White Paper on International Chassis

University of New Orleans Transportation Institute

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NEW ORLEANS

Bethany Stich, Ph.D.
James Amdal
Ian Butler-Severson
Dennis Thornton
Peter Webb

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Executive Summary

Containerized shipping, which accounts for approximately 60 percent of all world seaborne trade while generating approximately 12 trillion United States (US) dollars in 2017, links trading partners between the water, rail, and air modes (as well as on-time distribution points and retail outlets). Therefore, the international chassis is, in turn, "…the linchpin of today's international commerce" (Lane, 2015).

The University of New Orleans Transportation Institute (UNOTI) examined the issues surrounding the current state of international chassis utilization in the United States (US). The international chassis system in the US is unique compared to global chassis utilization where the motor carriers, the freight customers, or off-site terminals provide chassis. However in the US, the divestment of international chassis by ocean carriers, which began in 2009, resulted in three major international chassis leasing companies linked to the foreign carriers being the American shippers' only options for international chassis leasing in many cases. This situation is compounded by the fact that DCLI is in the process of acquiring the domestic fleet of one of the other two major international chassis lessors, TRAC Intermodal, which is slated to be completed in January of 2018. The extra cost associated with the lack of international chassis lessor competition profits the foreign ocean carrier lines while raising costs for domestic consumers.

This situation is exacerbated by the complexities of the international chassis pickup and drop off process. Truck drivers are not allowed to use a container from one carrier with an international chassis linked to another ocean carrier, leading to wasted turnarounds as drivers are required to drop off and pick up otherwise interoperable chassis. Furthermore, the actual number of international chassis is insufficient "…the number of chassis has increased only 2.7% in the last four years, compared with an 11% rise in containers entering US ports" (Whelan, 2015). The exact number is not known, but estimations of international chassis in US circulation range from 500,000 to 600,000. The international chassis are standard ocean container chassis that were originally provided by the ocean liners and remain in circulation (See Section 2, Scope and Size).

In an effort to coordinate equipment (storage and movement), regulatory compliance, and improve supply chain efficiencies, ports began what is known as "pooling." In pooling, lessors formalize an agreement where their chassis are made available at terminals that are doing business with a "gray" (neutral) pool. While not perfect, this process helps alleviate some of the availability concerns yet does not reduce the cost burden assumed by domestic consumers.

Cost and availability are not the only concerns; safety is also of importance. Almost half of the international chassis date from before 1997, and it is common at marine terminals to find international chassis still in circulation that are older than 20 years. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and drayage companies, rather than the ocean carriers. Newer chassis are safer as they are outfitted with radial tires, antilock brakes, and LED lights. Additional technological developments at work involve the use of GPS systems and data analytics to enhance the efficiency of international chassis moves within the supply chain. However, until international chassis ownership and management is settled, new investments in this technology seem unlikely.

In the research and analysis that follows, UNOTI has concluded that the best solution to this problem lies in the cultivation of a national chassis pool, with full interchangeability of identical chassis regardless of the ownership of the container. Federal investment in the chassis fleet – in the form of public-private partnerships between the federal government and motor carriers – would spur job growth in the immediate sense where the chassis manufacturers are located while increasing efficiency at the ports through reduced chassis down-time. American truckers and shipping industries would benefit from competitive chassis leasing costs, safer and more efficient chassis, and stimulated job growth across the related US industries. Most importantly, the significant reduction, or elimination, of chassis-related shipping inefficiencies would lower the price of consumer goods in the US. Ultimately, encouraging the growing practice of motor carriers owning their own chassis may be the best answer, as this is the global standard.

1. Historical Context

Global seaborne container trade is believed to account for approximately 60 percent of all world seaborne trade, which was valued at around 12 trillion US dollars in 2017. Containerized shipping links trading partners between the water, rail, and air modes (as well as on-time distribution points and retail outlets). Containers are how freight moves seamlessly from one mode to another and this system as a whole depends upon intermodal drayage. Without international chassis, the containers cannot move by truck. The international chassis is, in turn, "…the linchpin of today's international commerce" (Lane, 2015). Intermodal drayage refers to the movement of containers between the port and an inland destination. Drayage typically includes either delivering an export container to the port or picking up an import container. It "is a hub-and-spoke system with the ports and terminals as the hubs and drayage providing the spokes" (NCFRP, 2011). According to the US Customs and Border Patrol, "…more than 26.3 million imported cargo containers [passed] through the nation's ports of entry [in 2015]" (US Customs and Border Protection 2016). If it takes about "…2.5 drayage trip legs for each container moved… due to the need for tractor-only moves and empty container repositioning" (Tioga Group, Incorporated 2011, 11:1), then American truckers made almost 66 million truck trip legs in FY 2015."

Trucks carry 64 percent of the tons and 69 percent of the value of freight moved in the United States (US). By 2045, it is projected that trucks will move essentially the same percentage of the expected 25 trillion total tons of freight. Nowhere is the importance of trucking more obvious than in relation to North American Free Trade Agreement (NAFTA) freight flows. From August 2015 to August 2017, trucks carried 64.7 percent of US NAFTA freight. That amounts to $31.9 billion of the $52.0 billion of total imports (61.4%) and $31.1 billion of the $45.4 billion of total exports (68.5%) (Bureau of Transportation Statistics, 2017). These intermodal movements are critical to the domestic and global supply chain. However, recent shifts in international chassis management are creating gridlock at key transportation hubs, financially rewarding international ocean carriers while overburdening domestic motor carriers, and artificially inflating the cost of transport. Ultimately, this results in higher prices for American consumers.

Traditionally, ocean carriers provided international chassis in the US as part of their pricing package (Tioga Group, 2011). However, in response to the financial meltdown of 2008, Maersk decided to divest themselves of chassis beginning in 2009. Other ocean liners soon followed (Bonney, 2015b). Since then, international chassis supply has undergone changes in ownership and leasing, causing fragmentation and complexities in the business structure in the US. Provisions of international chassis by ocean carriers at the marine terminals are a legacy of containerization's origins in the US as envisioned by Malcolm McLean and Sea-Land Systems. "Everywhere else in the word container chassis are supplied by customers, truckers, or off-terminal pools, and are brought to the marine terminal by the drayage driver" (NCFRP, 2011).

