

Intermodal Chassis Utilization: The Search for Sustainable Solutions

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Abstract

Whereas in Europe chassis are owned by the trucking firms, in North America the chassis historically has been provided at no charge. This means the chassis is not a source of revenue for the shipping lines and railroads, but instead an operating cost absorbed by all their intermodal customers, a cost spread out among each container movement. The world-wide recession, new roadability regulations, and the need to improve labor and equipment productivity are driving the industry to search for sustainable solutions. This paper identifies the chassis problems faced by the industry and explores emerging business models, system designs and technologies to achieve a more efficient intermodal system for all players.

Keywords: Intermodal equipment, chassis, intermodal freight, intermodal terminals, and rail intermodal.

INTRODUCTION

Intermodal freight relies on a joint production model where the chassis is a necessary “supporting” element for the movement of containers to and from terminals and often within terminals. Chassis fleet size and positioning is a recurring issue for the industry in that too few chassis results in a shortage of assets to support modal transfers, while too many chassis results in significant storage, rehandling and damage costs. Like any other assets, chassis need to be effectively managed.

Unlike container and intermodal trailer volumes, chassis fleet statistics do not exist. Industry sources estimate the North American fleet to be around 820,000 (Mitchell, 2007; Prince, 2008). However, because of the recession of 2008-2009 this estimate may be as much as 10 to 15% over the current fleet size. Thus, for around 25 million container transshipments per year, including empty container moves, the mean chassis utilization rate would be a dismal 2.5 trips per month. There are nevertheless large deviations in the utilization level, especially due to the varying use of information technology systems and methods to track equipment assets, the ownership of the chassis, and the different business models of the chassis providers.

Whereas in the Europe chassis are owned by trucking firms, in North America chassis have been predominately owned by shipping lines and leasing companies, managed by terminals and pool operators, and operated by truck carriers on their behalf. This has saddled the North American market with a higher intermodal cost structure because the chassis is not a source of revenue for the shipping lines and railroads that provide chassis, but instead an operating cost absorbed by all their intermodal customers. Commonly, there are no chassis usage charges, meaning that since chassis costs are externalized they tend not to be rationally used.

The chassis also has evolved into a warehouse on wheels—a supply chain buffer (Rodrigue and Notteboom, 2009). Whether empty or full, most containers are stored atop a chassis at both the terminals and distribution centers. But the problem is when a container is not being moved, the chassis no longer functions according to its purpose. The long periods of chassis “dormancy,” as chassis serve as wheeled storage, is a major inhibitor of better equipment utilization. The problem is inherently problematic at most North American terminals. Unlike in Europe, where terminal growth involved the stacking of containers to better use limited real estate assets, most North American terminals expanded horizontally because land tended to be more readily available. In such a setting the storage of containers is horizontal and requires a chassis at the terminal for each container in storage. This strategy is logical as it avoids additional lifts since compensation is usually per container lifted, with all additional intra-terminal rehandling and lifts to be assumed by the terminal operator. Additionally, truck operators have the convenience of being able to quickly drop or pick up a container / chassis pair at the terminal without having to wait for the container to be lifted from / to the chassis.

The port free dwell time means that once a loaded container is transferred from a vessel to a chassis, it can sit atop a chassis for up to 10 days before leaving the terminal. Further, to ensure containers can be delivered to customers there is a pressure on the terminal operator to maintain a large chassis fleet since container shipments arrive in large batches and many customers wish to receive their consignments as soon as

available. The alternative, stacking import containers, drives up terminal operating costs because it adds to the number of handling lifts (minimum of 2 lifts per transfer, more if buried in a stack), as opposed to the single lift per transfer when a container is unloaded to a chassis and placed in storage for drayage firm pick up.

Essentially, providing greater capacity at conventional terminals is usually a choice between more stacking (reducing land costs while increasing handling costs), or the added costs from purchasing and maintaining a larger chassis fleet. In terms of labor productivity, while 0.4-0.75 TEUs per man-hour per full-time employee is the mean for US ports, the predominately wheeled operations at the ports of Los Angeles and Long Beach is around 0.8 TEUS per man-hour (MARAD, 1998). There is also a level of service issue since it usually takes 15-20 minutes to pickup a container on a chassis, and 45 minutes or more for a stacked container (Le-Griffin, 2008).

Utilization problems extend to the distribution centers as well. While container storage at terminals is a mixture of wheeled and stacked, reach stackers (or cranes) are not available at distributions centers. Thus, the choice for a truck driver is to wait for unloading and return with the empty container and chassis, or leave the container/chassis for unloading at a later time (the more prevalent drop and leave, pick and go option). Many chassis get “lost” in the system, with months going by before being used again. A further drag on chassis utilization is when there is not a daily fee assessed; other supply chain priorities will take precedence over the need to get the empty container/chassis back to the terminal.

Ship lines continued to invest in ever larger containerships and expanded port facilities to exploit economies of scale. But as vessel sizes have increased, acute logistical challenges were involved for the inland flow of freight: one 8,500 TEU vessel could fill 40 or more 100-car double-stack trains. This creates diseconomies such as additional demands and higher requirement in the timing of inland containerized shipping as larger amounts of containers need to be shipped over a shorter period of time. Two hundred shipments on a single train manned by two crewman and a few locomotives compared to 200 drivers and tractor trailers, and the

ability to move freight 2.8-5.5 times more energy efficiently than by truck (ICF, 2009), makes double stack rail the most efficient and sustainable option to move freight over land. However, the proliferation of double stack trains has effectively doubled main line volume along many corridors, requiring a much greater chassis fleet to handle the greater volumes at the terminal. Since double stack service presents significant scale economies advantages, the pressure on chassis assets will grow as more Eastern railroad corridors gain the clearances to carry double stack trains, further accelerating the double-stack driven trend of container on flatcar (COFC) volume growth and relative trailer on flatcar (TOFC) volume decline. With sufficient density, many more corridors can attain equivalency with the high-capacity high-frequency corridor from Los Angeles to Chicago where rail matches over-the-road truck service in terms of speed and reliability. By 2010, citing energy and cost advantages, major carriers JB Hunt and Schneider stated plans to containerize their entire intermodal fleet.

