodal LOS tradeoffs in decision-making. The highlights from these tasks follow. A separate report on these tasks was prepared.

The need for a LOS scale that can be assessed equally across modes stems from the fact that the term "LOS" has largely become associated with assessing the capacity of roadways for motor vehicles. However, the results of this report illustrate that while capacity (based on delay and speed) is the primary LOS evaluation measure for motor vehicles, the frequency of service is the primary evaluation measure for assessing transit, while safety/comfort are the primary evaluation measures for the bicycle and pedestrian modes. Thus, the development of a LOS score that can be applied equally across modes may not be practical without normalizing these scales in some manner. Furthermore, interviewed stakeholders indicated that there is not a problem with using the LOS terminology and scale to describe the quality of service for the transit, bike, and pedestrian modes.

The other objective of this project is to assess how stakeholders currently use LOS measures to make decisions for each mode and how they want to utilize the measures to make decisions in the future. Stakeholders plan on continuing to use LOS measures to assess existing conditions, identify roadways in need of improvement, and prioritize construction projects. Some stakeholders also indicated that they would like to use the measures to allow LOS trade-offs between modes. In addition, stakeholders believe that multi-modal LOS measures should be used to promote a balanced multi-modal transportation system by modeling all modes.

The sentiment from selected members of the Transportation and Land Use Study Committee was that too much emphasis has been placed on evaluating motor vehicle mobility, whereas the transit, bike, and pedestrian modes have largely been ignored. The development of multi-modal LOS measures was recommended by the Transportation and Land Use Study Committee to focus on improving mobility through transit, bicycling, and walking, and to stop planning primarily for motor vehicle mobility.

Generation of Alternatives

In light of previous attempts to identify a means for assessing LOS equally across modes, the research team decided to extract new approaches by using a series of brainstorming/creative thinking sessions involving transportation experts and stakeholders. In consultation with FDOT, the research team developed an advisory committee consisting of Florida Department of Transportation, Florida Department of Community Affairs, Hillsborough MPO, and City of Tampa government representatives, Sprinkle Consulting, and CUTR.

The research team facilitated these sessions to identify the most widely accepted methodologies to pursue. The team held a series of six facilitated brainstorming/creative thinking sessions with the advisory committee.

At the first series of meetings on February 12-13, 2001, the advisory committee was introduced to the creative thinking process based on the works of Dr. Edward De Bono, one of the world's leading authorities on conceptual thinking as the driver of organizational innovation, creativity, and problem solving. Dr. Edward de Bono divides thinking into "vertical thinking" and "lateral thinking". The former is the more traditional method - using the processes of logic, removing inhibitions and suppressing judgment. According to De Bono, lateral thinking, however, is defined as "a way of thinking that seeks a solution to an intractable problem through unorthodox methods or elements that would normally be ignored by logical thinking." The lateral thinking approach involves disrupting an apparent thinking sequence and arriving at the solution from another angle. In effect, it is designed to get people to think out of the box by starting out of the box.

There are differences in approaches to the two types of thinking. The traditional form for brainstorming often results in "flopping about" with slight variations of known solutions. However, developing breakthrough ideas does not have to be reliant on luck or a shotgun effort in which traditional brainstorming session participants often find themselves. The lateral thinking methods used in this project were designed to provide a deliberate, systematic process using proven "tools" that will result in innovative thinking.

One critical part of the lateral thinking process assumes that the application of creativity to assessing level of service equally across modes requires a systematic approach. The advisory committee needed to focus on the same problem at the same time. Otherwise, the group would have been sidetracked with some debating the merits of a particular idea while other participants are noting its flaws or voids in understanding. Even if sidetracked, the group may have developed good ideas on all sorts of problems – except the one they had been asked to think about.

The first step was to identify the different focal points that this project could take both in general area terms and specific purpose or problem-focus. The characteristic of the *general area focus* is that the area of thinking is defined but not the problem. This allowed the group to think about anything associated with the area. General area foci can be broad or specific. For example, "corridor analysis" might include ideas for defining a corridor, methods for conducting the analysis, corridor analysis focused on nonmotorized transportation alternatives, etc. A more specific general area focus might be "corridor analysis approaches for bicycle facilities". This would narrow the creative thinking process.

The *purpose focus* is the more commonly used focal type. A *purpose focus* channels the creative thinking process to solving a particular problem or achieving a certain end. For example, the purpose may be to carry out some task (e.g., simplify the data collection requirements).

The advisory committee identified the following general area and purpose focal points on the task at hand – assessing level of service equally across modes.

General Area Focus

1. Assessing everyone's mobility
2. Low income/inner city mobility
3. Differences in measurement methods
4. Differences in the purpose of measurements
5. Corridor analysis
6. Corridor analysis with and without bike facilities
7. Area wide analysis
8. Internal mobility
9. Concurrency application
10. User needs for LOS measures
11. Development Review/assessment mobility management appropriateness
12. Equal assessment
13. Trade-offs
14. Crash data
15. Demand
16. Application of Multimodal level of service
17. Cross impact analysis
18. Computational practicality
19. Need for common grading system
20. Target LOS
21. Area sensitive standards
22. Common LOS measures
23. Multi-dimensional measurement
24. Understanding of quality of service versus level of service
25. Future LOS
26. Cost benefit
27. Prioritization
28. Transportation Land Use Study Committee
29. Facility selection
30. Scales of LOS

Purpose Focus

1. Assess impact of multimodal facility. As tool for engineers, planners
2. Accommodate all users in a corridor
3. Develop method to trade-off between diff modes
4. Develop single method to measure same thing, same way
5. Determining if LOS equally across modes is desirable or necessary
6. Evaluation of the effectiveness of Transportation Concurrency Exception Areas/multimodal districts
7. Introduce new lexicon to differentiate between different modes
8. Promote a balanced multimodal system
9. Define what is meant by a balanced multimodal system
10. Establish target thresholds
11. Develop instructions to use
12. Develop method for equitable fund. For method
13. Integrate demand to TLOS, Bike, Pedestrian LOS
14. Incorporate this project results in state, local, highway capacity manual (HCM), TCQSM
15. Promote multimodal land use planning
16. Address parking and vehicle LOS
17. Incorporate reliability into LOS
18. Reduce crash rates

From the generation of these lists, it became abundantly clear that there was a wide range of perspectives that the group brought to the table ranging from implementation considerations to use of the results.

The next step of the process was to vote to select the points to focus the creative thinking process from the list of 48 responses that the group identified. Each person selected the five best responses to the question and rank ordered them, with "5" representing the best response of the five selected. The votes were tallied and are reported below in Table 1. The table also shows how the respondents rated the response. For example, six people selected the response *"Determining if LOS equally across modes is desirable or necessary"* with four of the six people rating it as their highest response.

Responses that did not receive many votes should not be interpreted as unworthy. Some responses received few votes but several people in the room gave them a high priority.

The responses were then ranked based on a weighted score. Five points were awarded to each item receiving a highest priority ranking (#5); four points were awarded for the second highest priority item, and so forth. Half of the 48 responses received at least one vote from the committee members present.

Table 1

Best Description of Focal Point - Voting Results

	# of Votes by Weighted Response						
Response	**5**	**4**	**3**	**2**	**1**	**Total votes**	**Wtd Score**
Assessing everyone's mobility	0	0	0	0	0	0	0
Low income/inner city mobility	0	0	0	0	0	0	0
Difference in measurement methods	0	0	1	1	0	2	5
Different purposes of the measurements	0	1	0	0	0	1	4
Corridor analysis	1	0	1	0	1	3	9
Corridor analysis with and without bike facilities	0	0	0	0	0	0	0
Area wide analysis	0	1	0	1	2	4	8
Internal mobility	0	0	0	0	0	0	0
Concurrency application	1	0	0	0	0	1	5
User needs for LOS measures	0	1	0	1	0	2	6
Development Review/ assessment mobility management appropriateness	0	0	0	0	0	0	0
Equal assessment	0	0	0	1	0	1	2
Trade-offs	0	0	0	0	1	1	1
Crash data	0	0	0	0	0	0	0
Demand	0	0	0	0	0	0	0
Application of Multimodal level of service	0	0	0	0	1	0	1
Cross impact analysis	0	0	1	1	0	2	5
Computational practicality	0	0	0	0	0	0	0
Need for common grading system	0	0	1	0	0	1	3
Target LOS	0	0	0	0	0	0	0
Area sensitive standards	0	0	0	0	0	0	0
Common LOS measures	0	0	0	0	0	0	0
Multi-dimensional measurement	0	1	0	0	0	1	4
Understanding of quality of service versus level of service	0	0	1	0	0	1	3

Response	# of Votes by Weighted Response					Total votes	Wtd Score
	5	4	3	2	1		
Future LOS	0	0	0	0	0	0	0
Cost benefit	0	0	0	0	0	0	0
Prioritization	0	0	1	0	0	1	3
Transportation Land Use Study Committee	0	0	1	0	0	1	3
Facility selection	0	0	0	0	0	0	0
Assess impact of multimodal facility. As tool for engineers, planners.	0	0	0	0	0	0	0
Accommodate all users in a corridor	0	1	0	1	0	2	6
Develop method to trade-off between diff modes	1	2	1	0	0	4	16
Develop single method to measure same thing, same way	1	1	0	1	0	3	11
Determining if LOS equally across modes is desirable or necessary	4	1	0	0	1	6	25
Evaluation of the effective of transportation concurrency exception areas/multimodal districts	0	0	0	0	0	0	0
Introduce new lexicon to differentiate between different modes	0	0	0	1	0	1	2
Promote multimodal balance	0	0	0	0	0	0	0
Define balanced multimodal system	0	0	0	0	0	0	0
Establish target thresholds	0	0	0	1	0	1	2
Develop instructions to use	0	0	0	0	0	0	0
Develop method for equitable fund. For method	0	0	0	0	0	0	0
Integrate demand to transit level of service, Bike, Pedestrian LOS	0	0	0	0	2	2	2
Incorporate this project results in state, local, highway capacity manual, transit capacity quality service manual	0	0	0	1	0	1	2
Promote multimodal land use planning	0	0	0	0	0	0	0
Address parking and vehicle LOS	0	0	0	0	0	0	0
Incorporate reliability into LOS	0	0	0	0	0	0	0
Reduce crash rates	0	0	0	0	0	0	0
Scales of LOS	1	0	0	0	0	1	5

From this list, it became readily apparent that the group agrees that assessing level of service equally across modes is a reasonable course of action.

CUTR developed a creative thinking meeting format to separate out thinking into six types (see Table 2 below). Each type specifies a direction and focus for thinking. The advisory committee was told the sequence that the types would follow. The sequence was designed to allow for full discussion of the problem, generate alternatives and, ultimately, reach a conclusion. By separating the thinking into six types, the Committee was forced to focus on one aspect of the problem at a time. Participants were directed when to switch thinking from one type to another. This sequential framework was used because it releases the group from inefficiency of the circular discussions and argumentative nature of traditional meetings. Another benefit of this sequential approach is it allows the committee to be able to explore alternatives in parallel.

