The Consensus Council
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The Need for a Harmonized Truck Size and Weight System and Improved Trucking Productivity

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Cultivation of wild grains and cereals in the Fertile Crescent, deemed the cradle of civilization, in 10,000 BC created the need for a transportation and supply chain system that has been developing ever since.[1] When hunter-gatherers evolved into agricultural societies and learned that they could produce more food than could be consumed the need for a transportation system, irrespective of how crude and fundamental, was borne. The movement of commodities, processed agricultural products, and food has been taking place ever since from areas of surplus output to locations of demand that experience a deficit in production. Along the way on the path of human civilization and economic development it became recognized as the principles of absolute and comparative advantage would result in a higher standard of living for all involved. This in turn resulted in trade and globalization. Again, it is the transportation and logistics systems that are critical for trade to occur. Yet, society throughout history has continually placed roadblocks in the movements of commodities and goods for all kinds of reasons, many of them unreasonable as noted by Heilbroner's and Milberg's *The Making of Economic Society*.

Figure 1. The Fertile Crescent: Circa 10,000 BC

> "One of the most striking characteristics of the Middle Ages, and one of its most crippling obstacles to economic development, was the medieval compartmentalization of authority. Over a journey of 100 miles, a traveling merchant might fall under a dozen different sovereignties, each with different rules, regulations, laws, weights, measures, and money. Worse yet, at each border there was apt to be a toll station. At the turn of the thirteenth and fourteenth centuries, there was said to be more than 30 toll stations along the Wesser River, and at least 35 along the Elbe; along the Rhine a century later, there were more than 60 such toll stations, mostly belonging to local ecclesiastical princes. Thomas Eykes, an English chronicler, described the

[1] Ancient history Encyclopedia, Joshua J. Mark, published on 02 September 2009

> system as “the raving madness of the Teutons.” But it was not only a German disease. There were so many toll stations along the Seine in France in the late fifteenth century that it cost half its final selling price to ship grain 200 miles downriver. Indeed, among the European nations, England alone enjoyed an internally unified market during the middle and late Middle Ages. This was one powerful contributory factor to England’s emergence as the first great European economic power. ”[2]

Fred Smith, founder and chairman of FEDEX recently made the case for the free movement of goods and commodities at JOC’s 2014 TPM conference when he said; “ In an ideal world, I think all countries would declare universal free trade and be done with it. After all, that was at the center of the American miracle and the commerce clause in our constitution.” That clause provides the U.S. Congress the power to regulate commerce across state borders.[3] The framers of the Constitution wanted to prevent states from enacting discriminatory rules and regulations that favored one state over another or unjustly enriching themselves at the expense of other states such as happened in certain places in Europe. Whether by design or not, it increased competition and unified the country.

There are several reasons for harmonizing truck size and weight regulations with the goal of improving transportation efficiency and effectiveness in the northern plains region of North Dakota, South Dakota, Minnesota and Manitoba. They mainly center on economic and environmental rational as delineated below but could also include safety.

- ✓ Agriculture continues to become nationally and globally more economically competitive
- ✓ Transportation and the logistical system is one area of control in which the region can affect competitive outcomes
- ✓ Increases in agricultural production in the region have been phenomenal over the last 60 years, putting more pressure on infrastructure
- ✓ Innovative truck configurations could reduce highway impacts while decreasing shipping costs
- ✓ There is a potential to reduce CO_2 emissions
- ✓ There may be positive safety impacts

Agricultural markets are generally thought to be highly, or sometimes perfectly, competitive. They involve homogeneous products that are produced by a sufficiently large number of sellers who sell into a market where price discovery is open to a large number of buyers who don’t control prices. The ability to differentiate your product is challenging at best, and largely impossible in many cases. The attributes of most or many of the subsectors of the agricultural industry conform to Michael Porter’s Five Factor Model of Competition (Figure 2).[4]

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[2] 1Robert Heilbroner and William Milberg, The Making of Economic Society, 11th Edition, Prentice Hall, 2002, p. 40.
[3] The Commerce Clause describes an enumerated power listed in the United States Constitution (Article I, Section 8, Clause 3). The clause states that the United States Congress shall have power "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes."
[4] Michael Porter, Competitive Strategy, Techniques for Analyzing Industries and Competitors, the Free Press, 1980, p. 4.