Much research has been undertaken to identify ways in which a greater percentage of truck traffic can be handled by intermodal rail in Europe (Tsamboulasa et. al., 2007) and the United States (AASHTO, 2003; Bryan et. al., 2007; Casgar, et al., 2003). Yet none of these studies address reducing chassis costs by improving its utilization level. Rail solutions to increase domestic intermodal volumes have been historically focused on ways to efficiently remove the driver and line haul tractor from the rail move (e.g. Piggyback) or to remove the railcar (e.g. RoadRailer). Other proposals have been to try to eliminate the crane to lower terminal costs (Iron Highway proposed by Bryan et. al. By-Pass Route proposed by Casgar et al.). Although these proposals may fill niche markets with a smaller footprint that requires less labor and does not require acreage to store chassis, there is little evidence that either of these systems can generate the volumes to warrant more frequent trains, or be rapid and reliable enough to be competitive with road services. Surprisingly, none of these proposals suggests new designs and technology to address the growing double stack market.

Most equipment studies address containers, not the chassis, such as a proposal by Gorman (2005) to create a spot market to address container and trailer balancing and utilization challenges, or Boile et al. (2009) who looked at optimal locations for container depots and the repositioning of empty containers to improve asset availability and utilization. The intermodal industry itself has begun to address the chassis problem with solutions such as automated container yards (Port of Virginia), and widespan gantry rail terminals (Kelly, 2010).

This paper analyzes the components of chassis costs, examines the advantages and disadvantages of existing solutions, and identifies the labor and equipment cost savings to shipping lines, railroads, terminal operators and drayage firms. By quantifying chassis-related costs to terminals and drayage firms, it will be possible to ascertain when more capital-intensive intermodal non-wheeled operations are justifiable.

CHASSIS COSTS AND TERMINAL OPERATIONS

The North American chassis fleet must carry 96” wide international and 102” wide domestic containers that are 20, 40, 45, 48 or 53 feet in length. Originally, chassis sizes matched container lengths implying that there was one chassis class per container class, but eventually the universal chassis was introduced in the late 1980s to accommodate multiple container sizes (40-53’), mitigating some of the matching problems. Although most chassis are 96s in the U.S., 102s are prominent in Canada because they provide a more stable load distribution.

Capital costs for a new chassis range from \$10,000 to \$14,000, which is approximately 3 or 4 times that of a new container. The life cycle of a chassis is typically 15 to 18 years, as opposed to 10 to 12 years for containers, but like containers, is dependent upon how it is used. Upon reaching the end of its life cycle, the owner typically retains equipment title and remanufactures the equipment to extend the useful life as much as possible. Aside from the direct costs inherent in owning and operating any piece of equipment, chassis have a multitude of additional costs, which are masked by the difficulty of cost valuation for shared equipment, the complexity of the cost formation mechanisms, and a lack of cost transparency.

Ownership and Operation Models

The intermodal chassis is unique in that ownership and operation are rarely uniform. A breakdown of the chassis ownership reveals that shipping lines and leasing companies own the bulk of the assets (82%); what remains is owned by railroads (10%), truckers (5%), and terminal operators (3%)(1). To address supply imbalances, chassis pools have been established to help firms cooperate to reduce regional surpluses and deficits. Chassis pools tend to have better utilization levels. Estimates from operations managed by Consolidated Chassis Management LLC (CCM) suggest that their utilization is 2 or 3 times higher than the mean because of smaller fleet size and multiple on-hire/off-hire locations to pick up and drop off a chassis. CCM has made it much easier to minimize empty dray miles by expanding to 75 stop/start locations in Chicago. Trac Intermodal, leasing on a per use basis, or through an agreement to use a minimum volume of chassis per day, offers ship lines and railroads the largest North American fleet at over 260,000 chassis. Maersk, the world's largest shipping line, does not participate in chassis pools, but entered the business in 2009 by starting to lease their North American fleet of 90,000 chassis for \$11 a day through their subsidiary Direct ChassisLink. By 2010, 10 other carriers announced plans to gradually phase out providing chassis to truckers. Maersk, with economies of scale, is getting into the market, while the smaller players are withdrawing or are turning toward pools. Pools can be categorized as neutral, co-op, or universal. Neutral pools involve an appointed lessor providing chassis at a daily rate; co-op pools involve users contributing and sharing chassis; universal pools are co-op pools expanded to meet the needs of all stakeholders (chassis available to all).

