TRUCK SIZE AND WEIGHT RESEARCH CHALLENGES

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Above: A tanker truck crosses I-75 over the Great Miami River on a summer evening in downtown Dayton, Ohio. Trucks carry more than 70 percent of the nation's freight by weight.

Each day, the nation's multimodal transportation system moves 51 million tons of freight. Over the next 20 years, this figure is likely to increase by 22 percent. Although freight moves via multiple modes, trucks carry more than 70 percent of the nation's freight by weight (*1*).

Although it is in heavy demand, trucking is a low-margin industry. Legislative efforts to address this disconnect and to support economic development by making targeted industries—such as agriculture and manufacturing—more cost-competitive by lowering transportation costs often focus on increasing truck size and weight (TSW) limits. However, policy analysts and researchers have struggled not only to calculate the impacts but also the benefits of TSW policy changes. These challenges are not new.

In 1962, the American Association of State Highway Officials (AASHO, now AASHTO) conducted its iconic Road Test. Researchers drove several truck configurations around several loops to evaluate how trucks affect pavement (Figure 1). The test found that one fully loaded 18-wheeler caused the same amount of pavement damage as 9,600 passenger cars. Almost 60 years later, this figure is still often frequently cited, even though pavement design, trucks, and truck tires are different than they were in the 1960s.

Is that figure still valid? Right or wrong, it is still being used today. The AASHO Road Test is illustrative of the larger challenges involved in analyzing this research. Research in this area is still in its infancy, and many years later, fundamental questions remain unanswered.

- **Safety.** State crash record systems often do not contain information about a crashed truck's weight. Therefore, it is difficult to say with any certainty how different weights or truck configurations would affect safety quantitatively.
- **Economics.** Increases in TSW could induce a mode shift from rail and, for better or worse, would affect various segments of the trucking industry

FIGURE 1 AASHO Road Test pavement study, 1962. (Source: American Association of State Highway and Transportation Officials.)

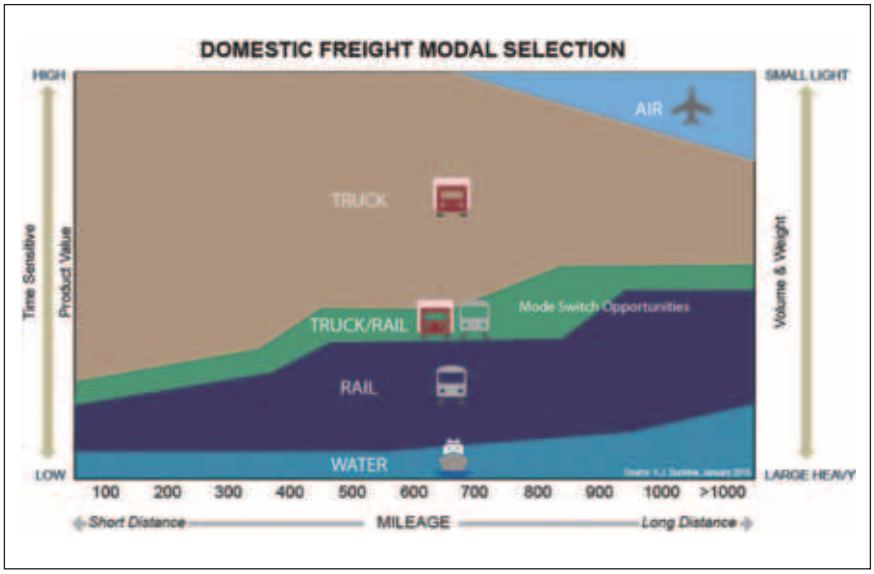

FIGURE 2 Increases to truck size and weight limits may have skewed traditional mode shift decisions made on distance, time, weight, value, and perishability. (Source: Keith Bucklew, HDR.)

(Figure 2). But there is no agreed-upon method to evaluate the potential economic impacts of a change.

- **Impact on infrastructure.** The impact of increased TSW on bridges and certain pavements (those that have received pavement rehabilitation treatments) still is relatively unknown. Resulting modeling challenges limit the ability to calculate the long-term impact of heavier trucks. This may change with increased use of weigh-in-motion bridge and pavement sensors.
- **Regulations.** Policy differences between states make it difficult to undertake national-level research or policy changes. Additionally, border states contend with different weight standards in Canada and Mexico.

Truck Size and Weight Regulation in the United States

In 1956, the Federal-Aid Highway Act authorized the development of the Interstate Highway System (IHS). To support the long-term maintenance of the system and to create national design standards, the Act instituted a gross vehicle weight (GVW) limit of 73,280 pounds and a 96-inch width limit on the IHS. Under this Act, the federal government did not regulate TSW issues outside of the IHS.

