# RESEARCH NEWS

**Summer 2004**

*A Publication of the Region 2, University Transportation Research Center* *Summer 2004*

## CONTENTS



## Running for the 7:45: The Effects of Public Transit Improvements on Commuter Stress

Richard E. Wener, *Polytechnic University*, Gary W. Evans, *Cornell University,* Donald Phillips, *Polytechnic University* & Natasha Nadler, *Fordham University*

This research project took advantage of the implementation of a major mass transit improvement by New Jersey Transit which provided a "one-seat ride" into New York City for many commuters who previously had to transfer in Hoboken in order to take Port Authority Trans Hudson (PATH) trains into New York City. The creation of this new service provided a natural experiment in which some riders switched to the new route, while others continued to use their previous route. We studied psychological and psycho physiological responses to these commuting options, using a quasi-experimental, pre-post change, field research design.  We found that riders on this new line had lower levels of stress, as multiply measured, than they had earlier, before the advent of this new train, or as did other riders currently using the Hoboken-PATH option. The stress effects seemed to be mediated by the time of the trip – that is, the reduced trip time of the new, direct service seemed to be a primary factor in the reduced stress to riders. Predictability of the trip was also inversely correlated with stress, but did not distinguish between the commuter groups. These results were largely replicated with a student group who rode the same lines acting as simulated commuters.

*Note: This paper was among the top ten papers downloaded from the Kluwer Online Journal web site.*

## UTRC Director Cited in New York Times Article

In the article, "Jamaica Seeks to Build on AirTrain," Dr. Robert E. Paaswell cited the importance of the AirTrain for potentially reviving downtown Jamaica.  The AirTrain is an important link between Jamaica, Queens and Kennedy International Airport, taking passengers from railroad-subway connections to the passenger terminals in about 12 minutes.  A rail link has been suggested between Lower Manhattan and Jamaica that would improve the connection for business people and travelers.

The Jamaica area which is a major hub for the Long Island Rail Road, and has extensive subway and bus service, is an ideal opportunity for transportation planners to create an urban  of what these planners call transit-related smart growth communities.

"With necessary and significant private, public or mixed investment in site acquisition and maintaining new and modernized infrastructure, downtown Jamaica could be successfully revived," according to a study issued last year by City University's Institute for Urban Systems, whose principal authors were Robert Paaswell, Harry Schwartz and Linda Stone Davidoff. Because of its connection to the airport, the economic engine of Jamaica's resurgence was expected to be airlines and air travel related businesses, although real estate specialists caution that development should not be limited to transportation-related projects.

## Calendar

### Visiting Scholar Seminar:

**Cars and Communities**

**Friday, September 17th, 2004**

**Registration Open**

**Speaker**

Dr. Ben Hamilton-Baillie
Sustrans, UK Transport

**Location**

Baruch College
Information & Technical Building
151 East 25th Street
7th Floor, Room 750
New York, NY

**Agenda**

*Registration & Refreshments:* 9:30 am - 10:00 am

*Seminar:*
10:00 am - 12:00 noon

# Director's Message

**Robert "Buz" Paaswell, Ph.D.**
**Director & Distinguished Professor**

As we gaze into the future of transportation, the implementation of Intelligent Transportation Systems (ITS) promises to improve and enlighten our mobility to travel for work, shopping, and leisure. These technologies will automatically inform drivers of road conditions and suggest alternate routes; enable bridge and highway operators to make real-time management decisions to prevent traffic congestion from forming; improve the speed and reliability of public transit services; deliver customized information that supports seamless end-to-end travel choices ; reduce the red tape associated with the regulation of commercial vehicles; and provide a safe and secure system that can both detect and respond to regional crises.

The great challenge posed by ITS is that "intelligent technologies" are advancing far faster than transportation agencies are able to adapt and deploy them in the field. To put ITS into practice, transportation agencies must develop entirely new ways of doing business. They must establish new channels of interagency cooperation, the capacity to evaluate the benefits of alternative technologies, and the ability to fund these new types of projects. They must also develop new systems of real-time decision making, more flexible infrastructure designs that enable the full benefits of ITS to be realized, and updated partnerships with their workforce.