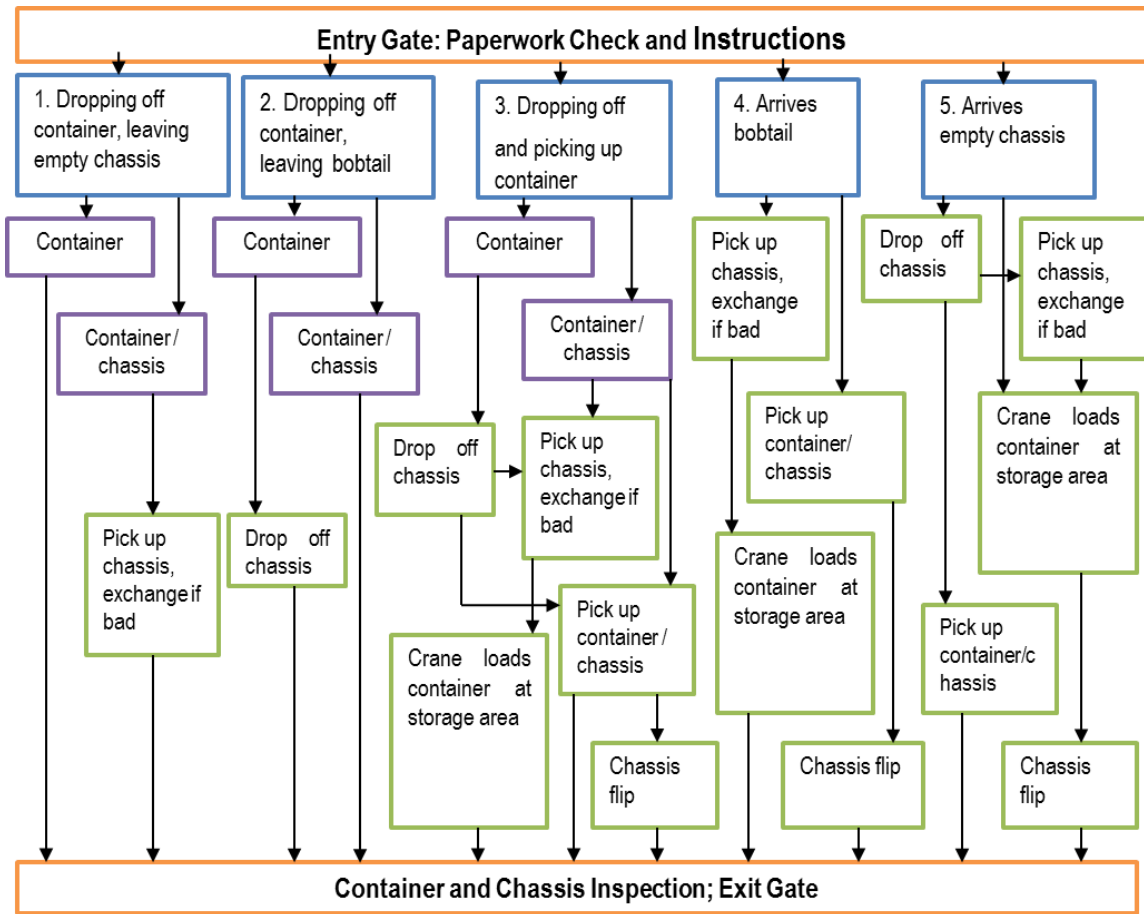


Figure 1. Truck Processes at a Conventional Intermodal Terminal

Management and Storage

Figure 1 shows the labor-intensive multi-step challenges facing terminal operators in managing five truck/chassis/container processes within their gates. The labor for parking and retrieving chassis include but are not limited to: survey, lifts/handling, interchange, inspections, and gate operations.

Typically terminals experience increasing marginal cost for chassis storage as volumes increase. Empty chassis can be parked, stacked or racked. Terminals racking and stacking chassis require a chassis stacker and operator. Although parked chassis terminals require neither, they need greater real estate and the labor associated with tracking and managing the fleet, including searchers to locate chassis and containers miss-parked by drayage drivers.

Because any tractor can pick any chassis/container, wheeled container storage also requires greater terminal security, and greater gate vigilance, than what is required for non-wheeled terminals where cranes load/unload containers only after appropriate documentation has been verified.

Inspections and Container Flips

Unlike mandatory annual state vehicle inspections, liability risk necessitates a driver vehicle inspection report (DVIR) before leaving the terminal to ensure mechanical, electrical, brakes and tires are not defective. Upon returning, another DVIR is required, but if there are no defects, the DVIR will not be petitioned and does not need to be reported. Conflicts between the parties arise from the difficulty in determining whether the defect was normal wear and tear or abuse, as well as whether the defect was already there when the chassis left the terminal. There is also a conundrum for the driver paid per trip: whether or not to forego reporting minor defects, hoping the defect will not be noticed on return inspection to avoid losing valuable time waiting on a container flip (transfer of the container from a defective to an operational chassis). Dray drivers at rail terminals can be delayed over 2 hours waiting for a chassis flip (Harrison, 2009), or even a terminal employee fixing a minor problem (mud flap or burned out break bulb) can result in considerable delay. Another burden for the most underutilized asset in intermodal is the Federal Motor Carrier Safety Administration (FMCSA) Comprehensive Safety Analysis regulations (CSA, 2010), which forces owners to inspect equipment annually regardless of the level of utilization.

Maintenance and Repair

Chassis fleet operators annually budget around \$300 per chassis for maintenance, considerably more in marine terminals using union labor. That is because when the chassis are owned and managed by the ocean carrier, they pay the terminal to store chassis, and use an outside maintenance and repair (M&R) company. The M&R company receives higher rates and parts, inflating the cost of managing and repairing each chassis. There is also a cost to move a chassis from a terminal to and from the M&R yard, which varies greatly depending on the location of the vendor. Chassis sustain greater damage than most equipment due to

stack or rack handling, and lack of incentive for drivers to treat pooled equipment with care—the tragedy of the commons problem. A major shipping line estimates damage from chassis stacking at the Port of Los Angeles alone to be over \$4 million annually. Stacking damage in adverse weather cities is likely to be even greater (e.g., brake lines). Further, because drivers are evaluated (employee) or compensated (independent operator) by the number of paid loads delivered, small equipment problems, which can develop into larger problems, often go unreported when the chassis goes back to the pool. Identifying the cause and the party responsible for chassis damage is extremely problematic because the damage is often not easily visible for inspectors or for automated camera systems (currently being implemented for container inspections), particularly in the case of tires. Repair vendors also are reluctant to make the determination of abuse.

