Commission Briefing Paper 4J-06
Future Trends in Vehicle Regulation

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Date: January 23, 2007

Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on how newly manufactured motor vehicles are regulated at the federal level, beginning with an overview of regulatory principles and philosophy in place today. The paper examines factors that will influence how regulations are developed in the future and constructs likely regulatory approaches that will be required over a 50-year time line. The paper suggests a need for a systems approach when developing federal regulations, shifting from a fragmented, single-issue focus (e.g., safety, energy, or emissions) to a broader, more integrated systems approach to achieve reductions in fossil fuel use, greenhouse gases and other emissions, and road injuries and fatalities, while simultaneously increasing the efficiency of our national transportation system.

Background and Key Findings

A major component of U.S. vehicle regulation has been safety-related. While this approach has been successful in reducing crashes and their consequences, the U.S. has not addressed driver and infrastructure components to the same extent as other countries. Future federal motor-vehicle regulatory policies and initiatives should be shifted from a single-issue, independent focus on safety, energy, and emissions to a more systems-efficiency approach that considers all these issues together before independent regulatory changes on any one of these subjects are made. Ubiquitous sensors in the vehicle and in the infrastructure will dramatically change the operation and performance of the traffic system as well as the ability to monitor, regulate, and enforce the behavior of the total traffic system. However, these technologically-driven changes will not only affect safety, but also security, the reliability and efficiency of travel, avoidance of congestion, and ultimately energy use and emissions. It appears that the most promising means for reducing traffic crashes, injuries, and fatalities is through crash avoidance technologies that intervene to prevent the crash by supplementing human control with machine control of motor vehicles in high-risk situations.

A vitally important enabling technology that will be the underlying basis for many crash avoidance technologies is vehicle-to-vehicle and vehicle-to-infrastructure communications, referred to as Vehicle Infrastructure Integration (VII). VII will also have significant energy use and emissions reductions benefits and will materially improve highway system efficiency.

However, government policy initiatives (either public investments or the granting of licenses and franchises) are required before such a system can or will be implemented.

Future energy supply will greatly influence the future of road transport. Efforts to reduce fossil fuel use and reduce international energy dependency while simultaneously improving air quality are, therefore, likely to be key future national imperatives. It is highly likely that regulatory initiatives will be required to manage energy distribution and use for the transport industry. There will be a need to balance emission controls designed to improve local air quality, which can reduce engine efficiency, with those that address the larger and arguably more important issues of fuel conservation and climate change.

When viewed in the larger context, these diverse regulatory issues have a common safety theme – ranging from the safety of the individual to the safety of society, and, in the largest context, the safety of the planet. This interdependency of future regulation argues for a new institution, perhaps along the lines of the United Nations Economic Commission for Europe (UNECE) World Forum for Harmonization of Vehicle Regulations (WP 29) model of integrating all primary regulatory initiatives under a single umbrella.

Future regulations will likely focus on initiatives such as:

Light vehicles

- Safety through VII directed toward crash avoidance but regulated in a different way – evaluation and rating of VII concepts, systems and performance rather than approval of specific devices.
- System efficiency (market-based congestion pricing) – while this is not a regulatory issue today and would be controversial, future conditions may drive this concept, beginning with improved charging for road use, beyond the gasoline tax, and moving to distance-based charging. The main regulatory role will be in setting standards for the electronic charging system.
- Future emissions regulations will likely need to consider both emissions and energy used, such as the type and quantity of energy consumed and emissions produced per person trip.

Heavy Vehicles

- Safety through vehicle control directed toward crash avoidance.
- Time of day, routing, and demand control (to reduce congestion and improve efficiency) by using telematics for compliance via third-party providers – including collecting road tolls, managing road usage, and tracking fleet vehicle type and locations.
- Performance-based vehicle size and weight regulations, providing flexibility to override prescriptive rules on the basis of improved vehicle safety and productivity.
- Separate vehicle emissions standards will likely be required based on truck class and operating environment (urban vs. rural).