To discuss these challenges and to explore how academia might assist efforts to employ ITS technologies to enhance public transit, the UTRC recently assembled a unique gathering of researchers, students, developers, engineers, managers, and decision makers from government, academia, and industry to focus on the Intelligent Transportation Systems Technology in Public Transit. The conference was graciously hosted on May 19th by the CUNY Graduate Center. The goal of the conference was to discuss the state of the practice in the public transit sector's implementation of ITS, and to develop problem statements for research that would help agencies overcome hurdles that they currently face. This dedicated forum provided an excellent learning and networking opportunity to those interested in the best practices, local conditions, integration, safety and security, customer support, and operations & maintenance of ITS technologies for public transportation.

The conference was a great success. The UTRC is proud to sponsor this event and to be an active participant in public transportation research through our research program, our education of students and practitioners, and our technology transfer programs that provide for such forums. Proceedings from the conference will be available on UTRC's web site later this summer

**University Transportation Research Center, Region 2**
**www.utrc2.org**

***Robert E. Paaswell, Ph.D.***
***Director***

***Robert F. Baker***
***Research & Technology Transfer***

***Camille Kamga***
***Administrator & Information Technology***

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# Research Summaries

***Assessment of Border Crossing Needs in New York State*** Mark Seaman and Allison L. C. de Cerreño, Ph.D., New York University, Todd Goldman, City College of New York. Sponsor: New York State Department of Transportation

Since the signing of the North American Free Trade Agreement (NAFTA) in 1993, trade between the United States and Canada has soared. Most of the goods traded across the border are transported by truck, and this traffic has grown dramatically, with US-bound crossings up almost 40% to nearly 7 million crossings in 2002.

This rapid growth has stretched the capacity of the border transportation network. Heightened security since September 11, 2001 and expedited clearance initiatives have also placed new demands on the border infrastructure. As a result, crossing delays have become routine at some locations, with backups sometimes stretching for miles and affecting travel choices.

New York State is one of the leading conduits for commercial trade between the United States and Canada; its ports of entry at Buffalo-Niagara and along the northern border handle 29% of the truck traffic between the two nations. This trade brings economic benefits to the entire country, as more than three-fourths of the shipments through New York's top two border crossings neither originate in nor are destined for the state itself. Yet New York bears the brunt of the cost, through damage to its roads and congestion and pollution at the border.

In 1998, Congress established a Borders and Corridors program to assist states in maintaining and developing the transportation infrastructure necessary to support NAFTA. However, most of the funds were directed by Congressional earmarking to programs which may have had a less-than-national impact. Funding for border infrastructure suffered, as it received only $154 million of the $1.1 billion appropriated over five years. New York State received only $13 million for its border projects.

The Rudin Center for Transportation Policy & Management at New York University's Wagner Graduate School of Public Service and UTRC are conducting a study for New York State DOT to assess the implications for both the state and country if New York's key border and corridor needs are unmet. The study team is performing an analysis of the border crossing needs identified by NYSDOT and other agencies, and is looking at origin-destination patterns to identify the role of New York's trade corridors in US-Canada trade. The study will analyze the trade-offs that can be made within the framework of state and national policy objectives and scarce resources.

## PERFORMANCE MEASURES FOR EVALUATING TRANSPORTATION SYSTEMS: A STAKEHOLDER PERSPECTIVE

John C. Falcocchio Polytechnic University

Prepared for the 83rd Annual Meeting of the Transportation Research Board January 11-15, 2004 Washington, DC

This paper provides a conceptual discussion on the use of performance measures in transportation. Performance measures are needed to assist decision makers in setting priorities, generating financial resources, and allocating funds. They are also needed in assessing needs, evaluating system performance, or simply communicating with customers and other stakeholders. To be effective in their purpose, performance measures need to be linked to the goals and objectives that guide transportation decisions. The goals and objectives of transportation systems are inherently an expression of the various stakeholders that are impacted by the system. This includes not only the providers of transportation, but also the customers and the communities that house the transportation infrastructure. Therefore, performance measures must include metrics that address the interests of all stakeholders. In response to federal mandates/guidelines of the last decade, much research has been done on this subject, and a lot of information has been disseminated through the various professional media. This paper discusses the key aspects of performance measurement, recommends a framework for the application of performance measures, and highlights some of the major issues that need to be resolved in implementing performance measures for decision-making.