There are many industry suppliers who cannot control price of inputs and thus extract profits from the core industry. A large number of buyers and a transparent market results in competitively determined market prices. And, assuming availability of information and a sound transportation and logistical system, arbitrage will prevent market discrimination and separation. There has always been the threat of new entrants, the origins of the United States was a good example of a new entrant into the global supply of grain and other agricultural commodities in the early history of the country. More recently, Brazil is a great example of a new entrant into the global agricultural industry and also exemplifies how building transportation infrastructure can improve its competitive advantage. At this time, there are no good substitutes for food. Finally, there is substantial rivalry among firms within the industry along the supply chain from production agriculture through processing, distribution, and retail (although it certainly varies by segment). The bottom line is that the agricultural industry is highly competitive. In such an economic environment it is extremely important that firms are well managed and all opportunities to gain a competitive advantage are exploited.

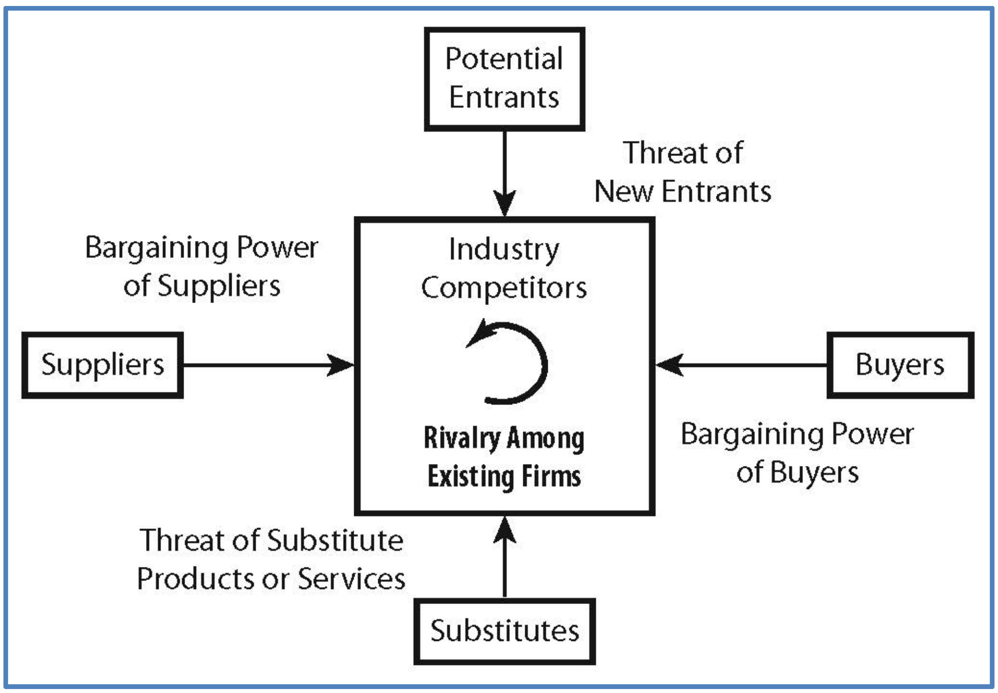

Figure 2. Forces Driving Industry Competition; Porter's 5-Factor Model

Although agriculture has always been a completive industry, due mainly to the nature of commodities for which it is difficult to develop product differentiation, it is becoming increasingly so. This is because of advances in transportation and logistics. Agriculture has become increasingly competitive in the latter part of the 20th Century and will continue to become more competitive on a global basis in the 21st Century.

> "An increasing emphasis will be placed on managing and optimizing supply chains from Genetics to end-user/consumer. This supply chain approach will improve efficiency through better flow scheduling and resource utilization, increase the ability to manage and control quality throughout the chain, reduce the risk associated with food safety and contamination,

and increase the ability of the crop and livestock industries to quickly respond to changes in consumer demand for food attributes."[5]

To address this competitive environment government, the private sector and NGO's will have to collaborate in the area of public policy that results in a transportation and logistics system that is the most effective and efficient as possible.

One path to success is to carefully manage that which you can't control and to exploit that which you can affect the outcome of. This maxim could aptly be applied to production agriculture in the three-state and one Canadian provincial region of the International Legislative Forum (ILF). The region is blessed with an agricultural natural resource base which can be little controlled. Similarly, weather and climate cannot be controlled. Mechanization of agriculture began with the initial domestication of grains and has continued to rapidly improve in the last 100 hundred years and is spread throughout the world within a market system driven by profit maximization, market share, and other private sector goals. Advanced technology in seed, chemicals, and remote monitoring is similarly spread throughout the agricultural producing regions of the world. This results in a highly competitive industrial agricultural complex in a global context. The one area where states, provinces and countries can develop a competitive advantage is the development of their transportation and logistics systems. This is made all the more important since agricultural production and processing is not local in nature. It is usually regional with commodities and processed products moving across state and provincial borders.