The drayage process is a transaction between an ocean carrier and a customer for the conveyance of goods. The motor carrier acts as a third party intermediary. This intermediate position places the burden of the unevenness of demand, inconsistent priorities, misdated information and cost pressure squarely on the motor carriers (and to a somewhat lesser extent marine terminals). "A key challenge facing drayage companies is matching up the movement preferences of importers and exporters with the protocols and capabilities of marine terminals and ocean carriers… leading to inefficiencies, delays, excess costs, and unnecessary emissions" (NCFRP, 2011).

A chassis, being more complex than a shipping container (e.g. moving parts, wheels, bearings, lights, etc.), is more subject to damage versus a container. A chassis is defined as a special type of truck trailer/undercarriage developed specifically to facilitate roadway based transportation of domestic and marine shipping containers. Chassis refers to the skeleton structure consisting of a frame, multiple axles (2 to 3) and several locking mechanisms (known as twist locks) to facilitate locking of the container on the container chassis. Chassis are designed specifically to transport shipping containers by truck between various shipping facilities and are the primary means of transporting containers by roadway to and from

ports and other shipping facilities. For the purposes of this report, we are only discussing international chassis (unless otherwise specified), defined as the standardized international chassis designed specifically to be readily interchangeable for use with internationally standardized 20', 40' and 45' shipping containers. Other names for this same chassis include: marine chassis, ocean carrier chassis, ocean liner chassis, and ocean container chassis. Other kinds of chassis include:

- Domestic chassis: Domestics chassis are designed specifically for use with 48' and 53' length domestic shipping containers.
- Triaxle chassis: A chassis used in hauling 20' or 40' containers with three axles and a center that slides out, allowing for either size of container. This allows for better weight distribution and allows the hauling of heavier containers.

Chassis are subject to United States road operation safety requirements and account for most equipment-related problems which lead to delays. This has led to undue logistical inefficiencies for the trucking industry and truck drivers respectively to delay times involving container pickup and/or return turnaround times at port facilities.

In an effort to coordinate equipment (storage and movement), regulatory compliance, and improve supply chain efficiencies, ports began "pooling" chassis. In pooling, lessors negotiate an agreement where all lessor owned international chassis are made available at terminals that are doing business with a "gray" (neutral) pool. In 2014, the Department of Justice's antitrust division ruled that the Ports of Los Angeles–Long Beach (LA-LB) international chassis providers could share their international chassis, roughly 100,000, in a "gray" pool. This ruling set the precedent for the creation of additional chassis pools. At LA-LB, this took the form of a port-wide "pool of pools" in which the three largest international chassis lessors – TRAC Intermodal, Flexi Van Leasing, and Direct Chassis Link (DCLI) – have arranged for truckers to now "…pick up and drop off chassis at any of the terminals served by the three chassis pools," instead of having to split the operation into two separate trips (Mongelluzzo, 2015a). This allowed TRAC, DCLI and Flexi-van the free interchange of international chassis between the pools they managed separately within the port's jurisdiction. This was the first attempt to mitigate a major choke-point for truckers (Bonney, 2014).

Key Chassis Regulations

Containers and chassis are governed by a set of laws, regulations, conventions and standards both internationally and nationally. The first instance of international chassis regulation was the Customs Convention of 1972, which was entered into force on December 6, 1975. Oversight is provided by the World Customs Organization. Shortly thereafter the International Maritime Organization put the International Convention for Safe Containers in force on September 6, 1977 with a two-fold purpose:

1. To maintain a high standard of safety for human life in the transport and handling of containers;
2. To facilitate the international transport of containers by providing uniform international safety regulations applicable to all forms of surface transport.

The International Organization for Standardization's International Standards for freight containers and chassis has adopted 30 international standards for all manner of containers: air, surface, intermodal; containers on-board vessels, tank containers, platform and platform-based containers (The Institute of International Container Lessors, 2017).

The Uniform Intermodal Interchange & Facilities Access Agreement (UIIA initially) is the standard contract governing the interchange of intermodal equipment between ocean carriers, railroads, equipment leasing companies and intermodal trucking companies. It covers facility access, equipment interchange procedures, equipment usage rules, liability and insurance requirements, administrative processes, and dispute resolution (NCFRP, 2011). At the terminal the driver will go through terminal sub processes that include:

- Verifying the identity of the driver and motor carrier

- Verifying the transaction is legitimate (inbound and outbound)
- Checking the condition of equipment (inbound and outbound) and issuing an Equipment Interchange Report (EIR)
- Performing the exchange of container and chassis with the container yard

Standard Chassis Operations at Container Yard

Regardless of the type of container yard, at the time of pick-up or delivery, the driver must first locate, inspect, hook up, and test an international chassis before it is roadable. The extra time for a driver to obtain this chassis at a terminal ranges greatly with an average of about 12 minutes. If an issue arises that the driver cannot personally address, an average additional hour "troubled ticket" time is incurred (NCFRP, 2011).

When a driver takes a loaded container or international chassis out of the terminal, the motor carrier assumes liability for its timely return in good condition. If the equipment is returned late the motor carrier is charged a demurrage fee. If the equipment is judged to be damaged (beyond normal wear and tear) the motor carrier is charged for repairs. Once the equipment is returned and inspected, the terminal operator accepts responsibility and releases the motor carrier (NCFRP, 2011). See Figure 1.1.

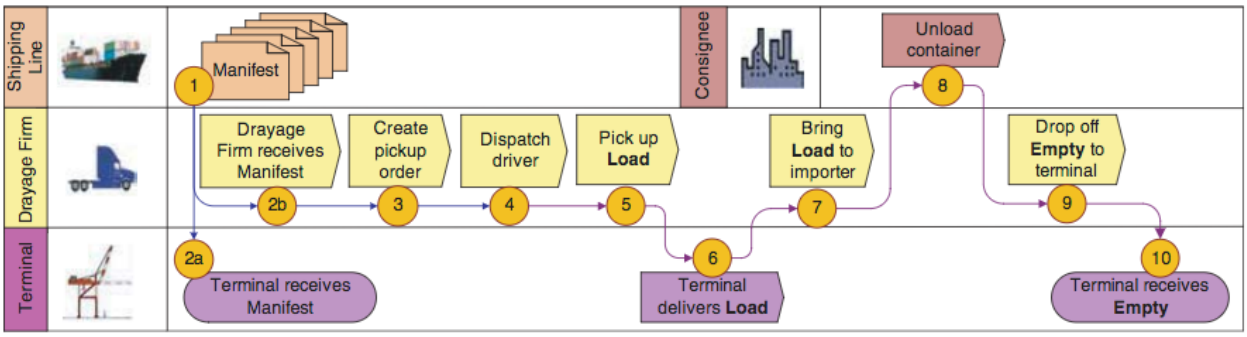

Figure 1.1: Export Drayage Process Source: NCFRP, 2011

Regarding roadability, legislation was passed in 2009 with oversight provided by the US Federal Motor Carrier Safety Administration (FMCSA). This established a regulatory requirement for safe operation, inspection, repair and maintenance of intermodal chassis in the US. Requirements include:

- Single Intermodal Equipment Provider (IEP) for each chassis (December 2009)
- IEP establishment of inspection, maintenance, repair, and recordkeeping program (December 2009)
- Standardized audit trail of driver Roadability Component Defect (RCD) reports
- Standardized audit trail of Driver Vehicle Inspection Reports (DVIR)
- USDOT number applied to all chassis (December 2010)

"The key effect is to hold IEPs responsible for maintaining chassis to FMCSA standard and establish a corresponding audit trail… The burden has thus been placed disproportionately on the drivers and motor carriers, who must either find a good chassis or wait to have one fixed" (NCFRP, 2011). These regulations and the resulting standardized audit trail were created to ensure that IEPs actually maintain international chassis on schedule and repair defects noted by drivers, thereby establishing a shared safety responsibility among intermodal equipment providers, motor carriers and drivers (Rodrigue, J.P., 2012). Given the average age of an international chassis in the US is 19 years, this legislation was notable for maintaining safety and roadability across chassis operations.

2. Size and Utilization

According to a report published by the National Cooperative Freight Research Program (NCFRP), the age and safety of international chassis has become a major concern for intermodal transportation. The report stated that roughly 40% of international chassis were built before 1997 (Rodrigue, J. P., 2012), that the average age of chassis in the US is approximately nineteen (19) years old, and that it is very common for the available chassis stored at US ports to exceed this median age.

Size of the US Chassis Fleet

In the US, there are an estimated 725,000 chassis (international *plus* domestic) in circulation. Of total chassis, eighty percent (approximately 565,000) are ocean container international chassis (of which some 490,000 are estimated to be active). See Figure 2.1 and 2.2 (Source: Rodrigue, J. P., 2012). Eighty to ninety percent of the international chassis are standard ocean container chassis that have been provided by the ocean liners, with the rest provided by the cooperative pools or motor carrier companies. The fleet of domestic container chassis is much smaller and estimated to be in the order of 160,000 units. Clearly, the chassis leasing companies play a larger role in supplying the marine market compared to the domestic market, largely due to the ocean carriers' chassis ownership legacy. Due to the unique US ocean liner chassis supply model that remained the status quo up until approximately 2009, the ratio of chassis to loaded containers in the US is considerably higher than in most other countries (Tioga Group, 2011 and Rodrigue, J. P., 2012).

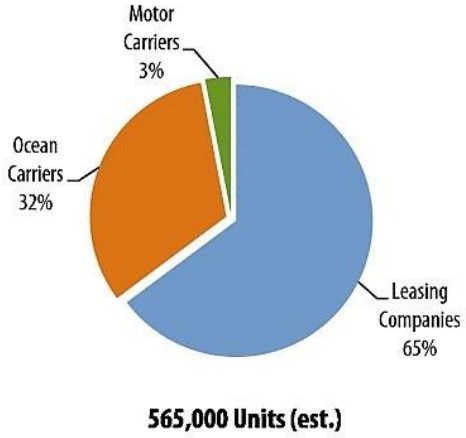

Figure 2.1: US International Chassis Ownership

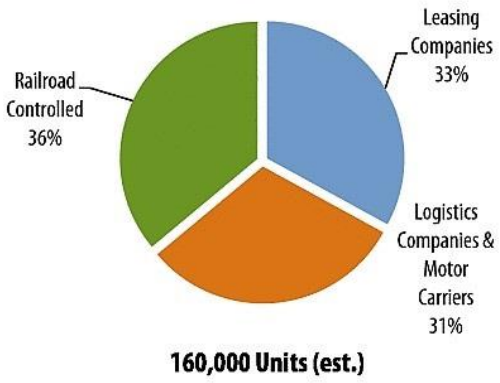

Figure 2.2 US Domestic Container Chassis Ownership

Distribution of the Major Chassis Leasing Companies and Model Types

The following are a few examples of chassis leasing companies and model types. Figure 2.3 illustrates the distribution of the different types throughout the country.

North American Chassis Pool Cooperative (NACPC). NACPC was organized by motor carriers and provides premium chassis pools consisting of high end chassis with radial tires and LED lights. Three locations in the Ohio Valley have a total of 300 chassis; Savannah, GA includes 150 chassis; and Houston 250 chassis. NACPC also provides 18,000+ chassis to five regional pools operated by Consolidated Chassis Management (CCM). CCM maintains six regional pools with a total of approximately 130,000 chassis (Morley, 2017). In November 2017, NACPC announced they were adding another 1,200 new chassis and were planning future expansions with the goal of improving chassis quality and controlling costs.

Direct Chassis Link (DCLI): Charlotte, NC. DCLI's fleet consists of 136,000 chassis. Upon completion of the acquisition of TRAC intermodal (anticipated in January 2018), DCLI will own, lease, or manage

approximately 136,000 international chassis, as well as approximately 80,000 other chassis, for a total chassis fleet of over 216,000. Additionally, the company manages over 86,000 domestic intermodal containers for third parties, via its REZ-1 asset management platform (DCLI, 2017, and Morley, 2017).

TRAC Intermodal: Princeton, NJ. Acquisition by DCLI is currently underway and is expected to close in January of 2018. TRAC Intermodal's fleet consists of 80,000 chassis. (Morley, 2017).

Flexi Van Leasing: Kenilworth, NJ. Flexi Van's Fleet consists of 177,000 Chassis at 600 marine locations comprising nine (9) pools and sixty (60) depots (Morley, 2017).

