TRANSPORTATION RESEARCH DIGEST

MARCH 2009

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TO: TRANSPORTATION PROFESSIONALS, MANAGERS, & POLICY MAKERS

FROM: ARIZONA TRANSPORTATION INSTITUTE

The volume of information on transportation issues, policies, technologies, and related topics is huge. Not even the most well-read professional can keep up with everything that might be useful to know. The *Transportation Research Digest* series is designed to expedite the transmission of information by condensing and summarizing significant documents. Busy professionals or managers may quickly obtain the gist of new developments and determine whether they need to see the full document.

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A "Topic" code in the Table of Contents will help readers more quickly identify items of interest. The topic codes are explained in the table below.

Code	Topic	Code	Topic
ADM	Administration	PLAN	Planning
AIRP	Airports	PRIV	Privatization
AVIA	Aviation	RAIL	Railroads
BIKE	Bicycles	RDSD	Roadside
CON	Construction	ROW	Right-of-Way
ECON	Economics	SAFE	Safety
ENV	Environment	STR	Structures
FIN	Finance	TECH	Technology
INOV	Innovations	TOLL	Toll Roads
MAIN	Maintenance	TRAN	Transit
MISC	Miscellaneous	TRF	Traffic
MVD	Motor Vehicle Dept	TRK	Trucking
PAVE	Pavement	VEH	Vehicles

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MARCH 2009

TABLE OF CONTENTS

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MARCH 2009

Increasing Airport Capacity Without Increasing Airport Size by Viggo Butler & Robert Poole, (Reason Foundation, 3415 S. Sepulveda Blvd., Suite 400, Los Angeles, CA 90034; http://www.reason.org/ps368.pdf; Phone: (310) 391-2245) (Mar 2008)

Highlights

- This study explains the core NextGen technologies and procedures that can be used to increase airport runway capacity without expanding the airport's geographical boundaries.

The United States faces a real possibility of running out of airport capacity—not everywhere, but in particular at a number of the 35 most important airports in the national system. According to the Federal Aviation Administration, these are airports in large, urbanized areas such as New York, Chicago, Miami, Los Angeles, and San Francisco. The problem is seldom lack of capacity in airport terminals. Large airports are financially self-supporting, and are generally able to finance terminal expansions. Rather, the problem is one of adding needed runway capacity. Without enough runway capacity, these airports will face increasingly serious problems of delay, which already plague the New York airports.

Most of the critically important urban-area airports are hemmed in by expensive real estate. Adding a new runway of between one and two miles in length, spaced the required 4,300 feet from existing runways, typically requires large amounts of land, which many airports do not own. This often leads to divisive, protracted battles with airport neighbors to acquire the needed land. Even when the airport eventually prevails (which is often not the case), the long delay in adding the new runway can mean a decade or more of extra delays, as well as construction costs significantly increased due to inflation over the ensuing years.

What if there were ways to expand the runway capacity of an airport without expanding the airport's footprint? That would mean that an urban area could receive the economic benefits that come along with continued growth in air service without the protracted battles over land acquisition, and without the long delays attendant to such battles.

The purpose of this policy study is to explore an array of new technologies that hold significant promise for expanding the functional capacity of airport runways. These technologies—most of which already exist—are planned for incorporation into a completely new air traffic control system to replace the current system over the next 20 years. The overall concept of operations and system architecture is being developed by a federal inter-agency planning group, the Joint Planning & Development Office, advised by aerospace/electronics industry teams. This new approach is being called the NextGen system.

Currently, runway capacity is limited by five factors:

- In-trail separation of aircraft—how closely aircraft can be spaced one after another when approaching the runway;
- Lateral separation, especially in bad weather, between aircraft approaching the same airport on parallel runways;
- The sequencing and separation of departing and landing aircraft on

runways that intersect (e.g., at LaGuardia);
- The sequencing of departing and arriving aircraft on a single runway; and
- The sequencing of aircraft approaching airports located in close proximity to one another, where one aircraft must cross the path of another aircraft landing at a nearby airport (e.g., in the Chicago, Los Angeles, and New York metro areas).

In broad outline, NextGen addresses these constraints in the following ways:
- Use already developed but not fully implemented aircraft communication devices to safely reduce the physical separation of aircraft;
- Use specialized approach and departure procedures, now being implemented at a few locations, as the standard for all approaches and departures;
- Improve the management of aircraft wake turbulence in the airport vicinity; and
- Use these same technologies with central computer systems to manage aircraft movements on the ground.

This study explains the core NextGen technologies and procedures that can be used to increase airport runway capacity without expanding the airport's geographical boundaries. It then shows how these technologies could be applied to address specific types of runway capacity problems, using San Francisco International and the three main New York airports as illustrative examples.

The same technologies also offer realistic prospects for reducing the noise impact of airports on their neighbors. These benefits will be accompanied by savings for aircraft operators—on fuel use, crew time, and aircraft utilization. The reductions in fuel use and more efficient use of engines at lower altitudes will bring about noticeable reductions in emissions, producing both local and global benefits.