Table 2

Six Types of Thinking and Their Purposes

Six Types of Thinking	**Purpose of Thinking Method**
Managing the Thinking Process	Sets the agenda Sets the timing Defines the problem/focal point Establishes the process for approaching the problem Summarizes the decisions or conclusions
Information Available and Needed	Gathers background data Identifies areas where information is missing
Alternatives & Creative Ideas	Generates alternative approaches Discovers ways of overcoming obstacles Lays out how else the concept might be carried out
Benefits, Positives and Values	Finds the benefits of the ideas Identifies the positives Identifies the value of the ideas
Caution, Difficulties and Problems	Identifies the faults or reasons that we should not choose this approach
Intuition and Feelings	Selects the approach/shows how we feel about the idea Signals intuition, feelings and emotions

The first step in the sequence was to identify what we know or take for granted about the problem of assessing level of service equally across modes. From that point, the group was asked to describe the benefits of the idea of having such a method for measuring LOS equally across modes. The third step was to invite the group to identify the faults or reasons for not doing it. The group was asked to generate possible solutions or alternatives using a creative thinking technique (described below).

The following lists the response of the first three steps.

<u>What Do We Know/Take for Granted?</u>

The full group agreed to the following:

- That it's possible to measure level of service equally across modes
- We can determine a method where LOS C for one mode equals LOS C for another mode
- That there is a potential problem
- Modes include auto, bike, pedestrian, and bus (truck included in auto)
- We measure LOS separately/individually.
- LOS is different across modes <u>now</u> (e.g., Auto LOS F is not equal to Bike LOS F)
- LOS can be calculated for all modes
- People have access alternative transportation modes
- LOS should be based on user perception
- Government LOS should equal People LOS
- A single measure would improve transportation planning –achieving 1 and 2
- Six level scale is appropriate for all modes
- Decision makers will not discern differences between LOS (modal)
- Bike C not equal Auto C
- Need more clarity
- Broad audiences can understand quality or LOS
- LOS measurements are professionally defensible
- Bike, pedestrian, and transit should be routinely considered in planning design and operation of highways
- Assessing LOS is a worthwhile activity
- LOS does not equal quality of service
- Highway Capacity Manual is the <u>definitive</u> source on QOS/LOS concepts

- Necessary to educate the transportation professional on QOS concepts
- Cost money to fix
- Will have to incorporate into QOS (ARTPLAN)
- Current methods don't include Land use compatibility.
    - Suburban vs. urban in non-auto QOS/LOS
- Doesn't consider continuity of systems (e.g., missing sidewalk and/or bike facility segments
- Missing user response to motor vehicle LOS
- Methods to measure aren't static; need to be flexible like midblock crossing, intersection
- FDOT has multiple related projects underway midblock, point, and corridor LOS measures
- Former Transportation Land Use Study Committee wanted a multimodal measure
- Growth management may change from concurrency to full cost accounting
- New intergovernmental coordination process will need to consider or use a method for measuring LOS equally across modes

<u>What are the positives of having such a system?</u>

- Gives impetus to multimodal planning
- Might give assessment across all modes to tie into impact fees
- Makes it easier to understand by public and elected officials, transportation professionals
- Simplifies the trade off process
- Provides consistency in measurement across modes
- More environmentally sensitive
- Promotes livable communities
- Provides a better evaluation of concurrency (area wide)

<u>What are the negatives or drawbacks?</u>

- Not assessing the same thing
- May need completely new methods to measure LOS/QOS
- May involve more subjectivity than "exact" science
- Increases level of effort by people who apply it
- Not everyone understands the current methods

- Current research stands on own
- FDOT tried to match up Transit and Auto LOS without technical merit
- Auto LOS and transit lacks behavioral data
- Auto LOS is entrenched within industry
- Wide funding disparity exists between modes
- Demand is more important than LOS

What should we do?

The advisory committee expressed concern initially whether assessing level of service equally across modes was desirable and/or feasible given the different needs revealed in the current methods of measuring LOS. They agreed that the current levels of service are appropriate for their mode, understandable by broad audiences, and professionally defensible. However, after they identified the advantages and drawbacks associated with a system of measuring level of service equally across modes, the advisory committee also agreed that this system would be of significant value to policymakers, developers and the transportation industry. In particular, the participants noted that it would give more impetus to multimodal planning and simplify the process for making trade-offs among modes at the local level.

Even with unanimous agreement to move forward with the development of such a method, the advisory committee recognized several challenges inherent in their decision. The group cited the lack of a common denominator among the current measures as one of the most significant obstacles. In particular, they noted that only the bicycle and pedestrian levels of service are based on system characteristics that have been correlated to user responses. At the same time, the group saw the resistance to any change in the other modes' LOS methods as another obstacle. Pointedly, the advisory committee concluded that a fundamental requirement for the development of such a method to assess LOS equally across modes would be to relate the LOS for each mode to user perceptions.

The advisory committee then began the process of identifying alternative approaches to the problem. In effect, the committee began to develop a system that keeps the current LOS methods in place but seeks to relate each mode's LOS to the other modes' LOS by establishing the relationship to user needs as a common characteristic.

What alternative approaches should we consider?

For this mode of thinking, the provocation operation (PO) or the stepping stone technique was the creative thinking approach selected. The purpose of the provocation statement is not to be "right" but to move the mind to new ideas (i.e., start thinking out of the box by starting out of the box). The PO technique helps individuals or groups generate new ideas by deliberately starting from a situation that forces them to consider "what happens next". Provocations need to be "uncomfortable". The technique relies on the brain's innate ability as a self-organizing mechanism to make sense of various inputs or a particular situation.

Acting upon the normal thought processes and turning them inside out produces the PO. The process used to create these provocations is as follows:

First, one of the easiest ways to craft a provocation is to systematically take something that we take for granted and escape from it. This escape may be in the form of negating it, dropping it, or doing away with it. Other approaches are to reverse the normal direction of action or preface with the phrase "Wouldn't it be nice if …". After the development of the PO statements and selection of the PO statements that make us the most "uncomfortable", the group then must move forward from the provocation to get new ideas.

The natural inclination is to use normal "judgment" on the provocation. Given that the purpose of provocation is to deliberately think differently (i.e., out of the box), then judgment would often result in the rejection of the statement. Even the suspension of judgment – a cornerstone of most brainstorming methods – does not tell us what to do. "Suspending judgment" does not help us extract value from the provocation. We must actively move to new ideas.

There are four major forms of movement from response to idea.

1. Top-of-Mind - Some ideas just come from whatever pops into your mind based on the provocation. A phrase or image may stimulate an idea.
2. Extraction - Pull out something such as a feature or principle from the provocation rather than only considering the "whole".
3. Focus on the Differences - Examine what is different between the provocation and normal way of doing things.

4. Moment-to-Moment - Think what happens from moment to the next. In effect, this method is a movie in your mind – you can see the situation developing every step of the way. You can also rewind and pause at a particular point to examine closer what might be changed.

The group developed the following Provocation Operation Statements based on what we stated that we knew or took for granted (see above).

<u>Provocation Operation (PO) Statement</u>

PO System measures the transportation professional
PO Perception of LOS is totally random
PO Levels are unnecessary
PO LOS has no relevance to decision making
PO No one drives
PO Don't need Highways
PO Wouldn't it be nice if transportation professionals started without pre-conceived ideas
PO LOS has great significance to the public
PO Not all modes need LOS
PO Who are you kidding that it is professionally defensible
PO Wouldn't it be nice if LOS defensible by children?
PO HCM is useless document
PO Everyone has a copy of HCM

Several of the provocation statements were used to develop ideas on a "system" or approach to assessing LOS equally across modes.

PO 1 System measures the transportation professional

- Picture of designer by facility w/phone number to yield more accountability
- Failure of system equals a loss of credibility
- The current situation is a faceless community/ everywhere looks the same; this would put a "face" on it
- Objective measures to rate transportation professional (to justify raises and budgets)
- Measures transportation professional so financially accountable
- Enhances professional credibility

- Would actually be measuring a different time frame- it would be measuring the performance of transportation professionals in the past
- Measure current projects to improve performance
- Public might vote on transportation professional
- Would create a system that is more fair, support for more money, and reduce political pressure

PO 2 No One Drives

- We get “Disney World”
- Focus moves to delay from capacity
- Different measures of effectiveness
- Improve land use patterns
- More use of horses
- Not everyone has to drive every day which could lead to “No drive Thursdays”
- Improved localization
- One less mode to deal with
- Would result in improved facilities to other modes as more money would be available for other modes
- Expectations are different
- More centralized control of the transportation system; how people choose to travel
- No need for transportation management organizations (TMOs) and other groups
- Eliminates intermodal carriers / dissimilarities
- Changes focusing to measuring people rather than vehicles
- Would make <u>aesthetics</u> more important as capacity is no longer an issue
- Would result in changes in urban design criteria
- Would allow for more accommodation of major users
- Change could shift peak travel time of day
- Could shift emphasis from highway LOS to address multimodal needs
- Measure LOS would focus on leading to solutions – what would work
- Measure what we want to communicate to constituencies
- Changes to urban design criteria
- Not measuring right thing-not mobility

- Drivers want:

Speed	time
Aesthetics	comfort
Reliability	convenience

- There could be more movement from concurrency concerns to urban design
- Focus would shift to internal trips / internal mobility
- Applicable to MMTF only? TCEA? DRI?
- Applicable of techniques to intersections → area wide
- Relate to targets

PO 3 Levels are unnecessary

- Have continuous scale
- Don't measure at all
- Establish a polar scale with only good-bad score. Simplifies cross modes
- Easier and more accurate/ statistical reliability
- Gather user input
- Focus on specific area (geographic)(measure may not be necessary in some areas)
- Not necessary for auto mode, only calculate other modes
- Straight calculation – no grouping
- Regulatory
- For well-trained people such a measure is not needed
- Not needed for planning
- Use videos and simulation instead of Levels
- Not needed to determine solutions when we can see it
- Forces transportation professionals into the field
- Communication with public would be easier
- Better/worse → relative measure
- Videos maps
- Communicate using a “time” measure such as speed
- Move to using units (perception) such as minutes of delay per mile rather than LOS without units
- Create DOW Jones Index
- Move to a more temporal / longitudinal measure to gauge progress over time

- Everyone is transportation expert
- Requires the use of a dynamic means of representing conditions

Assessing the Alternatives

Using the sequential thinking process, the next step was to assess the alternatives and prepare proposed approach(es) for testing. At its second series of meetings on March 15-16, 2001, the advisory committee focused on harvesting the ideas generated in the February sessions into specific proposals. Each of these alternatives was then subjected to identification of the positives then the negatives associated with each alternative.

The attributes for each of the following concepts selected by the advisory committee are described along with a listing of the advantages/strengths and disadvantages/problems with each idea.