## JOHN JAY COLLEGE PROFFESOR PRESENTS IN FRANCE

Jim Cohen (John Jay College/CUNY) is continuing his research on the effects of public and private financial intermediation on transport infrastructure development. In November, he gave a paper summarizing the primary source data he collected in the past year from Treasury, Federal Reserve and other national archives. During the next six months he will be locating similar data for the history of French capital formation. In June of 2004 he plans to present his comparison of French and U.S. approaches at the Business History Association's biennial international conference in Le Creusot, France.

# Research Summaries

***Information Technology Organization: Organizing to Meet the Needs of the Regional Offices of New York State Department of Transportation,*** by William A. Wallace, Cheng Hsu, and Scott O'Connor, Rensselaer Polytechnic Institute & NYS Department of Transportation, Albany, NY

This project is conducted mainly in 2003 under a contract to Rensselaer by the NYS DOT through the UTRC. It assessed the roles and responsibilities of the Regional Information Technology (IT) organizations of New York State Department of Transportation. To accomplish this assessment, the study identified and documented the resource needs at all Regional Information Technology organizations. The resultant information shall enable Regional Directors and other Department managers to make more efficient and effective use of the Department Information Technology resources. In addition, we have also developed recommendations and a roadmap for the betterment of the Regional IT functions to serve the Department's mission.

The basic approach of the study had three foci: (1) continually engage the Department throughout the study; (2) review previous work, including the META Group's findings on the Department's Information Technology (IT) organization in 1999 and relevant studies conducted under the auspices of Transportation Research Board, and (3) intensive interviews conducted with staff at the Main Office Information Services Bureau (ISB) and the Department's Human Resources staff and at all of the Regions of New York State Department of Transportation. These foci guided the study as summarized in the material to follow.

The basic methods used in this study were meetings, interviews and field studies – with representatives from ISB, Human Resources, Regional Offices and TRB. These methods incorporated two major study techniques: (1) *benchmarking* based on knowledge of the best practices in the field (covering both government and industry, for example, customer service requires 24/7 operations); and (2) *questionnaires* that used the benchmarks to measure the state of the art of IT practices at the regions

The field study at each region started with an interview with the Regional Director, which was followed by a meeting with the leadership of all the functional groups, a break-out meeting with Design, Maintenance, and TMC/TOC (when relevant), respectively, and a meeting with Regional IT staff.

The collected data were analyzed to identify the common tasks, links, and needs, as well as those unique to each region. A trip report was produced to document the study at each and every region and provide a first level analysis of the results.

A Final Report was prepared and submitted to the Department. It includes an aggregate level model and the results of the study; the questionnaires and survey instruments used in the study; and a collection of trip reports, one for each region. It is available from William Wallace: wallaw@rpi.edu, (518) 276-6854 or www.utrc2.org

## XIII Pan-American Conference of Traffic and Transportation Engineering

**September 26th – 29th, 2004**
**Albany Crowne Plaza**
**Albany, New York**
**For full up-to-date information visit the conference website at *http://www.eng.rpi.edu/panam/***

The Rensselaer Polytechnic Institute is hosting the Pan-American Conference of Traffic and Transportation Engineering (PANAM XIII) will be held for the first time in the United States on September 26-29, 2004, at the Albany Crowne Plaza Hotel, Albany, New York. This important activity is endorsed by the Society of Hispanic Professional Engineers (SHPE).

PANAM is the premier transportation conference in Latin-America. It is more than 20 years old and the largest transportation event that focuses on this important part of the world. Held bi-annually since its inception in 1980, this important conference is regularly attended by several hundred transportation researchers, senior decision makers and transportation professionals, including present and past Transportation Ministers, from nearly all countries in the Americas.

Papers will deal with the various facets of transportation engineering and planning, including: Transportation planning and economics, Demand and network modeling, Traffic engineering Public transportation, Sustainable transport policies, Transport and land use, Transport and the environment, Transportation infrastructure, Freight transportation and logistics management, Intelligent Transportation Systems and information technology applications, Road pricing, Transportation funding and private concessions, Human resources, and Road safety .

