

TRANSPORTATION RESEARCH DIGEST

FEBRUARY-MARCH 2008

ARIZONA TRANSPORTATION INSTITUTE

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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.

The *Transportation Research Digest* is not meant to present definitive resolutions of scientific or policy controversies, but contributions to the pursuit of knowledge and the debate of issues. The intent is to be comprehensive rather than conclusive on the multitude of issues and topics of concern to those working in the field of transportation. Readers are encouraged to obtain the original document summarized in the *Transportation Research Digest* and subject the content to their own judgment.

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Transportation Research Digests from December 1995 to November 2003 are available at <http://www.dot.state.az.us/ABOUT/atrc/Publications/DocRev/TRDtest.htm>

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ADM	Administration	PLAN	Planning
AIRP	Airports	PRIV	Privatization
AVIA	Aviation	RAIL	Railroads
BIKE	Bicycles	RDSO	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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Thank you.

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Airport Aviation Activity Forecasting, ACRP Synthesis 2 by William Spitz and Richard Golaszewski, GRA Inc. Jenkintown, Pennsylvania (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>) (2007)

Highlights

- The primary statistical methods used in airport aviation activity forecasting include market share analysis, econometric modeling, and time series modeling.

This synthesis study provides a review of airport aviation activity forecasting in the United States. Forecasts of airport aviation activity have become an integral part of transportation planning. Most airport-specific forecasts are prepared on behalf of airport sponsors and state or regional agencies. The type and method of forecasting can depend importantly on the purpose for which the forecast is being made. For example, there may be sharp variations between forecasts used to support an annual budget versus a long-term facilities expansion.

In practice, an important factor affecting many forecasts is that they are developed in support of the master planning process that is used by FAA to identify capital projects that may qualify for funds from the agency's Airport Improvement Program. This is the primary federal funding mechanism for public-use airport improvements.

The primary statistical methods used in airport aviation activity forecasting include market share analysis, econometric modeling, and time series modeling. These methods can be used to create forecasts of future airport activity over time. Simulation models are a separate method of analysis used to provide snapshot estimates of traffic flows across a network or through an airport.

There are several activity measures typically included in airport aviation activity forecasts; the two most commonly used for commercial airports are aircraft operations and passenger enplanements. Based aircraft counts are important at general aviation airports because they drive the need for hangars, fueling, and other facilities.

One of the most important requirements in preparing forecasts is to obtain accurate historical data on aviation activity. There are many useful data sets available from the federal government and other sources. For forecasts involving econometric modeling, it is also necessary to obtain historical data and future estimates of the explanatory variables to be included in the model.

The market share approach to forecasting is a top-down method where activity at a particular airport is assumed to be tied to growth in some aggregate external measure (typically a regional, state, or national aviation growth rate). For this method to produce reasonable predictions, it is important that the presumed relation between airport activity and the larger aggregate measure be relatively constant over time.

Many airport forecasts use econometric methods that utilize explanatory variables-factors thought to explain changes in the demand and/or supply of aviation activities. These factors can be broadly grouped into macroeconomic and demographic factors, airline market factors, air transport production costs and technology, regulatory factors, infrastructure constraints or improvements, and

potential substitutes for air travel. Although econometric modeling is potentially a very sound and powerful method, there are many ways in which the specific model can go wrong, and it is not always obvious how best to proceed when statistical tests or data issues indicate a problem.

Time series modeling is another forecasting approach that involves some form of extrapolating existing data into the future. In its simplest form, it is based only on values of the variable being forecast and projects the future based on current or past trends. Because one does not need to collect data on other variables, it can be a low-cost method compared with econometric modeling. Although the approach is conceptually simple, specific statistical techniques that are employed to make it more accurate can be quite sophisticated. This method can be useful when there are unusual conditions that make the relationship between local activity and other external factors unstable.

Simulation models are a separate method of analysis used to obtain high-fidelity snapshot forecasts of traffic flows in a network or at an airport. Such models impose precise rules that govern how passengers or aircraft are routed, and then aggregate the results so that planners can assess the infrastructure needs of the network or airport to be able to handle the estimated traffic.

Airport forecasting studies often neglect the issue of uncertainty. Most often, forecasts are presented only as point estimates, although it is common to also present alternative “high” or “low” estimates that are based on differing assumptions about external factors thought to affect the forecast. Although this can provide a reasonable range of estimates, there are

additional sources of uncertainty related to the statistical properties of the models employed that are often neglected entirely.

Accuracy is another often-neglected aspect of forecast evaluation, largely because it can only be done after the fact—when values can actually be measured and compared with their forecast estimates. This problem is particularly relevant for long-term aviation forecasts where accuracy cannot be fully assessed for many years. Once the data are accessible, there are a variety of metrics available to measure forecast accuracy.

There is a potential for optimism bias in airport forecasting that is countered by the issuance of FAA guidance documents, requirements for master planning, and other rules that local sponsors must follow when applying for grants.

In cases where more than one forecast is available for consideration, a number of alternative approaches can be pursued. These include critical analysis of each individual forecast to help identify possible errors or mistakes, consideration of each forecast’s predictions by experts in the field who may possess significant domain knowledge regarding current and future airport activities, and combining multiple forecasts to yield consensus averages.

Several avenues for future research are suggested by this study including investigation into the reliability of data collection (particularly at smaller airports), detailed study of common statistical and data problems associated with econometric forecasting models, the potential use of time series models and how their predictions compare with other methods, and formal studies of how well typical aviation forecasts project future activity.

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The Benefits and Costs of New Fuels and Engines for Cars and Light Trucks by Ryan Keefe, Jay Griffin, And John D. Graham (RAND Corporation, Publications Orders, P.O. Box 2138, Santa Monica, CA 90407-2138; phone: 877-584-8642; order@rand.org; http://www.rand.org/pubs/working_papers/2007/RAND_WR537.pdf) (Nov 2007)

Highlights

- This report examines the benefits and costs of three alternatives to the gasoline-powered internal combustion engine.
- Advanced diesel technology had the best benefit/cost profile.
- Vehicles powered continuously by a mixture of 85% ethanol and 15% gasoline had the worst benefit/cost profile.
- If the cost of producing ethanol for E85 declines significantly or if gasoline prices remain very high (\$3.50 per gallon), then E85 can compete.

Concerns about high gas prices, global climate change, and the risks of oil dependence are spurring interest in new engines and fuels for passenger cars and light trucks. Automakers are considering new propulsion systems for vehicles, while the U.S. Congress and many states are considering new legislation to reduce oil use in the transport sector of the economy.

This report examines the benefits and costs of three alternatives to the gasoline-powered internal combustion engine for the 2010–2020 period: gasoline-electric hybrid technology, advanced diesel technology, and vehicles powered continuously by a mixture of 85% ethanol and 15% gasoline (E85), where the ethanol is produced from corn. Each technology is compared to a gasoline-powered vehicle (with otherwise comparable features) from both a consumer and societal perspective, with results expressed on a per-vehicle basis for a new mid-sized car, a midsized sport utility

vehicle (SUV), and a large pickup truck. The key numeric output of the analysis is the net present value (NPV) of a technology expressed in 2005 dollars.

The nominal results from the consumer perspective account only for technology cost, fuel savings, mobility, and performance. For the passenger car, the private NPV was \$198 for the hybrid, \$460 for the diesel, and –\$1,034 for the vehicle that runs on E85. For the SUV, the NPV was \$1,066 for the hybrid, \$1,249 for the diesel, and –\$1,332 for E85. For the pickup truck, the NPV was \$505 for the hybrid, \$2,289 for the diesel, and –\$1,632 for E85. These results assume fuel prices of \$2.50 per gallon for gasoline, \$2.59 per gallon for diesel fuel, and \$2.04 per gallon for E85 (including the current 51-cent tax credit for use of ethanol in motor fuels).

The results of the private analysis are sensitive to fuel-price assumptions. In a high gas-price scenario (\$3.50 per gallon), the diesel retains an advantage over the hybrid for pickup trucks, but the hybrid is preferred for cars and SUVs. The NPV of the E85 vehicle also improves in the high gas-price scenario. It has positive NPV for all three vehicle types, and the size of the NPV is larger than the NPV of the hybrid and diesel for passenger cars. A low gas price (\$1.79 per gallon) hurts all three alternate technologies: Hybrids and E85 have negative NPV in each vehicle type; diesels are unattractive for cars but retain a positive NPV for SUV and pickup applications.

The societal perspective includes a much larger range of considerations such as conventional tailpipe pollutants, greenhouse gas emissions, and energy security. Despite the added complexity of the societal analysis, the results are similar to those reported for the consumer perspective. For the passenger car, the NPV is -\$317 for the hybrid, \$289 for the diesel, -\$1,046 for E85. For the SUV, the NPV is \$481 for the hybrid, \$1,094 for the diesel, and -\$1,500 for E85. For the pickup truck, the NPV is \$132 for the hybrid, \$2,199 for the diesel, and -\$2,049 for E85. The absolute magnitudes of the societal results are influenced by the exclusion of transfer payments (e.g., fuel taxes).

The societal results are also sensitive to future fuel prices (see attached summary table). At expected long-run fuel prices (\$2.50 per gallon), public policies that accelerate the diffusion of diesels and hybrids may, depending on the balance of existing policies,

enhance social welfare to a greater extent than policies that enlarge the use of E85 based on corn-based ethanol. But if the cost of producing ethanol for E85 declines significantly or if gasoline prices remain very high (\$3.50 per gallon), then E85 has positive NPV and can compete favorably with diesels and hybrids. If the cost of gasoline should fall significantly and stay low (\$1.79 per gallon), then the only promising measures are some limited application of advanced diesel engines in large pickup trucks.

In order to provide context for these analytic results, the report discusses a variety of market developments and public policies that are influencing the rate of penetration of these technologies. Ideally, public policy should focus on setting the correct incentives for market participants and allowing the best portfolio of technologies to emerge through market competition.