Defining the Safety Problem

Imagine a small city of 43,000 people annihilated each and every year. Imagine 95% of the population of Chicago injured each and every year. Imagine the combined population of

Houston, Philadelphia, Phoenix, and San Antonio representing the number of police-reported crashes occurring in the U.S. each and every year – and this does not include the increasing number of unreported traffic crashes, estimated to be approximately twice that of the police-reported number. Traffic-related deaths exceed the national murder tally by 2.7 times and traffic-related injury exceeds crime-related aggravated assaults by 3.2 times. The economic cost alone for motor vehicle crashes in 2000 was estimated to be $230.6 billion. Yet, society tolerates a large and stable public health problem in the form of road trauma. Transportation engineering performance is continually improving (in terms of accident rates) to accommodate increasing miles of travel year after year however the number of casualties remains very high and their rate of decline is small. Clearly, the role of government regulation as an instrument for correction is necessary and given the persistent history of loss, the long-term need for government regulation in vehicle safety is assured. Future efforts will require a change in the safety culture driven from the top and using modern business management practices.

Table 1: Annual U.S. Crash Statistics

(Source: NHTSA Traffic Safety Facts, 2005)

Number of police reported crashes	6,159,000
Number of people injured	2,699,000
Number of people killed	43,443

Table 2: Annual U.S. Crime Statistics

(Source: Department of Justice, Federal Bureau of Investigation 2004)

Property Crime	10,328,225
Number of people injured aggressive assault	854,911
Number of people murdered	16,137

Note: The National Institute of Allergy and Infectious Diseases estimates about 20,000 deaths occur each year from the influenza or its complications.

Forty years ago when Congress created the Department of Transportation and the National Highway Safety Bureau there were over 50,000 traffic fatalities annually. Today our annual death toll is about 43,000 but more people are driving more cars more miles on more trips. Factoring in the increase in vehicle use, there has been a 3-fold improvement in traffic crash rates since that time. Much of this improvement in safety can be traced directly to vehicle safety regulation.

About Regulation

To consider the future trends of vehicle safety regulation, it is necessary to briefly discuss other forms of vehicle regulation. It is expected that future regulatory initiatives will increasingly involve interdependency of all forms of vehicle regulation with a common focus traceable to transportation system safety outcome, either within the context of the vehicle, its occupants, and other road users; or in the broader context of global safety including the environment. To achieve this interdependency it is anticipated that the regulatory methodology will need to change. The current regulatory structure for motor vehicles sold within the U.S. is represented in Figure 1. It shows that the federal government regulates road vehicle performance in the areas of safety, fuel economy, and emissions.

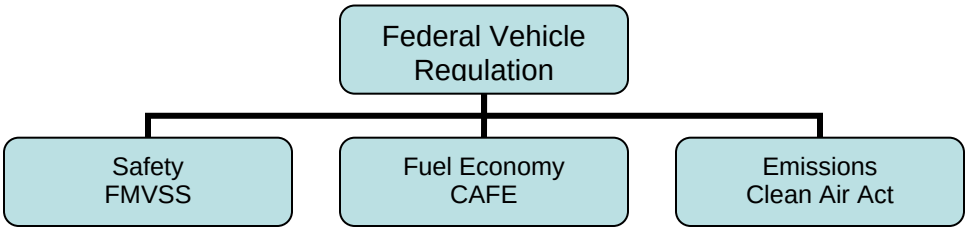

Figure 1: The Three Principal Motor Vehicle Regulatory Mechanisms for New Vehicles Sold within the U.S.A.