In 1974, the overall GVW limit increased to 80,000 pounds and the Federal Bridge Formula was established to limit the weight-to-length ratio of a vehicle crossing a bridge. This formula limits the concentration of weight in one area by spreading the weight over additional axles or by increasing the distance between axles (*2*, Figure 3).

Eight years later, Congress addressed ongoing challenges created by inconsistency among the width and length regulations of various states with the creation of the Surface Transportation Assistance Act of 1982. This Act expanded federal authority over truck length and widths beyond the IHS to a "National Network"

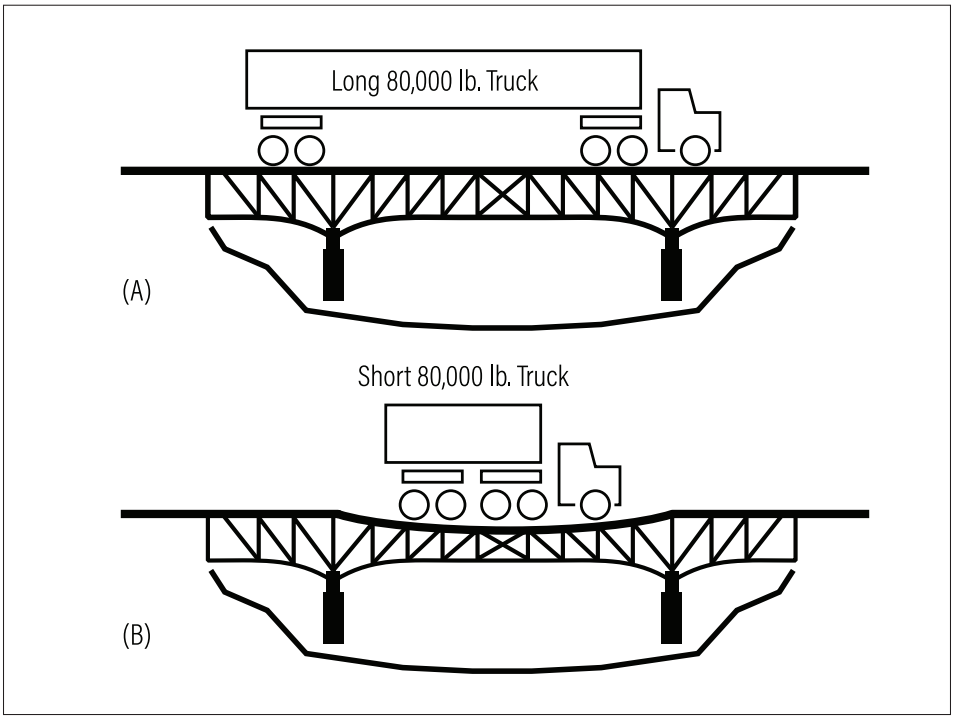

FIGURE 3 Visualization of the federal bridge formula. (Source: FHWA.)

Photo: Flickr

Complicating TSW research are trucks grandfathered by preexisting state laws—notably Rocky Mountain Doubles, or trucks with two linked trailers—that are allowed to exceed 80,000 pounds on the nation's Interstates.

that includes other major federal-aid roads. The Act also standardized minimum lengths for truck trailers and twin trailers. Subsequently, the Intermodal Surface Transportation Efficiency Act of 1991 restricted states from further expanding long combination vehicle corridors (*3*).

EXCEPTIONS TO THE RULE

From a policy standpoint, this pattern of federal regulations appears linear. However, in reality the situation is significantly more complicated. When the Federal-Aid Highway Act of 1956 was enacted, the law grandfathered preexisting state truck size and weight laws. Subsequent federal laws continued this exemption.

By grandfathering preexisting state laws, trucks are allowed to exceed 80,000 pounds on the Interstate System in certain states (e.g., I-90 in Indiana, Ohio, and New York). From a truck size standpoint, the most visible outliers are Rocky Mountain Doubles and triple trailers on non-tolled facilities.

Complicating the situation further, many states make allowances for heavier trucks under certain circumstances to make select industries more cost-competitive—for example, trucks carrying agricultural products, intermodal containers, drilling equipment, and manufacturing parts. Minnesota allows agricultural trucks with six axles to reach 90,000 pounds with an annual permit, and Michigan allows trucks of up to 164,000 pounds across 11 axles to move sawmill logs.

RESEARCH CHALLENGES

Significant research challenges result from the same operational differences created by laws that vary from state to state. Although research can be done within individual states, or among those that do not have grandfathered laws, the results often are not applicable nationwide.