- Dow Jones User Ratings
- Multimodal LOS Profile (a.k.a. Slide Rule)
- Weighted Slide Rule
- Community Standards Based Method
- Modified Miami Method
- Sensory Method
- Icon Method

Dow Jones User Ratings

The group collectively described the Dow Jones User Ratings option with the following attributes:

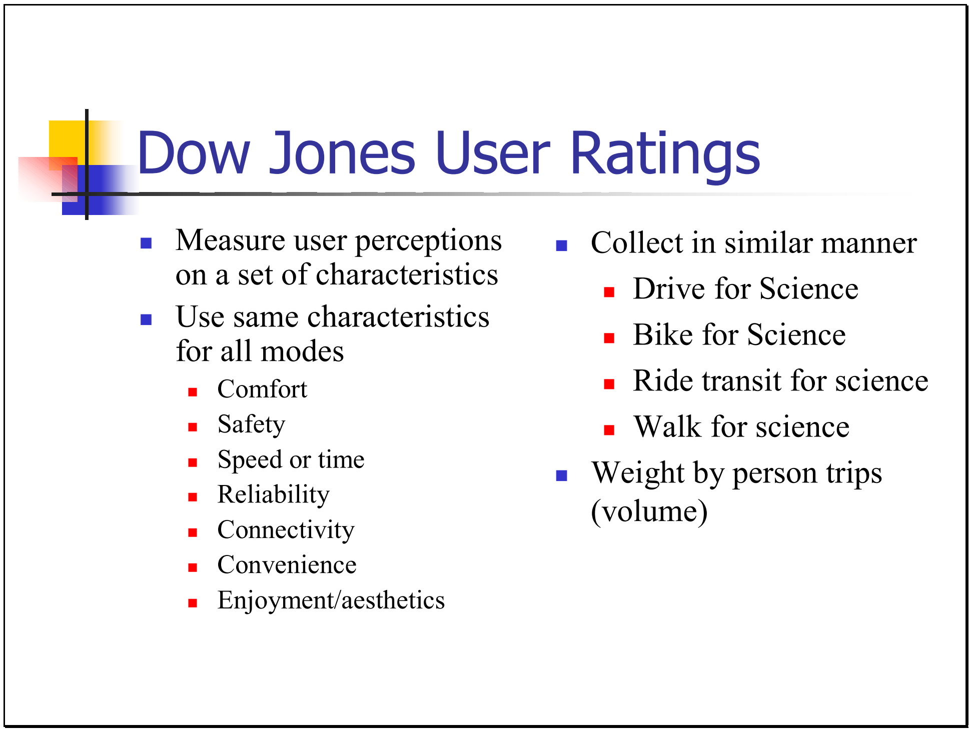

Figure 1 - Summary of Dow Jones Rating method

The group assessed the positives/benefits of the Dow Jones User Ratings (DJUR) method as: Makes all modes based on user perceptions by adding “Drive for Science” and “Ride transit for science” efforts. It would use the same characteristics across all modes.

- Builds political consensus via a survey of people’s assessment rather than transportation profession’s assessment.
- Provides a consistent measure to compare the system over time and across geography much like the Dow Jones stock index.
- Generates media interest. The media would love it as a means to generate stories and lists such as the “10 Worst Intersections”.
- Increases work for consultants.

The group also identified the following perceived drawbacks of such a system.

- Increases the costs for measuring LOS.
- Increases the data collection effort. Many factors are missing for some of the modes (e.g., Drive for Science) and, thus, the workload of local staff would have to increase.
- Relies on public opinions makes the DJUR very subjective (i.e., difficult to identify specific improvements).
- Masks differences and underlying interactions.
- Encounters resistance to change, as the development of a new way to measure system performance would take a lot of effort to convince current transportation professionals and others who are invested in the status quo.
- The usefulness of some characteristics (e.g., travel time or delay for bicycle users) is debatable.
- User opinions would be collected from people who are outside of that particular area and may not be familiar with prevailing conditions.

Multimodal LOS Profile (a.k.a. Slide Rule)

Under this method (Figure 1), the actual levels of service of each mode are aligned (i.e., the LOS bars move).

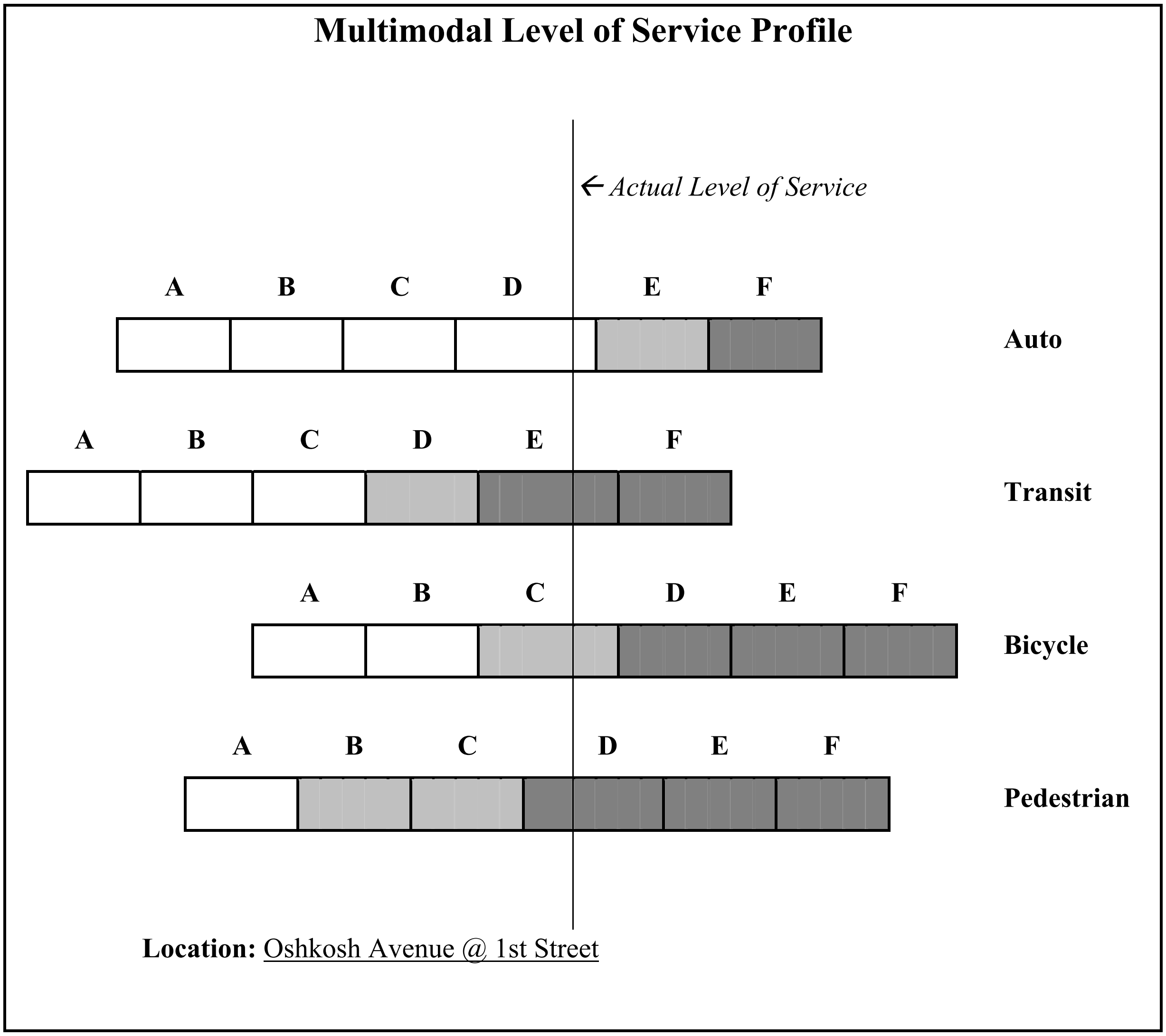

Figure 2 - Multimodal Level of Service Profile

The group assessed the positives/benefits of the MMLOS Slide Rule (Slide Rule) method as:

- The slide rule is more continuous method of showing how close a particular mode is to the previous or next LOS (i.e., we can "see" whether the LOS is a high D vs. low D).
- Shows LOS clearly for each mode.
- Provides way to compare one mode vs. another.

- Recognizes value/progress of within range changes (i.e., moving from a high D to a low D).
- Provides way to compare one facility vs. another.
- Now have a common scale – green, yellow, red.
- The slide rule provides an easy to understand method (Visual).
- Provides flexibility for interpreting the results.
- Provides more information content than just a number.
- Does not require additional data collection.

The group also identified the following perceived drawbacks of the slide rule system.

- Implies that the range of experience is the same across modes due to the equal length representation of the letter grades (i.e., same level of effort required to move from one letter grade to another within the modes and across modes).
- Requires additional time and resources to portray LOS network-wide.
- Doesn't lend itself to trade-offs across modes.
- Doesn't lend it to fund allocation at the area-wide and corridor levels.
- Can't rank order & prioritize.
- Someone has to determine what is acceptable (Politicians?).
- Requires cross-country connections/cooperation.

Weighted Slide Rule

This option was an extension of the Slide Rule concept discussed above. The major difference is the conversion of the above to a single quantified score that is weighted and that represents overall LOS. Weighting schemes could take into account one or more of the following:

- Weight by # people
- Weight by CO2/mile
- Weight by cost
- Weight by CO
- Weight by energy
- Weight by geography

The group identified the following advantages or benefits of the Weighted Slide Rule system:

- Converts several multi-modal LOS measures into a single score.
- Makes it easy to prioritize when converted into a single score.
- Allows for the comparison of facilities.
- Simplifies a complex process.
- Permits communities to emphasis one mode over another (or not) by the weight assignment process.
- Can be adjusted to reflect changes in policies.
- Allows for applicability at different locations (i.e., geographic based) with different weightings.
- Provides a visual representation.
- Allows for single and system level calculations.

The group also identified problems or obstacles with the Weighted Slide Rule

- Masks modal characteristics.
- Uses subjective classifications (e.g., Green/Yellow/Red).
- Is not calibrated to user perceptions (good vs. bad).
- Demands a level of effort for creating all charts.

Community Standard Based Measurement

Another permutation of the Slide Rule was discussed by the group (see Figure 3). The focus of the Community Standard Based Measurement aims at aligning the scales along the community standard axis and showing the gap between what actually exists and the community standard. For example, in the exhibit below, only Pedestrian LOS A is acceptable to this particular community. However, Highway LOS of A through D would be acceptable. The scales are disproportionately sized to allow for the alignment with the various community standards. The gap could be measured as the area under the acceptable standard. Furthermore, the gap could be weighted by geographic location. What is acceptable could be determined by location or subarea.

The group found the following benefits and advantages of the Community Standard approach to include:

- Permits the differences to be viewed easily as all acceptable areas line up and the current conditions of the area under question vary (zigzag) to view differences.
- Makes it easier to compare relative differences.
- Assigns priority by sizing by LOS modes (modes which more important/desired to be emphasized can be made by stretching).
- Leaves standards in place but shows actual performance.
- Provides a measure of quantifying the gap between standards and performance.
- Shares many similar benefits to the Slide Rule.