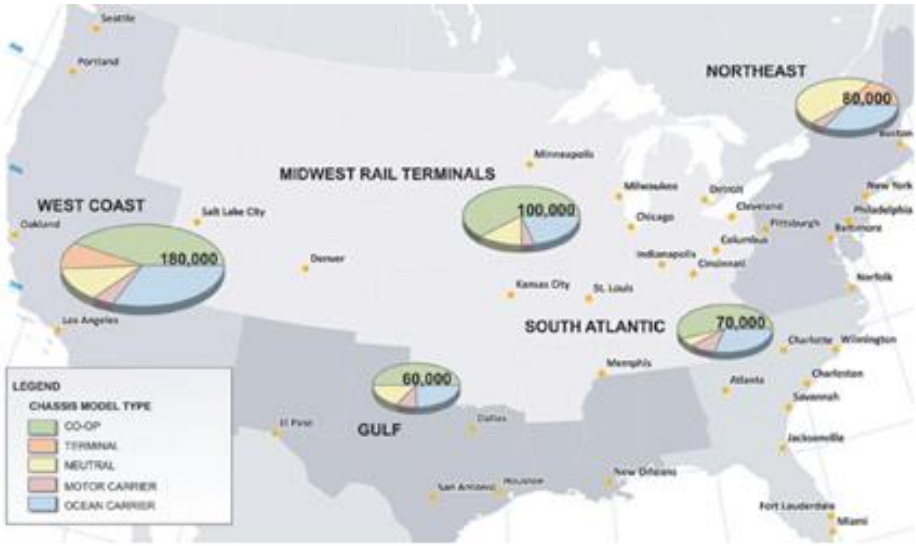

Figure 2.3: US Chassis Leasing/Ownership Distribution (Source: Rodrigue, J. P., 2012)

Current Chassis Pools at Major US Container Ports

Los Angeles–Long Beach (pool of pools). Participants include TRAC Intermodal, Direct Chassis Link Inc. (DCLI), and Flexi-Van Leasing. The total chassis pool is 100,000 and has been operational since May 2015. The pool incorporates fourteen (14) major marine terminals and four (4) major rail facilities with seventeen (17) start/stop locations.

The Port of New York-New Jersey (NY-NJ) tried to form a port-wide gray pool but the arrangement fell apart when Direct Chassis Link could not find a place to locate its part of the chassis pool (Morley 2017) as well as the labor issues associated with maintenance and repair (M&R) (Mongelluzzo, 2017c).

The Port of Houston Authority decided not to pursue chassis pooling given the complicated issues between the ocean carriers and unionized domestic labor. Private sector interests (motor carriers primarily) declined to pursue this option as well (Amdal, 2017).

Ports in the southeast belong to regional pools in which a truck driver can pick up and drop off the international chassis at the same terminal in any port within the regional pool (Hutchins 2015). For example, in Memphis a cooperative pool that incorporates 15,000 chassis from 11 major motor carriers has been put in place. Some, such as James Newsome of South Carolina Ports, have proposed a national chassis pool (Tirschwell 2017b). In New Orleans, Gulf Consolidated Chassis Pool (GCCP) provides a list of common chassis facilities which include the Port of New Orleans, Ports America, and Burlington Northern Sante Fe, Norfolk Southern, and Union Pacific.

Presently, from a national perspective, there is no overarching management solution to chassis pooling or chassis ownership.

Chassis Utilization

The shift in ownership of international chassis from ocean carriers to leasing companies occurred quite rapidly, and "…many acquisitions of the assets by the leasing companies had ancillary conditions negotiated by the ocean carriers linked to continued chassis usage" (Federal Maritime Commission Bureau of Trade Analysis 2015: 32, 33). In many cases, the original contracts between ocean carriers and leasing companies dating from when the carriers divested themselves of international chassis have ongoing "legacy" effects on leasing options for shippers, even though the carriers no longer own the chassis. In some chassis pools, this can limit leasing options for international chassis users.

Many stakeholders want the ocean carriers to be fully separate from the international chassis link of the supply chain (Federal Maritime Commission Bureau of Trade Analysis 2015). The control of the leasing options by the ocean carriers means that many truckers are locked into using the international chassis leased by the intermodal equipment provider (IEP) which are legacy-linked to the ocean carrier for whom they are making any given leg of their journey- there is no choice for these truckers (Mongelluzzo, 2017c). Generally, a motor carrier with permission to pick up a container from one ocean carrier would not have permission to use another ocean carrier's chassis to do so, despite complete physical interchangeability. For example, if a trucker picks up a Maersk container, they must use an international chassis leased by a Maersk legacy-related IEP for that portion of their trip. Then when they drop off the Maersk container, if they then pick up a container from American President Lines (APL), they must first go and collect an international chassis from the different IEP legacy-linked to APL. The truckers who must do this are not compensated for these extra moves, or "turns." Most truckers are paid by the turn, not the hour– and they are only paid for a turn where they pick up or drop off a container, *not* a turn where they must collect a different carriers' chassis.

"The overall cost of driver and tractor time spent in marine container terminals is estimated at over $1 billion annually. The cost of obtaining international chassis at stacked terminals, as opposed to arriving with an international chassis, is estimated at $2-4 million annually... Congestion in the container yard is estimated to cost motor carriers about $33-42 million annually… Extra drayage associated with empty containers, bare chassis, or bobtail tractors costs about $10.2 million annually" (NCFRP, 2011). Other costs include gate queuing, gate processing delays, exceptions and troubled tickets, and congestion on highways and streets (the last mile). In situations where there are few main international chassis leasing companies, the cost of leasing from them could be as high as $20 per day, as opposed to $12-$15.50 per day when using a leasing company controlled by domestic motor carriers (Mongelluzzo, 2017c). If motor carriers had more freedom to choose their chassis lessors or to own and use their own, the cost of imported goods would ultimately be reduced, benefitting Americans *not* foreign ocean carrier lines.

Industry Impacts

Although ultimately the customer pays the entire cost, that customer does not see all the component parts or the tradeoffs between them, particularly the costs associated with transport. Just the top ten commodities moved by trucks accounted for $7.679 trillion in 2015 alone (Bureau of Transportation Statistics, 2017). See Table 3.1.