MAP-21 Comprehensive Truck Size and Weight Study

Over the past 70 years, the U.S. Department of Transportation (U.S. DOT) has undertaken seven studies to explore the

TRB's Trucking Industry Research Committee

The TRB Standing Committee on Trucking Industry Research Committee and its Truck Size and Weight Subcommittee are actively developing research to answer many of the questions in this article as well as on other topics like permitting harmonization and multijurisdictional information sharing. For example, the committee cosponsored the 2020 TRB Annual Meeting workshop "Employing Weigh-in-Motion Data to Design, Rate, Manage, and Preserve the Nation's Bridge Structures."

As part of the 2020 TRB Technical Activities Division standing committee reorganization, the Truck Size and Weight Committee transitioned into a joint subcommittee of several related committees but has formally become part of the Trucking Industry Research Committee.

TSW topic (*4*). The latest was prompted by the Moving Ahead for Progress in the 21st Century Act (MAP-21). Enacted in 2012, MAP-21 required U.S. DOT to undertake a comprehensive truck size and weight study that addressed "differences in safety risks, infrastructure impacts, and the effect on levels of enforcement between trucks operating at or within federal TSW limits and trucks legally operating in excess of federal limits; comparing and contrasting the potential safety and infrastructure impacts of alternative configurations (including configurations that exceed current federal TSW limits) to the current federal TSW law and regulations; and estimating the effects of freight diversion due to these alternative configurations" (*5*).

Effectively, the MAP-21 study looked at the differences between trucks operating under the current federal TSW limits and those beyond current limits. Specifically, the project evaluated the effects on:

- Highway safety and truck crash frequency and severity;
- Pavement and bridge infrastructure service life impacts;
- Cost and effectiveness of enforcement; and
- Implications for the national transportation system including the modal share of freight movements.

At the beginning of the MAP-21 study, U.S. DOT identified several data-related issues that limited the ability of the effort to accomplish these goals (Table 1). Similar challenges were identified by a previous U.S. DOT comprehensive

TABLE 1 Data Challenges Identified in the 2016 MAP-21 Comprehensive Truck Size and Weight Study

TOPIC	CHALLENGES
Modal Shift	Freight Analysis Framework (FAF) data set limitations: • Required disaggregation to the county level. Exact origins and destinations are unknown, study used county centers as centroids. FAF does not provide routing (to calculate transportation costs), so calculations used shortest path routes between county centroids. Additionally, chained truck trips are not captured by the FAF. • Commodity groups too broad to identify specific characteristics.
	At the time of the study, the Vehicle Inventory and Use Survey was 13 years old. This aging data set was not able to represent current shipment sizes and annual usage rates for freight flows between distinct origins and destinations.
	Intermodal origins and destinations were not available from the Waybill Sample.
	A broad and exact set of truck rates were "difficult to obtain."
	Unable to undertake precise modal shift modeling due to data confidentiality.
Safety	A lack of truck weight data for individual trucks in state crash databases.
	Limitations in annual average daily traffic and weigh-in-motion data restricted the crash analysis to the Interstate System.
	State crash reports and databases (generally) lack information on the weight and configuration (count of trailers, a count of total axles, and the length of each trailer) of trucks involved in crashes. This significantly limits the ability of researchers to draw national conclusions or analyze the impacts of trucks above or below the federal limit on crash rates.
	AASHTOWare Pavement ME Design software did not accommodate consideration of axle load impacts on overlaid pavement performance.
	The impacts of tire types and tire–pavement interaction were not considered.
	Local roads were not considered because of general lack of pavement layer and traffic information required as inputs to AASHTO Pavement ME Design.
Bridge	No nationally accepted model for analyzing heavy truck or bridge deck interaction and deterioration.
	Inability to account for detour mileage and costs.
	Local bridges were not considered as the design, construction, and management of local bridges vary greatly given that there are thousands of independent local owners across the nation with differing practices.
Compliance	Most states lump funding for truck size and weight enforcement and safety together—hard to separate from a research standpoint.
	Inconsistent interpretations by states submitting compliance data.
	Differences arising between states cannot be solely attributed to differences in truck size and weight limits.
	Vehicles operating under a state-issued permit, including all divisible or non-divisible load movements, were all treated in the same manner.

Source: FHWA.

Photo: Oregon DOT

Trucks line I-84 in Oregon's Columbia Gorge after freezing rain and crashes caused the closure of the highway in 2019. Truck crash data can help further TSW research.

truck size and weight study completed in 2000.

Focused on overcoming these data-related challenges, the study team undertook an extensive outreach effort that focused on the public and subject matter experts to identify any potential new data, methods, or knowledge. The effort did not reveal any new approaches, however.