Airport officials, transportation planners and concerned citizens need to become aware of these new capabilities. Although full implementation of NextGen is probably 10-20 years away, the planning horizon for runway addition projects—especially if organized opposition to airport expansion is expected—is also likely to be one to two decades. Thus, planning for future expansion of runway capacity needs to begin taking into account what will be possible to do within 10-20 years that has not been possible up till now. In addition, everyone concerned about having adequate airport capacity in America's urban areas should support the timely implementation of NextGen by the federal government and the aviation industry.

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MARCH 2009

A Solution to Airport Delays in *Regulation* by W. Tom Whalen, Dennis W. Carlton, Ken Heyer, and Oliver Richard, U.S. Department of Justice (Cato Institute, 1000 Massachusetts Avenue, N.W., Washington D.C. 20001-5403; http://www.cato.org/pubs/regulation/regv31n1/v31n1.html; Phone (202) 842-0200) (Spring 2008)

Highlights
- The authors propose a market-based auction system with well-defined property rights to slots for airport capacity.
- The proposal would ensure that airlines effectively take into account airports' scarce resources when scheduling their flights, thereby reducing delays.
- The proposal would also help ensure that these public resources are allocated to their highest-valued uses.
- The revenues generated by this approach could be utilized to fund capacity expansions.

Airport delays are increasing significantly. Both the Bush administration and Congress are actively seeking ways to reduce the scope of the problem and better protect the rights of passengers in case of delay. Delays occur because airport capacity is a scarce resource and, at key airports, airlines are scheduling more flights than that capacity can support. As a result, more and more flights are delayed, even under normal weather conditions, and considerable costs are imposed on the traveling public. Passengers are paying, in effect, a much higher total price than the dollar price of their tickets.

Airlines' private incentives to schedule flights to serve more destinations and offer passengers more choice in departure times do not take into account the delays that their many flights impose upon other airlines because airlines do not face the proper price incentives to use scarce airport capacity efficiently. Consequently, airlines schedule too many flights, generating delays that ripple across the highly integrated airline network and adversely affect all passengers.

To address this problem, one approach, implemented by the Federal Aviation Administration at O'Hare Airport in Chicago and, in late 2007, at John F. Kennedy Airport in New York City, is to get the airlines together and have them collectively hammer out a solution. This, however, requires the airlines to make individually costly compromises on a multitude of scheduling decisions. Each airline in the end agrees to abide by a settlement only if the settlement leaves the airline better off than not agreeing, and the system thereby favors incumbents over entrants. Such collective decisionmaking does not necessarily benefit consumers. Indeed, collective decisionmaking by actual and potential rivals raises serious risks to competition.

Other proposed solutions to the airport delay problem seem to have a common theme: eliminate the problem by expanding the airports and improving the air traffic control systems to, in effect, eliminate the capacity scarcity. For example, current popular proposals include the spending of billions of dollars to add runways and expand other physical capacity (such as gates) at airports to accommodate more concurrent flight operations, and to improve air traffic control systems to allow for more intensive usage of existing capacity (by, e.g., shortening the distance between aircraft in airspace). Those methods of dealing with the problem are costly. Moreover, plans to expand capacity will not -- under even the most optimistic projections -- ameliorate the problem of delays in anything but the very long term.

Only by allocating existing assets efficiently can society squeeze the greatest possible value out of its scarce resources. Moreover, failure to do so may well result in capacity expansion plans whose costs do not justify their benefits. We need a market-based approach to the allocation of scarce takeoff and landing rights at airports where the demand for those rights at a zero price exceeds the ability of the airport to handle that many takeoffs and landings during some time period.

Conclusion

It is time to implement an effective, market-based solution that promotes efficient usage of airport capacity and reduces delays. In this article, the authors have proposed implementing a market-based auction system with well-defined property rights to slots for airport capacity. The proposal would ensure that airlines effectively take into account airports' scarce resources when scheduling their flights, thereby reducing delays. The proposal would also help ensure that these public resources are allocated to their highest-valued uses. This approach strives to balance administrative costs with economic efficiency, as it facilitates efficient flight schedule adjustments and entry at capacity-constrained airports. The revenues generated by this approach could be utilized to fund capacity expansions when the benefits of the expansions outweigh the costs, as might be indicated, for instance, by the prices airlines bid for airport slots.

The use of market-based solutions to problems of airport capacity allocation and airport delays is long overdue. Implementation of proposals along the lines of those laid out in this article would contribute greatly to achieving this objective.

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Techniques for Assessing the Socio-Economic Effects of Vehicle Mileage Fees by B. Starr McMullen, Kyle Nakahara, Smita Biswas, Dept of Agricultural & Resource Economics, Lei Zhang, Divya Valluri, School of Civil and Construction Engineering, Oregon State University (Oregon Department of Transportation, 200 Hawthorne Ave. SE, Suite B-240, Salem, OR 97301-5192; http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2008/ODOT-VMT_Fee_Impacts.pdf) (Jun 2008)

Highlights

- A change from the current gasoline tax to a VMT fee structure of the type considered in this study would have a negligible impact on income distribution.
- Concerns that rural households would be adversely impacted by the change in fee structure were unfounded.