Safety Regulations

The National Highway Transportation Safety Administration (NHTSA) is responsible for safety regulations applied to "new vehicles." Federal Motor Vehicle Safety Standards (FMVSS) went into effect on January 1, 1968 and are broadly categorized as 100-series "crash avoidance" standards that include such things as brake and lighting regulations, and 200-series standards that regulate vehicle "crashworthiness" such as seatbelt and airbag requirements. Series 300-, 400- and 500- standards address the risk of fires, hazards during normal operation, and certain special vehicles. Safety standards are designed for specific vehicle classes ranging from motorcycles to passenger cars to heavy trucks. Much of NHTSA's regulatory effort has been directed toward safety technologies such as seat belts, airbags, and energy-absorbing steering assemblies.

Corporate Average Fuel Economy (CAFE)

Corporate Average Fuel Economy (CAFE) is a requirement for average fuel economy performance of the entire fleet of passenger cars and light trucks for each vehicle manufacturer for the model year. NHTSA, which is part of the U.S. DOT, is responsible for establishing and amending the CAFE standards for trucks. Congress sets the CAFE standards for cars. EPA reports the CAFE results for each manufacturer to NHTSA annually, and NHTSA determines whether the manufacturers comply with the CAFE standards and assesses penalties as required.

Clean Air Act

In 1963, Congress passed the Clean Air Act which was formulated to reduce air pollution by setting emissions standards for stationary sources such as power plants and steel mills. Amendments were passed in 1965, 1966, 1967, and 1969 authorizing the Secretary of Health, Education, and Welfare to include standards for auto emissions. The Clean Air Act of 1970 was a major revision and set much more demanding auto emission standards. These standards were found to be overly ambitious and target dates were delayed as the auto industry faced serious economic limitations and seemingly insurmountable technological challenges. In 1990 the Clean Air Act strengthened motor vehicle emissions and alternative fuels regulations. It explicitly recognized that changes in fuels as well as vehicle technology must play a role in reducing air pollution from motor vehicles.

Heavy Truck Size and Weight Regulations

In addition to NHTSA safety regulations and EPA emission regulations, heavy trucks are subject to size and weight regulations designed to manage and protect the roadway infrastructure

(pavements and bridges). There are two distinct size and weight regulation systems: federal regulations that govern vehicles using the interstate system and state regulations for all other roads within each given state. Most states have unique regulations that are not necessarily compatible with other states or the federal government. Size and weight regulations are important to vehicle safety and productivity as they drive primary vehicle-design factors such as axle load, the number of axles and their location, the number of trailers, vehicle articulation type, and locations. These design factors ultimately influence the mass center height of the vehicle, which is the most important vehicle stability parameter. Despite the long-standing influence of size and weight regulations on vehicle stability and safety, size and weight regulation development is only now beginning to consider safety implications as part of their development. There is a growing need to update and harmonize federal and state size and weight regulations in order to improve productivity and safety of the fleet.

International Vehicle Regulation

The United Nations Economic Commission for Europe (UNECE) was established in 1947 to initiate and participate in measures for the post-war economic reconstruction of Europe with a view to strengthening the economic relations of the European countries, both among themselves and with other countries of the world. UNECE has become the vehicle regulatory forum not only for European countries but for much of the developed world with the exception of the U.S. It also includes the World Forum for Harmonization of Vehicle Regulations (WP29), which has been created to facilitate the harmonization of a broad range of transport and trade issues including safety and anti-pollution standards for all classes of motor vehicles and standards for the transport of hazardous materials by road.

Regulation Costs and Benefits

Vehicle regulations have had significant impact on safety and the environment. NHTSA estimates that approximately 330,000 deaths were prevented due to regulation of safety technologies during the time period 1960-2002. From the manufacturing perspective, NHTSA estimates that regulations added an average of $839 (in 2002 dollars) and 125 pounds to the average passenger car in model year 2001, which equates to approximately 4% of the cost and 4% of the weight of a new passenger car. For the average light truck in model year 2001, the average added cost was $711 (in 2002 dollars) and the average added weight was 86 pounds. Regarding the effectiveness of emissions regulations, the average car produces 60 to 80 percent less pollution than cars in the 1960s. More people are using mass transit, and leaded gas has been phased out.