Table 3.1: Top Commodities Moved by Truck		
Rank	**Top Commodities by Value**	**Billion USD 2015**
1	Mixed Freight	$ 1,315.00
2	Motorized Vehicles	$ 1,131.00
3	Electronics	$ 1,029.00
4	Machinery	$ 882.00
5	Gasoline	$ 671.00
6	Foodstuffs	$ 646.00
7	Plastics/Rubber	$ 537.00
8	Misc. Manufactured Products	$ 516.00
9	Pharmaceuticals	$ 477.00
10	Fuel oils	$ 475.00
TOTAL		**$ 7,679.00**

Causes of Backlog or Decline in Efficiency

Figure 3.1 illustrates the complexities in chassis supply created by the aforementioned dynamic (Tioga Group, Incorporated 2011, 11:14)

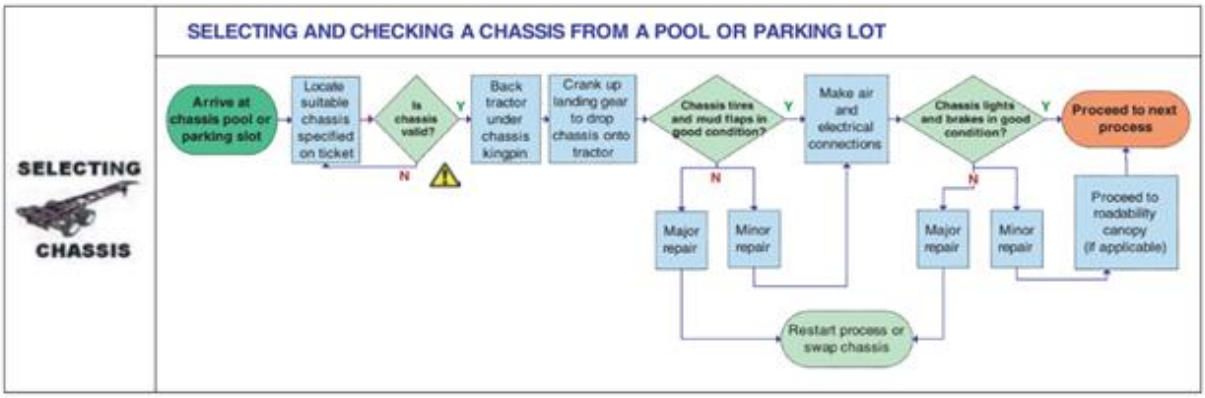

Figure 3.1 International Chassis Subprocesses (Source: Tioga Group, 2011)

Many chassis pools, such as the regional pool in use at Savannah, have greatly increased efficiency, and the practice of various pooling arrangements in general has become widespread. However, while chassis pooling is a step in the right direction, problems still remain. For example, the "pool of pools" at LA-LB still experiences delays. International chassis remained concentrated with overflows of empty containers at different terminals, leaving less chassis availability at other yards when they are in demand. This is due to an imbalance of international chassis with given demand due to fewer leasing options because of legacy links between ocean carriers and the few chassis lessors available. These linkages inhibit the motor carriers' choices of choosing a chassis leasing firm. Also, the large number of terminals linked to multiple different carriers makes the tasks of leasing, dropping off, and picking up international chassis more complicated. Other problems include different chassis load requirements at different terminals; that is, whether a truck can enter a given terminal yard with or without a chassis attached already (Mongelluzzo, 2017a).

There are numerous opinions as to why chassis pooling is not more efficient. Some cite the actual number of international chassis as the root of the problem: "…the number of chassis has increased only 2.7

percent in the last four years, compared with an 11 percent rise in containers entering US ports…" (Whelan 2015). Others cite labor issues, such as an insufficient supply of mechanics to maintain and repair international chassis (Whelan 2015). Negotiations with organized labor – the International Longshoremen's Association (ILA) on the east and Gulf coast; the International Longshore and Warehouse Union (ILWU) on the west coast – can be complicated when considering the necessary labor to maintain and repair an aging chassis fleet. Maintenance and repair of chassis is a factor that will become increasingly important as the chassis fleet ages (Tirschwell, 2017a). And, concerns have been raised of possible overcharging on the part of chassis pools with few lessors and therefore less market competition (Morley, 2015). A proposed solution to this is more competitive pricing among more international chassis lessors. If truckers could choose their chassis provider by cost, instead of being mandated for one associated with an ocean carrier, they would save money (Mongelluzzo, 2017c).

3. Safety, Technology and Employment

There is a critical need for improved safety/visibility and collaboration related to international chassis and the supply chain. However, the technology to make these improvements is lacking and what does exist is disjointed and not presently integrable.

Chassis Design Improvements

Toll tags on chassis: Whether toll transponders are working in a driver's cab or not, or if the driver purposely refuses to pay a toll, tags on chassis provide a secondary check so the toll fee is not increased based upon late payment (due to audit delays and billing via the drayage company).

Lightweight Chassis: Lightweight Chassis weigh 5,050 pounds compared with 6,500 pounds for a standard international chassis. These lighter weight options assist motor carriers that deal with the twin challenges of road weight limits and increased shipments of resins, lumber and other heavy freight (i.e. resins are heavier than most other containerized cargo, meaning shippers load to only 90 percent capacity).

Tires and Lights: Chassis with radial tires and light-emitting diode (LED) lights require less time out of service for repair than older models that still use recapped bias-ply tires and incandescent lights.

Efficiency and Usage Enhancements

One of the main issues surrounding international chassis unavailability (or over availability) is the problem of knowing their exact location and condition. One proposed solution to this is the entering of historical data – gathered from terminal operators – on chassis demand into mathematical models to assist in a more accurate prediction of chassis need at specific times and places known as Data Predictive Analytics (DPA). However, the daily dynamics of ports sometimes thwart this (Mongelluzzo 2017b).

Figure 4.1 is an example of a spreadsheet targeting efficiency and usage enhancements, regarding calculating truck emissions at a terminal (Tioga Group, Incorporated 2011, 11:90).