This study developed tools for assessing the distributional effects of alternative highway user fees for light vehicles in Oregon. The analysis used the example of a change from the current gasoline tax to a VMT fee structure for collecting highway user fees. The questions addressed were as follows:

1) Would the change to a VMT fee be regressive, placing disproportionate hardship on those in lower income groups?

2) Would rural areas in Oregon be adversely impacted relative to urban areas?

3) Would a change to a VMT fee discourage people from acquiring alternative fuel vehicles or more fuel efficient vehicles and thus would be contrary to the state and national priority of reducing fossil fuel use?

A static model and a regression model were developed and used to provide answers to the first two questions. A discrete-continuous choice model was also explored and recommended for future development to better address the third issue.

Results indicated that the income distributional impact of changing to an approximately revenue-neutral VMT fee of 1.2 cents per mile would result in a slight increase in regressivity relative to the regressive structure of the current gasoline tax. The impact for the lowest income group amounted to a change of less than one percent of their income. As a comparison, the increase in total gasoline expenditures that was caused by the near doubling of gasoline prices from $1.46/ gallon to $2.64/gallon between 2001 and 2006 was over five percent of income for the lowest income group.

The impact of the change to a VMT fee on rural areas was found to be opposite to that suggested by conventional wisdom. On average a household in a rural location would pay less under a revenue-neutral VMT fee of 1.2 cents per mile than under the gasoline tax, whereas those in urban areas would pay slightly more. This was largely due to the lower overall average fuel efficiency in the rural vehicle fleet relative to the urban fleet and the greater number of miles driven on average by rural households.

Results suggested that a change to a VMT fee would not be likely to create a significant disincentive to purchase more fuel efficient or hybrid vehicles. This was because the change in fee structure had such a small impact on the cost of driving relative to the price of gasoline. Indeed, continued increases in gasoline prices would dwarf any change in per-mile costs caused by the change in user fee structure considered here. It is higher gasoline prices that are likely to produce the increases in driving costs of the magnitude necessary to create the incentive to adopt more fuel efficient vehicles.

The study concluded that a change from the current gasoline tax to a VMT fee structure of the type considered in this study, would have a negligible impact on income distribution. Further, concerns that rural households would be adversely impacted by the change in fee structure were unfounded, as rural households would actually benefit relative to urban households. Preliminary results suggested that the change in user fee structure considered here would not be likely to significantly impact vehicle choice. If future promotion of more fuel efficient vehicles is a policy priority, further development of the discrete-continuous choice model would be desirable to have a tool that can better predict how policy changes may affect vehicle choice in the long run.

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MARCH 2009

Quieter Pavements Survey by Newton C. Jackson, Adriana Vargas, Jason Pucinelli, Nichols Consulting Engineers Chtd., 1885 S Arlington Ave., Suite 111, Reno, NV 89509 (Research Office, Washington State Department of Transportation, Transportation Building, MS 47372, Olympia, Washington 98504-7372; Project Manager: Kim Willoughby, 360-705-7978) (Mar 2008)

Highlights

- None of the states were able to provide sufficient information to accurately estimate the service life of the different quiet pavements types.
- There is a concern with the use of open-graded mixes in areas which require snow plowing.
- States that have continued to use open-graded friction course (OGFC) mixes tend to be in the southern part of the country.

A study was conducted that looked at the relative performance of quieter pavements in Europe and the United States based on pavement management data. A phone survey was conducted to get the best response and to specifically talk to those people in the state agencies that were involved with their pavement management system (PMS). Contact was made with 35 of the 50 states on the performance of open-graded mixes and stone matrix asphalt (SMA) mixes in their respective agencies. None of the states were able to provide sufficient information to accurately estimate the service life of the different quiet pavements types to the accuracy that can usually be accomplished from the Washington State Pavement Management System (WSPMS). About half the states contacted were able to provide an estimate of the service life they were experiencing from their open-graded mixes and a few were able to estimate the service life experienced from their SMA mixes. The estimated service life for the open-graded mixes provided by the states ranged from seven to fifteen years. Where states were able to provide an estimate of service life of their dense graded mix performance, the open-graded mixes were providing about 70 percent of the service life of the dense graded mixes.

Based on the authors experience and comments from other states there is a concern with the use of open-graded mixes in areas which require snow plowing in the winter and those that experience increased pavement wear from studded tire use. The survey found that those states that have continued to use open-graded friction course (OGFC) mixes tend to be in the southern part of the country, which do not have the same maintenance issues with snow plowing and studded tire wear. Consequently, most of the states in the northern part of the country do not appear to be using OGFC mixes as consistently as the more southern states.

As part of the state survey the current standard specifications for open-graded mixes were reviewed and summarized for those states that made them available. A collection of the state specifications for OGFC indicates that there are in general two sizes of stone gradations used in the United States. The gradation with the larger aggregate size (3/8" median) is used by states in the southeast which fit NAPA's guidelines for OGFC mixes. The rest of the states use the gradation with the smaller aggregate size (1/4" median) which originally came from the FHWA Technical Advisory for friction courses. There is no indication that the different gradings for the OGFC provide more or less service life.