Table ES-1: NPV of Hybrid, Diesel, and E85: Alternative Oil and Ethanol Prices (2005\$)

Passenger Car					
Oil Price Case	Hybrid NPV	Diesel NPV	E85 NPV by Ethanol Price		
			Low	Nominal	High
Low	-\$1,205	-\$374	-\$207	-\$2,110	-\$3,143
Nominal	-\$317	\$288	\$1,336	-\$1,045	-\$2,370
High	\$935	\$1,219	\$4,117	\$1,113	-\$627

Sport Utility Vehicle					
Oil Price Case	Hybrid NPV	Diesel NPV	E85 NPV by Ethanol Price		
			Low	Nominal	High
Low	-\$636	\$264	-\$379	-\$2,936	-\$4,347
Nominal	\$477	\$1,092	\$1,669	-\$1,504	-\$3,290
High	\$2,044	\$2,257	\$5,341	\$1,368	-\$950

Large Pickup Truck					
Oil Price Case	Hybrid NPV	Diesel NPV	E85 NPV by Ethanol Price		
			Low	Nominal	High
Low	-\$1,007	\$1,162	-\$568	-\$4,005	-\$5,925
Nominal	\$135	\$2,207	\$2,171	-\$2,046	-\$4,438
High	\$1,742	\$3,679	\$7,019	\$1,792	-\$1,272

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The Compromise Energy Bill: Harmful Regulation, Not Affordable Energy by Ben Lieberman (Heritage Foundation, 214 Massachusetts Ave NE, Washington DC 20002-4999; ph 202.546.4400; <http://www.heritage.org/Research/EnergyandEnvironment/wm1721.cfm>) (Dec 5, 2007)

Highlights

- ❑ Vehicle downsizing costs 1,300 to 2,600 lives per year. A tougher fuel economy standard would likely add to the death toll from vehicle crashes.
- ❑ Ethanol has failed to deliver on its promise to appreciably reduce greenhouse gas emissions and dependence on oil imports.
- ❑ Under this bill, the price increases for food and fuel would likely skyrocket.
- ❑ The bill does nothing to untangle the red tape that has slowed refinery expansions.

Congress' new energy bill contains a sharp increase in the federally mandated corporate average fuel economy (CAFE) standards. Under this proposal, each manufacturer's fleet of passenger vehicles would have to average 35 miles per gallon by 2020, a roughly 40% increase over current standards for cars and trucks.

In theory, consumers can save at the pump by being made to switch to more efficient vehicles, and at the same time reduce greenhouse gas emissions and oil imports. But doing so will raise sticker prices, and the costs could more than negate the energy savings.

Beyond costs, in order to meet the tough new CAFE standard, cars and trucks will need to be lighter, which makes them less safe in collisions. A National Academy of Sciences study concluded that vehicle downsizing costs 1,300 to 2,600 lives per year. A tougher fuel economy standard would likely add to the death toll from vehicle crashes.

Federally mandated smaller vehicles also raise the consumer choice issue. Washington is acting as if fuel efficient cars and trucks are currently unavailable, but in truth a variety of such models are already on the market for those who want them, including a growing number of hybrids. They fit the needs of some people, but not others. Does the American car-buying public--from soccer moms to seniors--really want or need Washington stepping in and forcing smaller vehicles on everyone?

The bill goes above and beyond the current renewable fuels standard with an expanded mandate that will cost Americans at the pump, at the supermarket, and at tax time.

The 2005 energy bill required that agricultural-based renewable fuels, mostly ethanol made from corn, be mixed into the gasoline supply. The mandate has raised the cost of driving, because mixing ethanol into the gasoline supply reduces fuel economy. Ironically, the increase in fuel economy standards in the bill will be partially negated by the expanded use of less-efficient ethanol.

Ethanol has also failed to deliver on its promise to appreciably reduce greenhouse gas emissions and dependence on oil imports.

At the same time, the diversion of corn to ethanol plants has led to higher corn prices, in turn leading to higher prices for food items such as corn-fed meat and dairy products. Current ethanol usage is much lower than that envisioned in the current bill, but an Iowa State University study estimates that food prices

have already increased by \$47 annually per capita, or \$14 billion overall.

The new bill seeks to increase the current mandate nearly five-fold--from 7.5 billion gallons by 2012 to 36 billion by 2022. Meeting this expanded mandate will require not only much more corn-based ethanol but also other renewable fuels that are even more expensive. The bill specifies that 21 billion gallons of the total be cellulosic ethanol, even though this energy source is just a few steps beyond the drawing board at this time. It is unknown whether it can be produced in such quantities and at what cost.

Under the new standards, the price increases for food and fuel, which are expected to be significant under the current, smaller mandate, would likely skyrocket.

The bill may also include hefty penalties for refiners that are unable to comply with the mandate--a real possibility, especially given how unproven cellulosic ethanol is at this point. These penalties would act as the equivalent of a gas tax, further raising the price at the pump.

In addition, the large government subsidies for renewables, including a 51-cent-per-gallon tax credit, would rise commensurate with the mandate. The agricultural subsidies to corn growers would also expand with the increase in acres planted. Further, the handouts necessary to launch the cellulosic ethanol industry would also be significant. These costs, to be borne by taxpayers, could soon reach tens of billions of dollars annually. In effect, taxpayers would be paying hundreds of dollars per household for the privilege of higher fuel and food prices.

Conspicuously absent from the bill is any effort to increase the supply of the proven energy sources that America relies upon. An energy bill that helps consumers would streamline or eliminate the many laws and regulations that restrict access to domestic oil, both offshore and onshore, but no such measures are included. The bill also does nothing to untangle the red tape that has slowed refinery expansions.

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Comparative Evaluation of Infrastructure Strategies to Reduce Emissions from Intermodal Freight Movement in Southern California by Jeffrey Ang-Olson & Cristiano Facanha, ICF International, 394 Pacific Avenue, San Francisco, CA 94111 in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC.* (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- ❑ Electrification of the entire mainline railroad system would achieve by far the largest emission reductions.
- ❑ The Alameda corridor electrification is the most cost-effective of the five strategies, followed by expansion of on-dock rail.
- ❑ Compared to the total baseline emission inventory in the region, the reductions are relatively small.

This paper evaluates five major infrastructure projects that could substantially reduce emissions from intermodal goods movement in Southern California: On-dock railroad expansion, Near-dock railroad expansion, Mainline railroad capacity expansion and grade separation, Electrification of the Alameda Corridor, and Electrification of the entire regional railroad mainlines. Given the importance of Southern California as a gateway for international trade, need for expansion of the capacity of the region's good movement system, and the contribution of goods movement to the region's serious air quality problems, it is important to understand the emissions impacts of major goods movement infrastructure projects. This study finds that all five infrastructure projects can reduce a significant amount of emissions.

Table 6 summarizes the emission reductions and cost effectiveness of the five strategies reviewed in this paper. Electrification of the entire mainline railroad system would

achieve by far the largest emission reductions, eliminating more than 80% total railroad emissions in the region. Mainline capacity expansion would achieve the next largest reductions. The Alameda corridor electrification is the most cost-effective of the five strategies, followed by expansion of on-dock rail.

Compared to the total baseline emission inventory in the region, the reductions in Table 6 are relatively small but not insignificant. Annual average baseline emissions from all sources in 2020 are projected to be 525 tons/day of NO_x and 103 tons/day of PM_{2.5}. Thus, reductions from the most effective strategy (total mainline railroad electrification) represent 3.9% of all NO_x emissions and 0.6% of all PM_{2.5} emissions.

Perhaps a more important comparison can be made against the emission reductions needed to achieve attainment of the ambient PM_{2.5} and 8-hour ozone standards. The PM_{2.5} attainment date is 2014, which is probably too soon to fully implement some of the strategies considered in this paper. Nonetheless, even partial implementation of some strategies could contribute significantly to the attainment goals. Of the emission reductions needed to achieve the PM_{2.5} standard (192 tons/day of NO_x and 14 tons/day of PM_{2.5}), the total mainline railroad electrification strategy would provide 11% and 5% of the target reductions, respectively. The ozone attainment date is 2021 (likely to be extended to 2023). Of the emission

reductions needed to achieve the ozone standard (383 tons/day of NOx), the total mainline railroad electrification strategy would provide 5% of the target NOx reductions.

Given the difficulty in achieving large emission reductions from any sector, these contributions would be significant.

Table 6: Summary of Strategy Impacts, 2020

Strategy	Emission Reduction (tons/day)		Cost-effectiveness (\$/ton)	
	NOx	PM2.5	NOx	PM2.5
On-dock rail expansion	2.92	0.13	\$22,000	\$537,000
Near-dock rail expansion	0.64	0.03	\$46,000	\$1,163,000
Railroad mainline capacity expansion	5.67	0.19	\$43,000	\$1,287,000
Alameda corridor electrification	2.22	0.07	\$15,000	\$485,000
Total mainline railroad electrification	20.63	0.64	\$43,000	\$1,348,000

Figure 1: Baseline Goods Movement NOx Emissions (SoCAB)

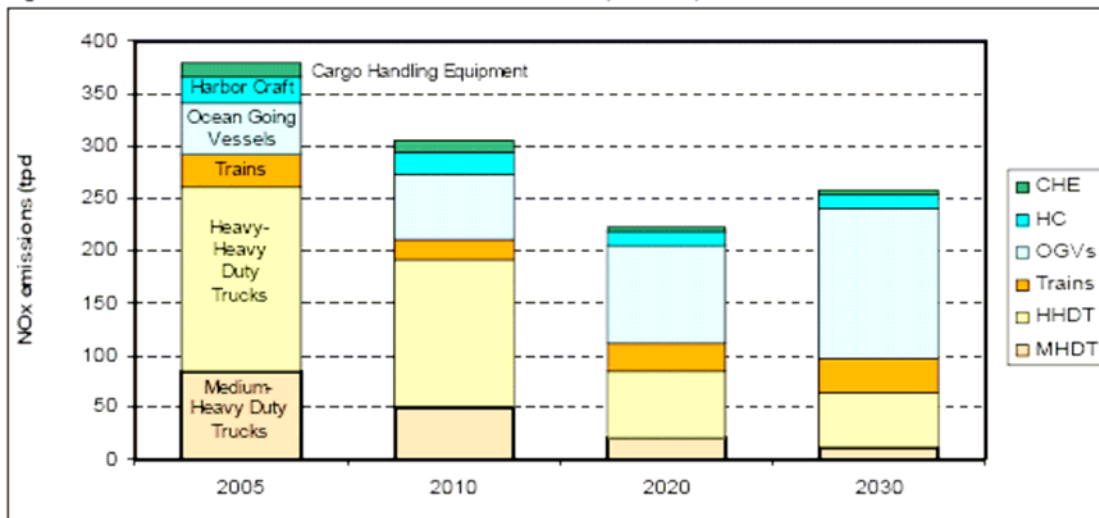
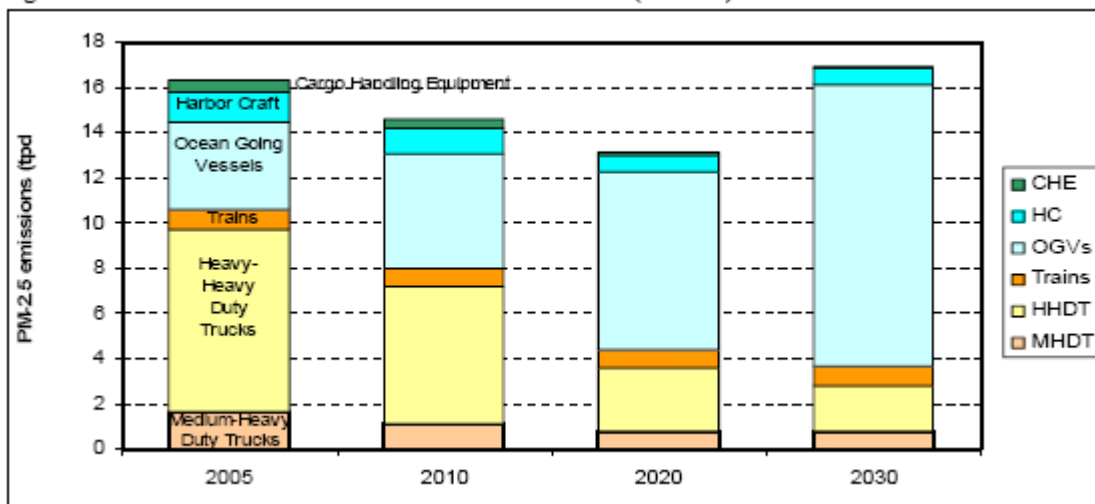


