Reengineering the Logistics of Empty Cargo Containers in the SCAG Region

FINAL REPORT

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METRANS RESEARCH PROJECT

Disclaimer

The content of this report reflects the views of the author, who is solely responsible for the accuracy of the information presented herein. The study was based on several field surveys as well as managerial and expert interviews conducted by the author with a number of industrial representatives. The author is appreciative of the individual experts and organizations identified in the attribution given in Appendix A (the names of certain individuals have been withheld in accordance with the request of these participants) for sharing their valuable time and providing expert opinions and strategic knowledge. With or without attribution, however, these participants do not assume responsibility for the contents or views presented by the author in this report.

Abstract

Project Objectives and Abstract:

This project describes existing logistics practices with respect to empty containers, and considers the economic and institutional circumstances that direct the movement of empty containers within the SCAG region. Building on findings and recommendations presented in the recently concluded Gateway Cities Study [1], this work explores the regional problems posed by empty containers in the context of existing international trading structures and through discussions with international marine carriers.

A key objective of this project is to understand the current logistics of empty containers related to the movement of cargo through the ports of Los Angeles and Long Beach. This project will investigate two aspects of the existing logistics system for handling empty containers: (1) the physical movement of empty containers, and (2) institutional arrangements and practices. In order of emphasis, however, the second aspect of this investigation will be the main focus of discussion. Accordingly, this investigation will assess the extent to which current global logistics practices constitute a barrier to rationalizing empty container movements within the study region.

It is envisioned that an appreciation of the overarching structure of international trade, and of how the market for global logistics values the efficient movement of empty containers, will provide an important frame of reference for this study. Without an understanding of this context and competitive environment, all efforts designed to rationalize empty container movements at a regional level may prove to be rather limited in their implementation.

The methodology of this study includes field surveys and interviews with local and international carriers, container leasing firms, trucking companies, intermodal transport operators, freight forwarders, and marine container logistics specialists. Findings of this research suggest that, although these operators are cognizant of the efficiencies that could be gained through a rationalization of empty container movements, the business opportunity costs associated with an inadequate supply of empty containers for customers in Asia far outweighs the likely gains of rationalized empty container movements in the SCAG region. Essentially, this study finds that carriers are willing to tolerate the regional inefficient movement of empty containers and bear repositioning costs as necessary conditions for optimizing the overall performance of their global container inventory and control operations.

Analysis continues with a consideration of the global logistics system as a whole, with regional markets such as that represented by the SCAG region comprising logistical sub-systems. This analysis leads to the conclusion that optimal solutions to the rationalization of empty container movements must consider all scales of the global logistics system, and that such solutions would work to better performance at different levels of the system as well as for the overall system. Possible strategies for optimizing empty container logistics at the international and regional scale indicate clear opportunities do exist for reducing the total number of empty container trips. However, in certain (market) situations, strategies intended to optimize performance at the

regional scale would work to degrade the system at the international level. This study suggests that the better solutions for rationalizing empty container movements would contribute positively to the performance of global logistics in total, and that strategies failing this test would not generate sufficient benefits to justify the cost of their implementation.