Most states in the survey used a polymer modified binder (PG 76-22) with fibers to control drain-down and provide the thick asphalt film that is required for OGFC mixes. Some states used an asphalt rubber binder, but these were in the minority and all tended to be located in the southern portions of the United States. There was also no indication in the survey that either binder type provided better service life. Those states that do use asphalt rubber binder are specifying a higher percentage of asphalt rubber binder compared to polymer asphalt binder. The OGFC mixes constructed at this time in Florida and Arizona with stiffer asphalt binders and thicker asphalt films (higher asphalt content) are performing better than those constructed in the 1970's and 1980's. However they are still not being used extensively by many northern states or by many states that allow the use of studded tires like Washington State. The Washington State Department of Transportation (WSDOT) can expect that the OGFC mixes constructed with stiffer asphalt binders and thicker asphalt films will perform better than the old mixes, but it is doubtful that they will obtain comparable service lives as that reported by Arizona and Florida, given Washington's weather and studded tire use.

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MARCH 2009

Linking of Mobility Performance Measures to Resource Allocation: Survey of State DOTs and MPOs by Jeremy Klop, Erik Guderian, Fehr & Peers, 621 17th Street, Suite 2301, Denver, CO 80293 (Colorado Department of Transportation – Research, 4201 E. Arkansas Ave., Denver, CO 80222; http://www.dot.state.co.us/Publications/PDFFiles/resourceallocation.pdf) (Dec 2008)

Highlights

- Agencies have just begun to establish policies on tracking performance measures and allocating budget based on performance measures.
- It is important to conduct before/after studies at project implementation locations in order to quantify the return on investment for specific mobility enhancement projects.

The objective of this study is to provide a summary of the best practices of state departments of transportation and metropolitan planning organizations (MPOs) throughout the country regarding the linkage between mobility performance measures and resource allocation. The only mobility performance measure currently authorized for the Colorado Department of Transportation (CDOT) to denote congestion is volume to capacity (V/C) ratio. Currently, the V/C is used to identify the segments with V/C ratio of .85 and above which are considered congested.

The project team began this study by performing a literature review of current practices of agencies across the country. Through the literature review process, a list of agencies was identified as the ones who should be contacted to fill out an on-line survey regarding performance measures and resource allocation. The agencies included all the ones in the Urban Mobility Pooled Fund Study (SPR 03-049), other state agencies with strong ties between performance measures and planning, and MPOs that work closely with departments of transportation.

The on-line survey was sent out to all the selected agencies in 2008 via e-mail. Fourteen of the twenty-eight agencies selected responded to the survey. The survey was divided into three different sections to obtain responses about each agency's policies and procedures related to performance measures and resource allocation. The sections were 1) performance measures, 2) mobility funding, and 3) resource allocation effectiveness. The project team reviewed the responses from the on-line survey and identified seven agencies to contact for a more detailed follow-up phone interview. Five of the seven agencies were able to be contacted and a 10 to 20 minute interview was conducted regarding performance measure and resource allocation.

Through the process of researching the best practices, reviewing the on-line survey responses and interviewing selected agencies via telephone the research team found that agencies have just begun to establish policies on tracking performance measures and allocating budget based on performance measures in the past five years. Because the process of allocating resources based on performance measures is so recent, results demonstrating the effectiveness of these policies are not available. Two state agencies, Washington DOT and Ohio DOT, have established a set policy for resource allocation on mobility projects based on performance measures.

Because a universal policy linking mobility funding to performance measures among the agencies surveyed and interviewed was not identified, the research team recommends the following process in determining a resource allocation policy suitable to the needs of CDOT.

The policy must address the following areas to be effective:

- *System Performance* - One or more benchmark performance measures need to be determined as the best measures of mobility in Colorado for resource allocation. Based on the survey responses, agencies around the country set their mobility performance measure benchmarks on capacity-based performance measures (V/C ratio) or travel flow based performance measures (travel time or travel speed).
- *Critical Deficiencies/Needs* - Once the system performance benchmark measures have been established, critical locations within the roadway network that have mobility issues will be identified.
- *Prioritization* - Colorado DOT will be able to prioritize the critical locations identified in the previous step based on the severity of the problem and the volume of vehicles or people being served at each location.
- *Resource Allocation/Investment* - Based on the annual mobility enhancement budget, the highest priority mobility projects will be funded and constructed based on need.
- *Measure Effectiveness/Return on Investment* - It is important to conduct before/after studies at project implementation locations in order to quantify the return on investment for specific mobility enhancement projects. The findings from these studies, based on empirical data collected from performance measures, are critical to review in order to make better decisions about the prioritization list and resource funding.

