Possible Solution to Predictable Highway Overuse

The Problem

Supply chain sclerosis, driver shortages and roadway congestion threaten to bedevil U.S. freight movement indefinitely. The first two of these problems have been well-reported, the third not so much. But projections of over 50% more long haul truck traffic by 2045, as compared to 2015, and 30% more freight volume by 2031 as compared to 2019, suggest we should expect exponentially increased highway congestion in coming years, with no solution to this problem in sight. Likewise missing are proposed solutions to the driver shortage and supply chain problems. Meanwhile, tens of thousands of miles of intercity railroad trackage lies dormant much of the time. Envisioning the movement of significant parts of the load on one intercity transportation network, *i.e.* the highway system, to the other major intercity transportation network, *i.e.* the nation's railway trackage, may be a bold dream, but the alternative may be the mother of all transportation nightmares.

Apart from the monumental changes in railway management that would be required, trains, as presently conceived, may well be only part of the equipment necessary to make this transformation a reality. To take full advantage of both intercity networks, vehicles capable of travel on both highways and railroads, and seamlessly transitionable from one to other, would likely also be required. Such vehicles, autonomously drivable, would greatly facilitate more efficient rail-truck intermodality, enabling direct shipping from freight origination points to destination points, with intermediate driverless long hauls (via rail) and more efficient rail yard transfers. Reduced demand for drivers would also likely result, not to mention the much improved fuel economy and environmental benefits of rail versus highway travel, long touted by the railroad industry. *(The Positive Environmental Effects of Increased Freight by Rail Movements in America, American Association of Railroads, June 2020)*

This leaves a major question, the challenge of whether vehicles capable of travel on both highways and railroads, and seamlessly transitionable from one to other can be developed. Suggestions to railroad insiders, as well as to truck makers and truck shipping users, that such a vehicle may be developable, have gone unanswered, having apparently fallen on deaf ears.

So there remains the holy grail of more efficient use of railroad infrastructure, much of which lies dormant a great deal of the time, to relieve, at least to some extent, highway congestion. As suggested above, the obvious potential benefits for truckers and truck shippers cannot be overlooked. And railroads may be convinced not to overlook their potential of increased revenue from the tolls likely to be extracted for passage of additional freight over their existing privately owned rail lines. Railroads may benefit as well from the greater efficiency realized in intermodal shipping by eliminating the time delays of truck-to-rail and rail-to-truck freight transfers and the relief of congestion at rail marshalling yards. Collectively these factors strongly suggest investigation of the practicality of autonomously drivable vehicles capable of long range or inter-city travel on both rails and roads and seamlessly transitionable between those travel modes (*i.e.* AUTORRs, autonomously drivable road-rail vehicles)

Practically, the developments of AUTORRs faces two major obstacles, namely (1) the development of autonomous trucks seamlessly and interchangeably capable of travel on highways and railways and (2) the cost and the monumental investment in time and systemic disruption likely to result from the necessary prototyping and evaluation of AUTORRs, all without assurance of commercial success.

Response To The First Obstacle

What might be necessary to make the AUTORR concept a practical reality?

First, autonomous trucks (ATs). Market forecasts for ATs typically focus on expanding regulatory permissions to include trucks requiring less and less in-person intervention and marrying ATs to specifically adapted routes. Only the most optimistic forecasts include fully autonomous on-road trucking in any time frame other than the distant future. But fully autonomous, *i.e.* driverless, trucks are already operational in limited confines, such as mines in Australia. Digitized rail networks, complemented with digitized roadway transition locations, may well accommodate fully autonomous trucks on rails and in road-rail transitions, the ATs being convertible at transition locations to whatever degree of autonomous control is permitted for roadway use away from those locations. Railroad marshalling yards and rail lines generally are already digitized, at least to some extent, and digitization of international cargo inlet ports together with connected road facilities would likely require only modest implementation. Coincidentally, railroad marshalling yards and international cargo inlet ports could be the venues most advantaged by autonomously drivable vehicles.