The group found the following problems and obstacles with the Community Standard approach to include:

- Could be misinterpreted.
- Shows that changing from one LOS grade to another varies across mode (i.e., we don't move through scale at the same rate).
- Makes it more difficult to explain to citizens why the length of LOS is different (by requiring a more technical explanation) if you use A-F rather than "acceptable/tolerable/unacceptable" or "green/yellow/red" gradations on the bars.

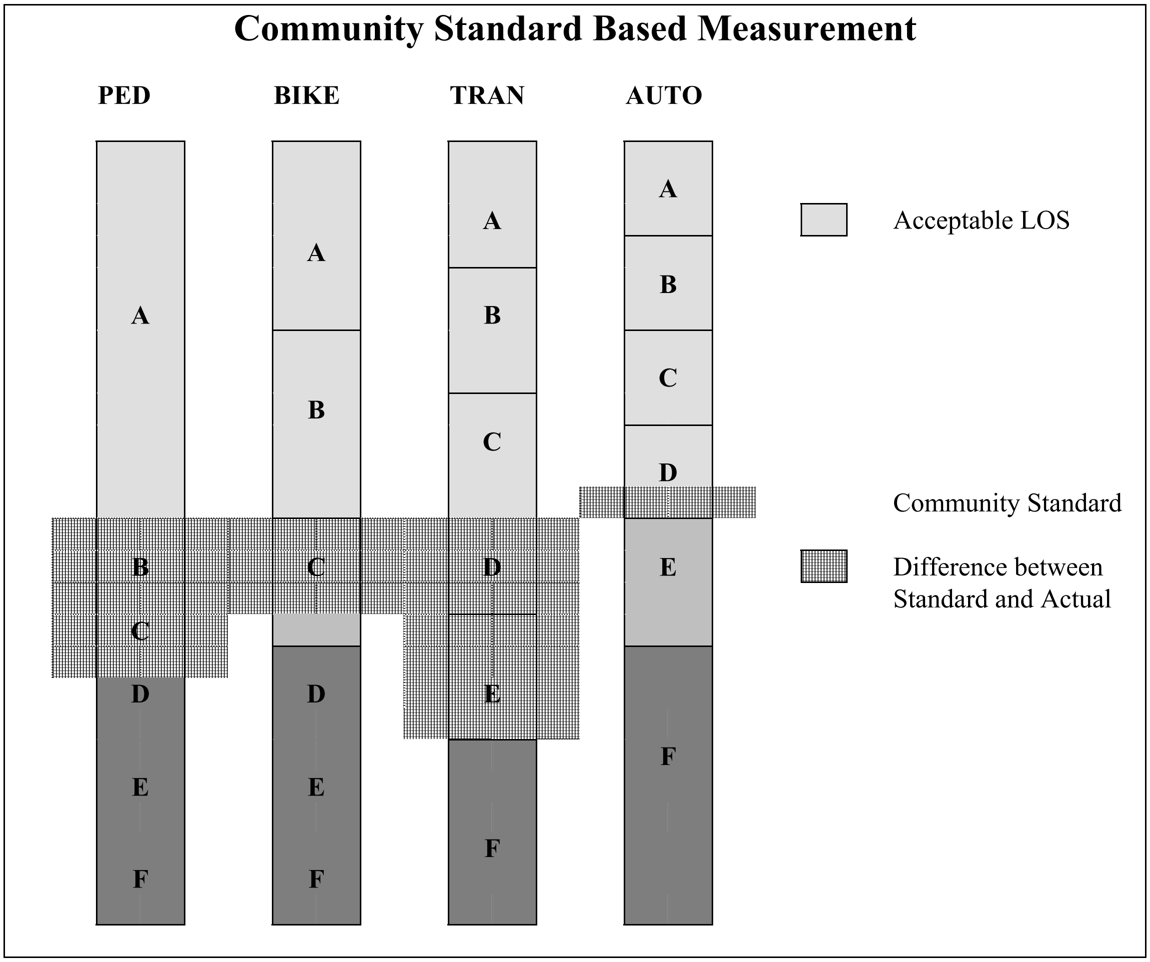

Figure 3 - Community Standard-Based Measurement System

Sensory – Static Picture

While the previous examples relied nearly exclusively on numbers or letter grades to communicate the concepts of levels of service, the group collectively described the Sensory LOS option with the following attributes:

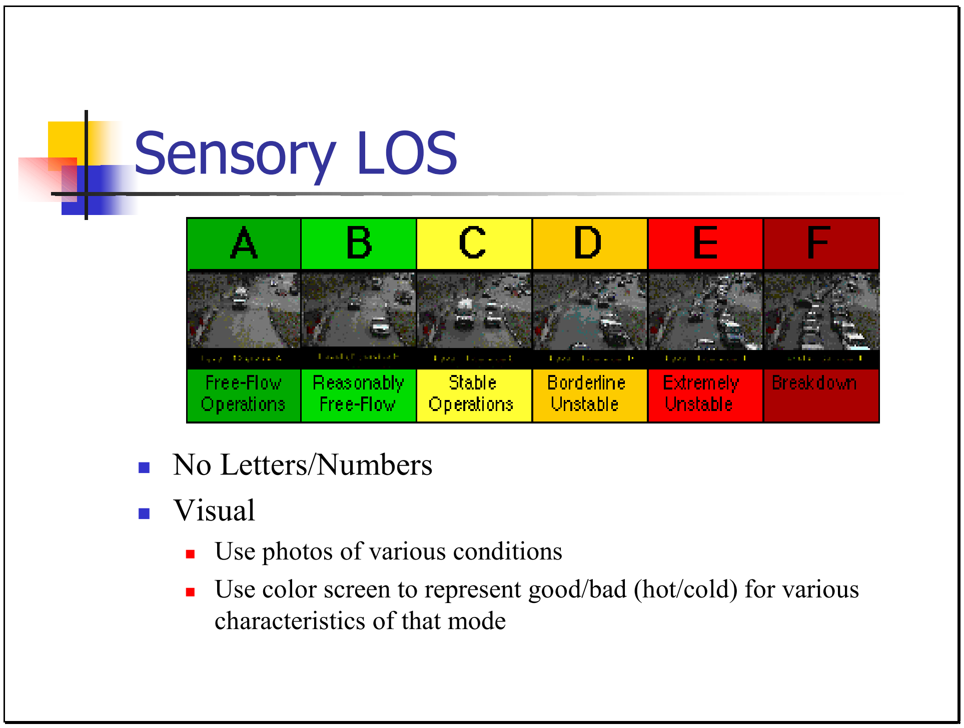

Figure 5 – Summary of Sensory LOS Concept

The group identified the following advantages and benefits associated with the Sensory LOS option:

- Use of visuals makes it simple to understand and easy to relate.
- Does not require explanation.
- Demonstrates way LOS is being measured today (for motor vehicles).
- Explains the differences of peak vs. non-peak traffic on the same facility.
- Uses static images means it is cheaper and more transferable than motion.
- Allows a community to capture shots over time at intersections with cameras.
- Captures and communicates skill level using particular icons (Kids thru Adults).
- Could use descriptive.

The group identified the following disadvantages and problems associated with the Sensory LOS option:

- Makes it easy to distort the truth.
- Can’t use to forecast.
- Pictures not available for some conditions or modes.
- Does not easily measure time and speed components of the experience.
- Uses same methods just different communication tool (does not provide anything new).
- Becomes more complicated – increases resources needed – more paperwork.
- Diverts discussion to “my road doesn’t look like that”.

Much of the focus of the group discussion was on the visual representation of the levels of service. However, the group also identified but did not assess the advantages and disadvantages of other “senses” such as sense of hearing (e.g., use sounds and/or change the volume) and sense of touch (e.g., use relief maps) to represent different levels of service. The group also recognized the potential of using the other senses as another means of communicating LOS to the visually impaired.

Modified Miami Method

The group also discussed the Modified Miami Method of measuring level of service that focuses on person carrying volumes and capacities (i.e., Person volume (divided by) Person capacity). The Modified Miami Method option was described as having the following attributes:

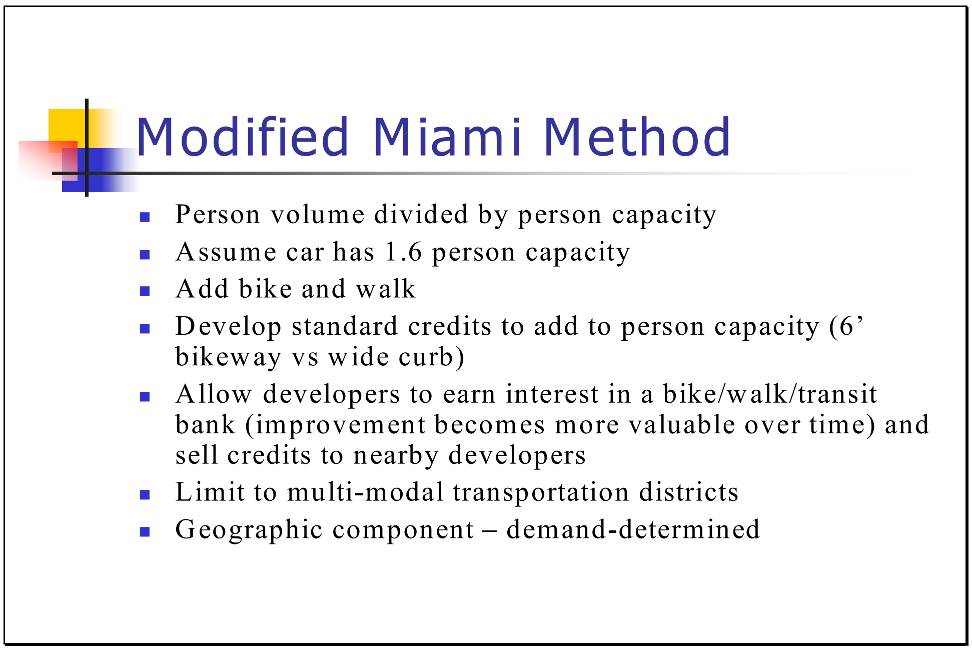

Figure 6 – Summary of Modified Miami Method

The group identified the following advantages and benefits associated with the Modified Miami Method:

- Credits given to developers for capacity improvements even if capacity is not used.
- Simple to calculate.
- Sounds good politically.
- Tried elsewhere.
- Reduces burden on the government to increase supply/provide infrastructure to meet peak demands based on vehicles.
- Results in more multimodal facilities.
- Promotes multimodal solutions.
- Ties to geographic area.
- Allows for different modes to be identified in different areas.
- Provides an efficiency/utilization measure.

The group identified the following disadvantages and problems with the Modified Miami Method:

- Lacks basis on user perceptions.
- Fosters a “We don’t care” image of public sector.
- Requires bike and pedestrian capacity to be measured (when it may be difficult or meaningless to measure).
- Doesn’t provide measures for individual modes.
- Might result in the building of useless facilities (on purpose) to gain capacity without solving the problem.
- May prioritize wrong things.
- May skirt concurrency.