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MARCH 2009

Crash Testing and Evaluation of F-Shape Barriers on Slopes by N.M. Sheikh, R.P. Bligh, W.L. Menges, Texas Transportation Institute, Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office P.O. Box 5080, Austin, Texas 78763-5080; 979.845.1734; http://tti.tamu.edu/documents/0-5210-3.pdf) (Mar 2008)

Highlights

- TxDOT's permanent cast-in-place F-shape barrier performed acceptably.
- TxDOT's free-standing, precast F-shape barrier with X-bolt connection successfully contained and redirected the vehicle.
- TxDOT's permanent and free-standing F-shape concrete barriers perform adequately on roadside and median cross-slopes of 6H:1V or flatter.

The Texas Department of Transportation (TxDOT) desires to use its permanent and free-standing F-shape concrete median barriers on roadside and median cross-slopes greater than the current recommended maximum of 10H:1V. In an earlier part of this research, a TTI research team conducted full scale vehicular finite element simulation analysis to evaluate several impact scenarios associated with placement of concrete barrier on typical depressed median configurations. The results of this analysis indicated a reasonable probability of acceptable performance of the F-shape concrete barrier for slopes as steep as 6H:1V. However, since the finite element pickup truck model used in the analyses had not been thoroughly validated for encroachments across median slopes and ditches, it was recommended that full-scale crash tests be performed to verify impact performance.

Researchers performed two full-scale crash tests in this part of the research for evaluating the TxDOT permanent and free-standing barriers on 6H:1V cross-slopes. These tests were performed with a pickup truck because it is considered to be a more critical design vehicle than the small passenger car in terms of stability, potential for barrier override, and occupant compartment deformation. Using results of the simulation analyses, the critical lateral barrier offset from the breakpoint of the roadside cross-slope was determined to be 7.25 ft. At this offset, the vehicle body was determined to be at its maximum height with respect to the local terrain, which is expected to maximize the potential for vehicle instability and barrier override.

TxDOT's permanent cast-in-place F-shape barrier was evaluated in the first crash test (Test 452106-3). The barrier performed acceptably for NCHRP Report 350 test 3-11. However, the lateral offset of the barrier in the crash test was inadvertently 6 ft more than the critical lateral offset. Consequently, the vehicle was losing height when it impacted the barrier and, therefore, may not have adequately evaluated the concern of vehicle instability. However, the researchers believe that the tested barrier location was more critical in terms of vehicle occupant compartment deformation. After reaching its point of maximum elevation, the vehicle began to nose down into the barrier, thus imparting greater impact forces than if the barrier was placed at the location corresponding to maximum vehicle height. The increased impact forces will result in an increase in occupant compartment deformation.

Compared to a permanent barrier, a free-standing barrier generally results in greater vehicular instability as it deflects laterally and allows greater vehicle climb and roll during impact. The second test (Test 452106-4), which was conducted with a free-standing barrier was, therefore, considered to be a worse case evaluation of vehicular stability for both types of barriers when placed at the critical lateral offset from the slope breakpoint.

TxDOT's free-standing, precast F-shape barrier with X-bolt connection was evaluated at the critical lateral offset of 7.25 ft from the slope breakpoint in the second crash test (Test 452106-4). The barrier successfully contained and redirected the vehicle in an upright manner and met all relevant performance evaluation criteria for NCHRP Report 350 test 3-11.

It can be thus concluded that TxDOT's permanent and free-standing F-shape concrete barriers perform adequately on roadside and median cross-slopes of 6H:1V or flatter. Since their performance was successfully evaluated for the critical lateral offset, the barriers should perform adequately for any lateral offset of the barrier from the roadway edge; and for any width of depressed V-ditch median as long as the barrier is placed at its center. Similar or better performance would be expected for similar barrier placements on more gentle (e.g., 8H:1V) slopes.

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MARCH 2009

Determining Effective Roadway Design Treatments for Transitioning from Rural Areas to Urban Areas on State Highways by Karen Dixon, Hong Zhu, Jennifer Ogle, Johnell Brooks, Candice Hein, Priyank Aklluir, and Matthew Crisler (Oregon Department of Transportation, 200 Hawthorne Ave. SE, Suite B-240, Salem, OR 97301-5192; http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2008/Rural_to_Urban.pdf) (Sep 2008)

Four Best Treatments for Reducing Speed

1. Medians in Series with Pedestrian Walks,
2. Medians in Series with No Pedestrian Walks,
3. Median with Gateway, and
4. Gateway with Lane Narrowing

This study determined the speed effects of roadway treatments implemented to slow drivers transitioning from rural environments to suburban communities. The study incorporated nine transition areas using a driving simulator where six of the transitions included treatments and three of the transitions were untreated (control sections). The selected treatments were based on individual treatments or combinations of treatments previously tested in the driving simulator during the two pilot study phases of the project. The treatments tested were as follows:

- Control Two Lanes (1)
- Control Two Lanes (2)
- Layered Landscaping
- Gateway with Lane Narrowing
- Control Two Lanes with Center Lane
- Median with Short Landscaping
- Median with Gateway
- Medians in Series with No Pedestrian Crosswalks
- Medians in Series with Pedestrian Crosswalks

The simulated resulting speeds were similar to speed trends observed in the published literature regarding similar field studies. This study found that four treatments had the greatest speed reducing effects: 1) Medians in Series with Pedestrian Walks, 2) Medians in Series with No Pedestrian Walks, 3) Median with Gateway, and 4) Gateway with Lane Narrowing; however, this observed speed results for this final treatment were not statistically significant at a 95% level.