- ✓ Natural resource base – little or no control
- ✓ Weather and climate – little or no control
- ✓ Mechanization – first advancement, spread through a free market system
- ✓ Technology – no control, transferable, available to all
- ✓ Transportation/logistics system – control, can create a competitive advantage

However, harmonization of truck size and weight rules and regulations among states and provinces has been an elusive goal for a number of years. A study conducted for the North Dakota Department of Transportation to evaluate truck size and weight issues in an effort to improve the region's economic competiveness was completed in 2007.[6] In the North Dakota Department of Transportation's 2014 freight transportation plan, harmonization of truck size and weight rules and regulations to improve regional competiveness was cited as an important issue by stakeholders in North Dakota and the surrounding states and provinces. This will become more important as cross border movements expand and production of agricultural commodities increase.

Production agriculture has been amazingly prolific in the past 50 years. Advances in all phases of production, agronomic practices including fertilization, timeliness, seed selection and population,

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[5] U.S. AGRICULTURE IN AN INCREASINGLY COMPETITIVE GLOBAL MARKET, Michael Boehlje, Department of Agricultural Economics, Purdue University, Staff Paper #02-06, November 2002.
[6] North Dakota Strategic Freight Analysis Summary Report, Regional Strategic Freight Study on Motor Carrier Issues, Upper Great Plains Transportation Institute, North Dakota State University, July, 2007.

seedbed preparation, and a host of other factors have resulted in dramatic increases in production as exemplified in Table 1. Wheat production increased 11% in North Dakota in the last 30 years, corn, a dramatic 1,090% and soybeans a significant 394%.[7] Similarly, Minnesota experienced increases of 113% in corn and 94% in soybeans in the same time period. South Dakota also saw some fairly significant increases during this time period with corn production increasing 176% and soybean production increasing 485%. This is just a few of the major crops; many other crops have experienced similar increases.

Table 1. Selected Crop Production Increases Over Time

Crop	Bushels	Bushels	% Change
North Dakota	**1982**	**2012**	**Δ**
Wheat	295,849,566	328,269,437	11.0%
Corn	34,122,728	406,059,209	1090.0%
Soybeans	31,069,124	153,601,859	394.4%
Minnesota	**1982**	**2012**	**Δ**
Wheat	111,500,972	76,133,135	-31.7%
Corn	610,113,278	1,297,767,570	112.7%
Soybeans	151,240,357	293,830,150	94.3%
South Dakota	**1982**	**2012**	**Δ**
Wheat	85,895,594	100,675,153	17.2%
Corn	174,109,203	480,330,680	175.9%
Soybeans	22,315,924	130,534,273	484.9%
United States	**1950**	**2012**	**Δ**
Wheat	1,019,344,000	2,266,027,000	122.3%
Corn	2,764,071,000	10,780,296,000	290.0%
Soybeans	299,249,000	3,033,581,000	913.7%

Source: NASS, US Dept. of Agriculture

This trend was also experienced across the United States over the past 62 years. Wheat production increased 122%, corn production increased 290% and soybean production increased 914%. These productivity gains are most likely true of all agricultural commodities grown in the United States and the World for that matter. The end result is s a significantly larger volume of commodities traveling from farm field to farm storage and/or elevator. From there they may go to a local processing facility. The upshot of it all is many more truckloads and many more tons will traverse the existing infrastructure. What's more, some of the infrastructure was not constructed with the increase in production

[7] Soybean production in North Dakota was not accounted for in the NASS survey prior to 1994 so the increase has been only in the last 18 years.

envisioned. This phenomenon is captured in a slide used by the North Dakota Department of Transportation that graphically makes the point (Figure 3).