The MAP-21 study also featured an independent National Academies of Sciences, Engineering, and Medicine study committee that reviewed these challenges. Although the National Academies committee recognized the challenges, it also did not identify new approaches or data sources (*6*).

The study found that the "data limitations were so profound that the results could not accurately be extrapolated to confidently predict national impacts." This finding further suggests "no changes in the relevant federal truck size and weight laws and regulations should be made until these limitations are overcome" (*6*).

To overcome these challenges, U.S. DOT suggested that the Transportation Research Board (TRB) convene an expert panel to develop a research plan to answer many of the more narrowly defined research questions that hinder a comprehensive look at the TSW issue. Specifically, U.S. DOT suggested that the group should focus on the following:

Safety. Determine improvements to crash databases and weigh-in-motion data coverage; testing is also needed to understand stopping distances for difference size and weight configurations.

Compliance and enforcement. Identify approaches to identify truck weight enforcement costs separately from all other truck safety enforcement costs.

Mode shift. Update the Vehicle Inventory and Use Survey (currently under way) and advanced models that reflect mode choice decisions.

Short line railroads. Create a framework for modeling mode shift impacts.

Freight Analysis Framework. Facilitate the ability to disaggregate to the county level and flow goods across a multimodal network.

Truck rates. Create a framework and process for the regular collection of truck rates.

Bridges. A nationally accepted methodology is needed to calculate bridge damage costs and deterioration by truck class.

Pavement. Refinement of AASHTOWare Pavement ME Design is needed to enhance pavement performance modeling capability—specifically for overlay pavements.

Local roads. Gather information about local roads used by trucks as routes to access major freight facilities (*6*).

TRB Research Roadmap

In 2017, the TRB Truck Size and Weight Limits Research Plan Committee (CTSW) began their work at the request of U.S. DOT to explore these issues through the development of a research roadmap in two phases. The committee prepared an initial report that identified potential research topics in five overall categories: safety, bridges, pavements, enforcement, and mode shift. This report was published in 2018 and submitted to Congress (*4*).

The committee's second report, "Research to Support Evaluation of Truck Size and Weight Regulations," developed

a series of 27 research problem statements that outlined how the topic improved TSW evaluation methods and data, general approaches, and likely project durations and cost. The problem statements were deliberately patterned after the standard outline used to submit research problems to the National Cooperative Highway Research Program (NCHRP) for funding consideration.

The committee developed the research program around the idea of prioritizing projects that could advance analysis techniques used to inform TSW policy decisions at the federal and state level. The program also included longer-term research concepts that were more complex and outcomes relatively unknown. The core research tracks identified by the committee's report focused on development of the following:

- Truck traffic, weight, and configuration database from nationwide weigh-in-motion installations and other sources;
- Discrete continuous choice model, or suitable alternative, capable of estimating the effect of changes in TSW regulations and other policies on shippers' and carriers' choices of freight mode, vehicle configuration, and shipment size;
- Pavement analysis methods for heavier axle limits, multi-axle groupings, and alternative tire and suspension types;
- Comprehensive model of the relationship of bridge deterioration and service life to vehicle loads;
- Comparative evaluations of crash risks of alternative configurations by the case-control method;
- Protocols for evaluating the performance of truck configurations with simulation, track testing, and field trials; and
- Measurement of relationships between frequency of overloads and enforcement methods and level of effort (*4*).

Although the committee's work was not designed to solve TSW issues, their efforts were intended to move the conversation forward by translating TSW research challenges into fundable research statements for the NCHRP program. Likewise, U.S. DOT's Freight Research and Data Strategy calls out the need to "produce a research and data plan to advance the state-of-practice and knowledge informing commercial motor vehicle size and weight policy" over the near term (*1*). If these plans are carried out, the next CTSW study should produce results that help inform policy makers.

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CENTENNIAL QUOTE

"I have been conducting research in transportation safety and investigating transportation occurrences for more than 20 years. My work has contributed to road safety policy and practice and to safety improvements in all modes. I hope that, in the future, I can have a positive impact on the world by improving transportation safety—and reducing suffering and pain—internationally. The Transportation Research Board (TRB) helps me to attain that potential impact by publishing my research in the *Transportation Research Record* and the TRB Annual Meeting proceedings. My participation on two Standing Committees allows me to keep abreast of developments in transportation safety, which enhances my ability to have a positive impact. The Annual Meeting, which I attend regularly, provides a place to connect with colleagues and learn—something that can be challenging in today's environment. Finally, TRB webinars are an excellent way to hear about international research, not only for myself but for my team.

—MISSY RUDIN-BROWN
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