SmartWay DrayFLEET Version 1.0 Primary Inputs & Outputs — DrayFLEET Version 1.0d of 06/10/2008

Primary Inputs	Default	Scenario
Port		
Calendar Year	2007	2007
Annual TEU	2,000,000	2,000,000
Average TEU per Container	1.75	1.75
Inbound Share	50%	50%
Inbound Empty Share	5%	5%
Outbound Empty Share	25%	25%
Rail Intermodal Share	25%	25%
Marine Terminals		
Average Inbound Gate Queue Minutes	15	15
Average Marine Terminal Min. per Transaction	30	30
Rail Terminals		
Weighted Average Miles from Port	5	5
Average Inbound Gate Queue Minutes	5	5
Average Rail Yard Min. per Transaction	15	15
Container Depots		
Weighted Average Miles from Port	2	2
Share of Empties Stored at Depots	10%	10%
Container Shippers/Receivers		
Weighted Average Miles from Port	25	25
Weighted Average Crosstown Trip Miles	10	10
Cost Factors		
Average Drayage Labor Cost per Hour	$ 12.00	$ 12.00
Average Diesel Fuel Price per Gallon	$ 4.00	$ 4.00

Initiative Inputs	Default	Scenario
Port/Terminal Initiatives		
Stacked Terminal (% stacked)	0%	0%
On-Dock Rail (% of rail on-dock)	0%	0%
Automated Gates (% of gate transactions)	0%	0%
Extended Gate Hours (% off-peak, 50% max)	0%	0%
Container Info System (% used)	0%	0%
Virtual Container Yard (% available)	0%	0%
Neutral Chassis Pool (% used)	0%	0%

Port
Terminal(s)
Scenario
Date

Activity Outputs	Default	Scenario	Change	% Change
Annual Activity				
Number of Drayage Trip Legs	3,498,452	3,498,452	0	0.0%
Drayage Trip Legs per Container	3.1	3.1	0.0	0.0%
Total Drayage VMT	65,706,753	65,706,753	0	0.0%
Drayage VMT per Container	57.5	57.5	0.0	0.0%
Fleet Required (FTE Tractors)	1,224	1,224	0	0.0%
Annual Duty Cycle Totals				
Idle Hours	1,869,294	1,869,294	0	0.0%
Creep Hours	994,223	994,223	0	0.0%
Transient Hours	572,700	572,700	0	0.0%
Cruise Hours	1,506,026	1,506,026	0	0.0%
Total Drayage Hours	4,942,243	4,942,243	0	0.0%
Drayage Hours per Container	4.3	4.3	0.0	0.0%

Emissions Outputs	Default	Scenario	Change	% Change
Pollutant (annual tons)				
HC	53	53	0.00	0.0%
CO	298	298	0.00	0.0%
NOx	1,108	1,108	0.00	0.0%
PM_{10}	37	37	0.00	0.0%
$PM_{2.5}$	31	31	0.00	0.0%
CO_2	88,497	88,497	0	0.0%
Fuel Use and Total Cost				
Fuel - Gallons	7,909,626	7,909,626	0.0	0.0%
Total Drayage Cost	$ 159,451,797	$ 159,451,797	$ -	0.0%
Drayage Cost per Container	$ 140	$ 140	$ -	0.0%

Figure 4.1 Primary Inputs Worksheet Source: (Tioga Group, Incorporated 2011, 11:90)

Data necessary include:

- Historical analysis of chassis movements
    - Size of vessels
    - Day of the week
    - Seasonal variations
- Location and utilization tracking
- Terminal requirement projections
    - Based on current vessel data
    - Vessels at berth
    - Number of import containers discharged on a certain day
    - How many export or empty containers were received
    - How many gate transactions were recorded

Challenges include:

- Dynamic harbor environment
- Vessel call shifts
- Mega ships
- Empty container movements

Current commercial providers of data analytic options for drayage tractors include:

- Qualcomm—www.qualcomm.com/products_services
- Teletrac—www.teletrac.net
- FleetMatics—www.fleetmatics.com
- Advanced Tracking Technologies, Inc.—www.advantrack.com

Aging Electronic Data Interchange (EDI) infrastructure and legacy Information Technology (IT) systems create challenges around data quality, reliability, real-time availability and exchange. In a recent survey by the Business Performance Innovation (BPI) Network, 90 percent of ocean supply chain professionals believe that real time access and information sharing between shipping partners is either “very important” or “important” to improving the efficiency and performance of the global shipping industry. A key challenge is overcoming the independent proprietary systems that have developed over time. These systems have different data standards and requirements, lack a common platform for sharing data and no

external industry quality control regulations. Thereby, the complex, highly orchestrated sequence of events that take place during a vessel call are handled through an inflexible, one-way communication system instead of real-time collaborative problem-solving; ultimately resulting in the drayage companies, terminal operators and port facilities incurring the costs associated with these inefficiencies.

A potential solution, not yet widely applied (and unlikely to be so unless chassis ownership issues are resolved), involves the use of "smart chassis." These are outfitted with sensors and a Global Positioning System (GPS) that can deliver data on cycle, wait, loading/unloading, and turnaround times – as well as information on the state of the chassis in terms of maintenance and repair for beneficial cargo owners (BCOs- the owners of the cargo being shipped) so that they are better able to determine which freight terminals are more problematic for turnaround times and why (Tirschwell 2017a). These chassis can keep up with the exact location of a container, and how rapidly the chassis is moving at any given time, as well as the time of its overall cycle from loading to unloading of its container. However, the expense and rough conditions within which chassis operate make this solution fiscally challenging.

Other areas where technological advancements can improve supply chain operations include:

- Air Emissions
- Congestion Reduction
- Noise Reduction
- Road Maintenance

New international chassis have the capacity to improve supply chain management, improve safety, and lower transportation costs for US consumers. However, perhaps the largest benefit would be to US manufacturing. New chassis estimates range from 100,000 to nearly 400,000. Areas where chassis manufacturing occur would see an increase in employment as well as wages (see Figure 4.2). This nearly wholesale replacement of the US international chassis fleet could be achieved through a voluntary public-private partnership between the federal government and the motor carriers, similar to the Clean Truck Replacement Improvement Program (Clean TRIP) funded by the US Environmental Protection Agency Diesel Emission Reduction ACT (DERA). Motor carriers wishing to own and operate their own chassis could qualify for federal funds if they could demonstrate how additional new motor carrier owned chassis could improve safety (roadability), reduce congestion (and/or thereby air pollution), and/or reduce costs (demonstrate a lower lessor fare or operation costs).