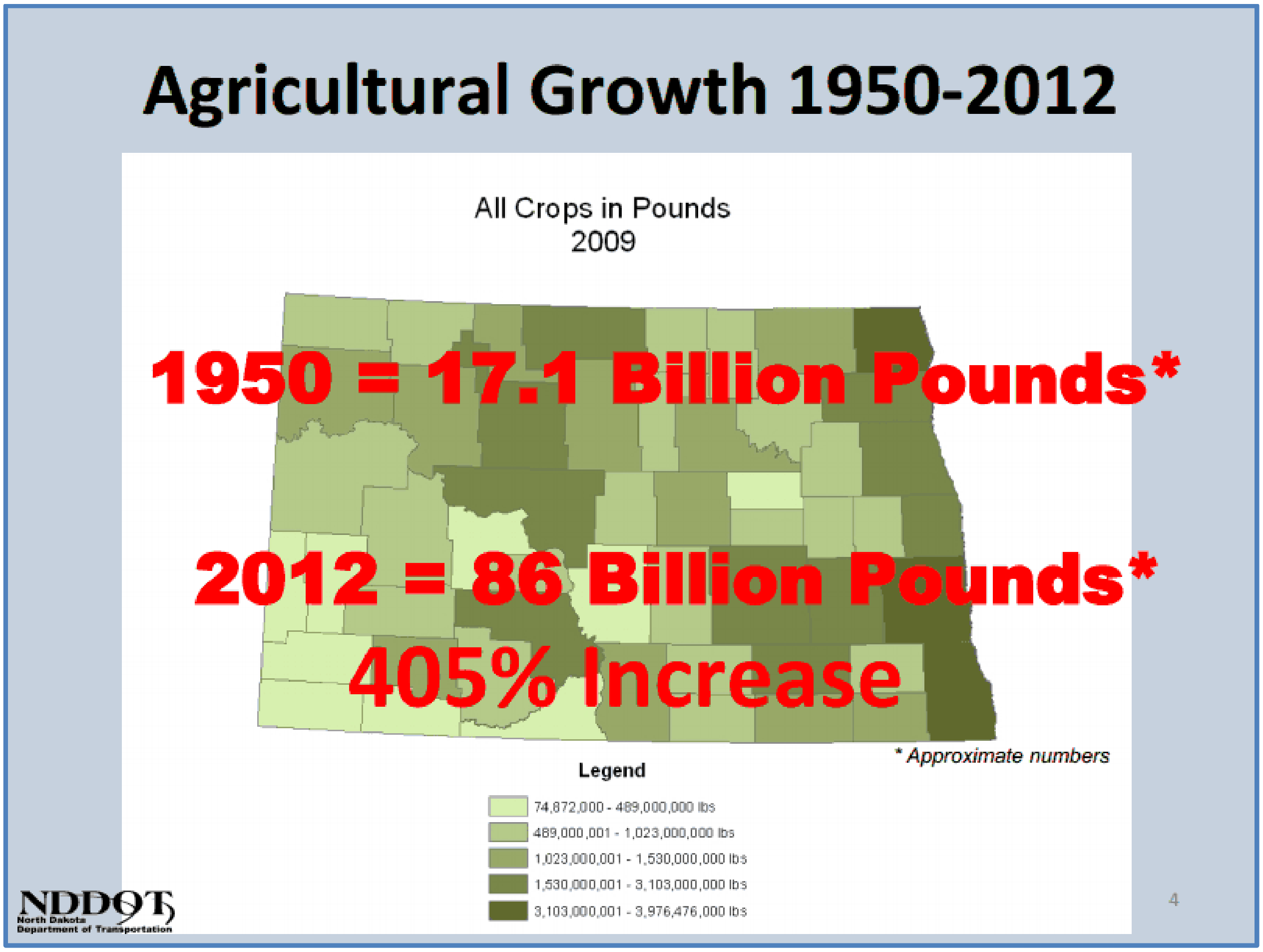


Figure 3. Increase in Agricultural Production over Time in Pounds

This increase in productivity is not expected to level off. In fact, it may well increase with continued advances in genetic engineering and the adoption of precision agricultural technology sometime in the future. Also, advances in fertilization, such as encapsulated time-released secondary and micro nutrients, are expected to bring about increases in production in the near future. This has implications for the road system since the truck is the first and last mile of haul and point of contact for agricultural commodities. This is and will present an ever increasing challenge for public policy makers in the region.

One way to address this challenge is to increase the productivity of trucks that handle agricultural commodities and other types of freight. The Canadian prairie provinces embarked on a broad freight transportation policy change in 1974 to improve trucking productivity in an effort to reduce trucking costs with the goals of increasing competition between the truck and rail modes and increasing economic competiveness of the region. These bold policy changes were significant at the time.