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Disclosure

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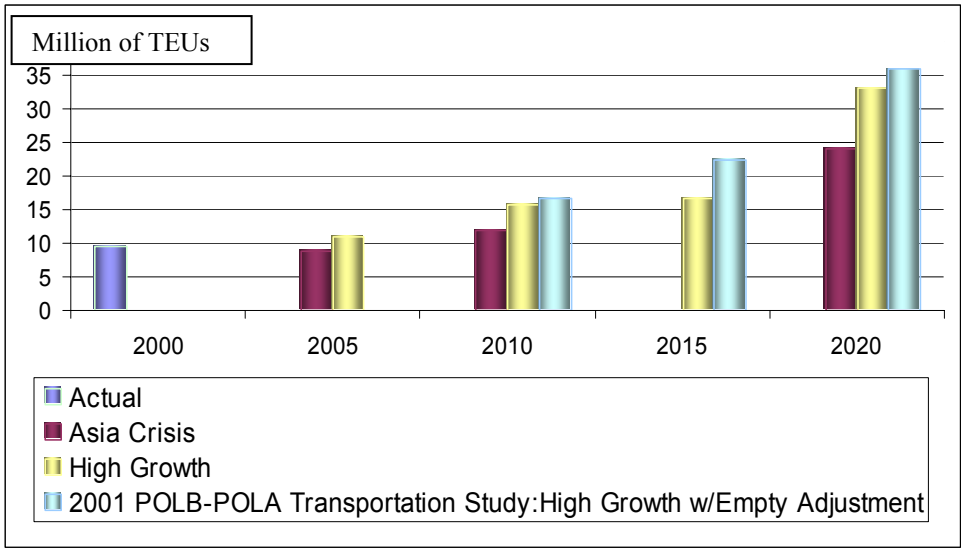
I. Introduction

Background

The San Pedro Bay ports of Los Angeles and Long Beach have benefited from the expansion of U.S. trade, especially trade between the U.S. and the rapidly expanding economies of Asia. One consequence of this increased trade volume is that containerized traffic has become a major business for these two ports. The ability to efficiently move cargo through these ports is crucial to the overall economic viability of the Southern California region, as well as to that of the state of California and the nation as a whole.

Regional Context

Along with the broadly distributed benefits arising from the growth of containerized freight [2] come a particularly focused set of problems and challenges for the regional transportation systems supporting the ports. The existing system for container transport to and from the ports relies principally on surface structures and vehicles (truck and rail trips) generated between these ports and off-site transport centers. These freight trips contribute to vehicular congestion and air pollution in the vicinity of the ports and along key transportation corridors such as the I-710 freeway. In addition to complaints about safety and increased traffic congestion, this port-related traffic often engenders intense environmental opposition due to its contribution to air and noise pollution.



Source: 1998 Mercer Management/DRI

Figure 1: Pedro Bay Ports Forecast: 2000-2020

Given the expected growth in cargo throughput of the port complex over the next 5 to 20 years (see Figure 1), these pollution and congestion problems, along with the surface transport system's growing capacity shortfall, can only get worse: the identification and implementation of

more efficient empty container logistics practices could contribute to a lessening of congestion and to improved air quality along principal freight corridors.