Top 10 Us Manufacturing Locations for Chassis

- Cheetah Chassis - Berwick, Pennsylvania. http://www.cheetahchassis.com/
    - Supplier to National Chassis in Tomball (Houston), TX
- CIMC Intermodal Equipment - South Gate, CA and Emporia, VA. http://www.cimcintermodalequipment.com/about-us/
- Pratt Industries, Inc - Bridgman, Niles, and Stevensville, MI. http://prattinc.com/about/
- Pro-Haul - Gallipolis, OH. http://prohaul.com/index.html
- Chassis King - Clearwater, FL. http://www.chassisking.com/
- Hercules Chassis - Hillsborough Township, NJ. http://www.herculeschassis.com/

Figure 4.2: Top US Chassis Manufacturing Facilities Map by UNOTI

4. Conclusion

The chassis system in the US is unique. In every other part of the world, the motor carriers, the freight customers, or off-site terminals provide chassis. They come to the marine terminal with the driver. In 2009, Maersk divested itself of its chassis and formed a chassis leasing company, DCLI, to provide chassis to shippers. By 2012 DCLI had spun off from Maersk, and most other ocean carriers followed suit, resulting in three major chassis leasing companies, legacy-linked to the carriers, being the shippers' only options for chassis leasing in many cases. In some chassis leasing pools, this situation is compounded by the complexities of the chassis pickup and drop off process. Chassis utilization becomes an unworkable and avoidable chokepoint in the supply chain. Truckers are not allowed to use a container from one carrier with a chassis linked to another, leading to wasted turnarounds as the drivers drop off and pick up the matching chassis.

Cost and availability are not the only concerns; safety is also of importance. Almost half of the ocean carrier chassis date from before 1997, and it is common at marine terminals to find chassis that exceed the effective lifespan of about 20 years. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and drayage companies, rather than the ocean carriers. Newer chassis are safer as they are outfitted with radial tires, antilock brakes, and LED lights. Additional technological developments at work involve the use of GPS systems and data analytics to enhance the efficiency chassis moves within the supply chain. However, until chassis ownership and management is settled, new investments in this technology seem unlikely.

If motor carriers could choose a lessor from among the chassis pools, based upon cost-competitiveness, rather than being mandated to one with legacy linkages to ocean carriers, the market would generate cost savings. A necessary condition to achieve this is the exit of the ocean carriers from the chassis node of the supply chain. A fuller answer is to encourage the developing practice of trucker ownership of chassis, which is the global model.

Ultimately, what is needed is a full-scale extensive study of the chassis landscape in the US. The most recent such study is already five years old (Rodrigue 2012). The current voices of all stakeholders need to be documented, as this is crucial to understanding potential solutions to the problems overviewed in this whitepaper.

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Acronyms

BCO	Beneficial Cargo Owners
DCLI	Direct Chassis Link, Incorporated
DPA	Data Predicting Analytics
DVIR	Driver Vehicle Inspection Report
ECY	Empty Container Yards
EDI	Electronic Data Interchange
ELD	Electronic Logging Device
FMCSA	Federal Motor Carrier Safety Administration
GCCP	Gulf Consolidated Chassis Pool
GPS	Global Positioning System
IEP	Intermodal Equipment Provider
ILA	International Longshoremen's Association
ILWU	International Longshore and Warehouse Union
LED	Light-Emitting Diode
M&R	Maintenance and Repair
MAP-21	Moving Ahead for Progress in the 21st Century Act
NACPC	North American Chassis Pool Cooperative
NAFTA	North American Free Trade Agreement
NCFRP	National Cooperative Freight Research Program
RCD	Roadability Component Defect
TWIC	Transportation Worker Identification Credential
UNOTI	University of New Orleans Transportation Institute
USDOT	United States Department of Transportation
VCY	Virtual Container Yards
VSA	Vessel-sharing Alliances

Definitions

Beneficial Cargo Owners - The importer of record, who physically takes possession of a cargo at the destination and does not act as a third party in the movement of such goods

Brakes - Chassis air brakes and brake shoes

Chassis Flip - If a container has been mounted on the wrong chassis or damaged chassis, the container must be transferred to a correct chassis before the driver can leave the terminal

Congestion Surcharge - A charge by drayage companies to BCOs when chassis issues aggravate other congestion problems

Cooperative Chassis Pools - A single chassis pools assembled from ocean carrier members and pool participants and leased from independent fleets

Dwell Time - The time spent in the same position, area, or stage of a process

Electronic Logging Device - Used to monitor truckers hours of service compliance

Equipment Repositioning - Re-positioning chassis/containers associated with supply chain imbalances and involves the various costs such as loading, transshipment, haulage, feeder, container detention, and discharge cost

Gray (or Grey) Chassis - A neutral "pool of pools" allowing chassis from multiple pool operators (chassis are interoperable) negating chassis flips based on pool affiliation

Landing gear - The frame, wheels, and machinery of a motor vehicle, on which the body is supported

Lights and Lenses - Must be intact and operate correctly. Lenses are typically set into the rear bumper for protection. Connectors to the trailer must also be in good condition

License, Registration and Inspection Tags - Sticker must be current for road service

Mud Flaps - A sheet of thin material that hangs behind a wheel of a vehicle and that stops mud and water from hitting the vehicle or other vehicles

Neutral Chassis Pools - Appointed lessor provides chassis at a daily rate

Terminal Chassis Pools - Maintained at terminals operated by independent stevedores that have multiple client ocean carriers

Third-Party Chassis Pools - Independent chassis pool that charges the ocean liners a per day rate

Tires - A 40-foot chassis usually has eight tires, all of which must have adequate tread depth and inflation

Transportation Worker Identification Credential - Required for any drayage driver entering the terminal. TWICs have embedded RFID capability, but the RFID readers are not yet available. Marine terminal entry gates are thus having drivers display TWICs for visual inspection. Eventually, TSA plans to incorporate TWIC readers in entry gate installations.

Twist Locks - The four twist locks that secure the corners of the container to the chassis

Appendix: Annotated Bibliography

https://www.joc.com/trucking-logistics/drayage/three-largest-us-ports-seek-ways-resolve-chassis-crisis_20140721.html

Introduction to chassis crisis. Discusses effects of shipping companies getting out of the chassis business, which created the crisis. Idea of the "gray pool" for Los Angeles-Long Beach and New York-New Jersey is floated, in which "…chassis [are] interchanged freely and possibly stored off dock instead of terminals", and managed by motor carriers or logistics companies. This most closely approximates the "rental pool" model discussed in Shiri and Huyn 2017, and is the international standard for chassis (TRB chassis paper).

https://www.joc.com/port-news/us-ports/port-los-angeles/drayage-community-praises-new-la-lb-gray-chassis-pool_20150305.html

Opening of chassis "pool of pools". TRAC Intermodal, Flexi Van Leasing, and Direct Chassis Link. Truckers can now "…pick up and drop off chassis at any of the terminals served by the three chassis pools", instead of having to split the operation into two separate trips.