These treatments all resulted in mean speeds slower than the control scenarios. The treatments that were most effective had the most impact on the driver, either by forcing a horizontal maneuver, positioning the driver in closer lateral proximity to roadside or median objects, or by drawing their attention visually with signs. Particularly, the medians in a series with and without pedestrian crosswalks treatment slowed drivers down adjacent to the treatment, though observed speeds remained marginally higher than the posted speed limit at these locations.

The "Median with Gateway" treatment also proved effective at consistently reducing speeds during and after the treatment as the combination treatment helped improve the conspicuity of the change in driving environment. The "Median Only" treatment had modest speed reductions as well.

Though minor speed reductions also occurred at the "Gateway with Lane Narrowing" treatment and to some extent at the "Layered Landscape" treatment, these perceived improvements were extremely small and generally not statistically significant.

Approximately one-half of the simulations included the use of a distracter word game during the rural portion of the simulation. Though this game was suspended as a driver approached a simulated “town” with a control or transition segment, a residual effect of the word game on driver speeds occurred for the initial segment of the transition for young drivers. This observation is interesting when compared to statistically insignificant speed changes for middle or older aged drivers also tested with and without the distracter. One possible reason for this observation is that the more experienced drivers (presumably the middle and older aged drivers) are not as easily distracted from the driving task as younger, less experienced drivers.

Further studies could be conducted to compare these simulated results with field results using before and after case studies at specific locations. Additionally, further studies can analyze the effects of these treatment options on speeds throughout the towns instead of only around the transition area.

The study also concluded that there is an age effect between the young drivers compared to the middle and older aged drivers at specific locations. The only locations where an age effect was evident were on the fringes of the transition areas and appeared most often to correspond to a concurrent distracter word game as indicated previously. Therefore, additional research seems prudent to determine if the observed speed variations were in fact due to the distracter game or some other feature unique to a rural road environment.

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MARCH 2009

Strategies to Address Nighttime Crashes at Rural, Unsignalized Intersections by Shauna Hallmark, Neal Hawkins, Omar Smadi, Cari Kinsenbaw, Massiel, Orellana, Zach Hans, and Hillary Isebrands, Center for Transportation Research and Education, Iowa State University, 2711 South Loop Drive, Suite 4700, Ames, IA 50010-8664 (Iowa Highway Research Board, Iowa Department of Transportation, 800 Lincoln Way, Ames, IA 50010; phone: 515-239-1101; http://www.iowadot.gov/operationsresearch/reports.aspx) (Feb 2008)

Highlights

- Lighting is most likely to mitigate crashes where the main cause is running the stop sign or other failure to yield right or way and broadside and rear-end crashes.
- Lighting and the accompanying maintenance and utility charges can be high.
- Less expensive solutions are summarized.

Roadway lighting is expensive to install, supply energy to, and maintain in perpetuity. Agencies have several mitigation strategies to address nighttime crashes. The installation of roadway lighting is only one of these strategies. This research assists local agencies in deciding when and where to provide rural intersection lighting to address nighttime crashes.

The types of crashes that occur at rural intersections were evaluated and are discussed in the crash characteristics section. Understanding the types of crashes that occur can provide insight to determining which mitigation measures might be most effective. A total of 26% of rural intersections crashes in Iowa occur during dark conditions. The most common causes for single vehicle crashes at rural intersections were run-off-road (27%), animal crashes (17%), and ran stop sign (16%). Common causes for multiple vehicle crashes at rural intersections include running the stop sign (21%), failure to yield right-of-way at stop or yield sign (20%), and other failure to yield right-of-way (10%). The most common type of crash for multiple vehicles was broadside (42%), followed by rear-end (14%). Lighting is most likely to mitigate crashes where the main cause is running the stop sign or other failure to yield right or way and broadside and rear-end crashes.

The use of lighting is often one of the first strategies considered and is popular with the traveling public. However, the cost of hardware to install lighting and the accompanying maintenance and utility charges can be high. Other strategies, such as use of advance stop line transverse rumble strips, may provide viable solutions. A range of solutions are summarized, including the use of advance signing to warn drivers of an upcoming intersection, use of sign beacons on stop signs or “Stop Ahead” signs, use of reflective material to improve the nighttime visibility of signs, improved signing and marking, use of flashing overhead beacons at intersections, advance stop sign rumble strips, and lighting.

A survey was developed to question Iowa counties and cities as to their lighting standards and practices. The survey was used to determine current lighting practices in Iowa. Results of the survey are provided. Fourteen cities and twenty-seven counties responded. The section discusses the types of criteria used to determine when lighting is appropriate, the type of lighting used, standards for lighting levels and layout, number of lights, and costs for lighting.