# Research Summaries

***New York City Arterial Freight Study,*** by George list, Rensselear Polytechnic Institute, and John Falcocchio, Polytechnic University, and Arnim Meyburg, Cornell University

This project has helped Region 11, NYSDOT more sharply focus its planning regarding freight-related actions. The Transportation Improvement Program (TIP) for New York City has needed a more accurate reflection of freight needs for network enhancement. The TIP is the list of projects approved for funding with federal monies by the Metropolitan Planning Organization, in this instance NYMTC. The City's principle arterials have been the major focus, especially in the boroughs of Kings (Brooklyn), Queens, and the Bronx. The main question has been: where would strategic investments in capacity, geometric improvements, and support services, such as Intelligent Transportation Systems (ITS), and changes in regulations affecting trucks and commercial vans have the greatest beneficial impacts on freight mobility and economic development.

To do this, the project team had to:

1) Learn about stakeholder needs;
2) Review the previous studies focused on truck, rail, and other freight modes;
3) Locate the freight-related problem spots on the arterial system (congestion, spillback, etc.);
4) Determine if the TIP contains projects that will correct or mitigate those problem spots;
5) Determine what the conditions will be in the future for freight flows;
6) Identify potential solutions to the future problems;
7) Outline several solution scenarios and evaluate benefits and costs; and
8) Develop consensus-based support among all stakeholders for the proposed solutions.

In addition, through meetings with freight stakeholder groups and the project's Technical Advisory Committee, the team identified the need to:

1) Assess the impacts of the truck regulations on truck mobility; and
2) Explore the issues related to allowing commercial vans to use the parkways.

This executive summary presents the results of these efforts by suggesting locations where network enhancements would have major value to freight logistics and economic development.

Stakeholder input is always important in planning studies. That is particularly true in freight related studies. Freight carriers have special needs that are not easily identified or understood unless one talks to them directly. Doing so helps ensure that the needs of the freight carrier community are met and that the solutions identified are relevant. A 1996 survey conducted by NYMTC was helpful in this regard. The study team also met with the freight carriers and terminal operators.

A network model was developed to predict current and future truck flow conditions on the City's arterial network. The new BPM (best practices model), sponsored by NYMTC, served as the basis for developing the project's model. The project model adopts the BPM network as its network, the BPM baseline flow matrix as its year 2000 flow matrix, and the BPM model's employment forecasts as the source of the data for developing the model's future trip table.

To verify that the project model was predicting credible results, its estimate of link volumes was compared with those observed in the field, i.e., the volumes on which the BPM flow matrix is predicated. Although there is some scatter, the overall trend is excellent for this type of model and the predictions of current and future truck flows are well within the acceptable range.

The next task was to identify a group of Year 2025 scenarios that should be investigated and determine the impacts on the network. being used in many other current highway investment studies.

Several options were considered by the study team and Region 11. and the following four were selected because they offer a wide range of possible network enhancements:

- S1: The existing Transportation Improvement Plan (TIP) / projects currently programmed
- S2: Add to S1:
  - Cross-harbor rail tunnel (from Brooklyn to either Staten Island or New Jersey)
  - Additional intermodal facilities at Maspeth, Fresh Pond, and the Pilgrim site
  - Full interchange at 39th Street on the Gowanus
  - Direct connection to Hunts Point from the Bruckner
  - Direct connection to the Harlem River Yard from the Bruckner
  - Connection from 65th Street Yard to the Gowanus
- S3: Add to S2:
  - New truckways: Verazzano to both Nassau Expressway and the LIE
  - Grand Central Parkway open to trucks (Triboro to BQE)
- S4: Add to S3:

Continued on next page

# Research Summaries

Continued

- Truckway from LIE across the Hell Gate Bridge to Harlem River Yard
- Clearview Expressway extension
- Truck tunnel under the Hudson River

These four scenarios are only a few of the many possibilities that exist. We also did a test of Scenario S3 to see what would happen if the cost of adding AADT (Average Annual Daily Traffic) "capacity" was a lot more expensive than originally assumed. A lot more facilities in the network see heavier use, so the average V/C (volume-to-capacity) ratio is much higher, and the total truck-miles and truck-hours are significantly higher since lengthier paths result from finding ways to make use of links that otherwise would be more lightly loaded.

It is important to note that the model is being made available to Region 11. This helps ensure that Region 11 will be able to analyze other scenarios in the future. Undoubtedly, many more will emerge as more inputs are received from the stakeholder community and other studies identify additional options.