"They had fundamental civil engineering implications for highway network planning, as well as for the design and evaluation of road geometry, pavements, and bridges, which require the specification of a design vehicle and (or) detailed information about truck volume, configuration, and weight. In addition, they impacted road safety, highway financing, modal competition, and energy efficiency. All three policies represented a major divergence from the U.S. truck size and weight standards enunciated in Bridge Formula B, U.S. federal transportation bills, and state regulations."[8]

One of the vehicle designs that resulted from this policy change was the Canadian 8-Axle B Train with a fifth wheel tridem axle dolly (Figure 4). In Canada, this trailer design allows for 12,100 lbs. on the steering axle, 37,400 lbs. on the tractor tandems axles, 46,200 to 50,600 lbs. on the tridem axle depending on spacing, and 37,400 lbs. on the rear trailer tandem axles. This results in a total maximum GVW of 137,500 lbs. with a payload of 99,900 lbs.

Given North Dakota has a more limited GVW limitation this trailer design allows for 12,000 lbs. on the steering axle, 26,000 lbs. on the tractor tandems axles, 41,000 lbs. on the tridem axle, and 26, 000 lbs. on the rear trailer tandem axles. This results in a total GVW of 105,500 lbs. with a payload of 68,000 lbs.

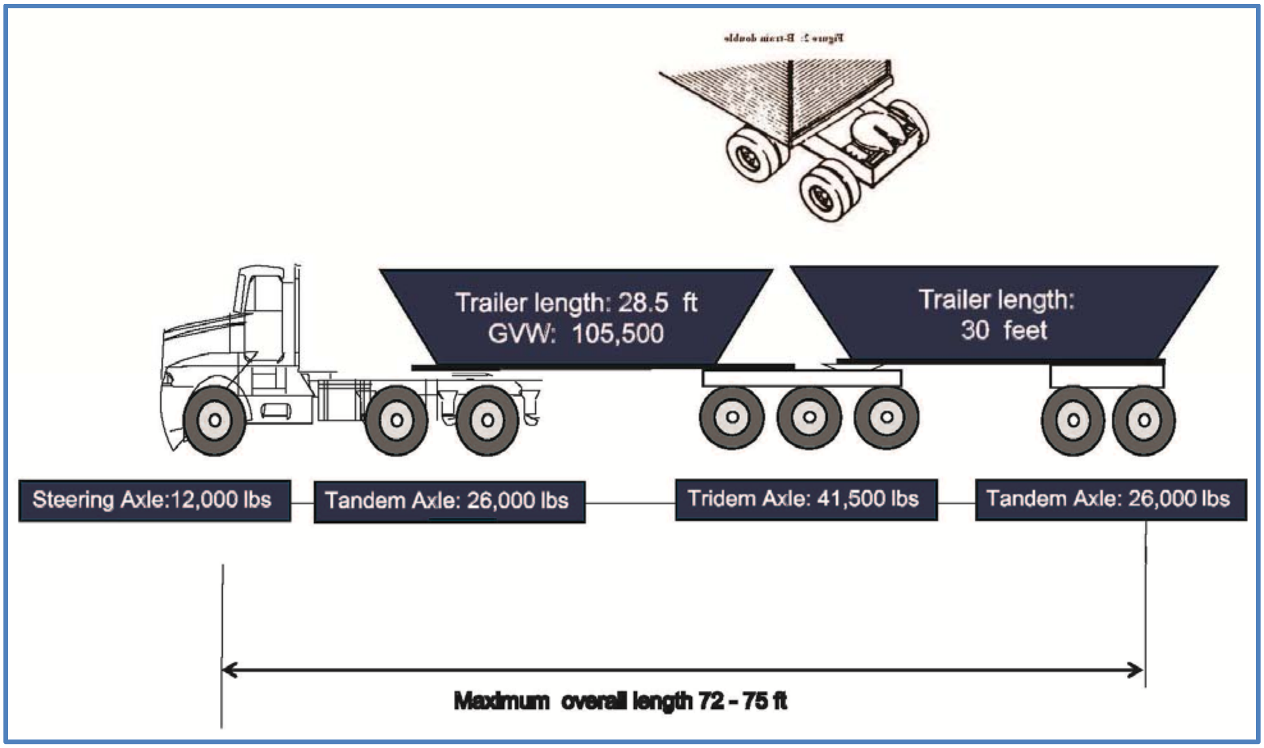


Figure 4. Canadian 8-Axle B Train with Fifth Wheel Tridem Axle with North Dakota Weight Restrictions