The evaluation section presents the results of a cross-sectional statistical evaluation of 223 rural intersections focused on the safety benefits of lighting and other treatments. Data were collected in the field for each intersection to complete a Bayesian statistical analysis that demonstrates the effectiveness of each strategy on nighttime crashes.

Another objective of this research was to collect a large sample of rural intersections both with and without lighting. It was hoped that there would be sufficient samples to evaluate type and placement of lighting as a safety benefit. A hierarchical Bayesian model using a Poisson distribution was used to fit various models. The first attempts modeled individual intersection approaches so that type and location of lighting could be included as variables. It was determined after a thorough evaluation of the data and resulting models that the only lighting variable which could be included was presence or absence of lighting rather than the evaluation of type, location, and quality of lighting. This may have been due to sample size, even though 223 intersections were included, or due to the fact that crashes at rural intersections are still fairly rare events, so differences could not be detected.

Models were developed separately for day and nighttime conditions. A number of variables were evaluated for both models, including type of control, presence of overhead beacons, presence of advanced stop line rumble strips, etc. The nighttime model included presence of overhead street lighting. The final daytime model indicated that the significant variables were number of approaches with channelization and whether the intersection was a high crash location (location had four or more daytime crashes in a three-year period). The final nighttime model indicated that the only relevant variables were presence or absence of lighting and whether the location was a high crash location (location had two or more nighttime crashes in a three-year period). The nighttime model results indicated that locations without lighting had twice as many crashes as locations with lighting. Use of lighting at rural intersections is most likely to be effective when there are two or more nighttime crashes in a three-year period. Based upon available data, no significant statistically significant relationship could be established between nighttime crashes and non-lighting low costs measures.

It is not known why the influence of other low-cost measures, such as advance stop line rumble strips or overhead beacons, could not be detected in the models. A number of intersections had a low number of crashes which may have masked the impact. Additionally some treatments are placed at high crash locations and even with a reduction, the location still has a higher than average number of crashes. As result, it is difficult to establish reduction with a cross-sectional model. Even though this study had hoped to address the removal of existing rural intersection lighting, the researchers were not able to discern enough clarity from the statistical evaluation to provide practical guidance.

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Kenosha-Racine-Milwaukee (KRM) Corridor Transit Service Options: An Investigation and Analysis by Thomas A. Rubin (Reason Foundation, 3415 S. Sepulveda Blvd., Suite 400, Los Angeles, CA 90034; http://www.reason.org/ps372.pdf; Phone: (310) 391-2245) (Dec 2008)

Highlights

- For each net new (one-way) passenger boarding, the cost would be $28.
- Passengers would pay only $2.92 per boarding.
- The commuter rail subsidy per passenger is 5.5 times that of express bus.
- Passenger rail service has high costs and low transportation benefits.

What sort of improvements to transit service would make sense in the north-south corridor from Kenosha to Racine to Milwaukee (the KRM corridor)? An alternatives analysis carried out by the Southeastern Wisconsin Regional Transit Authority (SWRTA) selected a commuter rail system using two-car diesel multiple units (DMUs), rejecting a bus rapid transit (BRT) alternative and a transportation systems management (TSM) alternative. This study reviews and critiques that decision process and offers several additional alternatives which may be more cost-effective.

The case for commuter rail in the KRM corridor rests on the lack of limited-access highway along the lake shore, where the larger fraction of population lives and where most of the activity centers are. The only such highway is I-94, which lies to the west. For service between and among the central business districts (CBDs) of the three cities, commuter rail offers a faster alternative than bus service, whether those buses would use existing highways or a hypothetical exclusive bus lane that could be added to highways near the lake shore.

But the proposed commuter rail service comes with a high taxpayer cost. SWRTA projects that by 2035, the commuter rail system would attract 4,817 new passengers each weekday. For each net new (one-way) passenger boarding, the cost would be $28—meaning that the annual cost for each working weekday round-trip commuter the system attracts would be over $14,000. That is a large sum for a very small improvement in transit. (Passengers would pay only $2.92 per boarding, compared with the $28 boarding cost.)

The particular form of BRT which SWRTA considered as an alternative consisted of an exclusive bus lane in each direction added to a local highway route connecting the three CBDs along the lake shore. The capital cost would have been comparable to that of the commuter rail service, but its trip time would be nine minutes longer from Kenosha to Milwaukee (62 minutes vs. 53) and would have attracted fewer riders. Hence, that alternative was rejected.

Not studied by SWRTA were several other promising alternatives that would have far lower capital costs. One such service is commuter express bus service on I-94, from park & ride lots adjacent to the Interstate. While such service would not be time-competitive for CBD to CBD trips, it would be attractive for trips from Kenosha and Racine’s western suburbs to destinations such as downtown Milwaukee, the University of Wisconsin-Milwaukee campus, and locations in Waukesha. Data from New Jersey, where longhaul commuter express buses operate along with commuter rail, show that express bus has far lower subsidy levels: the commuter rail subsidy per passenger is 5.5 times that of express bus.