Responding to clear inputs from the stakeholders, two additional issues were investigated as part of the study:

- Geometric restrictions on truck use (e.g., 53 ft trailers)
- Commercial vehicles on parkways

The review of the truck restrictions led to the following conclusions:

- The restrictions on the use of the 53 foot long, 102 inch wide tractor-trailer in New York City are having a negative impact on the ability of the air cargo shippers at JFK to maintain their share of the air freight entering or leaving the United States resulting in the lost of jobs and other economic related activities.
- The absence of an east-west corridor for truck traffic through Brooklyn results in truck freight taking a longer and more circuitous route.
- There is no central source of information on the truck restrictions and truck routes in New York City. Anyone trying to obtain information on this subject has to click down three or four levels in either New York State DOT's or NYC DOT's web page to find material related to the subject.

As a result, it is recommended that:

- A central clearinghouse be established where someone who desires information on bringing a truck into New York City can obtain all the information necessary regarding truck routes, truck restrictions, low vertical clearances and any other information that a driver might need to safety make a delivery in New York City in accordance with all the current rules.
- Serious consideration be given to expanding the routes on which the 53-foot long, 102-inch wide tractor-trailer can operate in New York City.

The review of the use of parkways by commercial vans led to the conclusion, as before in other studies, that the movement of goods to and from JFK and LaGuardia is being adversely affected by the congestion on the expressways in Brooklyn and Queens. Furthermore, a significant portion of the air cargo affected is high in value and low in weight. Hence, this cargo could easily be transported in vans that fit within the restrictions for vertical clearances and pavement thickness that exist on the parkways. It is recommended that the City seriously consider implementing changes that allow commercial vans to use the parkways. The full conclusions and recommendations are presented in the report.

## *Intelligent Transportation Systems Operational Support,* by Raman Patel, Polytechnic University

As part of the New Jersey's highway system, Intelligent Transportation Systems (ITS) has become a very effective tool in managing congestion, mobility, safety, security and other transportation objectives. As more and more Intelligent Transportation Systems come online, system administration, system management and system operational support becomes much more critical. ITS system administration management and operational support personnel and/or contracts need to be developed and in place early in order to provide this support in a timely manner. New Jersey is facing a significant challenge in keeping ITS at a high level of availability. This report outlines the issues faced by the New Jersey Department of Transportation (NJDOT) in operating and maintaining ITS and recommends an implementation plan for the maintenance and the support of contract requirements. The NJDOT currently operates ITS systems at the Transportation Operation Center North (TOC North) and Transportation Operation Center South (TOC South) for traffic management.

This final report is the product of the research study conducted in two phases that included a review of the current practices of similar Transportation Operation Centers (TOCs) in other states and an investigation of the issues faced by the NJDOT traffic operation.

# Research Summaries

***Development of a Prototype APTS/ITS Dynamic Assignment/Simulation Model*****,** Sponsored by the Great Cities University (GCU) Consortium, by Kyriacos C. Mouskos, Ph.D. CCNY-CUNY, Neville Parker, Ph.D. CCNY-CUN

The main objective of this research was the implementation of a dynamic traffic assignment model (DTA) and the demonstration of its use to evaluate various transit related alternatives. The model chosen for this study is called Visual Interactive System for Transport Algorithms (VISTA) that includes a dynamic traffic assignment model and a mesoscopic traffic simulator called RouteSim. The main output of the VISTA-DTA model is the path of each person from his/her origin to his/her destination, including the associated departure and arrival time. This output is saved into a database that can then be searched to summarize statistics at the link, path, bus route level or area of interest as well as time period of the day. The calibrated model is used to demonstrate the capabilities of the dynamic traffic assignment model in the evaluation of various bus-scheduling, infrastructure and signal timing alternatives.

Two test beds were identified for this project: *Downtown Newark, New Jersey*. The Visual Interactive System for Transport Algorithms developed at Northwestern University is implemented for the downtown area where the New Jersey bus routes operating from the Newark Pennsylvania station to the South through Broad Street are embedded into the model. The traffic flow data, geometric data and signal timing data for the Newark, NJ downtown area were provided by the City of Newark Traffic Engineering Division. The bus route schedules and bus stops were provided by the New Jersey Transit. A travel time study using three cars equipped with GPS devices was conducted on November 2002. New Jersey Transit provided GPS data, and automated passenger-counting data (boarding and alighting) for bus routes operating on Broad Street for November 2002. The travel time data were used to calibrate the VISTA-DTA model. *The general Chicago, Illinois area*. The Chicago, Illinois area was selected due to the availability of a test bed since it was developed for a related project by Dr. Ziliaskopoulos for the Regional Transportation Authority of Chicago. The existence of an implemented model for a large area is used to evaluate *regional* transit related improvements such as transit signal priority systems, bus scheduling and infrastructure improvements.