Icon Method

The group also discussed the use of icons as a means of helping communicating LOS across modes. The Icon Method option was described as having the following attributes:

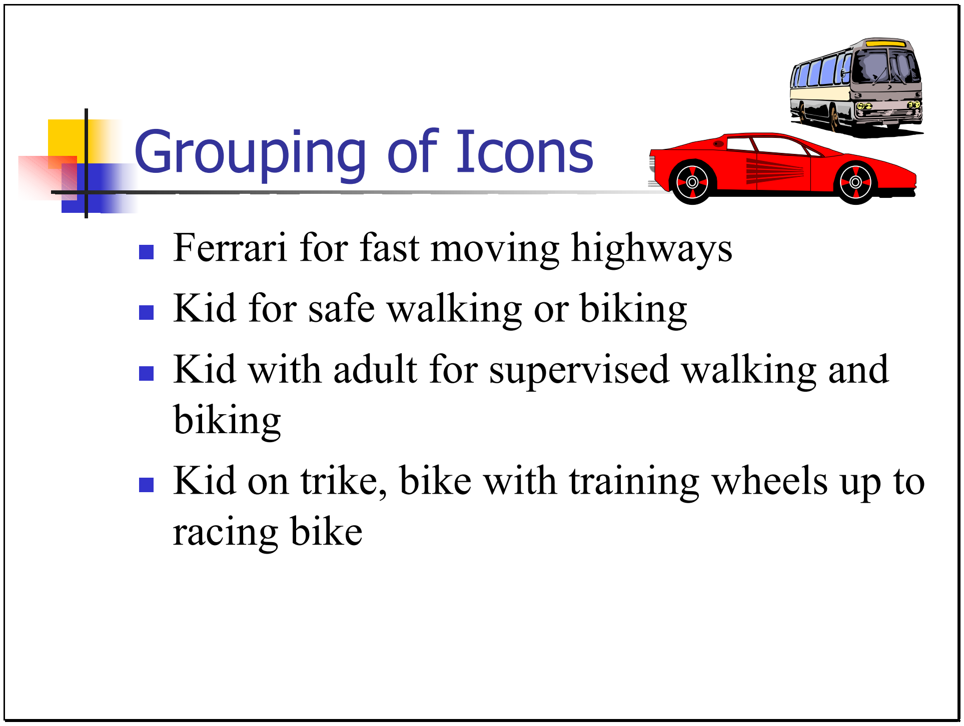

Figure 7 – Example of Icons to Represent Different LOS

The group identified the following advantages and benefits associated with the Icon Method:

- Uses icons to relate to skill levels (safe for children, safe only for children accompanied by adult, safe for adults only, etc.).
- Provides opportunity to show non-real circumstances (3 buses to represent changes in service or frequency).
- Decreases data intensity.
- Uses existing methods to quantify LOS.
- Shows all modes.

The group identified the following disadvantages and problems with the Icon Method:

- Lacks continuous symbols.
- Loses gradations (no representation of different gradations of LOS C).
- Limits to display capabilities (possibility that icons would be too complex).

Results

Advisory Committee Recommendations

For the short term, the advisory committee's preferred option is to pilot test the inclusion of the basic slide rule as an ART-Plan enhancement with the provision of a method to allow communities to weight the various modes. Furthermore, FDOT should provide guidance to local governments on setting targets to make sure not that the slide rule method for assessing equally across modes doesn't make it an exercise of simply translating the non-auto modes into an auto equivalency LOS.

The advisory committee recognizes that this system can perhaps adequately communicate the various modal LOS levels on a single facility. However, the committee also recognizes that it still does not, by itself, allow for assessing LOS equally across modes. The "slide rule" options will only truly be effective for that purpose when the characteristics are related to user perceptions. To that end, the advisory committee concluded that the identification of the common denominators across all the modes or users was necessary for a true method of assessing LOS equally across modes and permitting trade-offs across modes.

The advisory committee strongly recommends that FDOT seek to incorporate user perceptions to identify how to respond to the range of needs reflected by the various LOS measures and dynamic needs of transportation users. The advisory committee would like FDOT to explore the identification of the key factors or needs from a user perspective for each mode and the factors relative importance to each other.

The method to be pilot tested should be designed to identify the linkages or common ground between modes. The advisory committee believes that these linkages imply that when there is a degradation of LOS for Mode X then changes in LOS for the other modes would be required to reach the desired system performance. How communities will respond to the changing needs is the first step for allowing trade-offs (e.g., responding to an auto capacity problem with a safety improvement for bicyclists and pedestrians).

Ultimately, the advisory committee sees the development of a Dow Jones-like approach for assessing LOS across modes may be useful for trade-offs and accessing LOS equally across modes and the system. It may yield a mix of performance indicators common to each mode similar to how Price-Earnings ratios, 52-week highs and lows, etc. are reported in the business section of the newspaper. Furthermore, this Dow Jones approach would foster tracking over time.

The advisory committee recognized that there was a need for a developing a method for multimodal weighting to reach policy targets. They further recommended that the method should be flexible and be driven by policy to reflect different conditions. For example, some consideration should be given to different weighting or conversion factors based on corridor or location (i.e., the options and user trade-offs are quite different in downtown streets than roadways in remote office parks or suburban subdivisions). These target weightings should show people where the system stands today so they can communicate or determine weightings in the future.

The advisory committee recommended that the approaches be tested at 3 different locations with local involvement (i.e., hold mock test with local transportation staff).

The advisory committee also wanted consideration of using icons or other sensory representations when reporting LOS.

Conclusions

As previously discussed, the advisory committee's various "slide rules" depict different methods of representing LOS and assessing level of service across modes. For example, the Community Standard Based Measurement "slide rule" below groups the various levels of service into three broad ranges of acceptability (Figure 3 is for illustration purposes only). The relative acceptability in terms of levels of service grades varies by mode. Under this example, only LOS A is acceptable for pedestrians but LOS A through D would be acceptable for auto users.

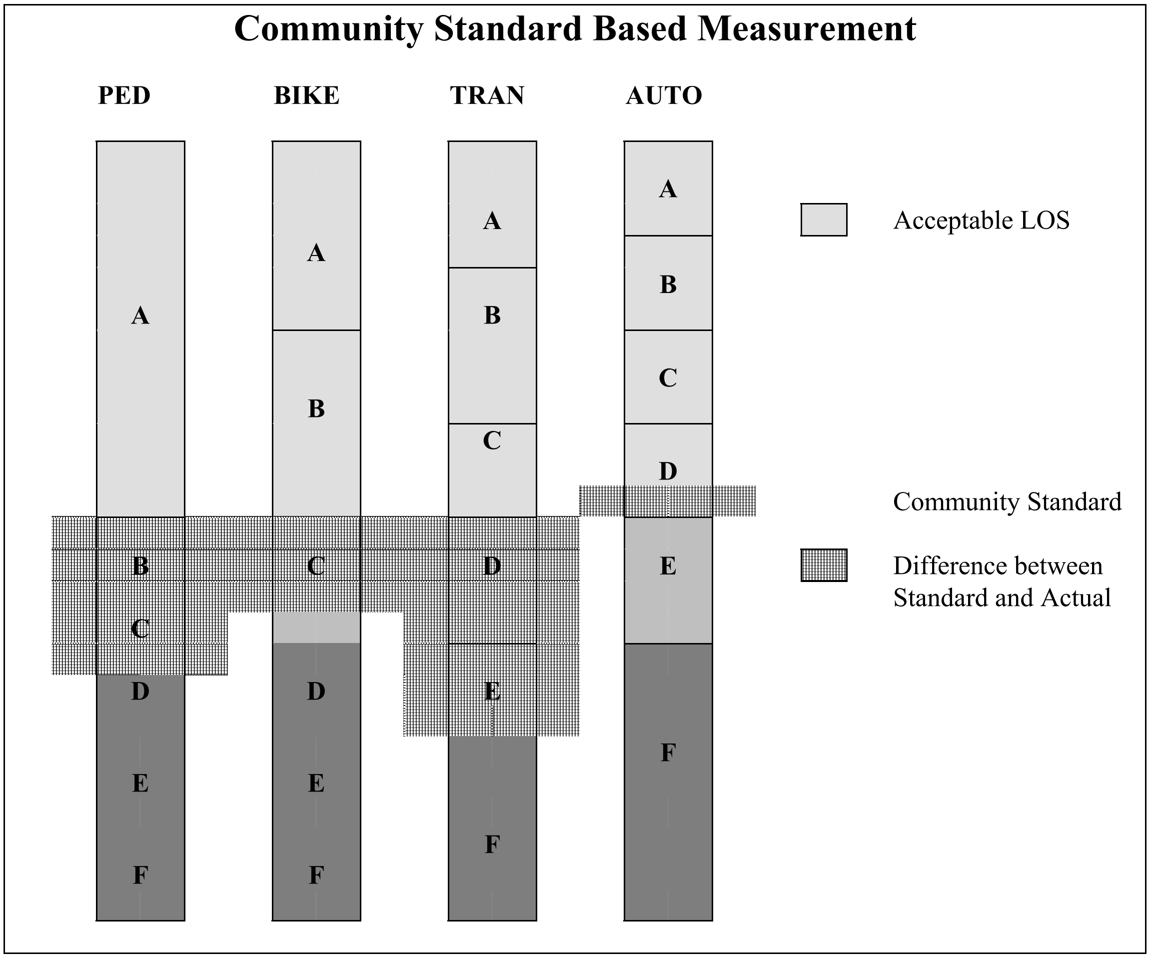

Figure 3 – Community Standard Based Measurement System

It was the consensus of the advisory committee that similar factors be used to measure LOS representations if level of service is to be assessed equally across modes (LOS C auto = LOS C bike, etc.). The factors used to calculate LOS for each mode currently represent a range of user experiences. Bicycle LOS is a safety and convenience function of the interaction of the attributes of the adjacent roadway facility, including pavement width, posted speed limit, etc. that was scaled based on user reaction. On the other hand, auto LOS measure is based largely on either vehicle speed or delay, depending on whether LOS is being calculated for a road segment or intersection. No single performance measure represents the predominant user-perceived measure of facility service of the other modes.

The different mix of factors to calculate LOS for each mode is a reflection of the transportation profession's assessment of the most critical factors for that particular mode. As a credit to the transportation engineering community, auto users rarely feel that their personal safety is threatened because of the design and maintenance of the facilities. If the levels of service were meant to be the same across modes then LOS F might represent the same as the potentially life-threatening experience bicyclist might encounter for a bicycle LOS F. For example, LOS F for an auto user might occur when the auto user is riding in a sub-compact on a busy, high speed highway with semi-trailers on all sides and barreling along at 70 mph in order to be equivalent to what a pedestrian might feel when attempting to cross a busy highway (pedestrian LOS F).