More challenging, practical AUTORRs would require wheels capable, without mechanical intervention, of travel on both rails and roads. One way this may be accomplished is by a combination of roadway wheels with railway wheels , the former of slightly larger diameter than the latter, as suggested for example in US Patents 7,077,065 and 2,135,307, of which representative embodiments are shown in Figures 1 and 2.

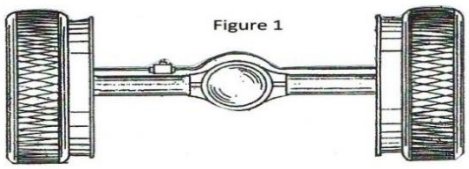
Figure 1

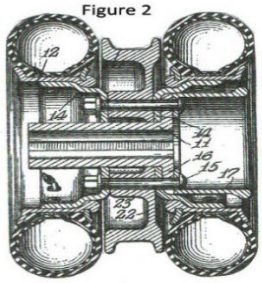
Figure 2

Transitioning of a vehicle supported by such wheels from roadway travel to railway travel, or vice versa, would occur at railway-roadway intersections where inclined road grades or ramps along the railway on either side of the intersecting roadway engage the vehicle's roadway wheels as the vehicle approaches or leaves the intersection traveling in the railway direction.

To be sure, adaptation of this concept for AUTORRs would require axially separating the railway wheel and roadway wheel components and spacing them consistent with existing road and rail infrastructure. AUTORRs so equipped, transitioning to or from a non-public roadway such as a limited access parking

area, could function driverlessly while in railway mode, to be driven away from the non-public roadway onto public highways in a conventional manner.

Integration of AUTORRs into existing railroad infrastructure would require only the addition of ramps at road-rail intersection and computerized vehicle control on the intersecting rail lines. As to the latter, computerized scheduling and responding to regulatory requirements for crash avoidance has already forced railroads in that direction. With such control, AUTORRs could operate independently or in convoys with other trucks or conventional trains. Accompanied by battery-laden rail cars charged in solar or wind energy-rich source areas, electrically driven trucks could be recharged en route, lessening recharging downtime and electrical grid demand in off-rail truck destination areas.

While this concept of AUTORRs has been described as one possibility for practical autonomous road- and rail-capable vehicles to demonstrate the feasibility of AUTORRs based on existing technology, quite likely improvements on this concept or other AUTORR concepts entirely can and will be developed by those with expertise in the relevant technologies.

Response To The Second Obstacle

As to the second of the perceived major obstacles to AUTORRs as a means for significant diversion of highway traffic to rail lines, major retailers may be the best motivators for truck manufacturers and railroads to address this obstacle, *i.e.* the cost and systemic disruption of a large-scale commitment to AUTORR development. Autonomous trucks are already being evaluated by a few major retailers for high volume, repetitive inter-warehouse truck routes, albeit with in-person driver-monitors on board. Many such routes likely parallel existing rail lines. With cooperative efforts of major retailers, truckers and railroads, a few such routes could be adapted for AUTORR travel, and a limited number of AUTORR prototypes could be assembled and tested. In this way, inter-warehouse shipments on those selected routes may be completely automated for a significant part of the inter-warehouse distance, conceivably without the necessity of an in-person driver-monitor. Thus, the AUTORR concept could be very useful for the retailers in the relatively near term. Equally important, this limited implementation could well serve as a prototype for evaluation of the concept for longer term and larger scale implementation.

The Solution

While commercial success cannot be guaranteed, AUTORRs may be the best long-range solution to the prospective continuing, and possibly much larger, problems of highway congestion, driver shortages and supply chain hang-ups. And large-scale retailers may be the most likely motivators for prototypical development and evaluation of AUTORR concepts. It remains for such large-scale retailers to realize the value of this approach to them and to the transportation industry generally. From railroads' standpoint, AUTORRs may also lessen railroad marshalling yard congestion and greatly simplify truck-rail intermodal freight transportation.

Railroads, the trucking industry, highway infrastructure and shippers, particularly including major retailers, all stand to benefit, both individually and collectively, by the systemic integration of the two major domestic shipping modes made possible by AUTORRs. It remains for transportation industry researchers, planners, and users to seize upon this possibly transformative development.