Rethinking Truck-Rail Intermodal Transport

Truck-rail intermodal transport, while highly advantageous in many economic and environmental ways, faces headwinds limiting its further growth, notwithstanding the tens of billions of dollars US railroads have spent on new infrastructure and equipment directly connected to intermodal operations. The alternatives, shipping by rail-only or truck-only, also face inherent limitations. Looking ahead to problems likely to arise from the greatly increased volume of shipping predicted for the coming decades and the unlikelihood of any expansion of already crowded highway networks, the trucking and railroad industries should consider a common solution. A modified form of intermodal transport may provide that solution,

The disadvantages of rail-only and truck-only shipping are obvious. Most points of origin and destination for freight shipments are not on rail lines, so some trucking from and to those points necessarily adds to the cost and time of rail shipping while cost and environmental concerns significantly disadvantage trucking only, versus rail shipping. Per mile per ton of freight, shipping by truck costs over four time the cost of shipping by rail and creates significantly more atmospheric pollutants and greenhouse gas emissions. According to one American Association of Railroads publication, on average, railroads are three to four times more fuel efficient than trucks and moving freight by rail instead of truck lowers greenhouse gas emissions by up to 75%, on average. According to the same publication, if just 10 % of the freight that moves by Class 7 or Class 8 (the largest) trucks) moved by rail instead, fuel savings would be more than 1.5 billion gallons per year and annual greenhouse gas emissions would fall by more than 17 million tons- equivalent to removing around 3.2 million cars from the highways for a year or planting 400 million trees. (*The Environmental Benefits of Moving Freight by Rail, AAR, July 2019*) The anticipated conversion of trucks, and even trains, from fossil fuels to electrical drives should positively impact both the economics and the environmental footprint of both modes of shipping, but it seems fair for present purposes to assume that the disparity in efficiency of rail versus truck transport will still be manifested if and when non-fossil fueled vehicles become more common.

Road-rail intermodal would seem to be an obvious way to take advantage of these inherent characteristics of rail and truck shipping. Indeed, that has been the case for longer range shipments and that has been the basis of significant growth of truck-rail intermodal shipping to date. Over shorter shipping distances, the advantages of truck-rail intermodal are seriously impaired by the greater proportion of shipment transit time and cost involved in the transition of freight from road to rail and vice versa. Yet penetration of that shorter range market, may be one important key to continued growth of truck-rail intermodal shipping.

According to one railroad insider's opinion, " , , , . far less intermodal highway to railway shifting will occur than was formerly expected unless something in the railroad intermodal business model changes." (*Jim Blaze, Is Intermodal Rail Stalling? Railway Age, Sept.5, 2019 and Will Short-Haul Rail Intermodal Ever Work? Railway Age, Jan. 2, 2020*) While much of Mr. Blaze's opinion is focused specifically on trucking's competitive advantages for shorter distance hauling, he also mentions other impediments to further growth of truck-rail intermodal, such as the conflict between railroads' commitment to computerized precision scheduling and delays endemic to intermodal transfers, and the lack of a rapid load-on/load off railcar platform. About this Mr. Blaze opines that, "Rail management doesn't have a mechanical engineering solution to grab this market." Logic suggests these problems extend not just to shorter distance shipments and trailer on- and off-loading but to the truck-rail intermodal model generally.

These problems, and the absence of industry solutions to them, prevails not only at shipment points of origin and ultimate destination but perhaps more significantly, at intermediate points, namely railroad marshalling yards, where individual railcars are repositioned from one train to another in order to guide each car to its intended ultimate destination. The great strides railroads have made in more efficient use of rail networks with computerized precision scheduled railroading acerbates this problem. Multiple industry publications make it clear that precision scheduled railroading has disincentivized [intermodal] shippers by lessening time for intermodal transfers. That commitment has also had the detrimental effect of eliminating rail transfer of intermodal units between railroads in large metro areas, forcing such transfers to be made by truck, thus requiring additional up-loading and down-loading. (*Outlook for intermodal largely uninspiring after poor 2019; JOC.com, Jan,10, 2020)* Nor is that a new problem. Intermodal railyard delays were among major problems plaguing shipper and logistic providers in Chicago in 2018. *(Chicago intermodal rail delays 'unprecedented' since January, JOC.com, Feb. 22, 2018)*

Still another head wind for rail-truck intermodal is its apparent incompatibility with one significant portion of long-distance truck shipping, namely the shipping of liquids, bulk materials and freight requiring refrigeration. While current rail-truck intermodal favors and is trending toward containerized freight with containers carried on flat cars and transferred from and to trucks, those bulk, liquid, and refrigerated shipments do not lend themselves to container transport.

Bucking the headwinds for truck-rail intermodal shipping with greatly enhanced use of that shipping mode would significantly reduce heavy truck traffic on interstate highways. Doing so would reduce both traffic congestion on, and the maintenance costs of, those highways while increasingly utilizing, with the benefit of precision scheduled railroading initiatives, the thousands of miles of class 1 railway routes, that lie dormant much of the time.