***An Exploratory Study Using an AIDS Model for Tradeoffs between Maintenance Activities/Travel and Discretionary Activities/Travel*** by Cynthia Chen, and Patricia L. Mokhtarian, City College of New York

This paper focuses on the tradeoff in time allocation between maintenance activities/travel and discretionary activities/travel. With the recognition that people are not completely free to allocate their time between activities and travel, we propose a linear constraint in time allocation between activities and travel, which indicates a minimum amount of travel one must do in order to allocate one unit of time to the activity. This minimum amount of travel is represented by the travel time price measure, obtained by dividing the total amount of time traveling to maintenance or discretionary activities by the total amount of time spent on activities of the same type. This travel time price is the time equivalent of price for performing an activity. We ask two questions: "If the travel time price of performing maintenance or discretionary activities increases, how will that affect one's decision on time allocation to maintenance and discretionary activities? And if one had one more unit of available time, how would this additional time affect one's allocation to maintenance and discretionary activities?" We use the San Francisco Bay Area 1996 household travel survey data and apply the Almost Ideal Demand System (AIDS) of demand functions. The empirical results provide the following answers to our research questions. With respect to the time equivalent of income elasticities of maintenance and discretionary activities, we found the former to be less than unity and the latter to be greater than unity. In other words, maintenance activities are a necessity and discretionary activities are a luxury. With respect to the own travel time price elasticities, if the travel time price of performing a certain type of activity increases (for reasons such as traffic congestion), one would reduce the time allocated to that type of activity. As expected, time spent on maintenance activities is relatively inelastic, while time spent on discretionary activities is relatively elastic. As for the cross travel time price elasticities (changes in time allocated to activity i itself in responses to changes in the time price for activity j), we found that $\varepsilon_{md} > 0$ while $\varepsilon_{dm} < 0$. The interpretation of these results is consistent with the classification of maintenance activities as a necessity and discretionary activities as a luxury.

## PROFESSOR CLAIRE McKNIGHT RECEIVES FACULTY SERVICE AWARD

Professor Claire McKnight of the City College School of Engineering and the UTRC received the Faculty Service Award at the Annual Meeting of the Alumni Association.

# Research Summaries

## *The New Transit Capacity and Quality of Service Manual Tour of the Expanded Guide for Transit Planners and Operators*

*Abridged from the TRB TR News, May- June 2004.*

*By* Herbert S. Levinson, and Kittelson Associates

The publication of the second edition of the *Transit Capacity and Quality of Service Manual (TCQSM)* Report 100 assembles a range of information and procedures to aid transit planners, operators, and researchers. The 572-page book with CD-Rom is a companion to the Transportation Research Board's reference, the *Highway Capacity Manual*.

The new TCQSM provides a consistent set of techniques and procedures for evaluating the quality of service and the capacity of transit services, facilities, and systems. The manual covers all types of public transportation - buses, rail transit, ferries, and terminals, and provides planning and operational techniques, along with syntheses of ridership and demands.

The new edition adds quality of service indices for urban fixed-route and demand-responsive transit. TCQSM brings together quality of service procedures and guidelines from a passenger's perspective, along with procedures to estimate transit vehicle capacity and person capacity.

The manual provides guidance but does not set standards. Setting standards for the amount or level of service that should be provided for a specific situation is the prerogative of individual transit agencies, which should take into account local characteristics and available resources.

The TCQSM consists of nine parts:

1. Introduction and Concepts
2. Transit in North America
3. Quality of Service
4. Bus Transit Capacity
5. Rail Transit Capacity.
6. Ferry Capacity
7. Stop, Station, and Terminal Capacity
8. Glossary.
9. Index locates key concepts and details in the text.