There is also considerable cost in filing and pursuing claims. In the intermodal industry, an inability to assign liability is referred to as “phantom damage claim,” which are considerable and yet difficult to be accurately estimated. If the damage is not identified upon return, there is little chance to affix liability later since the chassis damage could have been caused by stacking. Equipment theft by truck drivers is also a problem: replacing valuable OEM parts with substandard equipment, and then selling the OEM parts. Further, the motor carriers do not have any vested interest in the maintenance of the chassis; thus, put no extra effort into maintaining the chassis or preventing damage. The chassis is basically a shared asset problem in that the benefits of usage are spread fairly equitably among shippers, but the costs are not. All of this combined makes chassis costs much more expensive than if each chassis was owned and used by a trucker.

Phantom damage claims should decrease as IANA provides the industry with electronic processing of DVIR in order to comply with the FMCSA CSA "Roadability" regulations. This will enable motor carriers, ocean carriers, facility operators and maintenance and repair vendors to better maintain an operational record for each chassis, which has been difficult since there are no maintenance or DVIR records in the Global Intermodal Equipment Registry (GIER).

A secondary reality of phantom damage is that chassis care is rarely a criterion in drayage firm selection. Drayage contracts are primarily awarded to the firm submitting the lowest bid. Because chassis insurance is usually part of a ship lines overall insurance plan, and not itemized, it is difficult to determine. Nevertheless, chassis insurance cost can be expected to decline with less stacking and racking, more chassis ownership, longer term leases, and less M&R from a reduction in the number of times that a chassis is connected and disconnected. Further, by staying in the cab (reducing the climbing atop the chassis to hookup the electric and brakes), motor carrier workman compensation insurance should decline as well.

Terminal Real Estate

In addition to the gate itself, terminal real estate can be grouped into two categories: ramp operations and storage operations. Storage or parking capacity can be further divided into outbound (containers on chassis stored in blocks to expedite train loading), inbound (on wheels or stacked), empty storage and chassis storage, which often can take up to 35 percent or more of capacity. Thus, for every parking spot taken by a chassis—whether racked, stacked or parked—one less spot for a container is available. Obviously terminals benefit by maximizing the number of revenue generating parking or stacking spots (containers) while minimizing the need for non-revenue generating support parking spots (chassis). For terminals with no or limited room for expansion, chassis can become a serious issue in terminal performance; thus, relocating chassis storage outside of the terminal frees up terminal space to improve freight efficiency and increase throughput.

Chassis-Related Congestion and Synchronization Delays

Wheeled operations at rail terminals create considerable congestion and synchronization delays between hostlers, as well as hostlers and trucks, shuttling chassis to and from trackside. For example, to completely unload a double stack train carrying 216 containers, 113 empty chassis are shuttled from remote storage to trackside, once loaded the 113 chassis/containers are shuttled to outbound storage, next 113 empty chassis are shuttled trackside to unload the bottom containers, and finally, after loaded, the 113 chassis/containers

are shuttled to outbound storage. There must be synchronization as well: unloading of top containers cannot begin until empty chassis are trackside and interbox connectors are disconnected. Unloading of bottom containers cannot begin until empty chassis are trackside and interbox connectors are removed from the bottom containers. Loading of outbound train cannot begin until all inbound container/chassis are delivered to temporary storage for local pick up. Wheeled operations, and the need to pre-stage chassis for train unloading and chassis/container for train loading, also prohibits crane double cycling capable of reducing gantrying by 75%, the number of cycles required to turn a train by almost 50%, and train turn time by around 40% (Goodchild, 2011).

Transmodal Interchange

For transits involving transmodal (rail-rail) rubber tire interchange, the container moves on three different chassis before arriving at its final destination. If all four terminals use wheeled operations, there would be 14 “drop and leave” or “pick and go” chassis operations: 8 by hostlers and 6 by truck. To improve the efficiency for these rubber tire interchanges, the FHWA Crosstown Improvement Project, which began in 2007 (Kansas City), is testing the effectiveness of communication tools to improve chassis utilization as well as reduce empty miles. Ideally, a shared facility Thruport featuring widespan gantry cranes would eliminate chassis needs for interchange and reduce transmodal interchange to one lift (Rodrigue, 2008; Lanigan et al., 2007).

POTENTIAL SOLUTIONS

Intermodal transportation consists of three segments: line haul, terminal operations and drayage. Whereas line haul cost (and pricing) is the strength of intermodal rail, terminal and drayage costs (determined by the distance from the origin and destination terminals) are the major inhibiting factor for intermodal to be more competitive vis-à-vis truck in many corridors. One of the most efficient ways to reduce terminal and drayage costs would be for drayage drivers to own their chassis, or stay with the same chassis as much as possible. Not only will this eliminate the 10 to 15 minutes of time hooking up the chassis, lights and air brakes associated with wheeled operations, it also should eliminate the need for container flips, and chassis

inspectors at the terminals since the liability now fully resides on the truck operator. The chassis can be instead put on safety inspection cycles like the trucks that transport them.

A popular metric to compare intermodal terminals is container throughput per acre, which is problematic when the nature of operations differ (wheeled vs. stacked), and land and labor costs vary. Wheeled operation terminals have been criticized for having considerably lower annual throughput per acre than stacked operations, but often are praised for achieving a lower unit cost than densely stacked counterparts (Tioga, 2010). However, praising lower unit costs needs to be done in the context of total intermodal costs, not just the terminal's operating costs. Although there is less container handling with wheeled operations for the terminal operator, once land, capital, and the ancillary costs listed above are included, wheeled operations look far less attractive. Moreover, chassis costs are largely ignored in historical accounts of terminal operations (DeBoer, 1992; Spsychalski et. al., 2009) largely because a container still needs a chassis to leave the terminal regardless of terminal design and technology.