All of this leads to a question: Is there a mechanical engineering solution to enable much more extensive use of intermodal travel on existing rail networks, by facilitating road to rail and rail to road transfers, by facilitating train assembly and disassembly, by facilitating inter-train repositioning in marshaling yards and by providing for the intermodal transport of liquid, bulk, and refrigerated shipments?

Trains of autonomously drivable, rail travel-capable trucks may provide such a solution. Turning that "mechanical engineering solution" to practical utility may be difficult but not impossible.

Autonomously drivable trucks would be the first element of that solution. Practical autonomous vehicles, including trucks, promise enhanced vehicle safety and efficiency in the relatively near future. A fully committed marriage of autonomously drivable roadway-railway capable trucks to truck-rail intermodal transport would be a win-win for all. Specifically, autonomously drivable trucks, supported on highway-capable and railway-capable wheels and provided with railway compatible couplers, would be necessary to achieve this win-win, together with a patient, incremental introduction of such trucks. Such trucks would eliminate certain inherent disadvantages that limit the growth of rail-truck intermodal transport. The enhanced overall efficiency of freight transportation in this mode should more than compensate for the reduced freight weight per unit train length that it entails. Moreover, the design and building of such "vehicles" (be they considered rail cars or trucks), while not trivial, is well within the realm of existing expertise. Centralized control of such vehicles would not be dissimilar from the centralized control of trains as already implemented.

The mechanical elements of these intermodal vehicles would necessarily include, in addition to autonomous drivability, wheels not only compatible with rail and road travel but, most importantly, easily transitionable from road to rail travel and vice versa.

With respect to autonomous drivability, the automotive industry is well on its way to the development and introduction of autonomously drivable trucks. Indeed, fully autonomous off-road versions are already in use at certain large mining facilities in various countries. On road versions are likely to be introduced in stages, the earliest of which will require an in-person driver/monitor. As implemented for truck-rail intermodal vehicles, movement on and off trains and in marshaling or holding yards would not require such a person. An in-person driver/monitor could then take over, if and as required by travel authorities, for the roadway travel segments often referred to in the intermodal business as drayage segments.

Regarding the specialized wheels that would be required, one promising design suggested in a number of patents combines railway wheels with coaxially mounted roadway wheels of slightly larger diameter than the railway wheels. Vehicles with such wheels (possibly including railroad-type bogies in combination) would be transitionable from railway to roadway or vice versa by inclined grade ramps provided along the railroad tracks where those tracks intersect a roadway. With such ramps on both sides of a roadway, the roadway wheels of a vehicle on the rails approaching the intersection, would be engaged by the lower end of the inclined grade ramp on that side of the roadway and rolled up the incline of the ramp such that at the end of the incline, the vehicle proceeds onto the roadway on its roadway wheels. The similarly inclined grade ramp on the opposite side of the roadway would permit the vehicle to return to rail travel as the vehicle leaves the roadway. Once on the roadway, a vehicle uncoupled from adjacent cars or vehicles, may turn off the rail direction and onto the road direction and proceed on the roadway or to a holding area. Similarly, a vehicle my approach the intersection from the roadway and turn onto the track direction and then proceed along that direction of travel coupled to adjacent cars or vehicles, thus permitting train assembly, disassembly and reassembly. The roadway at such an intersection may be part of a conventional rail network or simply a connector to a holding area, such as a parking or staging area for vehicles. Existing rail networks would require such inclined grade ramps wherever a rail line intended for vehicles of this kind intersects a roadway or a railroad switch. That would include, of course, intermodal road-rail transition locations.

Still another mechanical element likely to be necessary for trains incorporating roll-on/roll-off autonomously drivable vehicles would be remotely controlled couplers like those on some conventional railway cars, mounted fore and aft on each vehicle. So long as such vehicles are intended only for use on the rear end of otherwise conventional trains or on trains comprised entirely of such vehicles, couplers may be designed which are lighter in weight than conventional railroad couplers. These lighter couplers could also omit conventional coupler-associated brake pressure conveying lines, vehicle-braking instead relying on automotive type brakes in the roadway wheels. Conceivably, such vehicles, with or without couplers, could also operate individually or in convoys, utilizing otherwise dormant rail lines.

Most likely, railroads can best manage the incorporation of autonomously driven highway-capable vehicles incrementally as railway cars at the rear end of otherwise conventional trains or in limited but highly specific shipment routes. This would also enable the incremental investment in what otherwise might be an unaffordable monumental capital project. Even a modest initial transition of truck-rail intermodal travel to such trucks could produce substantial economic and environmental benefits. Assuming initial success and gradual system and design improvements, the long-term benefits of greatly enhanced truck-rail intermodal travel, including more practical use over shorter distances and the incorporation of refrigerated and bulk carriers, could have enormous positive consequences. Perhaps most important in the long run would be the concomitant off-loading of trucks from an already congested highway system to existing underused railroad trackage.