Figure 2: Baseline Goods Movement PM-2.5 Emissions (SoCAB)



TRANSPORTATION RESEARCH DIGEST

ARIZONA TRANSPORTATION INSTITUTE

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FEBRUARY-MARCH 2008

Renewable and Nuclear Heresies in *International Journal of Nuclear Governance, Economy, and Ecology* by Jesse H. Ausubel (Program for the Human Environment, The Rockefeller University, 1230 York Avenue, New York, NY 10021, USA; E-mail: ausubel@rockefeller.edu; <http://phe.rockefeller.edu/docs/HeresiesFinal.pdf>) (Vol. 1, No. 3, July 2007) Excerpt from a review by Steven Milloy in *Environment News*, Publisher: Heartland Institute (October 2007).

Highlights

- Reliance on renewable energy sources would result in more intrusion on the natural environment than reliance upon nuclear power.

Rockefeller University's Jesse Ausubel, a prominent environmental advocate, has stunned other environmental activists by reporting in the July *International Journal of Nuclear Governance, Economy, and Ecology* that the use of renewable energy is wrecking the environment.

"Renewables are not green," is how Ausubel begins the article. It is a remarkable statement coming from someone who beat his fellow Greens to global warming alarmism by at least 10 years.

In his new article, Ausubel calculated the amount of energy produced by various renewable energy sources--including hydroelectric, biomass, wind, and solar power--in terms of power output per square meter of land disturbed.

For example, if you could collect the average annual rainfall of the 900,000 square kilometer Canadian province of Ontario--about 680,000 billion liters of water--and store it behind a dam 60 meters tall, you would produce a regular output of about 11,000 megawatts of electricity--which is only about 80% of the output of Canada's 25 nuclear power stations.

In other words, this works out to a power production rate of 0.012 watts per square meter of land. It would take 1 square kilometer of land to provide enough electricity for about 12 Canadians. This inefficiency is a key reason environmentalists have reduced their demands for greater use of hydroelectric power.

According to Ausubel, biomass is even more harmful. Large-scale power generation from biomass would require vast areas be shaved or harvested annually. It would take 2,500 square kilometers of prime Iowa farmland to produce as much electricity from biomass as from a single nuclear power plant.

"Increased use of biomass fuel in any form is criminal," Ausubel stated in a media release. "Every automobile would require a pasture of 1-2 hectares."

Wind power, Ausubel's study shows, is much less land-intensive than biomass, but that's not saying much. A 770 square kilometer area would produce only as much electricity as a single 1,000 megawatt nuclear plant.

A wind farm the size of Texas would be required to extract, store, and transport annual U.S. energy needs. "Every square meter of Connecticut" would have to be turned into a wind farm just to provide all of New York City's electricity demands.

Solar power is also quite a land hog, according to Ausubel. As photovoltaic cells are only 10% efficient and have seen no real breakthroughs in 30 years, U.S. electric consumption would require a 150,000 square

kilometer area of photovoltaics--an area the size of England--plus additional land for electricity storage and retrieval.

The photovoltaic industry would have to step up its production by 600,000 times its current output to produce the same amount of power as is generated by a single 1,000 megawatt nuclear plant.

In addition to land misuse, Ausubel identifies other undesirable consequences of renewables. Wind power produces low-frequency noise and thumps, blights landscapes, interferes with TV reception, and chops birds and bats to death; dams kill rivers; and solar power would require large areas of land be essentially "painted black" with photovoltaic cells. The infrastructure of a wind farm uses five to 10 times the amount of steel and concrete used in a 1970 vintage nuclear power plant.

The first part of Ausubel's heresy closes with a sobering assessment: "Cheerful self-

delusion about new solar and renewables since 1970 has yet to produce a single quad of the more than 90 quadrillion BTU of total energy the U.S. now yearly consumes. Renewables are not Green."

The second part of Ausubel's heresy is his prescription for nuclear power. Greens traditionally oppose nuclear power wherever and whenever they can. Even those Greens that say it's time to consider nuclear power seem to be paying no more than lip service to the concept--witness the lack of progress on greenhouse gas-free nuclear power despite all the hoopla about supposed fossil fuel-caused manmade climate change.

Ausubel says, "Like computers, to grow larger, the energy system must now shrink in size and cost. Considered in watts per square meter, nuclear has astronomical advantages over its competitors."

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

What If There Were “Green” Cars? A Litmus Test for Planners in Surface Transportation Innovations by Robert W. Poole, Jr. (Reason Foundation, 3415 S. Sepulveda Blvd., Suite 400, Los Angeles, CA 90034; 310/391-2245) (Dec 2007)

Highlights

- ❑ New hybrid cars are less polluting per person-mile than most urban transit systems.
- ❑ Transit averages 310 grams per person-mile, compared with 307 for the average 2006 model car.
- ❑ The 2007 Toyota Prius hybrid clocks in at just 147 grams per person-mile.

Over the last several decades, reducing vehicle miles of travel (VMT) has become a core goal of many transportation planners. The original rationale was cleaner air, since in much of the country, tailpipe emissions were the largest contributor to smog. But that problem is nearly resolved, as newer generations of very clean cars (and now diesel trucks) enter the fleet and older generations are retired. Today, the rationale for VMT reduction is to reduce greenhouse gas emissions. The draconian California bill to link state transportation funding to high-density land-use plans is aimed at reducing VMT. There are many other examples of transportation programs justified as VMT-reducers. A recent environmental summit in France even endorsed the idea of banning the construction of any more airports or highways.

However, suppose technology gave us a truly “green” automobile that produced little or no greenhouse gases (GHGs). Would we still want VMT reduction? After all, travel expands personal and economic choices—whether of jobs, recreation, entertainment, or dating. The huge cost of today’s urban traffic congestion should be measured not merely in time and fuel

wasted stuck in congestion, but also in terms of personal and economic opportunities foregone.

So let’s take a closer look at actual GHG production by various modes of transport. Wendell Cox has crunched the numbers, making what appear to be reasonable assumptions and reliable sources of GHG emissions per person-mile for urban travel, by mode (www.demographia.com/db-ghg-carstr.pdf). These figures include the costs of electricity generation and transmission for those modes using electric power and refining and distribution costs for modes using petroleum-based fuels.

For urban transport, as in many other comparisons, the way the New York metro area is treated makes a big difference. Transit has such off-the-charts mode share there, compared to anywhere else in the USA, that it’s entirely a special case. So comparing GHG emissions per passenger mile for personal vehicles with the average for New York transit is no contest—except for hybrid cars, New York transit is less than half as GHG-intensive. But when you compare transit everywhere else (aka, the real world), the picture is dramatically different. Transit elsewhere averages 310 grams per person-mile, compared with 307 for the average 2006 model car and 328 for the overall car fleet in 2006. Personal trucks and SUVs, of course, are higher—at 374 for 2006 models and 416 for the whole truck/SUV fleet in 2006.

But what’s on the horizon are dramatically lower personal vehicle emissions. The 2007 Toyota Prius hybrid clocks in at just 147, and a 2008 Peugeot hybrid diesel (so far

offered only in Europe) at 101. The latter is better than the average of New York metro area transit (140). And that is just what exists today. Technology is moving toward more efficient and less-GHG-intensive vehicles, and new government GHG standards are not far off. So the idea that we should be restricting mobility by VMT reduction mandates in order to “save the planet” from global warming may be unwarranted.

Incidentally, Demographia also has numbers for inter-city trips, comparing airline, rail (Amtrak), inter-city bus, and autos. Here the measurements are for CO2 trip emissions per passenger, by mode. The Peugeot diesel hybrid was best for short-haul trips, but a pretty close second was inter-city bus. Amtrak finished last or next to last, with numbers fairly close to SUVs. Airlines did better than Amtrak for trips of all lengths.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Statewide Distance-Based User Charge: The Case of Oregon by Lei Zhang and B. Starr McMullen in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC.* (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- ❑ The gasoline tax is no longer an economically efficient method of generating revenue.
- ❑ Among the most promising alternatives is a VMT fee, also called a distance-based user charge.
- ❑ It is a fee charged to individual drivers that is directly proportional to miles driven.

Before the introduction of cars, roads were usually financed locally since those in the area were generally the only ones who used the roads. Toll booths were used as far back as 1100 as a way to finance the bigger, more costly projects such as bridges. During the Industrial Revolution, as goods were being transported all over, a new way of financing roadways became necessary. It was no longer a local issue and local property owners were overburdened. In 1663, the first turnpike was established in Great Britain and by 1839, there were over 900 turnpikes. By the time automobiles were introduced in the 19th century, rail transportation had replaced turnpikes and policy makers sought yet another method of financing the roadways. It was then that the gasoline tax was introduced. In its early years, the gasoline tax served as a relatively efficient method of distributing the cost of maintaining roadways evenly among drivers. In 1919, Oregon, New Mexico and Colorado became the first states to pass the gasoline tax. By 1929, 48 states and DC had passed the gasoline tax.