Trans-Pacific Trade Imbalance

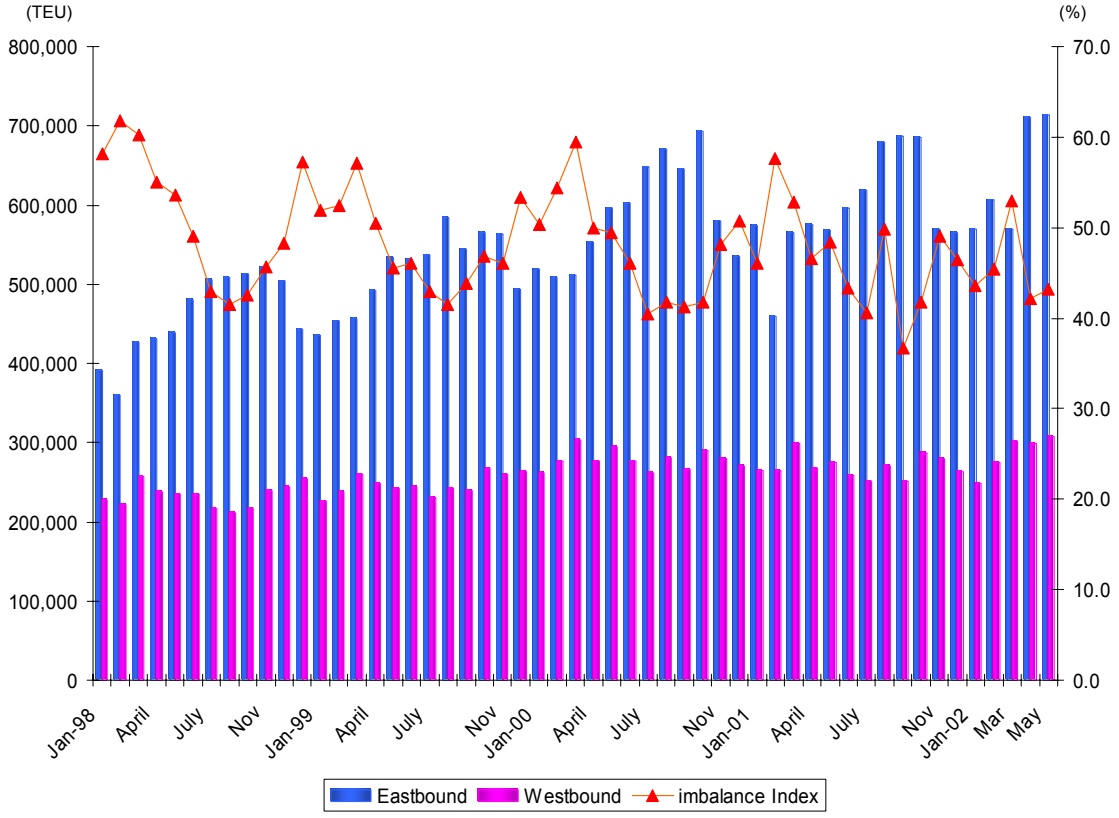


Figure 2: East-West Container Trade Imbalance (1998-2002)

As shown in Figure 2, current containerized trade through the ports of Long Beach and Los Angles is severely unbalanced, and this imbalance between imports and exports is expected to continue and even worsen. It is purely in relation to the emergence of this international economic phenomenon of trans-Pacific trade that the distribution and re-location of empty containers arises as an issue. For ocean carriers, in the past few years, an average of 40% to 50% of import containers shipped from Asia to the West Coast of the U.S. were eventually shipped back to Asia empty, and this repositioning of empty containers does add significant operational costs to ocean carriers. For local and regional entities, the movement of empty containers contributes significantly to freeway congestion and environmental problems. Truck traffic presently consumes 30 to 60 percent of capacity along the I-710 and SR-60 corridors at peak periods [3].

Cycle of Container Handling

These empty container trips occur for various reasons, including conditions of business agreements between shippers/consignees and the ocean carriers (who are generally the owner or supplier of shipping containers) that require all containers to be picked up and returned to container yards (CY) at the carrier's terminal, regardless of whether they are loaded or empty.

Basically, for inbound and outbound cargo (as diagramed in Figure 3), loaded containers are picked up by trucking companies from the carrier's terminal and are delivered to the consignee for unloading. They are then returned to the carrier's terminal, usually by the same trucking company. The same practice is in place for outbound cargo. Trucking companies pick up empty containers required by an exporter from a carrier's terminal and deliver these empty containers to the exporter for loading. After a container has been loaded, a trucking company will transport the loaded container to the carrier's terminal where it will be stacked at the pier prior to loading on to a container ship. It is clear that, in the case of both export and import cargo, at least two-thirds of the required truck trips involve empty container movements, either for empty pickup or empty return.