As discussed in the introduction, transportation investments are influenced by level of service ratings of the current and expected roadway facility performance are based on a variety of criteria and, in effect, weighted differently. LOS for automobiles, transit, pedestrian and bicycle modes are based on a variety of criteria and, therefore, calculated on a different basis. For automobiles, LOS is measured using average stopped delay for intersections, average speed for arterials and density for freeway segments. Automobile LOS "F" implies traffic is at a near standstill. For bicycles, LOS is a function of the typical roadway conditions, bicycle facilities, and safety perceived by users. Unlike automobiles where LOS "F" represents too many users, bicycle LOS "F" is just the opposite - only those who absolutely have to bike will do so, probably due to safety concerns or lack of facilities all together. LOS for pedestrians is similar to that for bicyclists. For fixed route transit, LOS measures access to transit routes based on population within walking distance to bus routes and service frequency.

The advisory committee concluded the current LOS measurement methods make the roadway facility performance and multimodal tradeoff decisions difficult to assess based on the current methods used. In effect, the advisory committee recognized that transportation system users have a hierarchy of needs that are common to all modes. This hypothesis is similar to Abraham Maslow's Hierarchy of Needs - one of the best-known theories explaining the actions of people. Dr. Abraham Maslow hypothesized that a hierarchy of needs motivates people.

The hierarchy he described may be represented as follows in Figure 4:

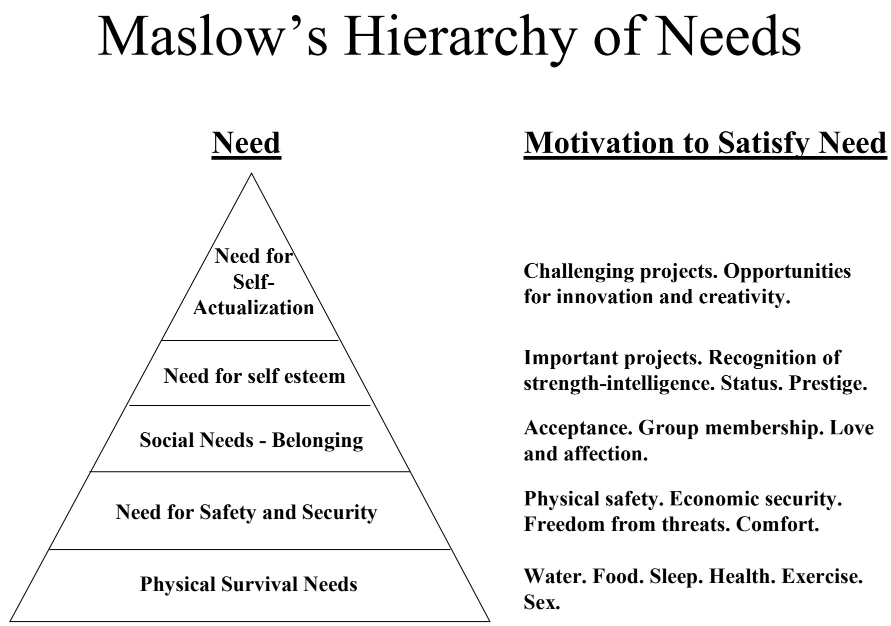

Figure 4 – Maslow’s Hierarchy of Needs

Maslow’s hierarchy states that once a person has met their most basic needs, they then begin to consider higher needs. As Maslow said, "as one desire is satisfied, another pops up in its place."

We developed the following hierarchy of transportation system user needs drawing upon the discussions of the advisory committee and patterning it after Maslow’s hierarchy.

The Transportation System User Hierarchy of Needs (Figure 5) is hypothesized as consisting of five levels of needs: safety and security (the most basic need), time, social acceptance, cost, and comfort and convenience. The traveler’s safety and security is considered to be the most basic need. Timesavings, convenience, etc. are nearly meaningless considerations if personal safety is threatened. Furthermore, this need is thought to include the degree of familiarity with the mode, route and destination. The more unfamiliar they are with the route, for example, the greater the likelihood that they are concerned with personal security. The next highest need relates to travel time, including access time, waiting time, and in-vehicle time. The need to link trips or *trip chain* also may determine the level of service from the user’s perspective.

The third level is categorized as social acceptance as reflected by personal and peer/society attitudes toward modes (for or against). This level suggests that people may choose a mode with a lower measured level of service based on some personal belief (e.g., environmentally friendly, better for personal health). Of course, the choices that provide a cost advantage offer another need. These costs can include fixed expenses such as the cost of the vehicle and variable expenses such as gas, transit fare, tolls, and parking. Finally, as the traveler seeks to optimize the travel experience then the needs of comfort and system reliability come to bear.

This ordering of these five basic needs says that only once the most basic need is met will the other needs be considered. Once the personal safety needs of the transportation system user are met to his or her satisfaction then the time need is addressed. When the time need is met then convenience need (e.g., how much delay is encountered) pops up. Finally, we hypothesize that comfort and convenience is the lowest ordered need.

In general, this hierarchy explains why only the highest levels of services for bicyclists and pedestrians (e.g., LOS A or B) could be comparable to the six LOS levels for autos. Only until conditions exist that approach the same "safety" threatening conditions for autos that bicyclists or pedestrians face will the assessment of LOS equally across modes be possible.

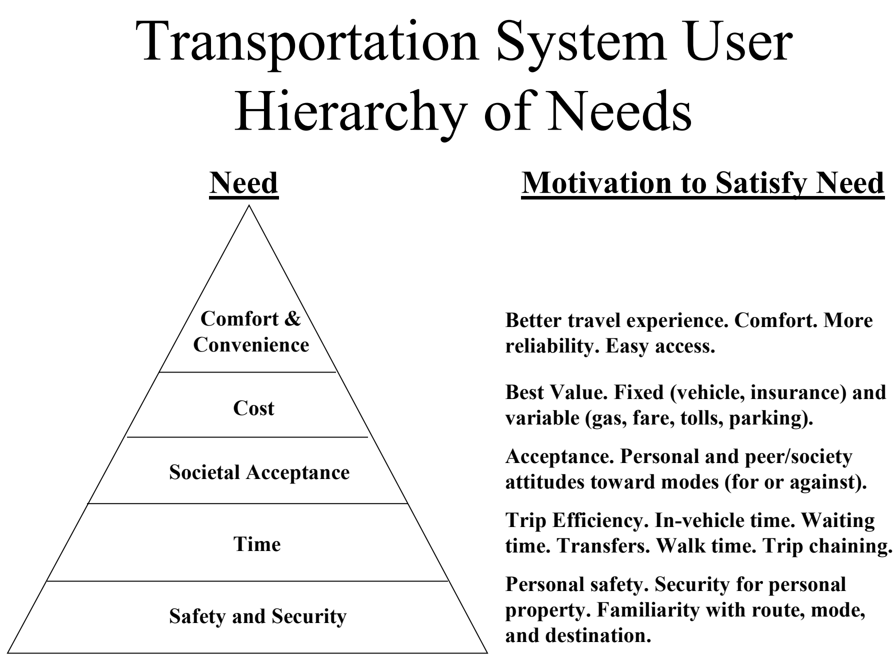

Figure 5 – Transportation System User Hierarchy of Needs

As the advisory committee noted, the various methods of measuring level of service for auto, transit, bike, and walk modes do not consider the same factors (i.e., the transportation system user's hierarchy of needs). In fact, as represented graphically in Figure 6, the current LOS measurements by mode may not cover the full range of the hierarchy. Therefore, assessing LOS equally across modes will require framing the LOS in the context of this hierarchy prior to design the pilot testing for assessing LOS equally across modes.

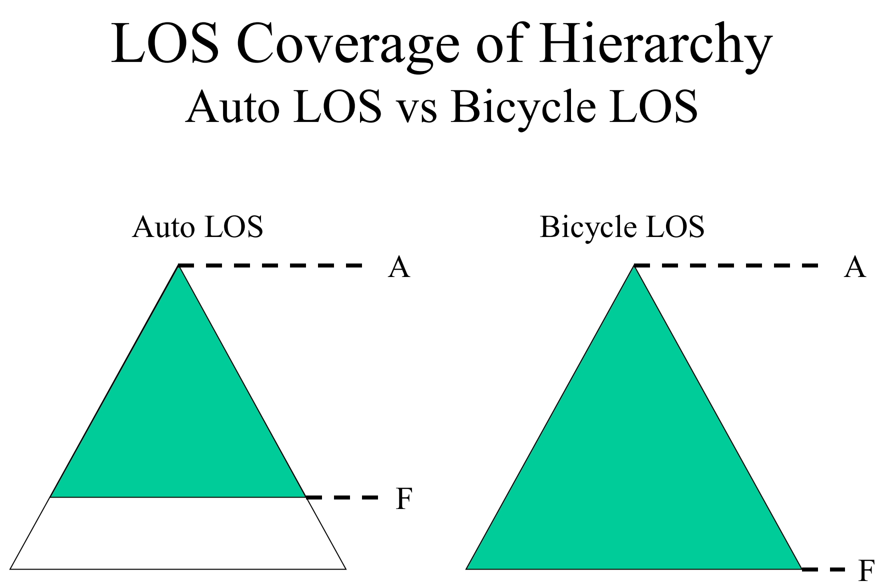

Figure 6 - LOS Coverage of Hierarchy

The advisory committee held several spirited debates about how the fundamental needs among all transportation users are the same but that different factors come into play. In effect, the advisory committee was discussing this concept of a transportation systems user hierarchy. According to Maslow, a satisfied need no longer motivates. The advisory committee also recognized this basic truth; once a basic need was met then the user would seek to have the next level of need met. Once the safety and security need is met for autos, for example, then the individual seeks to address his need to address time constraints (e.g., How can I get there in the shortest time? Will I be able to link my trips? Etc.).

At the same time, the threat or failure of the transportation system to meet the most basic need (e.g., personal safety) will make meeting the need of a different level moot. For example, a tourist exits his hotel room and decides to cross eight-lanes of Fowler Avenue to eat dinner at a local restaurant. He has two practical options: walk or drive. Even though it may be quicker to walk across the busy highway, he assesses the trip as a real threat to his personal safety if he tries to cross. Therefore, the basic need of safety and security overrides other needs (e.g., quickest method from point A to point B) and he chooses to drive.

The same hierarchy holds as you move up the levels. For example, a commuter may be circling downtown looking for an affordable parking space but once the price level need is met then the next need is convenience in terms of parking in a nearby location.

To be a hierarchy, the relationships must hold their positions relative to each other. The hierarchy does not exist by itself, but is affected by the situation and society norms. Some environmentalists or health-conscious travelers, for example, may be more willing to forgo the comfort that an auto or transit for a trip by bicycle because they perceive that option to be more in line with their personal beliefs or more acceptable to society. Level of service, therefore, is relative.