The reduction in the number of trips to move the 86 billion pounds of commodities produced in North Dakota in 2009 is significant to comparing a traditional 5 axle semi to an 8 axle Canadian B train (Table 2). 1,616,541 trips compared to 1, 266,568 trips, a reduction of 349,973 trips or 22%. This would be

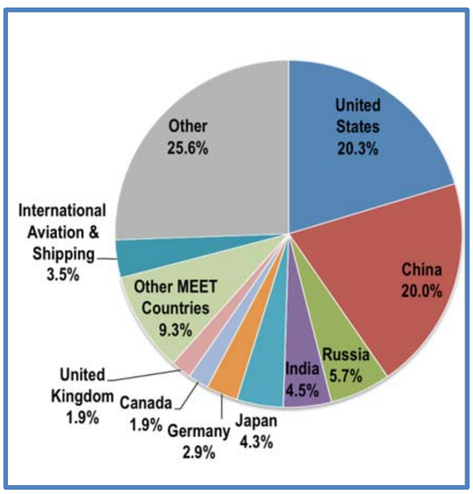
[8] Lessons learned about the impacts of size and weight regulations on the articulated truck fleet in the Canadian prairie region, Jonathan D. Regehr, Jeannette Montufar, and Alan Clayton, Can. J. Civ. Eng. Vol. 36, 2009, p. 607.

accomplished with less damage to the road system as well since the number of Equivalent Single Axle Loads (ESALs) is less for the Canadian B Train.

T able 2. Selected Factors for Various Weight Limits and Truck Configurations

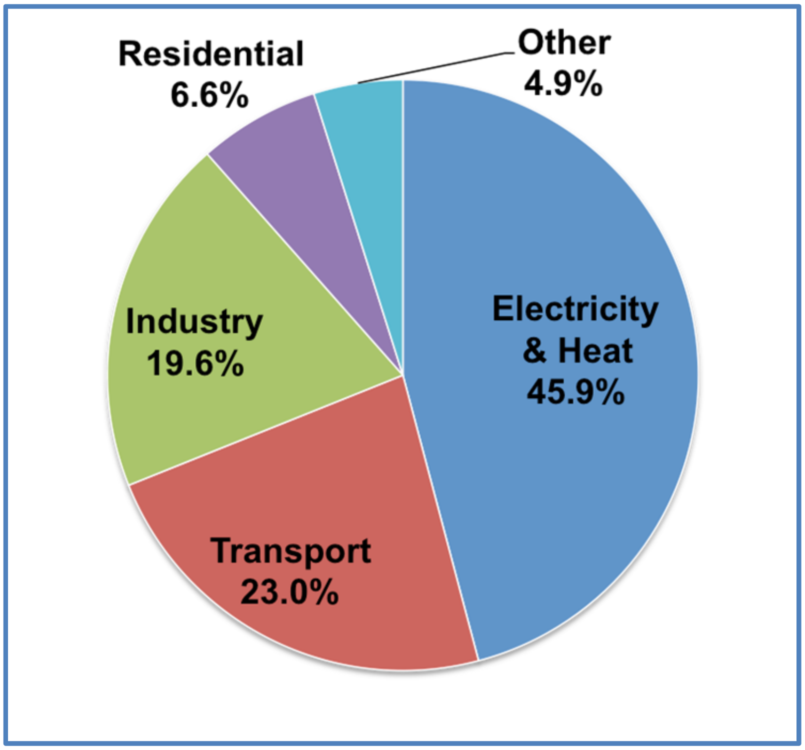
US Interstate Load Limits	5-Axle Tractor Semi Trailer
Tare	26,800
Payload	53,200
GVW	80,000
Trips to Move 86 B Lbs.	1,616,541
ESALs/Trip	3.48
ND Highways Load Limits	Canadian B Train 8 Axle Double LCV
Tare	37,600
Payload	67,900
GVW	105,500
Trips to Move 86 B Lbs.	1,266,568
ESALs/Trip (42,000 lb. Tridem)	2.75
CA Prairie Provinces Load Limits	Canadian B Train 8 Axle Double LCV
Tare	37,600
Payload	95,500
GVW	133,100
Trips to Move 86 B Lbs.	900,524
ESALs (46,200 lb. Tridem w <3.0 M spread)	5.60

The fifth wheel tridem axle B train is also safer than the traditional draw bar Longer Combination Vehicle (LCV). They provide a more stable environment for the second trailer resulting in fewer roll overs.