A second alternative is called BRT Lite—semi-express bus service operated on arterial roadways with traffic signal preference. In Los Angeles, the introduction of such service on Wilshire Blvd. led to a 40% increase in bus ridership, at dramatically lower subsidy levels than either BRT on exclusive lanes or any form of rail transit. While BRT Lite would not be time-competitive with commuter rail between the three CBDs, it could offer improved bus service on both north-south and east-west routes, at modest cost.

A third alternative is expanded vanpool programs, some sponsored by employers and others operated by transit agencies. Milwaukee County Transit Service (MCTS) operates a 27-van fleet, with passenger fares covering 100% of the operating costs. The federal transportation grant formula funding generated by vanpool operations can often pay for the capital costs of the vehicles.

Another advantage of transit alternatives using rubber-tire vehicles is that they can be expanded or contracted in proportion to actual demand. SWRTA's projections of commuter rail ridership are somewhat questionable, and if actual demand turns out to be lower than projected, over $250 million will have been spent before this knowledge exists. And due to quirks in federal funding, at that point if the system were to be shut down, much of the federal grant money would have to be repaid. The practical consequence is that such systems—no matter how unsuccessful—are virtually never shut down.

Finally, the arguments cited by SWRTA alleging major job creation and economic growth due to implementing commuter rail are difficult to justify. First, much of the capital spending (e.g., on the DMU rolling stock) will take place in other states or other countries, and the construction jobs (for new stations and sidings) would be temporary. And the idea that a few thousand rail transit riders per day would lead to a $2.1 billion increase in property values cannot be taken seriously.

Decisions about transportation improvements should be based on whether they produce enough improvements in transportation to be worth what they cost. SWRTA is proposing an approach with high costs and only modest transportation benefits. More cost-effective alternatives, such as those suggested in this study, deserve serious consideration.

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Driver Comprehension of Signing and Markings for Toll Facilities by S.T. Chrysler, A.A. Nelson, K. Fitzpatrick, Texas Transportation Institute, Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office P.O. Box 5080, Austin, Texas 78763-5080; 979.845.1734; http://tti.tamu.edu/documents/0-5446-2.pdf) (Feb 2008)

Highlights
- This report summarizes research activities in the second year of a three-year effort to assess driver comprehension of toll facility operations and traffic control devices.

Since 2006, the Texas Manual on Uniform Traffic Control Devices (TMUTCD) has contained a chapter governing signs for toll facilities (1). The standards and guidelines it contains apply to new and existing toll facilities in the state of Texas, including conventional toll roads with cash plazas, open road tolling facilities that accept electronic payment only, and managed lanes with a tolling component. As new toll facility operations and design continue to evolve in Texas, new traffic control devices are needed to convey information to drivers. In the past year, new operations have come to bear on toll roads in Texas. The most important of these is video tolling, which allows drivers to use an electronic toll collection (ETC) facility, even if they don't possess a toll tag. When a non-tag vehicle passes through a toll gantry, the system photographs the license plate of the vehicle. The tolling agency sends the registered vehicle owner a bill by mail for the toll plus a small handling fee. Many of the signs in the current TMUTCD Chapter 2J contain the phrase "TxTAG Only," which was originally intended to be used for ETC facilities. With the advent of video tolling, adjustments to these signs, or additional supplementary signs, will be needed.

The current federal Manual on Uniform Traffic Control Devices (MUTCD) contains no information directly related to toll facilities, but it does have some preferential lane guidance that can be applied to managed lanes. A recent Federal Highway Administration (FHWA) project summarized the best practices for toll plaza design, including traffic control devices. Additional research sponsored by FHWA focused on symbols used for electronic payments at toll plazas and on open road tolling facilities. These efforts led to a FHWA policy memorandum concerning toll plaza design and signing. An upcoming Notice of Proposed Amendment to the MUTCD, expected in the autumn of 2007, promises to address more fully issues relating to signs, signals, and markings for toll roads and managed lanes.

The first year of this project identified current practices in other states and countries concerning driver information on toll facilities (6). Most states and toll operators have tried to apply the principles of guide sign design and sign sequencing to their roadways. For the most part, toll road signing is identical to freeway signing. The places where it most differs are in directional signing from adjoining non-toll facilities and in toll plaza signing. The first year of this project also included focus groups in three Texas cities (Austin, Arlington, and San Angelo) to assess driver comprehension of toll route numbering, frontage road entrance ramp signing, guide sign banners, cash pull-out lanes for open road tolling, and pricing signs for managed lanes. During the first year, the researchers also developed example typical layout drawings and a detailed outline of a field book that will be the final product of this project.

This report summarizes research activities in the second year of a three-year effort to assess driver comprehension of toll facility operations and traffic control devices. The research during this year consisted of driver comprehension assessment of specific signs and markings. A parallel research and design effort was undertaken to develop principles of traffic control device design and placement that could be applied to new and existing roadways. A series of typical layout drawings is under development, as well, which eventually could form the basis for a revision to Chapter 2J of the TMTUCD.