Factors Shaping the Future Road Transportation

To set the stage for the future regulatory framework, this section will discuss important emerging factors such as fuel supply, greenhouse gasses, congestion, and human-machine limitations that will influence our transport options and generate new policy/regulations that will alter the transportation landscape and how we function day to day.

Energy

As shown in Figure 2, transportation accounts for 28% of total energy use, second only to the amount of energy consumed by industry. Imported petroleum is the current primary form of transportation energy; therefore, this important sector is arguably more vulnerable than most to problems of supply and security.

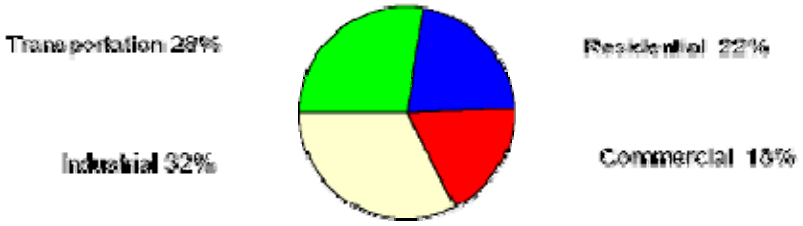

Figure 2: Transportation Energy Use as Part of Entire U.S. Energy Picture (2003 data - 98.2 Quadrillion BTU)
Source: EIA's Annual Energy Outlook (2005)

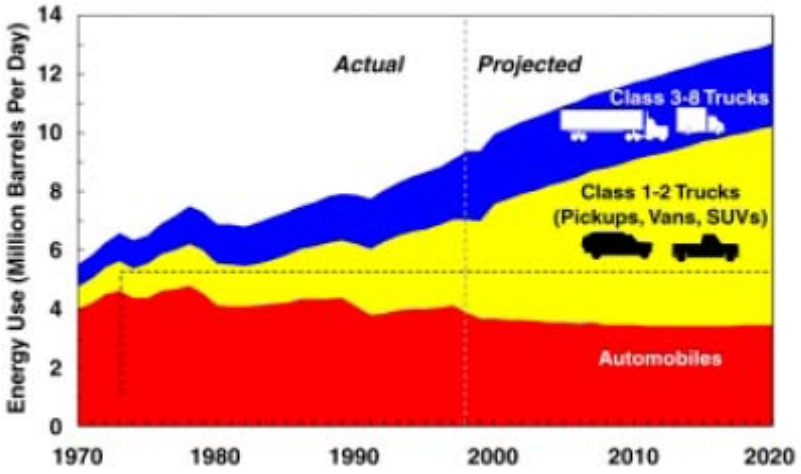

Figure 3: Past and Projected Petroleum Use for Road Transportation
(Source: EIA Annual Energy Outlook 2000)

Figure 3 shows the Energy Information Administration (EIA) projection of future transportation energy use to 2020. The general projected trend for energy use by automobiles is diminishing slightly; however, energy use by pickups, vans, and SUVs is projected to increase substantially as is energy use for freight transportation. Of these transport modes, freight poses the greatest challenge for alternate fuel supplies given the need for fuel sources that can deliver high power levels for extended distances. The Department of Energy's 21st Century Truck Program found that there is no practical fuel alternative currently available that can replace diesel fuel, a densely packaged energy source ideally suited for road freight transportation. Given the nation's reliance on goods transportation and the apparent lack of alternative fuel sources, it is likely that some form of fuel apportioning regulation or rulemaking will be required to ensure continued efficient goods transportation in the face of static or diminishing fuel supplies.