To improve chassis utilization and make intermodal chassis usage more efficient for terminal operators and drayage firms, there is a need for reducing the North American fleet, the average container dwell time, improving chassis handling conditions, focusing on necessary inspections, as well as greater chassis access outside the terminal gates to increase terminal capacity. At many terminals chassis parking, stacking, stowage consumes over 35 percent of storage parking capacity. Therefore, the trend on the design side is to move away from wheeled operations. There always will be chassis leasing, but this functions can be managed efficiently by third parties—outside the terminal—who are dedicated to providing the service. Thus, terminal densification strategies are often combined with a change in chassis operations. If a terminal does not face density pressures, chassis operations are likely to remain as they are.

On the technology side, there are new and emerging solutions: wide span gantry cranes and smarter stacking systems, four-mode swap bodies, automated transfer management systems (ATMS), and stacking with ATMS. All address the chassis problem in different ways, with different advantages and disadvantages.

Wide-span Gantry Cranes and Smarter Stacking Systems

The practice of stacking containers at marine and rail terminals is almost as old as the container itself. The difference now is that operations, management pre-planning and information technology tools have improved the efficiency of stacking methods to limit the number of rehandle lifts. Nevertheless, for an inbound container at a marine terminal, the intermodal transfer from vessel to truck entails at least two additional lifts for stacking operations vis-à-vis wheeled operations (one for straddle carrier operations): the container is lifted from the vessel to the hostler chassis, then from the hostler chassis to the stacks, and finally from the stack to the truck chassis for delivery. There also is a reallocation of labor to consider with stacking. More equipment and labor entailed in container handling is offset by less labor entailed in managing chassis operations.

At APM terminal that opened in 2007 at the port of Virginia, container yards are being used to partition hostler operations from drayage operations, avoiding traffic conflicts, and automated stacking cranes are being used to speed the transfer to and from the stacks. At new rail intermodal terminals featuring wide-span high-clearance (up to 5 containers high) overhead gantry cranes, the major objectives of container storage under the cranes (rather than remote storage) were to eliminate the need for hostlers and wheeled operations. There still will be rehandling lifts and delays for truck drivers waiting on a crane, especially during peak periods. That is because software is optimized for crane productivity, not drayage productivity, with containers loaded by easiest pick, not on a first come first serve basis. Nevertheless, continual improvements in crane strategies and associated terminal management systems can reduce truck turn times and rehandling lifts to make densification and the transition from wheeled operations (i.e., staying with the same chassis) more attractive.

Swap Bodies

Because in Europe shipping lines and railroads do not supply the chassis with their intermodal services, chassis utilization is priced in as a daily chassis fee. There is thus an incentive for the drayage firm to keep

the chassis asset active. Because drop and leave harms chassis utilization, and the stay with option until unloaded is unproductive, the European market is moving towards the swap body. The stay with option also limits the flexibility of the warehouse manager because when the container is unloaded immediately to expedite drayage operations, it comes at the expense of other warehouse priorities.

Swap bodies are containers with 4 retractable legs designed to minimize empty weight, fit the wider European size pallet, and solves the inefficiencies associated with drop and leave. The swap body was designed originally to be considerably lighter than a container and used for only road and rail. But since swap bodies are not stackable, can only be lifted by bottom pick, and are unsuitable for transport by sea, a 2003 European Commission Directive included the development of multimodal (truck, rail, ship, barge) stackable top pick swap bodies to primarily increase short sea shipping.

Intended for European commerce, the 4-mode swap body makes it easier to improve chassis utilization and will increase productivity at both the terminals and warehouses. It also minimizes empty weight, saving on capital cost (fewer materials required to manufacture) and fuel cost (less empty weight to be transported). If a critical mass is achieved in Europe, the estimated result is a 0.5-1.5 percent reduction in logistical costs (ICF, 2003). On the downside, the transition to swap bodies would create logistical challenges until critical mass is achieved (e.g., require new specialized inland terminals). European swap bodies require the time to lower and raise the legs, and entail the inefficiency of transporting the additional weight of the 4-jack system. More importantly, swap bodies are not a practical solution shipside or trackside at modern North American terminals because of the additional labor to set up the 4-leg system. Other issues include repair of the retractable legs and theft prevention.

Automated Transfer Management Systems (ATMS)

An automated transfer management system (ATMS) is a robotic active storage system that can lift any size container on or off of a chassis without the assistance of a crane, eliminating the need for wheeled storage in the terminal so that the chassis fleet can be much more aggressively downsized (Zumerchik, 2009).

Aside from achieving the same advantages as swap bodies, if available at both the terminals and distribution centers, drivers can achieve a much higher volume of revenue trips per day because of immediate selection (the container is always in a position to be picked up by drivers unassisted and without leaving their cab). At the Port of Houston, complications related to chassis were identified as the largest single cause of abnormally high truck turn times (Huyhn, 2008). Figure 2 shows the significant reduction and streamlining in chassis processes with ATMS, eliminating the complications related to chassis. Because of the ability of the ATMS to communicate directly with the gate, drayage firm and consignee, delays at the gate can be eliminated as well.

To minimize handling, ATMS stations ideally will be located trackside or shipside as terminal designs are modernized. Until that time, wheeled terminals will benefit from ATMS chassis flip stations, which were proven effective at reducing chassis flip times during 2010 testing at the Harvey terminal of the Canadian National Railway. Since drivers can spend considerable time searching a terminal for a replacement for a bad order chassis, during testing it became apparent that a multi-cell chassis storage dispensing variation should be teamed with the ATMS chassis flip stations. Located adjacent to the ATMS stations, the robotic immediate selection chassis dispenser will make it possible to reliably complete a chassis flip in under 10 minutes, and thereby ensuring maximum ATMS productivity. Investment return would be further improved by the elimination of all chassis-on-chassis damage caused by stacking and racking.