In the recent years, however, it has become evident, both at the national and state level, that the gasoline tax – the Highway Trust Fund’s primary revenue source – is no longer an economically efficient method of generating revenue. According to a report prepared by Cambridge Systematics, Inc., maintaining the nation’s current highways and transit systems required approximately \$222 billion in 2005, and that amount is estimated to be \$295 billion for 2015. In order to improve the current highways and transit systems, those numbers jump to \$271 billion (2005) and \$356 billion (2015). In reality, however, 2005 annual resources only amounted to approximately \$180 billion, from all levels of government, well short of covering even maintenance costs. The federal gasoline tax has not increased since 1993 and tax revenues have plummeted due, in part, to increased inflation and greater fuel efficiency. Alternative fuels and fuel efficiency have not completely disrupted tax collection, but it has become clear that an alternative to the gasoline tax is necessary.

Oregon faces similar challenges; its population is growing faster than the national average. Although average vehicle miles traveled (VMT) per capita has remained relatively constant, total VMT is expected to increase by 1.35% annually through 2030. According to the 2000 U.S. Census, the population in Oregon was recorded at 3.42 million and by 2030 there will be an estimated 4.8 million people; a 41% increase.

Current practices are inefficient in that drivers hardly recognize the marginal damage they cause to the roads and to other drivers. Economic theory suggests under certain conditions setting prices equal to marginal cost will yield the most efficient outcome. This methodology often falls apart when put into practice for several reasons including: a lack of support from the public or private sector, technological barriers or high costs. This has led to a vast literature on optimal second best pricing. Among the most promising alternatives is a VMT fee, also called a distance-based user charge that will eventually replace the gasoline tax. As with any tax increase, there are concerns regarding social equity and distributional effects that will place a greater burden on the lower income population. Many studies estimate the distributional impacts of a gasoline tax, which was found to be regressive. Fewer studies, however, have focused on the tradeoffs between efficiency and equity of a VMT fee.

A distance-based user charge has great flexibility in planning and implementation. The fee could vary, for example, by vehicle class, fuel efficiency, time of day, or location. In general, however, it could best be described as a fee charged to individual drivers that is directly proportional to miles driven. The user fee concept described throughout this paper differs from other road pricing schemes, such

as congestion pricing or toll roads. Although both schemes often involve GPS technology, they are limited to specific areas and communicate with vehicles through a system of sensors that can, for example, turn on when a vehicle enters an express lane.

Tolls are sometimes used to pay off the new road it exists on and are taken down once the builders make their money back. Express lanes offer superior services for a fee; users of these lanes are willing to pay to avoid heavy traffic and can expect more reliable arrival times. A distance-based user charge on the other hand, attempts to charge all drivers for their road use to generate enough revenue to maintain an entire road network. Road damage is more correlated with distance driven than with gasoline consumption, which allows for a distance-based charge to be fairer in the sense that it forces drivers to be more responsible for the damage they cause to the roads as well as external costs to other drivers.

This paper provides a literature review on previous and ongoing studies that involve the distance-based user fee concept, and describe the history and current status of the statewide policy initiative of replacing the gas tax with VMT fees in Oregon. This paper also summarizes the recurring issues with regard to VMT fees brought up by the general public and policy makers.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Audit Report: Department of Transportation Motor Vehicle Administration by Bruce A. Myers (Office of Legislative Audits, Department of Legislative Services, Maryland General Assembly, 301 West Preston Street, Room 1202, Baltimore, Maryland 21201; phone 410-946-5900; <http://www.ola.state.md.us/Reports/Fiscal%20Compliance/MVA07.pdf>) (Oct 2007)

Highlights

- ❑ MVA does not have effective policies and procedures to oversee its Ignition Interlock Program.
- ❑ Required documentation (such as proof of residency) was not always obtained for licenses issued.
- ❑ MVA did not take timely action to enforce State laws that require vehicle owners to maintain insurance coverage.

The Motor Vehicle Administration (MVA) is part of the Maryland Department of Transportation and is subject to certain provisions of the Transportation Article of the Annotated Code of Maryland. MVA has jurisdiction over a variety of activities related to the ownership and operation of motor vehicles, including the registration and titling of vehicles. MVA maintains a headquarters location in Anne Arundel County and 24 branch offices throughout the State with a total authorized workforce of approximately 1,600 employees. According to MVA records, during fiscal year 2006, MVA's collections, which primarily consisted of motor vehicle excise taxes and vehicle registration fees, totaled approximately \$1.3 billion.

The Department of Transportation – Motor Vehicle Administration (MVA) was audited for the period beginning January 1, 2004 and ending November 30, 2006.

The audit disclosed that MVA does not have effective policies and procedures to oversee its Ignition Interlock Program (IIP). By

requiring enrollees to have ignition interlock devices installed in their vehicles, IIP is intended to help prevent individuals convicted of alcohol-related driving violations from driving while intoxicated. However, MVA failed to take appropriate follow-up action for certain individuals who repeatedly violated the terms of the program, and such individuals were subsequently returned to a normal driving status.

The audit also disclosed that procedures and controls over driver's licensing transactions and related suspensions and revocations were not sufficient. For example, required documentation (such as proof of residency) was not always obtained for licenses issued, and certain licenses appeared to have been issued improperly, such as to individuals who were deceased. License suspensions and revocations and related appeals were also not processed timely, allowing licensees to retain their driving privileges for longer periods.

MVA's procedures for monitoring licensed vehicle dealerships were not comprehensive to ensure that vehicle titling and registration transactions were properly processed and that the related excise taxes and fees were properly assessed. For example, dealership audits of these activities were not comprehensive, and MVA improperly waived certain penalties assessed for late submission of vehicle excise taxes and related fees by the dealerships.

MVA did not take timely action to enforce State laws that require vehicle owners

to maintain insurance coverage for registered vehicles. Although State law requires the immediate suspension of a registration for any vehicle for which the insurance coverage is terminated or lapses, we found that MVA generally waited 115 days to process these suspensions. Furthermore, MVA did not invoice uninsured motorists for the related assessed penalties in a timely manner.

Numerous security and control deficiencies existed with respect to eMVA Store, which is operated by a contractor and provides online services to the public. For example, sensitive personal and financial information of eMVA Store customers was not adequately protected, critical security events were not adequately monitored, and critical software was out of date. Furthermore, the

contractor was not required to receive periodic audits of its online security controls.

Finally, a number of internal control and record keeping deficiencies were noted in areas including the Vehicle Emissions Inspection Program, cash receipts, purchases and disbursements, and equipment.

MVA's accountability and compliance level was unsatisfactory, in accordance with the rating system established in conformity with State law. The primary factors contributing to the unsatisfactory rating were the number and significance of these audit findings, and the number of repeat audit findings from a preceding audit report. In this regard, MVA did not sufficiently address 12 of the 22 findings in the preceding audit report.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Best Practices of Concrete Pavement Transition Design and Construction by Youn su Jung, Dan G. Zollinger, and Shiraz D. Tayabji, 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>) (Apr 2007)

Highlights

- Proper jointing of concrete pavements is essential to ensure good performance since it is the primary key to avoiding random cracking and irregular joint movements.
- Making gradual changes between two slabs or employing load transfer equipment could reduce this discontinuous transition problem and improve performances.

Pavement transitions are key and common elements of pavement design. Transition details that are necessary for joining pavement sections that incorporate different design elements may include pavement type and pavement structure. Transition elements are necessary to ensure a smooth transition between two different pavement sections and to minimize future pavement performance issues. In this research, field visits were conducted in selected districts to survey conditions of concrete pavement transitions relative to slab cracking and associated distresses that may be related to improperly restrained segments due to inappropriate jointing practices or other design-related factors. In many districts, various forms of cracking were witnessed, providing a means to ascertain the causes and concepts for design improvements to prevent such cracking in future construction. Proper jointing of concrete pavements is essential to ensure good performance since it is the primary key to avoiding random cracking and irregular joint movements. Environmental factors such

as temperature and moisture difference between top and bottom of a slab generate curling stress; this stress can cause cracks on the pavement with traffic load. Sub grade volume changes by non-uniform settlement or expansion also impose stresses to pavement, but it is controllable by treated base relative to climatic factors. As another source of stress, traffic loadings over pavement generate deformation, especially on the corner. The major factors relating with transition behavior such as radius of relative stiffness, modulus of sub grade reaction, combined slab thickness and elastic modulus, joint stiffness, and load transfer efficiency are discussed with reliability concepts.

Joint spacing, slab thickness, and joint stiffness are the prime factors in the performance of concrete pavement transition. Joint spacing is highly related with environmental factors such as temperature and moisture. When joint spacing is short, curling stresses are low, and joint openings between two adjoining slabs are small minimizing the possibility of premature cracking. However, the more sawcut joints, the greater the impact on rideability. The advantage of longer joint spacing is improved ride ability; however, the slab has greater vulnerability to cracking due to traffic and climatic combinations and decreased joint load transfer efficiency (LTE) by greater joint openings. Dowelled joints can compensate for the lack of aggregate interlock; therefore, proper joint spacing needs to be balanced with

the need for doweling for economical and good performance design. Slab thickness design is important as a starting point in transition design and is a key in affecting the amount of deflection of a transition pavement. Failure to meet the established deflection criteria may shorten service life. A load transfer device can be used to satisfy deflection criteria and stiffen the joint against load deformation. Joint stiffness is an element of LTE between adjacent slabs and reduction of deflection. It consists of stiffness due to aggregate interlock and dowel bars.

This report focuses on the measures to improve current transition design in terms of three general categories: transverse construction joints, longitudinal construction joints, and thickness transitions. The general features such as joint details, tie bars, and dowels are addressed for each transition type; limitations are identified, and then optimized configurations relative to deflection criteria are discussed. The objective of the transition between continuously reinforced concrete (CRC) pavements is to maintain uniformity of both support and cracking across the transition area while the transition of CRC and jointed-concrete (JC) pavement is to allow the action of the joint reinforcement in the joint to isolate the movements of the CRC from the JC slab. The goal of CRC to asphalt concrete (AC) pavement transition is to reduce the free edge deflection to those developing at an interior slab location with a concomitant reduction in subgrade stress. A bridge terminal transition facilitates change from one pavement type to structure while maintaining a smooth vertical

profile. Performance of the transition can often focus on the opening and closing of the transition joints and their ability to maintain proper stiffness throughout these opening and closings. Otherwise, the seamless design considered as a continuum structure rather than individual elements can be an improvement to remove transition joints that are often the source of maintenance issues.