Emissions

In October 1997, the EPA adopted new emission standards for model year 2004 and later heavy-duty diesel truck and bus engines. The goal was to reduce particulate matter (PM) and Nitrogen Oxide (NOx) emissions from highway heavy-duty engines. Effective for the 2007 model year, the new regulations impose very stringent emission standards on PM, NOx, NMHCs (nonmethanehydrocarbons), as well as the elimination of the earlier crankcase emission control exception for turbocharged heavy-duty diesel engines. The new EPA regulations target reductions of both PM and NOx by 98 percent from 1988 levels. While these changes have produced impressive results, they have also decreased the efficiency of diesel engines requiring about 5% more fuel to perform the same task and therefore placing greater strain on the nation's fuel supply and generating more greenhouse gas (carbon dioxide, which is associated with global warming). Given that the EPA emissions regulations are largely focused on reducing smog in localized or urban areas, future regulatory efforts will likely require a more global approach to balance the needs of local interests with those of the international community.

Human Interaction with Automation

A less obvious factor that may impact regulation is human interaction with automation. Given the high level of crashes and fatalities that persist in the face of significant advancements in vehicle safety design and occupant protection, it is clear that human limitation has emerged as a formidable barrier to further improvements in safety performance. Driver distraction and lack of attention are key behavioral problems. In many cases the cognitive and physical requirements for sudden collision avoidance simply exceed human capabilities. The concept of using selective machine intervention over human control offers a promising solution to the current crash reduction stalemate. An example is electronic stability control (ESC), a relatively new technology that senses early stages of loss of vehicle control and intervenes by selectively braking certain wheels to maintain vehicle control. Recent studies have shown that this technology reduces the odds of certain crash types by 40% to 70%, making it the most significant safety technology to date. This concept of crash avoidance is the most desirable outcome for potential vehicle conflict as the benefits of avoiding a crash far exceed those of surviving a crash. This is the first automotive control technology to emerge that completely bypasses the human and mechanically intervenes to reduce the probability of loss of vehicle control. Prohibiting absolute human control of motor vehicles offers great promise for reducing traffic crashes.

Future Regulation

Safety

When government began regulating vehicle safety in the 1960s, the practice of automotive safety engineering within the industry was in its infancy. Over time the industrial safety culture has matured to a point where it has become the leading force for the development and deployment of new safety technologies. For example, ESC technology was conceived and developed by vehicle manufacturers and their suppliers without any regulatory pressure or force. Side curtain airbags are another safety technology that was introduced by industry without regulatory prompting. Government regulation has been used successfully to standardize evaluation techniques for the technology and to ensure its widespread deployment. It is anticipated that this trend will continue. The focus of future regulatory efforts will likely promote the development of objective evaluation techniques for new safety technologies. When the cost benefit findings from the evaluation of new technologies are sufficiently convincing, the regulatory instrument can be used to ensure deployment.

With over 40 years of vehicle safety regulation behind us, we are still faced with over 43,000 traffic fatalities per year resulting from more than 6 million police-reported traffic crashes. Despite the development of sophisticated practices in vehicle safety design and occupant protection, an inordinate number of crashes and traffic fatalities continue to occur. Making strides in safety will require taking the human out of the control loop under high crash-risk situations.

Congestion

The projected increase in traffic density will also influence the regulatory framework in regions where congestion is common. It is possible that in large metropolitan areas, congestion road pricing will be implemented to serve as a demand management tool. Such a system was implemented in central London in 2003, and it has reduced traffic congestion and improved bus and taxi service. Under this scenario, vehicles would have access to certain traffic lanes for a price that could vary depending on the severity of congestion at a given time. The road therefore would become a commodity with a varying price tied to supply and demand. This kind of demand pricing tool would help encourage travel prioritization, place a more transparent economic value on telecommuting (fewer trips to the office), and encourage more in-home shopping (fewer trips to retail stores). With the development of higher quality in-house entertainment we can also anticipate fewer trips for entertainment. Value pricing placed on high quality roads would also provide an incentive to shift discretionary traffic to secondary and tertiary roads and highways.