http://www.fmc.gov/assets/1/Page/PortForumReport_FINALwebAll.pdf

Pp. 23-38 completely outline all the issues surrounding chassis ca. 2015. Proposed cross-stakeholder solutions were: implementation of more gray pools for chassis interoperability; improved inbound container volume forecasting; more capital investment in chassis; redesigning terminal layouts for facilitation of chassis; more mechanics specifically devoted to chassis work; the complete exit of ocean carriers from the chassis business; rail intermodal terminals moving to grounded operations ("Wheeled operations at these facilities impede potential progress toward motor carrier or shipper owned and operated chassis fleets"- p. 37); chassis modernization; application of UIIA interchange arrangements to chassis ("UIIA is a multimodal negotiated interchange agreement that serves as the standard interchange agreement for most intermodal equipment interchanges *except* chassis. Reportedly, chassis leasing companies continue to insist motor carriers sign their proprietary interchange agreements"- p. 27); inspect chassis immediately upon their return, not right before the drivers have to leave the terminal with them; pushing the Federal Motor Carrier Safety Administration (FMCSA) to more aggressively enforce roadability compliance; and sufficient regulatory oversight of the transition from ocean carriers to equipment leasers as providers of chassis.

http://www.wsj.com/articles/ports-truckers-contend-with-chassis-shortage-1436207475

"…the number of chassis has increased only 2.7% in the last four years, compared with an 11% rise in containers entering US ports, according to industry data…Keith Lovetro, chief executive at TRAC, which owns about 310,000 chassis…says there are enough chassis at most ports and blames delays on a shortage of mechanics to perform maintenance on chassis and repair them when they are damaged… 'It's not necessarily the total number of chassis,' said Joni Casey, president and CEO of the Intermodal Association an industry group. 'The chassis just aren't in the right place at the right time'."

http://www.morethanshipping.com/chassis-the-linchpin-of-the-trucking-industry/

Accusations of "price gouging" by the chassis leasing companies.

https://www.joc.com/port-news/longshoreman-labor/international-longshore-and-warehouse-union/ilwu-chassis-trouble-likely-be-resolved-court_20151021.html

The ILWU was performing additional inspections of chassis in addition to those done by the chassis leasing companies. The leasing companies did not get into the chassis business with the understanding that they would be using union labor – costlier – to perform inspections. Chassis leasing companies getting ready to sue the ILWU for performing "illegal" inspections. This is the labor-derived slowdown node in the terminal operations process to which Ian's LNG friend Lawrence was referring when we spoke with him about chassis at TRB this year.

https://www.joc.com/port-news/us-ports/port-new-york-and-new-jersey/ny-nj-%E2%80%98gray%E2%80%99-chassis-pool-awaits-deal-ila_20151207.html

At this time in NY-NJ, the principal chassis leasers – TRAC, DCLI and Flexi-Van – were using ILA labor for their inspections and maintenance. The ILA wanted to nail down guarantees that their contracts would continue to be honored despite any changes in creating the chassis pool. NY-NJ wanting to create a single pool co-op rather than a "pool of pools". The shipping lines, which formerly owned the chassis, were bound by the ILA contract from the strike of 1977. The new leasers of chassis are not. Thus, the ILA's insistence on guarantees.

https://www.joc.com/port-news/terminal-operators/la-lb-chassis-back-sends-warning-signals_20170327.html

"Pool of pools" at LA-LB not working as smoothly as hoped. Chassis get concentrated with overflows of empty containers at different terminals, leaving less chassis availability at other yards when they are needed. Drop in imports during Chinese New Year exacerbated the problem. Other problems persist, including different chassis load requirements at different terminals; that is, whether a truck can enter a terminal yard with or without a chassis attached already.

https://www.joc.com/trucking-logistics/drayage/bcos-stand-gain-tech-predicting-chassis-demand_20170505.html

Historical data on chassis demand are being entered into mathematical models to assist in the more accurate prediction of chassis need at specific times and places. However, the daily dynamics of ports sometimes thwart these early models.

https://www.joc.com/port-news/us-ports/new-chassis-business-model-would-cut-costs-trucker-says_20170609.html

If truckers could choose their chassis provider by cost, instead of being mandated for one associated with a shipping line, they would save money.

https://www.joc.com/port-news/us-ports/port-new-york-and-new-jersey/long-delayed-ny-nj-chassis-pool-%E2%80%98making-progress%E2%80%99_20150921.html

At this point in the port of NY-NJ, the two main issues holding up the implementation of a "gray pool" chassis model were reported to be close to resolution. The issues were union jurisdiction over maintenance and repair chassis, and avoiding the possibility of price-fixing and supply manipulation by chassis providers.

https://www.joc.com/trucking-logistics/drayage/ny-nj-joint-chassis-pool-collapses_20170914.html

The tentative deal for the NY-NJ chassis "gray pool" fell apart because DCLI could not find a new place for its chassis pool. DCLI pulled out after an ultimatum from Flexi-Van.

https://www.joc.com/port-news/us-ports/port-new-york-and-new-jersey/ny-nj-port-considers-options-after-chassis-pool-collapse_20171003.html

Some of the options considered include having the NY-NJ Port Authority become more involved in a chassis pool; bringing the Ocean Carrier Equipment Management Association (OCEMA) into the picture; having more competition from more Intermodal Equipment Providers (IEPs) providing chassis to the pool, as well as trucker and shipper owned chassis. Two of the three main chassis providers – TRAC and Flexivan – believe that their intermediate solutions are working so far, and the third one – DCLI – is awaiting the availability of land from which to operate its portion of the chassis pool. The expectation was that the chassis problem would become intolerable without a gray pool given the raising of the Bayonne Bridge to accommodate larger mega ships, but so far the port has not been overwhelmed with containers to the degree anticipated. A major difficulty for reaching an agreement four gray pool is that the majority chassis supplier, TRAC, wants to be the sole manager of the pool.

https://www.joc.com/port-news/us-ports/demise-chassis-pool-ny-nj-has-many-shaking-heads_20171009.html

Some people think the chassis supply is adequate for NY-NJ and that the market will straighten out the kinks. Wider industry sees the chassis pool collapse as a grave development. Ocean Carrier Equipment Management Association (OECMA) considers NY-NJ "at risk" due to the lack of a working chassis pool. James Newsome of South Carolina Ports wants a national chassis pool, "…like the rail TTX fleet". Says the southeast is "…going to come up with a chassis pool that has a young fleet of chassis and works for the customer base".