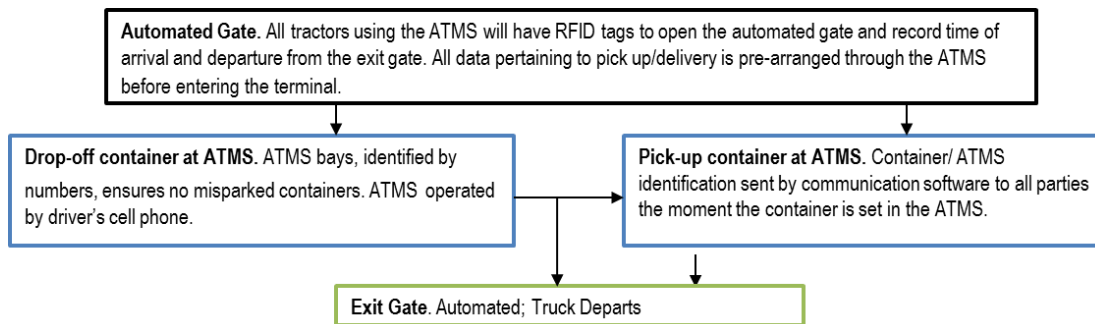


Figure 2. Simplified Container Transfer at an Intermodal Terminal with an ATMS

Another system funded by the European Union is called Metrocargo, which automates the transfer of containers horizontally from a sorting platform to a flatcar under electrical track (not designed for double-stack). However, this is not a true ATMS system because it does not offer immediate selection to both crane and truck: trucks require waiting on a crane to transfer the container to and from the sorting platform, and drivers cannot make a self-service transfer.

Appointments in Conjunction with ATMS

To reduce ATMS capital cost at marine terminals, the use of ATMS in conjunction with stacking at container yards is a viable transition solution (Huyhn and Zumerchik, 2010). The ATMS makes the densification of operations much more efficient in the transition from wheeled to stack operations while still achieving faster truck turn times than wheeled operations. The objective would be for drayage firms to make appointments so that the container is transferred from the stacks and placed in a stack-side ATMS for immediate selection before the driver's arrival. Since the crane would be working well ahead of appointments, this also would be effective at achieving the elusive goal of maximizing crane productivity while minimizing truck turn time. Container throughput per acre would be higher, while achieving quicker truck turn times than wheeled terminals. This solution also would be effective for a mixed wheeled and stack terminal: wheeled containers would be loaded into the stack-side ATMSs by the hostler drivers. In essence, the appointment would initiate the chassis flip by completing half the chassis flip operation before the driver arrives. Another ATMS alternative operation could be a queuing system so that drayage drivers would take the next available container to avoid any waiting.

Whether the terminal is a wheeled or stacked operation, the availability of ATMS stations at terminals and shipper/receiver facilities will be needed to ensure efficient turn times for truckers who will be increasingly arriving with their owned/leased chassis. Along with taking responsibility for chassis maintenance, mandatory electronic onboard computers, more stringent hours of service regulations, and new engine technologies that reduce fuel mileage will be driving up costs, particularly for short-haul drayage truckers. A

salient way for the industry to limit drayage costs increases is by vastly improving trucker productivity, which includes the number of turns a trucker can achieve per day by eliminating detention time at terminals and shipper/receiver facilities. Further, as the number of post-panamax container ships expands there will be a propensity to increase stacking density at marine terminals and additional congestion may result for landside operations. In such a context, there will be greater need to reduce container handling (number and distance) so that trucks can get in and out of terminals not only more quickly, but more efficiently as well.

Toward a More Rational Utilization Market

Until recently, increases in carrier volumes, combined with then capacity constraints on the railroads, drove the demand for over-the-road capacity. Since the demand grew faster than the supply, equipment owners were forced to halt any attrition program, procure new equipment and continue employing a wide range of aged chassis. Then, the 2008-09 recession triggered a 35% decline on cargo volumes across the board, leading to a reversal of the situation where owners/operators with a chassis excess capacity in the range of 20%. As the sector begins to recover, owners still operate old fleets with questionable specifications. Retiring equipment at an accelerated rate by imposing higher roadability specification requirements (i.e. ABS braking systems, side-curtains, side lighting, etc.), will be an incentive for owners to scrap older non-compliant equipment. And for shipping lines not yet participating in pools, the economic justification will grow to join as fleets are downsized since pools are the most economical means to maintain a sizeable buffer of chassis, which is fundamental to meet unforeseen demand surges (spot shortages).

Along with getting more use out of existing chassis assets, one of the best ways to keep the a low cost of service is to reduce chassis damage. Currently there is neither an incentive to be a good caretaker of the chassis, nor, in many cases, to return chassis/empty containers promptly to improve utilization. As railroads and shipping lines stop providing chassis and reduce or eliminate chassis storage and operations at the terminals, capital and operating costs will be lowered, thereby freeing up capital for other capacity expanding investments. During a terminal renovation cycle (2005-7), Maher proved this by moving chassis leasing

operations outside of the Port Elizabeth terminal gates in New Jersey. The real estate within the terminal then was rededicated to increasing throughput and improving efficiency (respectively, metrics container capacity per acre and container handling efficiency factor; Zumerchik, et. al., 2011). The main rationale of this move was to improve terminal asset utilization in light of a high expectation of future traffic growth. Similar to that of the two major chassis leasing companies, Maher was one of the first to establish a universal chassis pool. Originally the pool was developed to service a captive audience (their terminal customers). But as vessel-sharing agreements have grown over the years, Maher's customers began calling other facilities, so it became critical to locate the equipment pool outside the gates, leading to a change in the chassis management model (Figure 3).

Leasing companies are well positioned to successfully fill the void. Trac Intermodal and Flexi-Van have been able to leverage their software and management expertise to transition from supplying chassis to neutral pools to managing the co-ops. Thus, moving toward a more rational market with stakeholders as alternative operators of co-op pools is a positive development for the market. Another positive is major carriers, like Hunt and Schneider, providing their own chassis for domestic container traffic.