Vehicle Infrastructure Integration (Communication)

Among the most promising initiatives for safety improvement is electronic integration or communication from vehicle to vehicle and from vehicle to infrastructure. This untapped safety and productivity source offers great potential for aiding the driver by providing relevant information and, most importantly, by offering a platform for using vehicle safety control technologies to compensate for the limitations of the driver. For example, VII would provide a guarantee that a driver would not disregard or miss a stop sign. The technology would know the location of the stop sign and apply the vehicle bakes should the driver not respond.

With VII fully adopted, it is conceivable that in 50 years, traffic signals at intersections could be redundant and possibly eliminated. The time and energy lost from braking, idling, and accelerating at intersections could be greatly reduced by instead synchronizing the intersection approach velocities of vehicles so that they pass through the intersection without conflict.

Vehicle Compatibility

Heavy trucks are a vital component of our transportation network and the global economy, and truck travel is growing faster than car travel. The projected growth in the freight task almost guarantees a doubling of heavy truck traffic in the medium term (20 years). Given that trucks deliver almost all of our consumable goods, they represent an essential transport mode that has no obvious replacement. Most trucks are not well suited to alternative fuel choices, meaning that an essential component of our transport network is highly dependent on uninterrupted fuel supplies. There is a need for contingency planning to ensure that freight transport has guaranteed fuel supplies in the event of unanticipated shortages.

From a traffic safety perspective, trucks are poorly matched to the light vehicle fleet in terms of vehicle mass, vehicle responsiveness, and function. It is likely that future regulation efforts would include mechanisms to reduce this incompatibility either through technology or alternate infrastructure that will effectively separate the traffic streams. This can be done physically through the construction or designation of truck-only roads or through the applications of technology that can isolate vehicle streams.

Future Fuel Systems

Within a 50-year time frame it is anticipated that there will be very significant changes in the energy allocation and distribution systems for road transport. As high quality non-renewable energy sources diminish, very significant international regulatory initiatives will likely be needed to control consumption and encourage the development of new eco-friendly energy supplies. It is anticipated that global regulation of fossil-based fuel use and after treatment will be necessary given the broad impact of greenhouse gases on the global environment. The ongoing search for new energy supplies and storage will present challenges to the regulatory system to ensure safety and to ensure energy and reliability of supply. Energy availability, distribution, and use will likely be the greatest challenge that society will face on the 25- to 50-year time horizon.

Integration of Future Regulatory Systems

At the moment, at least three separate regulatory agencies govern new vehicles and several others govern vehicle operation. With the rising importance of energy supply, local and global emissions, congestion and safety, and the need to accelerate transport efficiency of all modes, it is likely that future regulation will require a unified approach that can objectively ensure that the most pressing technologies are deployed without undue consequence to the other priorities. Therefore, future regulations will likely shift emphasis from a single focus on safety to a systems-efficiency theme (where safety remains a component). It will likely include vehicle-to-vehicle and vehicle-to-infrastructure communications that will require government regulation to implement and maintain.

Future regulations will likely focus on initiatives such as:

Light vehicles

- Safety through VII directed toward crash avoidance but regulated in a different way – evaluation and rating of VII concepts, systems and performance rather than approval of specific devices.
- System efficiency (market-based congestion pricing) – while this is not a regulatory issue today and would be controversial, future conditions may drive this concept, beginning with improved charging for road use, beyond the gasoline tax, and moving to distance based charging. The main regulatory role will be in setting standards for the electronic charging system.
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CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 4J-06

One reviewer commented as follows:

The paper discusses adequately the important emerging factors that can influence transportation options and generate new policies and regulations for light and heavy vehicles.
There is much room for achieving high energy efficiency in the nation's automotive fleet by adapting changes in engine designs and other vehicular aspects. Energy efficiency legislation has not been aggressively pursued in the U. S. Even with all the technological advances, the average fuel efficiency of automobiles remains lower than what it was 50 years ago. Dramatic fuel efficiency improvements are technologically achievable, thereby reducing the problems of air quality as well as enhancing fuel conservation.