Additionally there is the added benefit of reducing greenhouse gases (GHG), specifically CO_2. The U.S. was one of the largest contributors to CO_2 emissions in the world in 2006 (See figure to left). Although it is being reduced by the increased use of natural gas replacing coal and other carbon fuels, it is likely that the U.S. will remain a significant contributor for the foreseeable future because of the nature of its economy and standard of living.

One of the largest contributing sectors to CO_2 emissions is transportation, second only to electricity and heat production (Figure 5). As the U.S. moves to replace coal with natural gas or

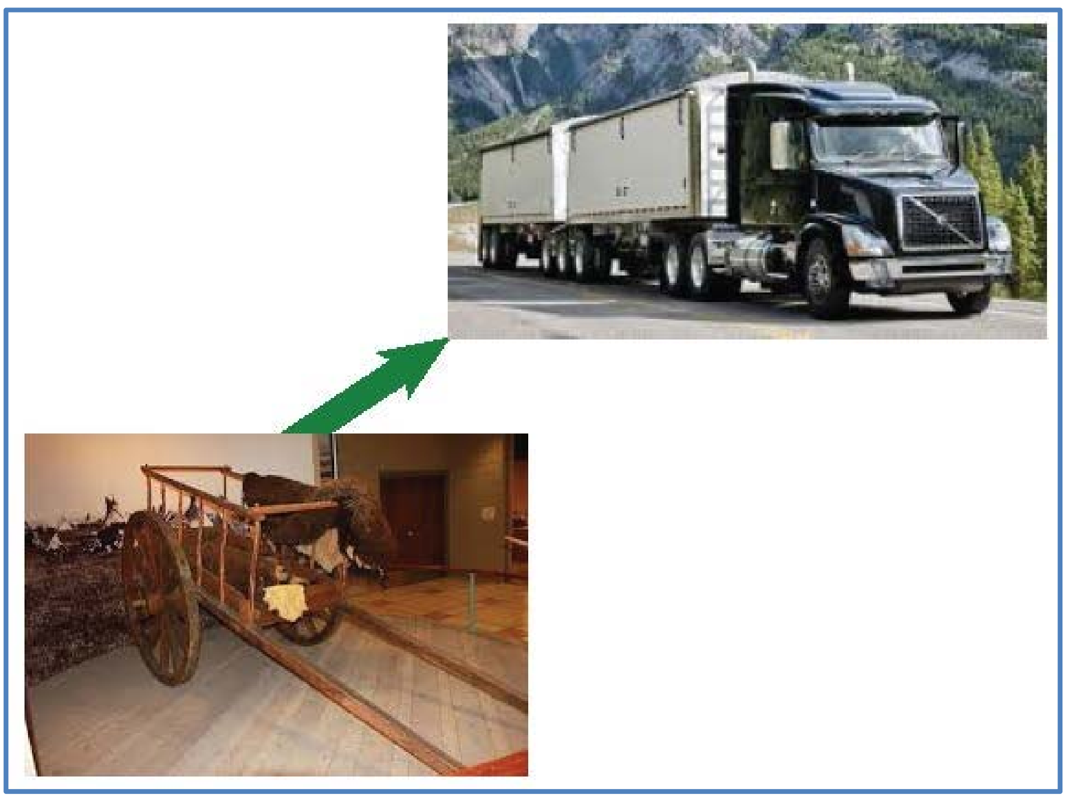


carbon capture technology becomes feasible the transportation sector may become a larger contributor to CO_2 emissions.

This paper is not meant to resolve the issue of truck productivity and the challenges of harmonizing truck weight and size differences among political subdivisions. That is indeed an ambitious undertaking. Instead it is meant to illustrate what we might be giving up as a society by not trying to figure out how to move in this direction and stimulate discussion to get us started down that path.

Figure 5. CO2 Emmisions by Sector, 2006: Source: TTILIT, Japan

Is it time to move on?



It is time to address the issue of tuck productivity such as the Turner proposal which was made some years back. In 1989 Francis Turner, former administrator of the Federal Highway Administration, proposed a new configuration of truck that would reduce wear on the highways and increase trucking physical productivity. The American Association of State Highway Transportation Officials (AASHTO) requested the Transportation research Board to evaluate the proposal.

Turner's proposal, the study's starting point, was as follows:

1. Reduce legal single axle loadings to a maximum of 15,000 lb. and tandem axles to 25,000 lb.
2. Allow greater vehicle lengths; and
3. Raise maximum gross weights to as much as 112,000 lb.