This hierarchy method of framing the issue helps shape the approach and focus the design of the pilot project to assessing LOS equally across modes. The expectation is the data collected for the pilot project will allow for a quantitative-based "adjustment factor" so each LOS gradation means the same for all modes. Ideally, the analysis will reveal a model that takes the form a step function, where there are clear demarcations when there are changes in LOS (e.g., when do an auto user, a transit rider, a bicyclist, and a pedestrian feel unsafe.)

In effect, analysis would reflect the advisory committee's thinking that normalizing the LOS gradations across modes via user opinions (albeit via shifting of the scales or applying some to-be-determined discount factor) would create these bands of acceptable standards gradations or overlays (e.g., green, yellow, and red) as shown on the slide rules.

Though Maslow's theory pervades the literature on employee motivation, a TRIS search did not reveal any transportation research related to a hierarchy of needs for transportation. However, time and cost based methods may overlook psychological factors. A brief literature search was conducted to establish the relative importance of these psychological factors or "motivators".

Overall, the small body of literature indicates that there are most certainly cognitive processes at work when one is choosing a travel mode, and that these processes do not necessarily relate to an objective assessment of the characteristics of a particular mode or demographic factors. In fact, Kuppam, Pendyala, and Rahman declare attitudinal data so important in understanding mode choices that "their omission from mode-choice models may be more serious than the omission of demographic variables" (1999:75).

According to Koppelman and Pas, attitudinal data related to beliefs or perceptions have for too long been the only focus of psychological factors in transportation research. Their examination of the social psychology literature led them to state, "that other psychological dimensions might be important determinants of travel behavior" (1980:28-29). The psychological elements that contribute to mode choice are typically abstract concepts such as independence or freedom, values of time, and needs fulfillment. These elements are often individually defined, and the sources reviewed here provide no ranking of their relative importance. However, those psychological aspects that are considered to contribute to travelers' mode choices do recur throughout the literature. Detecting such themes in published transportation research is in support of a Maslow-like Hierarchy of Needs. The following is a summary of several resources that discuss the psychological aspects related to mode choice.

Ulberg (1989) contends that values, beliefs, and psychological factors do play a role in mode choice decisions, but the relationships are not well understood. The author defines values as deep-seated beliefs guiding human behavior. With regard to mode choice, bus riders are distinguished from non-bus riders on the basis of two values—they (bus riders) evaluate "equality" very high and "freedom" very low. "Family security" was found to be a strongly held value among those who downsized cars and reduced their driving in response to the gasoline crisis of the 1970s. Those who did not participate in such behaviors placed a high value on "a comfortable life" and "an exciting life." Values were also found to have a "significant effect" on the size and number of cars a family owned.

With respect to the hypothesized "societal acceptance" level, Ulberg cites psychological research that provides evidence for two types of personalities—internals and externals. Internals generally feel able to control their fates, and externals feel relatively unable to do so. Internals would feel less anxiety about traveling via automobile than would externals, and internals would tend to experience automobile travel as more interesting and involving. Internals are more likely than externals to participate in efforts for social change, they tend to have higher incomes, and they are more likely to drive alone. They also have a higher need to be independent and in control, making them less willing to depend on others for their transportation.

Ulberg stresses the use of caution when promoting ridesharing and transit in appealing to environmental concerns, as those who may respond to environmental messages may also be the least likely to switch to modes requiring dependence upon others. Also, individual differences in the perception of one's ability to control outside forces have implications for how decisions are made. The author states that planners should not assume that everyone feels their individual decisions have impacts on transportation.

The influence of stress on transportation decisions is also an important individual difference. The general assumption is that driving alone in congestion is the most stressful mode of travel, but some may find it relaxing. Some find comfort and relaxation in the contact with other people provided by ridesharing, but it could be extremely stressful for others. Perceptions tend to be individualistic.

The small body of research that has been done on the fulfillment of psychological needs with regard to transportation indicates that this is an important component of transportation choices. One theme is the need for independence. Ulberg cites research, conducted twenty years prior to his assessment, which revealed independence as one of the most important factors distinguishing bus riders from auto commuters. However, the author notes that given rising congestion issues in urban areas, this may no longer be as obvious.

Another psychological need for which humans seek fulfillment, according to Ulberg, is the need for community. In some cases automobiles can become the focus of community, such as in carpooling. The desirability of carpooling has been found to correlate with the number of acquaintances one may have in the carpool.

Self-expression is another psychological need, and the type of automobile chosen and the various ways of personalizing or decorating it may provide some fulfillment for the need of self-expression. However, there is no self-expression permitted in the use of mass transit. Further, the automobile satisfies the need of control over one's environment. The control over the environment the automobile offers through mobility is reinforced by the ability of people to control the machine itself. Ulberg states that because these needs will always exist for at least some part of the population, alternative modes to the automobile should consider these needs as well. In addition, because they are described as psychological factors that relate to travel mode choices, such variables should be included in a hierarchy of transportation system user needs.

Ulberg stresses the importance of individual differences in mode choice decisions. Psychological and cultural differences may be correlated with demographic variables, but do not vary directly with them. Even when considering demographic and situational variables, people exhibit variation in decision-making. The author states that it may be “impractical” to measure such differences in planning-oriented research, but they should be considered in the interpretation of research results or promotion design.

In addition to the perceptions, demographic differences, and individual variations that exist in mode choice, consideration must be given to the cognitive processes that people use. There are different ways of gathering, processing, and storing information, and these differences can have an effect on mode choice decisions. Ulberg recognizes four parts to the cognitive process:

- Combining multiple attributes—combining several dimensions and making one choice, such as evaluating the time, cost, and convenience of various modes, somehow weighing them with respect to each other, and making a choice;

- How choice affects attitudes and perception—mode choice can affect attitudes and perceptions and vice versa. People tend to evaluate their chosen mode most positively. Choice does affect perception, and people tend to place the greatest importance on the attributes that support their mode choice;

- Using knowledge—despite individual characteristics and behaviors or experiences, perceptions are also determined by the actual attributes of a particular mode. The presentation of information does not guarantee that it will be incorporated into the decision-making process. If the added knowledge results in new behaviors, the new behaviors will not endure if they do not satisfy other transportation requirements, whatever those may be; and,

- Influence of habit—once a choice is made, attitudes and perceptions are typically changed so beliefs support the choice. People tend to emphasize the importance of attributes that support their current choices and seek no new information that would tend to change those choices. Habit should not be overemphasized however, and major life changes, such as moving or having children, may result in a change in habits.

Ulberg concludes that understanding how people process information is critical in the study of mode choice behaviors and in promoting alternative transportation choices. Models that do not consider these factors cannot interpret the process of mode choice accurately or realistically, and promotions that do not consider these factors will not be effective.

Koppelman and Pas (1980) contend that traditional travel demand models provide only limited understanding of the behavioral processes underlying travel decision-making. These models tend to focus upon objective measures of system performance and demographic characteristics. Furthermore, because such models ignore measures of traveler attitudes, including perceptions of service attributes and personal feelings toward different services, they do not reflect the wide range of strategies that can be designed to influence consumer travel behavior.

The authors' focus is the consumer process in mode choice for nonwork and nonschool trips to a suburban central business area (Evanston, Illinois). They analyze the relationships among perceptions, feelings, preference, and choice.

Choices among travel alternatives are made based upon perceptions of the alternatives rather than on objectively measured characteristics. The formation of perceptions is influenced by both measured (demographic) and unmeasured (experience, psychological make-up) individual characteristics, in addition to modal attributes. Perceptions of alternative mode choices therefore differ among individuals.

Koppelman and Pas claim that transportation researchers have typically focused on a single psychological aspect in explaining travel behavior, that being perceptions about the attributes of the object. They contend that research in social psychology indicates there may be other psychological dimensions at work in determining travel behavior. In addition to individual perceptions about object characteristics, the liking and disliking of the object may affect the attitudes one has about that object. Further, social norms, such as what one believes others expect, and one’s personal norms contribute to explaining behavior. The authors assert these may be contributory factors in mode choice decisions.

The authors’ study reveals a generally very positive attitude toward car travel, a less positive affect with regard to walking, and a relatively neutral stance toward bus travel. There was a “high degree of sensitivity” toward major increases in gasoline prices, but “little sensitivity” toward lower bus fares, despite positive reaction to improved bus service. There was indication of willingness to carpool for some trips, as well as to reconsider the car as the primary mode, given cost increases. Koppelman and Pas interpret these findings as a general lack of commitment to participants’ existing mode choices. With regard to personal normative beliefs, the overall feeling was that walking *should* take precedence over car or bus travel. As for social norms, most respondents did not feel their peers would be “surprised” at their regularly traveling by car.

Psychological measures of mode feelings, in addition to consumers’ perceptions of various mode performance characteristics contribute to preferences, and therefore to consumers’ travel mode choice decision-making process. Koppelman and Pas contend that this has great implications with regard to strategy development because it implies that preferences can be changed without necessarily altering service characteristics. However, the authors state that it could suggest service improvements resulting in mode use changes could be limited if deep feelings about modes are not changed in the process.

Mitchelson and Gauthier (1980) state that understanding the decision-making process in travel is crucial in examining the effects of system changes on all urban travel groups. They contend that psychological and situational variables are great influences upon travel mode choice.

In contrast to Koppelman and Pas (1980), who stated that attribute perceptions were a commonly studied variable among transportation researchers, Mitchelson and Gauthier claim that this is one set of psychological variables that has been neglected in research. The authors assert that perceptual variables are extremely important because they form the initial aspect of mode choice, which the authors define as the transformation of an objective set of variables into subjective ones that provide the basis for distinguishing between alternative travel modes. In addition, perceptual variables include the evaluation of those alternatives and the final mode choice. Mitchelson and Gauthier refer to this transformation as the psychophysical function, and contend that understanding this process as it relates to travel behaviors is very important.

The authors present the results of a two-phase survey research study in Columbus, Ohio, designed to establish the broader dimensions of mode choice, as well as the relationships between mode characteristics and the broad dimensions of travel mode image. Statistical and interpretive considerations allow the authors to establish a six-dimensional space of travel mode cognition encompassing travel burden, safety, convenience, privacy, flexibility, and comfort.

Based upon trade-off data and perceptual variations along group membership similarities, Mitchelson and Gauthier determine there to be three aggregate market segments: a relatively unbiased group, a bus-biased group, and an auto-biased group. Coinciding with the findings of the other literature, these authors report that individual choices are reinforced by perceptions. The bus-biased group generally gave the best bus ratings and the worst auto ratings. The auto-biased group, in general, provided the best automobile ratings and the worst ratings for the bus. The unbiased group provided mean scores that generally fell between the extremes of the auto and bus ratings.

Mitchelson and Gauthier assert their findings are "suggestive at best" because of small sample sizes and the restrictions of using the trade-off method of subjective evaluation. They do contend that their results provide added support to modeling urban travel demands through disaggregate behavioral approaches. Further, the authors state that their approach is useful to the task of interpreting mode choice decisions and their relationships to the physical characteristics of travel modes.