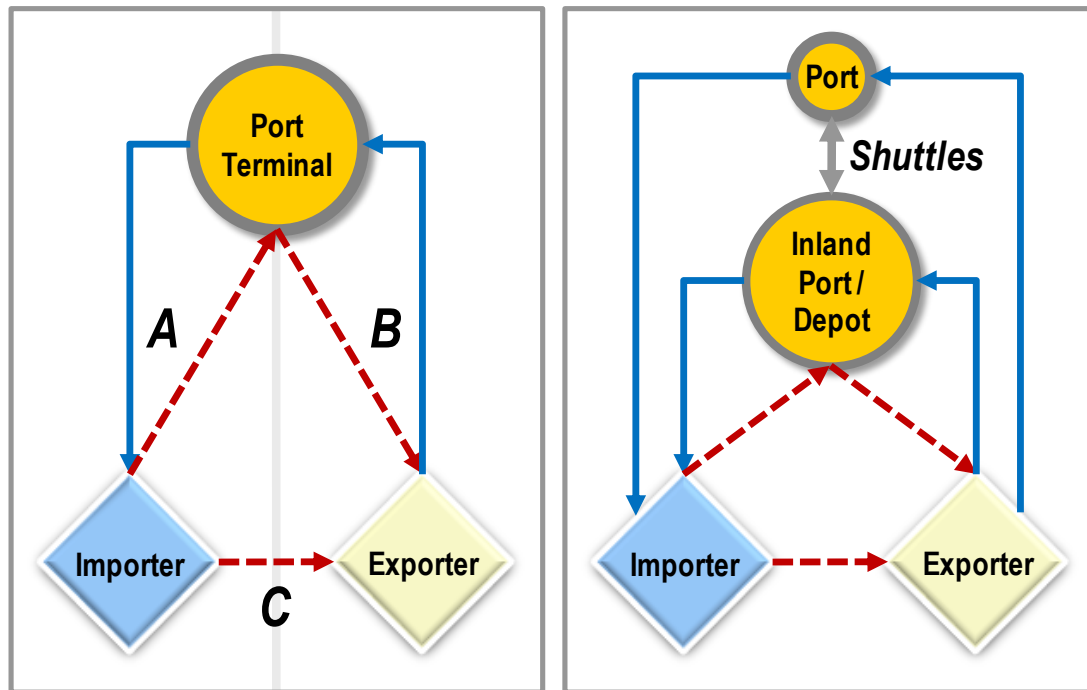


Figure 3. The Traditional (Left) and Emerging (Right) Chassis Management Model

The transition to the more rationale European model and universal chassis pools will be gradual. For example, a major complaint about current neutral chassis pools is that the ship lines may only put their older repair-prone chassis in the pool. On the other hand, as a greater percentage of the North American chassis fleet incurs a daily use charge, the less prevalent will be the practice of using terminal storage as a “warehouse on wheels,” allowing for the downsizing of the North American fleet and making the market much more rationale.

CONCLUSION

By reducing terminal and drayage costs, particularly reducing chassis-related costs and improving utilization, there is a potential to increase the market share of intermodal transportation. Improving the efficiency of chassis-related operations and bringing the chassis fleet closer to parity with the drayage fleet would significantly lower both terminal and drayage costs. A reduction in the fleet, better care of the remaining

assets (particularly by reduced handling), and the elimination of terminal chassis storage, inspections and maintenance all would vastly improve intermodal efficiency.

Because more efficient and productive terminals have significant competitive and productivity advantages for a region, future research should be geared toward the collection of data to better quantify the total costs of wheeled operations so that public-private investments in new intermodal terminal designs and technology, which minimize or eliminate wheeled operations, can be more comprehensively evaluated. The paper underlined that chassis assets should be part of this exercise. There are clear signs that the industry, namely terminal operators, are moving towards chassis utilization business models that attempt to internalize costs that were previously externalized.

Assessing chassis and terminal operations however require metrics such as average chassis cost per container transit. The Global Intermodal Equipment Registry began validating the active population in 2010, and driver vehicle inspection report processing also can be used to validate the equipment turns and utilization. In the end, efficiency gains, which will be substantial, are vital to increase the attractiveness of many more intermodal corridors.

References

- American Association of State Highway and Transportation Officials (AASHTO). *Freight-Rail Bottom Line Report*. Washington DC: January, 2003.
- Boile, M., S. Theofanis, A. Baveja, N. Mittal. "Regional Repositioning of Empty Containers: Case for Inland Depots," *Transportation Research Record: Journal of the Transportation Research Board*, 2066 (2009): 31-40.
- Bryan, J., G. Weisbrod, C. Martland and Wilbur Smith Associates. *Rail Freight Solutions to Roadway Congestion: Final Report and Guidebook*. NCHRP Report 586. Transportation Research Board, 2007.
- Casgar, C., D. DeBoer, and D. Parkinson, *Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues*. Gaithersburg, MD: Foundation for Intermodal Research and Education, 2003.
- DeBoer, David J. *Piggyback and Containers: A History of Rail Intermodal on America's Steel Highways*. Golden West Books, San Marino, CA, 1992.
- Goodchild, A., JG McCall and J. Zumerchik. "Reducing Train Turn Times With Double Cycling in New Terminal Designs." Accepted for publication in the *Transportation Research Record: Journal of the Transportation Research Board*, 2011.
- Gorman, Michael. "Fleet Ownership and Intermodal Supply Chain Efficiency." *Journal of Law, Logistics and Policy* 72(1), (2005): 63-70.