Longitudinal transitions are to maintain integrity and to prevent excess widening of the longitudinal joint between adjoining lanes. Joint patterns that delineate adjacent lanes should be as continuous as possible to maintain uniformity of movement between longitudinal lanes. The objective of ramps transition is to tie the movements of the ramps with the movements of the main lanes, but a transition for intersections is to promote compatibility of the movements between orthogonally arranged pavement segments included in the intersection. Transitions between new pavement and existing pavement, main highway lane and ramp, and overlay induce thickness change transversally or longitudinally. Making gradual changes between two slabs or employing load transfer equipment could reduce this discontinuous transition problem and improve performances.

To fully benefit from the findings from this project, it is recommended that implementation efforts be undertaken to further advance key transition details outlined in this report. Candidate transitions could be those at terminal bridge connections and placement intersection.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Consideration of Weather Conditions to Estimate Missing Traffic Data by Sandeep Datla in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC.* (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- The impact of cold and snow on traffic volume varies with day of the week, hour of the day and the adversity of cold.
- Weekend traffic is more susceptible to cold than weekdays.
- The impact of cold on peak hours (6%-13%) is less than off-peak hours (10%-17%).
- A reduction of 0.5% to 2.0% in traffic volume due to each 'cm' of snowfall is also concluded in this study.
- The proposed traffic-weather models provided better traffic volume estimates than the agency method.

A detailed investigation is carried out in this study to analyze the highway traffic volume variations due to cold and snow. Regression models are developed to relate the traffic volume with cold and total snowfall. In order to analyze the effect of cold according to its severity, it is categorized into 5°C intervals. The R² values of the daily traffic volume models are greater than 0.99 and all of them are statistically significant at 0.001 or a higher level when they are tested against null hypothesis using F-test. A great majority of hourly traffic volume models are also statistically significant at 95% confidence level (using F-test). The R² values of hourly models of day-time hours range from 0.957 to 0.998. Based on these statistical test results it can be concluded that selected regression analysis with continuous and dummy variables is appropriate to relate traffic volume with snow and cold.

The study results indicate that the impact of cold and snow on traffic volume varies with day of the week, hour of the day and the adversity of cold. Traffic volume in an hour decreases with the increase in severity of cold. In case of extreme cold (below -25°C) the winter hourly volume can be expected to reduce by about 17%. The weekend traffic is more susceptible to cold than weekdays. Even though Friday is a weekday, its response to cold differs from other weekdays. The impact of cold on peak hours (6%-13%) is less than off-peak hours (10%-17%).

Even though driving conditions may not be affected due to severe cold, the reduction in traffic volumes may be due to less desire of travelers to travel during severe cold temperatures because of risk in travel and increased necessity for precautionary measures for safe journeys.

A reduction of 0.5% to 2.0% in traffic volume due to each 'cm' of snowfall is also concluded in this study. Weekends experience slightly higher reductions in traffic volumes due to snowfall than weekdays. The impact of snow on traffic volume is appeared to be high in evening hours for both weekdays and weekends. However, reductions are generally similar through out the afternoon hours.

A detailed investigation is also carried out in this study to illustrate the usefulness of traffic-weather relationships in the context of imputation analysis. The imputation efficiency of traffic-weather models is compared with most efficient imputation method used by

highway agencies. The proposed traffic-weather models provided better traffic volume estimates than the agency method. The average and 95th percentile estimation errors of traffic-weather models are less than the agency method by about 30%-50%. The maximum estimation errors of study models are 50% to 75% less compared to the agency method. Therefore, it can be concluded that inclusion of weather conditions result better estimates of missing values. Even though the variations in traffic volume are very high during adverse winter conditions, the estimation errors resulting from the weather models are very

reasonable. Hence, the developed models can be recommended for imputing missing traffic volumes.

It is believed that study findings can help transportation agencies to develop and manage better data systems. Further study is currently underway to evaluate the performance of advanced imputation methods to impute missing traffic volumes during adverse winter conditions. Transferability of traffic-weather models to other jurisdictions which experience similar weather conditions should also be investigated.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Driving Under the (Cellular) Influence: The Link Between Cell Phone Use and Vehicle Crashes
by Saurabh Bhargava and Vikram Pathania, Working Paper 07-15 (AEI-Brookings Joint Center for Regulatory Studies; 1150 Seventeenth St., N.W., Suite 1100, Washington, D.C. 20036; phone (202) 862-5847; jcenter@aei-brookings.org; <http://www.aei-brookings.org/admin/authorpdfs/page.php?id=1412&PHPSESSID=0ec33ca724a4818f61a1fced1b837ad3>) (July 2007)

Highlights

- ❑ Contrary to some earlier studies, the authors find no evidence for a relative rise in crash rates due to cell phone use while driving.
- ❑ These findings should renew interest in empirical research examining the effects of cell phone use and reopen policy discussions on the costs and benefits of regulations.

The link between cell phone use and driver safety has emerged in recent years as a topic of considerable research and policy interest. Most studies have concluded that cell phone usage increases crash risk with some even comparing its danger to that of alcohol consumption. The most notable of these studies (Redelmeier, Donald A. and Robert J. Tibshirani, "Association Between Cellular Telephone Calls and Motor Vehicle Collisions," *New England Journal of Medicine*, Vol. 336, pp. 453-458, 1997) suggest that cell phones result in a four-fold increase in relative crash risk. Policy makers in several states have responded by pushing through either partial or complete bans on cell phones while driving.

The authors investigate the link between driver phone use and crash rates by exploiting a natural experiment induced by a discontinuity in pricing in popular cell phone plans. The authors first document a jump in call volume immediately after 9 pm on weekdays when most plans since 2002 allow for free calls using two large, distinct set of call level data. No

such jump occurs on the weekend. Given call sensitivity to the change in marginal prices, the authors then examine the corresponding change in crash rates around the 9pm threshold since 2002. In order to control for possible confounds, the authors compare the change in crashes around 9pm to the same change in the period prior to the introduction of pre-paid plans in 1998, as well as to weekends. While the Redelmeier and Tibshirani results imply an approximately 1 to 8% rise in crashes across the pricing threshold, the authors find no evidence for a relative rise in crash rates. In fact, the upper bounds of the authors' estimates allowed them to rule out any rise in fatal crashes larger than 2.4% and any rise in all crashes larger than .9%. To corroborate the results, the authors pursue three additional empirical strategies. None of these provide evidence to support a link between crash rates and driver cell phone use.

Reconciling our findings with that of the 4.3 fold increase in relative crash risk observed by Redelmeier and Tibshirani presents a challenge. However, a few hypotheses exist. Drivers for whom cell phones greatly increases the risk of a crash may be overrepresented in the Redelmeier and Tibshirani sample. Such selection effects suggest that the Redelmeier and Tibshirani result is at best an upper bound for the population of drivers as a whole. Further, risk-loving drivers may simply treat cell phones as a

substitute for other distractions (e.g. talking to a fellow passenger, or fiddling with their radios) (Hahn, Robert W., and James E. Prieger, "The Impact of Driver Cell Phone Use on Accidents," *Advances in Economic Analysis & Policy*, Vol. 6, No. 1, 2006.).

It is important to note, however, that this research does not imply that cell phone use is innocuous. It simply implies that current cellular use by drivers does not appear to cause a rise in crashes. It could be that drivers who use such devices compensate for the added distraction by driving more carefully. This hypothesis is consistent with the theory put forth by Peltzman (Peltzman, Sam, "The Effects of Automobile Safety Regulation," *The*

Journal of Political Economy, Vol. 83, pp. 677-726, 1975).

The authors believe that these findings should renew interest in empirical research examining the effects of cell phone use, and possibly reopen policy discussions on the costs and benefits of regulations where such dialogue has quieted. One direction of future research, which may prove particularly important to policy makers involves examining whether the influence of cellular use differs across drivers and contexts. The authors' research design allows for such an analysis of driver heterogeneity if one uses differences in cell phone price sensitivity across demographic groups as an additional source of treatment variation.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Effectiveness of Speed Control Measures on Nighttime Construction and Maintenance Projects: Some New Evidence by Lindsay Miller, Dulcy Abraham & Fred Mannering, Purdue University, West Lafayette, IN 47907-2051 in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC.* (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- The goals of this research were to demonstrate a methodology and provide some additional insight into the nighttime speed control strategies that may help to improve safety for workers and the traveling public.

In the last two decades, state transportation agencies have shifted their focus from new construction to the rehabilitation and improvement of current highway infrastructure as new-project costs have risen and funding has declined. With rehabilitation and improvement projects, state agencies are often faced with prospect of working at night. A survey of state Departments of Transportation (DOTs) and the Illinois Department of Transportation (IDOT) district offices found that the most important advantage of nighttime construction/maintenance is the significant reduction in congestion and delay for the traveling public due to lower nighttime traffic volumes. Delays and congestion caused by lane closures are minimized at night because traffic volumes are at their lowest. This advantage is considered an overriding factor in selecting night work over day work. However, the safety of nighttime work zones has become a major concern in recent years. In 2005, there were 1,074 work zone fatalities in the United States and approximately one-half of these fatalities occurred at night.

There have been numerous studies that have analyzed safety concerns in nighttime work zones. The consensus of previous work is that poor visibility, driver inattention and speed are primary contributors to compromised work-zone safety at night. Of these factors, speed control has received the most attention from state transportation agencies in their efforts to improve work-zone safety. A review of the extant literature shows that there are a multitude of techniques that have been used to control work zone speeds including regulatory speed limits, recommended speed limits, work zone speed limits, police enforcement, speed-display monitors (giving a display of a vehicle's speed to their driver), changeable message signs, variable speed advisory systems, rumble strips, increased fines, citizen's band radio alert systems, and narrowed lane widths. Recently, it was found that of the available speed-control methods, regulatory speed limits, increased fines, and police enforcement were the most popular. In a survey of state-highway personnel, it was found that speed control was considered most critical in the active work area and that police enforcement was thought to be the single most effective speed-control method, followed by regulatory speed limits, work-zone speed limits, speed display monitors, increased fines, changeable message signs and narrowed lane widths.

The intent of this study is to collect speed data from active nighttime work zones in

Indiana and conduct a statistical analysis to identify the factors (including observed speed control efforts) that significantly affect the mean and standard deviation of vehicle speeds in work zones. The study will focus on interstate projects due to their high speed limits and frequent use of speed control. In developing an interrelated statistical model of mean speeds and standard deviations of speeds, we hope to provide some new evidence on the relative effectiveness of various speed control methods and add to the growing literature on this topic.