According to Kuppam, Pendyala, and Rahman (1999), despite the recognition of the importance of traveler attitudes, perceptions, and values in mode choice behavior, there has been relatively little use of attitudinal and preference data in planning practice. The authors attribute this to two primary reasons: household travel data collection often ignores such variables; and attitudinal and preference data are typically not considered useful in travel-demand forecasting because they are not as easily quantifiable or predictable as demographic variables.

Kuppam et al used the 1991 data set of the Puget Sound Transportation Panel (PSTP) because it contains detailed information regarding attitudes, demographics, and travel behavior. As determined in the other studies reviewed here, the authors found that overall, people tended to favor their chosen travel mode. While different aspects of a particular mode were valued by those who use them, such as bus users being more sensitive to pollution and travel costs than were single occupant vehicle (SOV) users, relatively similar values were placed on time by all modal groups. With the exception of “nonmotorized transport users,” each group ranked highly the ability to arrive to their destination on time.

In general, SOV and car/vanpool users were found to feel that riding the bus did not “fit their lifestyle,” but they did agree that the bus is an enjoyable mode of travel at significantly higher rates than did those who use the bus. However, they were not likely to stop driving as a result of higher gasoline prices, and were not as willing as bus users to pay higher taxes for transit improvements. This is in contrast to Koppelman and Pas (1980) who found a high degree of sensitivity among auto users with regard to increases in gasoline prices. This variation could be related to the fact that 11 years separate these two studies.

Kuppam, Pendyala, and Rahman contend that, based strictly upon this data, attitudes and mode choice are clearly interrelated, but that it is unclear whether attitudes shape behaviors or if the opposite is true. They assert the relationship is most likely bilateral, in that attitudes shape behaviors, and, through experience, behaviors shape attitudes. The authors call for appropriate modeling methods that can longitudinally explore these relationships.

With regard to how closely behaviors matched traveler preference in mode choice, analysis reveals the following:

- Approximately 88 percent of respondents who indicated the SOV was their preferred mode commuted this way;
- Thirteen percent of those car/vanpooling or using transit preferred using the SOV mode;
- Among those who preferred to use the bus, only 58 percent actually did so;
- Approximately 42 percent of respondents would consider using the bus if circumstances were “favorable;” and,
- Thirty three percent of commuters using the SOV consider it their least preferred mode.

Kuppam, Pendyala, and Rahman suggest that these findings may indicate a group of commuters that feels “captive” to the SOV mode, and that would potentially abandon solo driving in favor of transit use.

As in the previous studies discussed here, these authors found that, in general, attitudes and preferences vary across demographic variables and that they may be of significant influence in mode choice decisions. Evidence of this influence is based upon the results of likelihood ratio Chi-squared statistical tests. These tests showed that both attitudinal and demographic variables are valuable in interpreting mode choice behaviors, but the statistical significance of attitudinal factors was nearly twice that of demographic factors. The authors therefore suggest that the omission of such factors in research and planning may be more serious than the omission of demographic factors.

Neveu, *et al*. (1979) use perceptual mapping techniques to explore the influence of such aspects as comfort, convenience, and reliability with regard to work trips. While they state that previous research has examined these factors individually, the authors contend theirs is the first study to consider all three as they jointly contribute to mode choice decisions.

A survey was conducted among downtown Chicago commuters to collect perceptual data for the study. Factor analysis, preference regression, and first-preference logit models revealed that commuters did not perceive the three variables as independent, and there was significant overlapping of the public perception of such abstract concepts. Neveu, *et al*. observed that none of the dimensions of each of these factors could be considered strictly belonging to comfort, convenience, or reliability. They found that elements of each appeared on more than one dimension, such as wait time or frequency, thereby contrasting the standard belief on the part of researchers that these are considered separate aspects of mode choice.

This literature review demonstrates the importance of these psychological factors to mode choice decisions. The implication of the term “level of service” suggests that we are concerned with the appraisal of existing (and potential) users of the various modes. It is clear that any method of combining level of service and, frankly, measuring LOS for the individual modes, will probably miss the mark if it fails to take into account these factors even though the various authors may use different factors or imply a different ranking than proposed in the Transportation System User Hierarchy of Needs. The following section outlines an approach for a pilot project to identify, construct and apply a Transportation System User Hierarchy of Needs to facilitate assessing level of service equally across modes.

Pilot Test Approach

Phase I Transportation System User Hierarchy of Needs

Task 1 Literature Review

The purpose of this task would be to identify the levels and potential indicators for each of the levels Transportation User Hierarchy of Needs.

For example, the following factors might constitute threats to personal safety for the auto user.

- Absolute vehicle speeds
- Vehicle speed differential
- Time of day (e.g., is there concern with impaired drivers in the late evening/early morning hours? Sunlight)
- Aggressive driving behavior (e.g., extensive weaving)
- Truck-auto mix
- Vehicle spacing to speed ratio (e.g., can a 2-car length gap be maintained?)
- Pedestrian crossing behavior (e.g., jaywalking)
- Condition of pavement (e.g., potholes)
- Shoulders
- Lighting/Visibility
- Presence of Bicyclists
- Weather (e.g., rain slick roads)
- Perception of crime in area given segment

Similar factors could be identified for the other modes and the remaining Traveler Hierarchy of Needs.

Task 2 Qualitative Research to Identify Key Indicators

This task would use qualitative research techniques to identify the relative importance of each of the indicators for each of the modes and levels.

Focus groups are the most common method for collecting qualitative data to help identify the factors or features that should be evaluated in the data collection task. The typical focus group consists of 8 to 10 people that have some common characteristic(s) relating to the subject (e.g., transit riders). A trained moderator leads the group through a series of questions “focused” on specific aspects of the issues. The information generated by a group will be more valuable because the interactions of the participants produce significantly more data than individual interviews. The participants may be required to take some notes and/or fill out forms, but audio and/or video recording capture most of the discussion data. After the sessions, the moderator transcribes conversation(s) from the tapes into documents that become the documentation of the sessions.

Given the potentially wide range of indicators to be considered and discussed for each level, FDOT should consider using a more dynamic method of collecting qualitative feedback to guide the development of the sampling plan (i.e., what needs to be measured),

Under the recommended dynamic method, participants use hand-held keypad (similar to a television remote) to submit their responses to questions posed by the moderator. These terminals transmit individual responses back to a computer that tabulates the data, and then displays a summary of the results for audience and/or moderator to review. Similar to the traditional focus group method, the moderator leads the group through the focus questions but may rely on the responses to determine where to probe deeper.

This “dynamic” focus group approach differs from the “typical” focus group in three ways: fostering participation, directing the discussion and capturing results. The dynamic version helps capture the responses from all participants, not only the most vocal. In a traditional focus group with 10 participants and a 30-minute segment for a specific question, each participant would be entitled to an average of 3 minutes to discuss. In fact, most groups include people who are very vocal and others who prefer to sit quietly. The “polling” nature of the transponder permits participants to all “talk” at the same time without interrupting the flow, so they don’t have to hold onto their opinions until it’s their turn. The responses also are anonymous as far as the other participants are concerned. In effect, this feature provides a safe haven for all ideas and provides a environment conductive for the free flow of discussion, so there’s less worry about feeling foolish or saying something wrong.

Though a good moderator will draw out the quiet participants or at least seek more balance among all the participants, the risk is the "response" captured may not accurately reflect how the group feels. Given the wide range of possible responses (see the list of potential auto personal safety needs/concerns above), trying to identify the key issues will be critical in developing a sampling plan.

A dynamic focus group approach helps the moderate direct the discussion better. There are two distinct phases of the "discussion". In the first phase, participants use the responders to "quantify" the extent of their input or reactions to a question. The results can be displayed so that no one's input is overlooked or lost. The responses are anonymous as far as the other participants are concerned. In effect, this features provides political amnesty for all ideas and provides a safe environment for the free flow of ideas, so there's less worry about feeling foolish or saying something wrong.

The second phase of the discussion is a verbal conversation, where the moderator uses the results to get participants to talk about the responses. When participants see the responses that others have entered, this "triggers" additional discussion.

A third major difference is capturing of the results. Participants record their own responses; all "votes" are captured without filtering or interpretation. The computer system records and saves all information entered by the participants. This will allow the analyst to later view or cross-tabulate how various individuals responded to several questions. The audio and/or video recordings become supporting sources of information for the session rather than the primary sources. Responses can be readily transferred to analytical and evaluation tools that allow the moderator and analysts to understand, clarify, rate and prioritize the group's input.

Task 3 Data Collection

The sampling plan (include method, sample size, etc.) for each of the modes (auto, transit, bike and walk) will depend on the indicators identified in Task 2. While existing LOS can be one factor to consider for stratifying the sample, it shouldn't be the only criterion.

The data collection plan will focus on approaches that the advisory committee most often referred to as "Drive for Science", "Ride Transit for Science", etc. It should be pointed out that some of the needs (e.g., cost and comfort and convenience) are not represented in the Bicycle and Pedestrian LOS so the data collection effort should include those modes as well.

There are at least two approaches that could be considered (though both approaches need not be mutually exclusive):

1. Use a single pool of participants to participate in all four "For Science" data collection exercises (i.e., Drive for Science, Bike for Science, Walk for Science and Ride Transit for Science). The use of a common pool will allow for relative comparisons across modes.
2. Use a simulator to replicate conditions that may be difficult to find in the field (e.g., when driving threatens personal safety, etc.) For example, if "perception of crime in the vicinity of a given segment" is considered to be a relatively important indicator of "auto safety need" based on the qualitative impact of Task 2, then the sample of segments to be represented under such scenario should take that into consideration.

Task 4 Data Analysis

The expectation is the data collected under Task 3 will allow for a quantitative-based "adjustment factor" so each LOS gradation means the same for all modes. Ideally, the analysis will reveal a model that takes the form a step function, where there are clear demarcations when there are changes in LOS.

In effect, analysis would reflect the advisory committee's thinking that normalizing the LOS gradations across modes via user opinions (albeit via shifting of the scales or applying some to-be-determined discount factor) would create these bands of acceptable standards gradations or overlays (green, yellow, red) as shown on the slide rules.

Task 5 Final Report for Phase I

This task would generate the models and adjustment factors. Phase II will apply the model in the field.

Phase II Pilot Testing

The second phase of the project would pilot test the model application in up to 3 areas in Florida in consultation with local transportation staff and FDOT District offices.

Final Thoughts

As stated earlier, upon completion of the pilot testing, we hope to validate the quantitative-based "adjustment factor" so each LOS gradation means the same for all modes. In turn, this approach to assessing level of service equally across modes will reflect the advisory committee's thinking that normalizing the LOS gradations across modes via user "hierarchy of needs" factors (albeit via shifting of the scales or applying some to-be-determined discount factor) would create the bands of acceptable standards gradations or overlays (green, yellow, red) as shown on the slide rules.

If the pilot tests prove successful, such a system would help Florida communities improve the application of LOS measures to assessing existing conditions, identifying roadways in need of improvement, and prioritizing construction projects. It should also facilitate the ability of decision makers to allow LOS trade-offs between modes and promote a balanced multi-modal transportation system.

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