The quality of service guidelines are an innovative feature of the manual. Defined as "the overall measured or perceived performance of transit service from the passenger's point of view," quality of service reflects the kinds of decisions that a potential passenger makes in deciding whether to use transit or another mode- usually a private automobile. The decision process has two parts:

1. Assessing whether transit is available, and if it is,
2. Comparing the comfort and convenience of transit with competing modes.

Transit capacity deals with the movement of vehicles and of people.

1. The *person capacity* of a transit route or facility is "the maximum number of people that can be carried past a given location during a given time period under specified operating conditions, with- out unreasonable delay, hazard, or restriction, and with reasonable certainty."

2. The vehicle *capacity* of a transit route or facility is "the maximum number of transit vehicles (buses, trains, vessels, etc.) that can pass a given location during a given time period," usually 1 hour.

Vehicle capacity depends on the minimum possible headway between individual vehicles. The minimum headway depends on control systems such as traffic lights or train signals, passenger boarding and alighting demand at busy stops, and interactions with other vehicles.

The major influences on transit capacity include vehicle, right-of-way, stop, operating, passenger, and street traffic characteristics. Transit vehicle capacity in units per hour depends on the:
Number of vehicles per unit-for example, cars per train;

- Minimum spacing between individual trains, buses, or ferries-determined by the size of the unit, the clearance times between successive units, and the dwell times at the busiest stations or junctions;

- Number of bus berths, ferry docks, or rail station track platforms; and

- Available green time for movement in seconds per hour (3,600 seconds per hour for rapid transit, less than that for street running).

The TCQSM is a living document, which will be reviewed and updated continuously by the TRB Committee on Transit Capacity and Quality of Service. Continued liaison with transit agencies will be an integral part of this continuing effort. User comments are welcome and can be made via the committee's website at http://webboard.TRB.org/-tcqsm.

*The author is a transportation consultant and Icon Mentor of the Region 2, University Transportation Research Center, City College of New York, City University of New York. Herb is a member of the National Academy of Engineering, as well as the Transportation Research Board Executive Committee; the Transit Cooperative Research Program Panel on Development of Transit Capacity and Quality of Service Principals, Practices, and Procedures; and Transportation Research Board Transit Capacity and Quality of Service Committee.*

# Traffic Congestion and Bus Speed

Claire McKnight, Herbert S Levinson, Camille Kamga, and Robert E. Paaswell of City College of New York, and Kaan Ozbay Rutgers University.

There is growing recognition that traffic congestion adversely affects bus speeds in mixed traffic flow. To estimate these affects, the University Transportation Research Center team made an extensive analysis of bus-traffic interactions along New Jersey Transit Routes 59 and 52 in Northern New Jersey. Bus speeds were obtained for some 690 individual segments (each record represented one bus trip on one rate segment). They were supplemented by automobile travel times. The information was summarized, and more than 20 "models" were developed.

The preferred model in terms of statistical validity, logic, and simplicity was as follows:

Bus travel times = 0.52 + 0.73 (Car travel times) + 0.06 (Ons per Bus) + 0.31 (Bus stops)   The $R^2$ was 0.63

There is a logical and intuitive appeal to an equation without a constant team. The resultant relationship is as follows.

Bus travel time = 0.80 (car travel time)   Plus 0.06 (Ons per bus) + 0.37 (Bus stops)

The coefficient of 0.06 represents the service times per boarding times prt passengers (in minutes) or about 3.6 seconds. The coefficient of the stop per mile, 0.37 reflects the time spent decelerating and accelerating, about 22 seconds per stops. What do these relationships mean?

- First, reducing the number and duration of stops will improve bus speeds.
- Second, increasing general traffic speeds (e.g. reducing the travel time rate), would improve bus speeds.

Thus, improvements in general traffic flow such as reducing volumes, was improving traffic signal timing, limiting or restricting curb parking, and managing left turns, would improve bus speeds. For example, increasing car speeds from 15 to 20 miles per hour while holding the number of stops and dwell times per stops constant would increase bus speeds from 10.7 to 13.7 miles per hour: a 17% gain in bus speeds. This corresponds to a savings of about 1.5 minute per mile, and a 15 minute savings over a 10 mile trip.   Providing bus only lanes, "queue jumpers" at busy intersections, and bus preferences at traffic signals would also improve bus speeds.

The research was financed by the New Jersey Department of Transportation, and the Region 2 University Transportation Research Center.

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