Summary and Conclusions

The goals of this research were to demonstrate a methodology and provide some additional insight into the nighttime speed control strategies that may help to improve safety for workers and the traveling public. Data were collected from July to November 2006 on work-zone characteristics and vehicle speeds on seven Indiana nighttime work zones that deployed a variety of speed-control methods. Seemingly unrelated regression estimation (SURE) was used to simultaneously model mean speed and speed standard deviation. The model estimation results show that the number of open lanes, original speed limit of the road section, distance from the work zone speed limit signs to the beginning of the work-zone taper, and the passing of time through the night – all resulted in higher mean speeds through the work zone. In contrast, police enforcement, percentage of semi trucks, and flow rate all decreased the mean speed. The estimation results for the model of the standard

deviation of speed indicated that the number of open lanes, number of work site speed limit signs, percentage of personal vehicles and traffic flow all increased the standard deviation of spot speeds through the work zone. Whereas observing speeds before midnight and a higher number of queued vehicles decreased the standard deviation of speed.

To be sure, the number of work sites visited limited our ability to assess many of the possible speed control strategies in nighttime work zones. This was further complicated by the fact that some of the work zone projects employed multiple speed control methods – making it statistically difficult to distinguish the individual effect of each speed control method on mean speed and speed standard deviation due to multicollinearity. However, even with our limited data, we were able to statistically quantify the effectiveness of police enforcement and the distance between speed-control signs and the active work zone in terms of reducing work zone speeds. Gathering additional data and applying the seemingly unrelated regression estimation approach would be a fruitful direction for future research and lead to additional insights on work-zone speed control effectiveness. Specifically, additional data could allow assessing various flashing light options on construction speed-limit signs, the effect of varying the location and number of the speed-limit signs based on the length of the work zone, the effect of varying the placement of the signs based on the location of the active workspace within the work zone, and a multitude of other factors aimed at reducing speeds in nighttime work zones.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Fatal and Injury Crash Characteristics in Highway Work Zones by Yingfeng Li & Yong Bai in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC.* (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- ❑ Male drivers caused most of the crashes.
- ❑ Both types of crashes had the highest frequencies during daytime non-peak hours.
- ❑ A majority of the crashes occurred on rural highways.
- ❑ Multi-vehicle crashes were the most common type for the crashes.
- ❑ Human errors, inattentive driving in particular, were the primary causal factors for the crashes.

The characteristics of fatal and injury crashes in Kansas work zones were investigated systematically utilizing statistical techniques such as frequency analysis and tests of independence. Significantly different characteristics between the two types of the crashes were identified as well in an effort to discover the factors that contributed to the increase of crash severity. The results also provide practical insights to facilitate the development of work zone traffic control strategies that could not only reduce the number of crashes but also mitigate the crash severity.

Summarized in Table 3 are the major general characteristics of fatal and injury crashes in Kansas highway work zones. The comparison study further discovered a variety of differences in characteristics between fatal and injury crashes.

Characteristic differences were discovered between injury and fatal crashes in the aspects including drivers at fault, crash

time, crash location, crash type, and causal factors. The researchers found that complicated geometric highway alignments (especially grades), unfavorable light conditions, involvement of heavy vehicles, alcohol impairment, and disregarding traffic control, were potential factors that contributed to the increase of crash severity in work zones. Comparison results also suggested that the fatal crashes were more related to high speeds while the injury crashes were more related to high traffic volumes.

Recommendations

Improvement of traffic control is the most direct method to reduce highway work zone crashes. More effective and sufficient work zone traffic controls should be installed. In particular, there is an urgent need to develop speed control methods that can be strictly enforced in the work zones. Illumination or highly retroreflective devices should be installed in the work zones that stay set up at night. Devices such as transverse markings or temporary raised pavement markers in the advance warning areas may be used to alert inattentive travelers of the upcoming work zones. Installation of median separators is necessary in some work zones with high risk of head-on crashes. Lower speed limits should be considered in work zones with complex highway geometric alignments. Special traffic control strategies need to be developed to guide trucks passing the work zones.

Male teenage drivers and drivers younger than 35 years of age frequently caused work zone injury crashes. Drivers aged 35 to 44 and older than 64 were the groups with the highest fatal crash rate in Kansas work zones. Truck drivers also create serious safety problems in work zones. The authors suggest the launch of driver-oriented education programs in order to raise awareness on highway work zone hazards. The fact that a major cause of most crashes was human errors also indicates the urgency for developing effective training programs to educate the traveling public.

In addition, some sections of the State of Kansas Motor Vehicle Crash Report need to be modified to better facilitate work zone crash investigation. For instance, the traffic control

devices listed on the report do not include temporary traffic control devices such as channelizing devices and temporary lighting devices that are commonly used in work zones. As a result, crash investigators (police) usually either classify those temporary work zone traffic control devices as “other” or do not record them. Revisions might also be considered for other sections such as pedestrian identification (regular pedestrian or construction worker), and detailed crash locations within work zones (advance warning area, transition area, activity area, or termination area). Descriptions of the work zone including the construction work types and construction activities at the crash scene should be also included in the crash reports.

TABLE 3 General Characteristics of Fatal and Injury Crashes

Category	Comparable Characteristics
At-fault drivers	<ol style="list-style-type: none"> 1. Male drivers caused most of the crashes. 2. Male drivers caused most of the truck-involved crashes and single-vehicle crashes.
Crash time	<ol style="list-style-type: none"> 1. Both types of crashes had the highest frequencies during daytime non-peak hours (10:00 a.m. – 4:00 p.m.). 2. Most of the crashes occurred in the construction season from April to November.
Crash location	<ol style="list-style-type: none"> 1. A majority of the crashes occurred on rural highways. 2. Most of the crashes took place on interstates and other principal arterials. 3. Most of the crashes occurred in non-intersection areas without the impacts of road special features such as bridges, interchanges, or ramps.
Crash type	<ol style="list-style-type: none"> 1. Multi-vehicle crashes were the most common type for the crashes. 2. Most truck-involved crashes were multi-vehicle crashes.
Causal factors	<ol style="list-style-type: none"> 1. Human errors, inattentive driving in particular, were the primary causal factors for the crashes. 2. Poor light conditions were a contributing factor for the crashes. 3. Adverse weather conditions, poor road surface conditions, pedestrian factors, and vehicle problems were not important contributing factors for the crashes.

TRANSPORTATION RESEARCH DIGEST

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The Impact of Red Light Cameras (Photo-Red Enforcement) on Crashes in Virginia by Nicholas J. Garber, John S. Miller, R. Elizabeth Abel, Saeed Eslambolchi & Santhosh K. Korukonda, Virginia Transportation Research Council, 530 Edgemont Road, Charlottesville, VA 22903 (Virginia Department of Transportation, 1401 E. Broad Street, Richmond, VA 23219; http://www.virginiadot.org/vtrc/main/online_reports/pdf/07-r2.pdf) (Jun 2007)

Highlights

- ❑ The affect on safety from installing red-light cameras is unclear.
- ❑ Results differ by location—in some, crashes are increased by red-light cameras.
- ❑ Jurisdictions need to carefully consider the use of red-light cameras on a case-by-case basis.

The cameras did not have the same associated impact in all jurisdictions. Cameras were associated with an increase in all six crash types in Arlington County, five of which were significant. In Fairfax City, in contrast, the cameras were not associated with any significant increases; they were associated with a significant decrease for three crash types.

The cameras did not have the same associated impact even within a single jurisdiction. For example, in Fairfax County, there were four intersections where injury crash rates decreased yet five intersections where injury crash rates increased.

The cameras were associated with an increase in rear-end crashes. A simple before-after comparison after normalizing by time and ADT suggested an average increase of 27% by intersection.

The cameras were associated with a decrease in red light running crashes. A simple before-after comparison after normalizing by time and ADT suggested an average decrease of 42% by intersection.

The cameras were associated with a decrease in injury red light running crashes. A simple before-after comparison after normalizing by time and ADT suggested an average decrease of 28% by intersection, the data suggested that cameras were associated with a decrease.

The cameras were associated with an increase in total crashes. A simple before/after comparison that controlled for time and ADT suggested an increase of 12% per intersection.

The association of the cameras with angle crashes differed among jurisdictions. The aggregate results suggested a 20% increase, whereas a simple before/after comparison that controlled for time and ADT suggested a 6% decrease per intersection.

The cameras were associated with an increase in the frequency of injury crashes. The aggregate results suggested an 18% increase, although, a simple before/after comparison suggested a 10% decrease per intersection.

The results of the comprehensive crash cost analysis varied based on the assumptions and jurisdictions used. Because rear-end crashes increased and red light running crashes decreased as a function of camera installation, the comprehensive crash cost analysis shows a range of possibilities based on comparing angle and rear-end crashes after camera installation. These results suggest that the cameras were associated with the following:

- When results for all six jurisdictions and all crashes (injury and noninjury) were combined, a net negative impact.
- When all crashes (injury and noninjury) were combined, a net positive impact for two jurisdictions (Alexandria and Vienna), a net negative impact for two jurisdictions (Arlington and Fairfax County), and mixed results for two jurisdictions (Fairfax City and Falls Church).
- A net positive impact for injury-only crashes only in some jurisdictions (Alexandria, Fairfax City, and Vienna) and a net negative impact for injury-only crashes in others (Arlington, Fairfax County, and Falls Church).
- A net positive impact for injury crashes when all jurisdictions were combined and the officer's indication of severity was used, provided the three fatal crashes in Fairfax County were excluded from the analysis
- Either a net positive or net negative impact for injury crashes when all jurisdictions were combined and injury severity levels were not used
- A net negative impact for noninjury crashes except in Falls Church, where

they were associated with a net positive impact.

Methodologically, the statistical tests employed usually, but not always, gave consistent results. Of 30 cases where an inconsistency was feasible (six crash types multiplied by five jurisdictions), there were no direct conflicts (where one test showed a statistically significant increase and another test showed a statistically significant decrease) and there were nine moderate conflicts (where one test yielded a statistically significant increase and another yielded a nonsignificant decrease or vice versa).

The cameras were not associated with a decrease in rear-end crashes over time after the initial increase that followed camera installation. It had been hypothesized that a large increase in rear-end crashes after camera installation might be followed by a decrease in rear-end crashes after motorists became habituated to the camera, but no such change was observed. This conclusion is limited by the fact that only crashes in Fairfax County were studied and the after period was at most a few years long.

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Red Light Running Cameras: Would Crashes, Injuries and Automobile Insurance Rates Increase If They Are Used in Florida? by Barbara Langland-Orban, Etienne E. Pracht, John T. Large, *Florida Public Health Review*, 2008; 5:1-7; <http://publichealth.usf.edu/fphr> (2008)

Highlights

- ❑ Rigorous and robust studies conclude cameras are associated with increased crashes and costs.
- ❑ Cities and counties should pursue engineering improvements to enhance intersection safety for all drivers and passengers.
- ❑ Cities, counties, and the state should be cautious in using traffic safety information from the automobile insurance industry.