- Harrison, R., N. Hutson, J. Prozzi, J. West, J. McCray, J. Gonzalez. *The Impacts of Port, Rail and Border Drayage in Texas*. Texas Department of Transportation, Project 0-5684. February 2009.
- Huyhn, N. and N. Hutson. "Mining the Sources of Delay for Dray Trucks at Container Terminals." *Transportation Research Record: Journal of the Transportation Research Board* 2066 (2008): 41-49.
- Huyhn, N. and J. Zumerchik. Analysis of Stacking Priority Rules to Improve Drayage Operations Using Existing and Emerging Technologies. *Transportation Research Record: Journal of the Transportation Research Board*, 2162 (2010): 1-8.
- ICF Consulting. *Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors*. Final Report. November 19, 2009.
- ICF Consulting, *Economic Analysis of Proposed Standardization and Harmonisation Requirements*. Final Report, October 13, 2003.
- Kelly, Tom, "New Terminal SOP." Presented at the IANA *Making the Intermodal Connection: The Role of Terminals*, International Delegates Conference, Fort Lauderdale, FL, November 12-13, 2010.
- Lanigan, J., J. Zumerchik, J-P Rodrigue, R. Guensler, M. Rodgers. "Shared Intermodal Terminals and the Potential for Improving the Efficiency of Rail-Rail Interchange." Presented at the *TRB 86th Annual Meeting*, January 21-25, 2007.
- Le-Griffin, Hahn Dam, *Assessing Container Port Productivity: Experiences of the Ports of Los Angeles and Long Beach*, Metrans Applied Research Project, Final Report, February 2008.
- MARAD, *Improving Productivity of US Marine Container Ports*, 1998.
- Mitchell, Mike, *International Chassis Pools*, Chassis Pools 101 American Association of Port Authorities Seminal, April 24, 2007.
- Prince, Ted, *An Intermodal Perspective*, 2008 AAPA Marine Terminal Management Training Program, October 23, 2008.
- Rodrigue, Jean-Paul "The Thruport Concept and Transmodal Rail Freight Distribution in North America", *Journal of Transport Geography* 16 (2008): 233-246.
- Rodrigue, J-P and T. Notteboom "The Terminalization of Supply Chains: Reassessing the Role of Terminals in Port / Hinterland Logistical Relationships," *Maritime Policy and Management* 36 (2), (2009): 165-183.
- Spychalski, J. and E. Thomchik, "Drivers of Intermodal Rail Freight Growth in North America." *European Journal of Transport and Infrastructure Research* 9 (1), (2009): 63-82.
- Tioga Group, *Improving Marine Container Terminal Productivity: Development of Productivity Measures, Proposed Sources of Data, and Initial Collection of Data From Proposed Sources*. Prepared for the Cargo Handling Cooperative Program, July 8, 2010.
- Tsamboulasa, D., H. Vrenkenb and A-M. Lekkaa, "Assessment of a transport policy potential for intermodal mode shift on a European scale." *Transportation Research Part A: Policy and Practice* 41 (8), (2007): 715-733.
- Zumerchik, J., J-P, Rodrigue and J. Lanigan. "Automated Transfer Management Systems to Improve the Intermodal Efficiency of North American Rail Freight Distribution." *Journal of the Transportation Research Forum* 48 (3), (2009): 59-76.
- Zumerchik, J., J. Lanigan Sr and J-P, Rodrigue. "Intermodal Energy-Based Sustainability Analysis and the Need for Efficiency Metrics", submitted for publication in the *Journal of Transportation Research Forum*, 2011.

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Jack Lanigan, Sr., Chairman of the Board, Mi-Jack Products Inc. Since founding Mi-Jack in 1954, Mr. Lanigan has been credited with collaborating with the railroads on many important intermodal innovations. Mr. Lanigan introduced the first Drott reliable overhead rubber tire gantry crane in 1963 for TOFC (trucks on flat cars), now called intermodal. Working with the Santa Fe in the mid-1960s, Mr. Lanigan helped convince the shipping industry to standardize container lengths and corner castings so that the railroads (Santa Fe, Union Pacific and the Southern Pacific) could accommodate all the ship lines' containers, which made the landbridge feasible. In 1967, Mi-Jack delivered the first crane with the twist lock top pick for the new standardized container, but because Matsen, APL and Sealand all had different corner castings and container sizes, Mr. Lanigan developed a corner side latch as a temporary top pick for the nonstandard containers during the transition. In the late 1970s, Mr. Lanigan worked with the Southern Pacific Railroad and APL on the top spreader that would accommodate the high side wall double stack car, and at the same time encouraged the development of the low side wall so that any type of side loader or overhead crane could load or unload double stack cars. Aside from equipment innovation, Mr. Lanigan is credited with developing the 2 for 1 terminal design (now the standard), and establishing one of the largest rail and port terminal operations in the nation, culminating in the 1997 Mi-Jack/Kansas City Railway Company joint venture to rebuild and operate the Panama Canal Railway to significantly reduce the volume of trucks transporting containers across the Isthmus highway. Mr. Lanigan was awarded the Intermodal Association of North America's Silver King Award (1989) and Intermodal Achievement Award (1992 on behalf of Mi-Jack) in acknowledgement of his contributions. David DeBoer in "Piggyback and Containers: A History of Rail Intermodal on America's Steel Highway" states that intermodal pioneers like Mr. Lanigan "cared so deeply about improving the business that they went substantially beyond the normal manufacturer-customer relationship. They often became missionaries for improvements that were only indirectly related to their primary products."

Marc Barenberg maintains over 14 years of intermodal equipment leasing and finance experience. He currently serves as a Managing Director for SoNo International, which offers intermodal remarketing and professional consulting to the chassis and container asset owning community. Previously, Mr. Barenberg spent three years at GE Transportation Finance as Vice President of Sales for North America, where he was responsible for identifying and executing structured finance and lease transactions to clients seeking intermodal and marine chassis and containers. Additionally, Mr. Barenberg held a variety of senior leadership positions at Trac Lease the world's largest intermodal chassis lessor/manager. Mr. Barenberg's responsibilities included, but were not limited to: business development, sales, equipment remarketing, joint ventures, operations, and special projects. Mr. Barenberg holds a Bachelor's degree in Political Science from Rutgers College.