Turner proposed that these limits apply to all trucks, but where axle weights could not practically be brought down to the indicated maximums that special permits and higher annual registration fees would be assigned. His example of a truck meeting the proposed limits was a double trailer combination with four tandem axles and a gross weight of 112,000 lb., which he estimated would reduce pavement wear per payload ton-mile by two-thirds compared with a 80,000 lb. five-axle tractor-semitrailer.

After a comprehensive evaluation the study committee recommended that every state, with careful assessment of the risks and uncertainties, consider this proposal as a supplement to current size and weight regulations. If Turner trucks were adopted in all states according to the recommended rules, they would reduce the cost of shipping freight and would not degrade safety. The total cost of maintaining the road system would be reduced, although pavement wear savings would be partially offset by higher bridge costs.[9]

Much additional research has been conducted since then and a number of new ideas have been evaluated that could increase payload while reducing wear on the highway such as the Trunnion Axle Configuration (Figure 6). The Center for Transportation Research at the University of Texas conducted a study comparing the impact of tridem axles versus trunnion axles on flexible and rigid pavements.[10] The study concluded that the trunnion configuration would have far less impact on flexible pavements and slightly more on rigid pavements, probably because of the width of the trunnion configuration reached the outer edges of the pavement. Presumably, this is where the tensile strength of the pavement is the weakest.

The subject is complex and a number of issues have to be taken into account such as the impact on bridges. But the importance of the viability of the economy of the Northern Great Plains should not be taken for granted and transportation plays a vital and key role in its continued success.

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[9] New Trucks for Greater Productivity and Less Road Wear: An Evaluation of the Turner Proposal, Transportation Research Board, TRB Special Report 227.

[10] Zhanmin Zhang, Izydor Kawa, and W.R. Hudson, Summary of Findings on the Relative Impact of Tridem and Trunnion Axles on Pavements and Bridges, Center for Transportation Research, University of Texas at Austin, Project Summary Report 1713-S2, October 2000

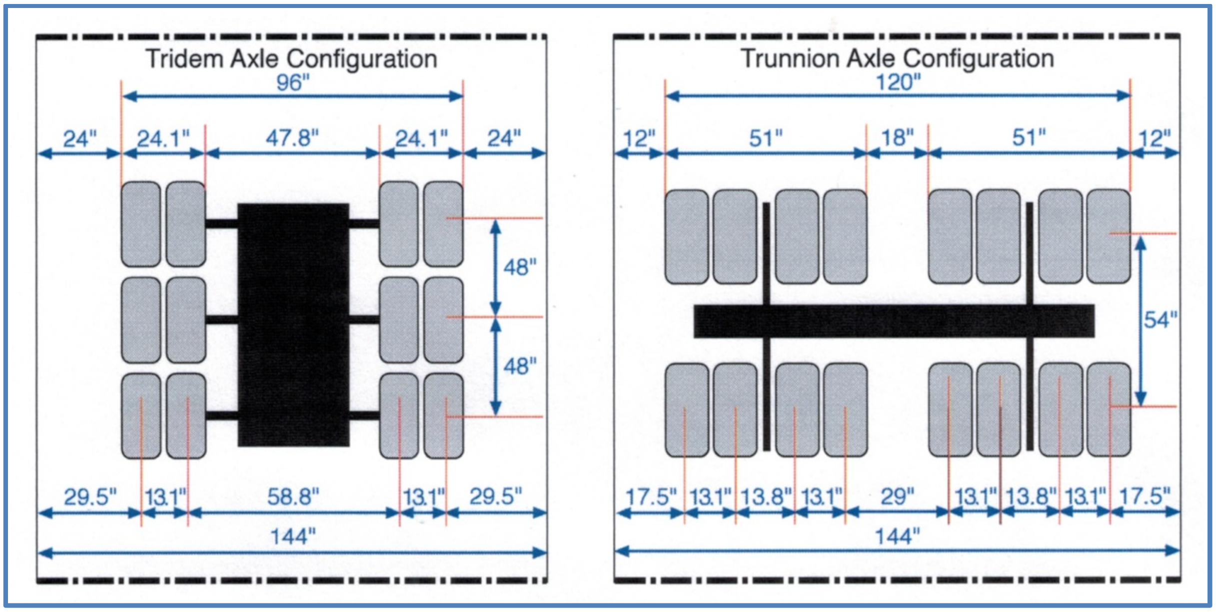

Figure 6. Illustration of Tridem and Trunnion Axle Configuration