The theory behind red light cameras as potentially effective is that they rely on deterring red light running primarily through punishment of a specific driving behavior and secondarily by changing drivers' experience. By definition, the punishable behavior and resulting potentially harmful action will already have taken place when a ticket is issued. In other words, the crash, injury, and mortality risks do not change immediately, if at all.

In contrast, engineering solutions produce immediate reductions in red light running and potential crashes. Thus, even if red light cameras could be effective in the long run, which is debatable, they are associated with an added cost, consisting of fines, crashes and injuries that could have been avoided by using engineering solutions, which are effective in both the short term and the long run.

Because the rigorous and robust studies conclude cameras are associated with increased crashes and costs, any economic analysis of cameras should include these newly generated costs to the public. Indirect costs to the public

are usually not considered in the calculation of total revenues and profits generated from red light cameras.

Cities and counties should follow the state's lead and likewise pursue engineering improvements to enhance intersection safety for all drivers and passengers. Proven engineering practices and counter-measures can reduce crashes and injuries due to red light running, as well as other causes of intersection crashes. A public health approach to improved intersection engineering is particularly needed since 26% of Florida's traffic fatalities occur at intersections (with and without traffic signals), in contrast to 18% nationally (NHTSA, 2005). This means that more than 22% of traffic fatalities in Florida occur at intersections for reasons other than red light running, as red light constitutes less than 4% of total traffic fatalities.

Further, red light cameras are an inefficient means to raise revenue for local and state governments and can disadvantage the state's economy. This occurs from the significant amount of funds, paid by local drivers, that ultimately accrues to private in-state and out-of-state special interests from camera use, rather than fully accruing to local and/or state governments.

If cameras are used in Florida, a portion of ticket fines (in essence, royalties) can accrue to the camera vendors in perpetuity, which are located in other states and countries. Likewise, the increase in crashes and probable injuries would result in automobile insurance rate increases, which could affect all drivers in a

community due to the pricing methods used by insurers. A portion of the insurance increase would be returned to certain business interests in the state; for example, in the form of higher insurance agency commissions and payments to automobile repair shops, hospitals, doctors, and rental car companies. However, a portion of the insurance increase would accrue to out-of-state interests, such as automobile parts manufacturers and, more importantly, to out-of-state insurance corporate accounts. Thus, red light cameras result in fines and insurance increases that would transfer disposable income from Florida drivers to private businesses in and out of the state, in addition to local and/or

state governments. It is not surprising that out-of-state special interests, such as camera vendors and the Insurance Institute for Highway Safety, advocate for camera use.

Finally, cities, counties, and the state should be very cautious in using traffic safety information from the automobile insurance industry. Insurance financial goals are to increase their revenues and profits, which do not necessarily include reducing traffic crashes, injuries or fatalities. Also, public policy should avoid conflicts of interest that enhance revenues for government and private interests at the risk of public safety.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Investigation of Vehicle Detector Performance and ATMS Interface by Dan Middleton, Ricky Parker, and Ryan Longmire, 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>) (Mar 2007)

Highlights

- ❑ New detectors do not always operate as well as inductive loops.
- ❑ The Wavetronix DataCollector/DataTranslator system appears to be very appropriate for interfacing with the TxDOT ATMS.

As TxDOT transitions from its current Advanced Traffic System Monitor (ATMS) architecture, it will need a mechanism to smoothly move to increased use of smart sensors. The solution investigated by this research involved two data appliances from Wavetronix called the DataCollector and the DataTranslator. After receiving this system, TTI, TxDOT, and Wavetronix engineers established a system of multiple vehicle detectors communicating with the Wavetronix system in the TransLink@ Lab in the Gibb Gilchrist Building on the campus of Texas A&M University. The entire test used the Wavetronix servers provided by Dell, although TxDOT would have preferred to do some of the testing using a more generic hardware platform. Wavetronix would have provided a software-only solution, but generic servers were not available during the test.

The tests by TTI indicated that the Wavetronix system does what it is designed to do, although the early version provided to TTI still needed additional development resources. TTI demonstrated that the system successfully communicates with multiple brands of

detectors and provides the data in the proper format and sequence needed by the ATMS. One remaining activity would be for Wavetronix to provide a software-only option, which should be evaluated by an independent party on servers provided by TxDOT.

Findings of this research indicate that the new detectors do not always operate as well as inductive loops. The ADR-6000 used inductive loops but its signal processing and, therefore, its accuracy are superior to a typical loop installation. The comparison being made here is with the more typical inductive loops. Presence detection (count) accuracies of standard inductive loops are typically in the 95 to 99% range if they have been installed properly and are well maintained. Loop speed accuracies are typically within 2 to 5 mph of true speeds, but again, proper installation and maintenance are critical. Sidefired microwave radar detectors in this research exhibited consistent speed accuracy, although limited tests of an overhead-mounted SmartSensor SS105 in its Doppler mode was even better (it can only cover one lane in Doppler mode). Therefore, the SmartSensor SS105 should be considered as an accurate speed detector for replacing loops with its orientation depending on site-specific accuracy needs. For a three-color urban speed map display, most of the detectors tested in this research have the needed speed accuracy.

The research findings indicate differences in accuracy of non-intrusive devices

according to levels of congestion. When congestion reaches a point where the prevailing speed begins to drop, accuracy of most non-intrusive detectors will probably decline significantly. Even for freeways that do not currently reach those congestion levels on a recurring basis, TxDOT decision-makers must consider that incidents can happen anywhere and at any time. Minimizing the variety in types and brands of detectors is important from an inventory and training standpoint.

Findings of this research indicate that, from a performance standpoint, microwave radar, magnetometers, and video image vehicle detection systems are probably all suitable for freeway applications. VIVDS is more complex, requires periodic lens cleaning, and is usually more expensive, but a positive attribute is that it offers a view of the traffic stream. However, some limited weather and lighting conditions may affect the latest VIVDS although the manufacturers have reduced those impacts in recent models. The magnetometer that was included in this research is by Sensys Networks and warrants continued evaluation over a longer period of time. Its accuracy levels are noteworthy and, of course, it is not affected by weather, but its battery life needs to be verified in high-volume traffic. One negative attribute is that it is an intrusive device, requiring interference with traffic for installation. It is a promising replacement for loops since

installation is faster. Finally, the SmartSensor SS105 (and its newer version, the HD) is a rugged device that:

- does not interfere with traffic,
- can be mounted on an existing pole,
- automatically calibrates speed and configures lane positions for each lane monitored,
- can cover up to eight lanes (10 lanes for the HD) in side fire orientation, and
- is apparently not affected by any weather or lighting conditions.

The Wavetronix DataCollector/DataTranslator system appears to be very appropriate for interfacing with the TxDOT ATMS. It is viable as a state-of-the-art, flexible, scalable, off-the-shelf, and immediate solution to TxDOT's need where a combination of its legacy components and contemporary detectors are being implemented side-by-side. Negative factors include the perception that the system is expensive, but decision-makers should be careful not to dismiss this solution before carefully costing out the alternatives. There is little competition at the present time, but products from all other competitors only collect data from their brand of sensors and cannot export data to other databases. These factors may be short-term deterrents for some TxDOT decision-makers but they should not be for long.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Intermediate Access to Buffer-Separated Managed Lanes by Kay Fitzpatrick, Marcus A. Brewer, and Eun Sug Park, 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>) (Mar 2007)

Highlights

- The objective of this research project was to develop guidance on intermediate access to and from buffer-separated toll lanes located within general-purpose lanes.

Access to interior managed lanes has been achieved using elevated ramps and at-grade ramps. At-grade access includes intermediate access and slip ramp terminal access. The objective of this research project was to develop guidance on intermediate access to and from buffer-separated toll lanes located within general-purpose lanes. The Appendix contains the guidance material. This material could be incorporated in future editions of the *Managed Lanes Handbook* or portions could be integrated into the *Roadway Design Manual*, the *Texas Manual on Uniform Traffic Control Devices*, or in a TxDOT standard sheet.

For intermediate access openings, other communities recommend opening lengths between 1300 ft and 2000 ft. While the recommended buffer width is 4 ft or greater, many sites have a 2- to 3-ft width. Between 500 and 1000 ft per lane change is suggested for determining where an access opening should be located with respect to upstream entrance ramps or downstream exit ramps.

To assist in developing the guidance material, researchers recorded operations at five intermediate access sites. The sites were either to a high-occupancy vehicle lane or a high-occupancy toll lane and were located in Dallas, Houston, and Minneapolis. The length

of the openings was between 920 and 1500 ft. Speed limits were either 55 or 60 mph, and there were three to four general-purpose lanes present.

Conclusions

Maneuvers: The number of attempts to enter or leave the HOV lane was counted for the five sites. Key findings include:

- A surprisingly large number of maneuvers (7%) were vehicles passing a slower-moving vehicle.
- For those moving in or out of the HOV lane, about three-fourths of the drivers began their lane change in the initial two-thirds of the opening.
- Approximately 9% of those moving into the HOV lane and 8% of those moving out of the HOV lane were not in compliance with the pavement markings. The percent of non-compliance increased to about 15% during those periods with low speeds (less than 40 mph) and high speeds (greater than 60 mph).
- The percent of maneuvers in compliance with the pavement markings varied by the length of the intermediate access opening. The compliance rate was greater for the longer access opening length (1500 ft) as compared to the 1,160-ft access opening length.

Passing Maneuvers: A surprisingly large number of maneuvers at the intermediate access openings involved vehicles passing slower-moving vehicles. Over 7% of all maneuvers involved a passing vehicle. At the two sites with the larger quantity of data, between 40 and 80% of the passing vehicles involved a vehicle leaving the HOV lane to pass a slower vehicle in the HOV lane. The proportion of passing maneuvers was found to be statistically related to the 5-minute HOV lane volume count. As the HOV lane volume increases, the proportion of passing maneuvers initiated from general-purpose lanes decreases. Depending upon the characteristics of a site, the provision of a passing lane within a one-lane managed-lane facility could improve service.

Maneuver Time: Maneuver time was calculated as being the difference in time between (a) when the vehicle first crossed the lane line separating the HOV lane and the general-purpose lane and (b) when the vehicle finished crossing the lane line. The average time to cross the lane line was 2.1 seconds for all the sites. While selected variables were found to be related to maneuver time, the relationship between the variables and maneuver time was not always logical and the variables only explained at best 10% of the variation in the data. Other variables are needed to better explain why drivers use more (or less) time to cross the lane line to or from the HOV lane.

Location of Access with Respect to Other Ramps:

- When presented with the opportunity to enter a managed lane that is located very close to an entrance ramp, drivers will attempt to cross multiple lanes to do so. At one location, vehicles were observed to weave from the entrance

ramp across four general-purpose lanes and enter the HOV lane in distances that are shorter than recommended.

- Most drivers who made the ramp-to-HOV lane weave maneuver entered in: (1) Zone 3 (the final third of the access opening, which would represent between 875 and 1250 ft of weaving distance as a minimum; distance is probably longer since many drivers were observed driving over the marked gore at the start of the maneuver) or (2) the HOV lane late (which would represent greater than 1250 ft of weaving).
- A small number (2.5%) of the ramp vehicles attempting to enter the HOV lane aborted their maneuver near the HOV lane. Additional ramp vehicles may also have been unsuccessful in their attempt to enter the HOV lane; however, that number could not be determined from the data.
- The successful weaving of ramp vehicles across multiple lanes occurred at typical freeway speeds and during high volumes.

Vehicle Position within Lane: Based upon the findings from a single site, vehicles appear to be shifting their position within the HOV lane and in some cases the lane adjacent to the HOV lane in response to the pavement markings. The transition from broken lane line to solid double lane lines includes a point that may be drawing the driver's attention. To minimize that potential, the researchers recommend that the solid lane lines end without having the point and that the broken lane line continues from the solid lane line that is closest to the general-purpose lane.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Low-Cost Bus Lines: Shaking Up Inter-City Travel in *Surface Transportation Innovations* by Robert W. Poole, Jr. (Reason Foundation, 3415 S. Sepulveda Blvd., Suite 400, Los Angeles, CA 90034; 310/391-2245) (Dec 2007)

Highlights

- ❑ This decade has witnessed a proliferation of new inter-city bus companies.
- ❑ They seem to be following in the footsteps of low-cost air carriers, by thinking outside the box to cut costs.
- ❑ The largest such company is Megabus.

One of the justifications offered for U.S. taxpayers to subsidize Amtrak is the idea that lower-income people (students, immigrants, the retired, etc.) need an affordable alternative to using the airlines for inter-city travel. That's always rung hollow since we've had nationwide Greyhound bus service since long before Amtrak. But Greyhound has been losing money for a number of years, and its annual passenger count has been declining since 2000—in part due to the growth of low-cost airlines.

But this decade has also witnessed a proliferation of new inter-city bus companies. So far, none is of national scope, but their niche markets are growing. And they seem to be following in the footsteps of low-cost air carriers, by thinking outside the box to cut costs dramatically.

The largest such company is Megabus, a subsidiary of the U.K.'s Stagecoach Group plc, which cut its teeth in Britain's deregulated bus market. Megabus offers a few seats on every bus for a \$1 fare, and uses pricing similar to that of the airlines, with low fares if purchased well in advance, and higher fares near the departure date (<http://www.megabus.com>). All booking is

done online, minimizing staff costs, and the company has no stations, picking up customers at known curbside locations. Thus far, the company is offering inter-city service in 10 states, three in the west and seven in the Midwest. There are 23 cities in the network, but so far you can only travel within—not between—the regions.

In the northeast, several companies offer bus service between Chinatowns in various cities. The largest of these seems to be Chinatown Bus (<http://chinatown-bus.com>), connecting Boston, New York, Philadelphia, Baltimore, and Washington. Fares vary, with "typical" one-way fares ranging from \$12 New York-Philadelphia to \$20 New York-DC. Another bus company, Vamoose (<http://www.gotobus.com/vamoose>), offers express service between Manhattan and two DC suburbs—Bethesda, MD and Arlington, VA for \$25.

Private companies are even moving into urban markets. Spanish Transportation Corporation of Paterson, NJ (phone: 973-881-9133) now runs 130 commuter buses into Manhattan each day, on three different routes. The company has grown from a van service with 14 vans in 1993 to a sizeable enterprise today. The buses are branded Express Service.

And Las Vegas now boasts a new door-to-door service among hotels and casinos on the Strip—at just \$2.50 per ride. Called Arrow, it is offered by (<http://www.vegas.com>), a travel and booking company. Also offered is a \$10 daily pass offering unlimited use of Arrow and the private Las Vegas monorail. Arrow

competes with the regional transportation authority's double-decker Deuce buses.

It is encouraging to see these entrepreneurial ventures, starting up and growing despite taxpayer-subsidized competition. As with low-cost airlines that sprang up after deregulation, their very

existence debunks the idea that airlines or intercity surface transportation or local transit is some kind of natural monopoly that must be controlled by the government. Consumers generally win when competition can flourish, and these examples show that competition still exists in these areas.

TRANSPORTATION RESEARCH DIGEST

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FEBRUARY-MARCH 2008

Analysis of Congestion Performance Indicators for Urban Road Networks by Carlos Moran and Karl-L. Bang, Department of Transport and Economics, KTH, Stockholm in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC*. (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- The problem of defining and selecting congestion indicators for area road networks have been presented including two different congestion definitions: Bottleneck-based and Travel time based.

The Stockholm Congestion Charging Trial (SCCT) was implemented with the goal to satisfy a number of transport policy objectives related to reduced car travel in the central area of Stockholm. This occurred in a stormy political and legislative environment, and the definition of congestion that the charges were intended to alleviate was never clearly stated. The traffic impact evaluation efforts were based on survey results for chosen links without any scientific review of the dynamic character of congestion or the statistic characteristics of selected indicators of performance.

For each definition, congestion performance indicators (indicators) have been described and estimated for a road axis in the centre of Stockholm for which traffic data from different data sources was available. The Bottleneck based estimator “queue-length” should be further explored, particularly regarding methodology for data collection. In the current study the sample size was often too small to obtain significant differences between the compared periods. A larger effort to collect queue data by means of floating car and/or air photography could have improved the

significance of the queue-length congestion indicator. However, it is observed that the queue estimations are much more sensitive when near saturation situations. Micro simulation models can however be a useful tool analyzing this problem.

The estimations of Travel time based indicators with the Automatic

Travel Time Camera System (ATTCS) data produced clear results with significant difference between the situation “before” (April 2005 without charges) and “after” (April 2006 with charges). However, the definition of the non-congested or reference situation showed some shortcomings. The present study overcame this problem by assuming values defined based on the sample, but future efforts should be focused on defining the reference level adapted to the specific characteristic of the studied object and the traffic policy targets.

The estimations of travel time based indicators with floating car data did not suffer from the reference value problem, nevertheless, the results for the comparisons “before” and “after” were often not statistically significant due to the small sample size available.

Based on the coefficient of variation of the different congestion performance measures a reliability ranking is provided. Further analysis of these aspects can provide useful guidelines for determining the sample size required in future measurements when a certain maximum percentage error is required.

Further considerations on the applicability of the congestion indicators should recognize three different target audiences:

- Authorities: Need reliable indicators for operational use as well as planning including socio-economic analysis. In this purpose, aggregation methods for area networks require further development.
- Car users: Need online easy to handle information for pre-trip planning and route choice.

- Non-motorized road users: Need an indicator of the local environmental congestion impacts.

Travel time based indicators are probably best suited for the interests of authorities and car users. However, the first group will define the references values based on the policy objectives, while the second group will define it based on their own perceptions of congestion. Further research of how drivers perceive different thresholds of congestion is required. The non-motorized road users might prefer bottleneck-based indicators.

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FEBRUARY-MARCH 2008

Congestion, Risk Aversion and the Value of Information by André de Palma, Robin Lindsey, & Nathalie Picard in *Transportation Research Board, 87th Annual Meeting, January 13-17, 2008, Washington, DC*. (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; <http://gulliver.trb.org/bookstore>).

Highlights

- Drivers with intermediate levels of risk aversion purchase information so that they can select the quickest route each day.
- Private information is always beneficial to an individual driver relative to No information, and the benefit exceeds the benefits they derive from Free information or Costly information.
- Free information and Costly information benefit drivers who are risk neutral or moderately risk averse.

This paper has studied the information-acquisition and route-choice decisions of risk-averse drivers on a simple road network with one “safe” route and one “risky” route. Four information regimes are considered: No information, Free information – which is publicly available at no cost, Costly information – which is publicly available for a fee, and Private information – which is available free to a single individual.

Several general theoretical results are derived. First, it is drivers with intermediate levels of risk aversion who purchase information so that they can select the quickest route each day. The least risk-averse drivers remain uninformed and take the risky route every day, and the most risk-averse drivers take the safe route every day. This pattern mirrors a finding that it is individuals with intermediate demands for travel who gain the most from information because travel is worthwhile for them under some conditions but not others.

Second, Private information is always beneficial to an individual driver relative to No information, and the benefit exceeds the benefits they derive from Free information or Costly information. Third, Free information and Costly information benefit drivers who are risk neutral or moderately risk averse. But very risk-averse drivers end up worse off even though some of them may be willing to pay for the information. A numerical example suggests that losers are likely to comprise a relatively small fraction of the population, but also that their losses as measured by compensating variation can be comparable to the highest gains of other drivers.

The analysis could fruitfully be extended in various directions of which two will be mentioned. One is to examine more complex road networks. The two-route network with one safe route has the advantage of being amenable to analytical methods. And it is a natural choice to demonstrate the potential drawbacks of public information to highly risk-averse drivers. But real applications of Advanced Traveler Information Systems (ATIS) in urban areas have to contend with multiple links and routes. Furthermore, the property of the model that information is most valuable to drivers with intermediate risk aversion is counterintuitive insofar as the benefits from information would seem, a priori, to be greatest for the most risk-averse individuals. In part, this result is driven by the existence of a safe route with superior “worst-case” prospects than the other route.

A second extension is to consider alternatives to the expected utility paradigm. Empirical evidence has been accumulating that contradicts expected utility theory, and in recent years Prospect Theory and other non-expected utilities have been applied in transportation research. Nevertheless, there are several reasons why these alternatives do not (at least yet) offer a clearly superior paradigm to expected utility theory for analyzing traveler decisions of the sort considered here. First, route-choice decision-making differs substantially from gambling on monetary values, and it is not obvious that similar behavioral patterns apply in the two contexts.

Moreover, it is not clear what is an appropriate reference point for Prospect Theory. Second, route-choice decisions are made repeatedly for commuting and other routine trips, and it is plausible that as individuals become familiar with a particular environment their travel decisions will converge towards expected utility maximization. Third, Cumulative Prospect Theory fails to predict route-choice feedback-based decisions. There is a need for more empirical studies of risk aversion and route-choice decisions in the context of information provision – both in the field and in laboratory settings.