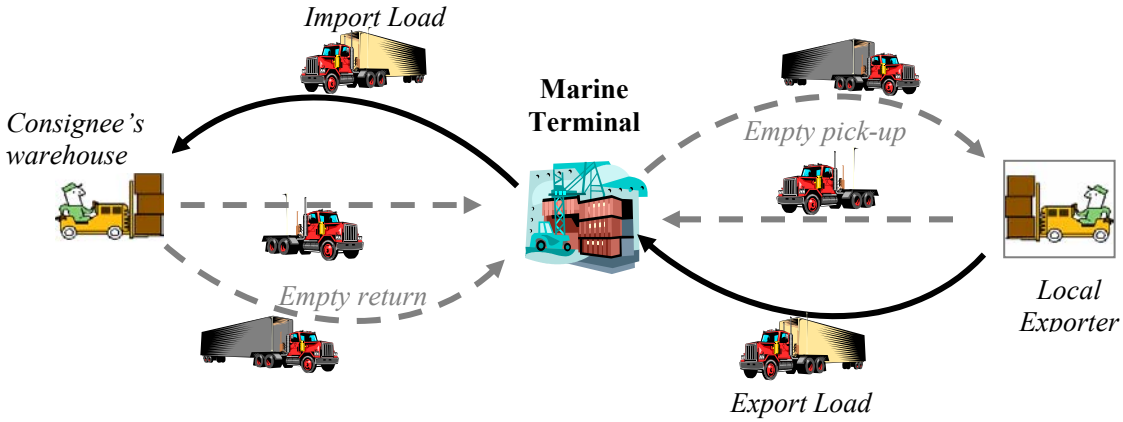


Figure 3: Cycle of Container Handling

For port operators, empty container problems will also worsen as terminal land availability grows scarce. Empty containers are often allowed a longer dwell time at marine terminals (anywhere from 14 to 50 days), and the current practice of local terminal operators is to store containers, especially imports, on a wheeled chassis instead of in grounded stacks of containers, as is the common practice of terminals in Asia and Europe. These relatively land-inefficient container handling practices tend to restrict overall terminal capacity. Additionally, the number of empty container movements at the terminals works to diminish the operating capacity of terminal gates. Drayage companies can experience an average of 2-hours waiting time at congested terminal gates [4].

As the problems associated with the movement of empty containers become more apparent, it is thought that a rationalization of empty container logistics will be of increasing strategic importance and come to be seen as valuable to all parties involved—from ocean carriers and shippers to intermodal (trucking) companies and local and regional governments.

Current Issues Concerning Empty Container Repositioning

The current practice—the manner in which empty containers are distributed and re-located—has developed over the past few decades along with the growth of international trade and containerization, and as an integral part of a competitive market environment that has encouraged ocean carriers to search for all possible solutions to reduce such non-revenue generating activities as repositioning empty containers. It is evident that carriers' interests have

given more strategic consideration to the logistics of forward-flow (loaded containers) than to the reverse movement of empty containers. Also, ocean carriers have thus far focused, with certain levels of success, their efforts on minimizing container repositioning costs in the ocean transit segment (e.g. utilize surplus ship slots for repositioning of empty containers), but with lesser thought applied to the inland transport segment.

The regulatory and market circumstances that give rise to the current imbalance in trade and number of empty container movements are rather complex and, accordingly, are not likely to be resolved through a single or simple solution. Several previous studies, including the recent Gateway Cities Study on Empty Ocean Containers Logistics, have pointed out that "the major barriers to rationalizing empty container movements in the region are not technical or economic, but institutional," and suggest that the greater burden for institutional change rests properly with the ocean carriers. Thus, from a particular perspective, it can be argued that the current practices related to empty containers seem somewhat irrational.

On the whole, however, these practices have arisen and perpetuated themselves in a highly competitive and international context wherein all parties, and especially ocean carriers, are cognizant of the inefficiencies inherent in the repositioning of empty containers and are motivated to achieve optimal performance. This being the case, the question of why obvious local inefficiencies in the movement of empty containers are permitted to persist in a competitive international setting deserves consideration. In evaluating alternative regional solutions to the problem of empty container logistics, it is important to keep in mind that international logistics are optimized at a global scale, and that realizing optimization at a sub-system level could very well compromise the performance of the system as a whole.

As noted in the Gateway Cities study, "empty containers move back and forth because, at present, there is no alternative." In positing possible future solutions, that study finds some promise in several nascent internet-based container information sharing ventures. The hope is that, given sufficient real-time information on the location and type of empty containers available, it would be more likely that the number of empty container trips in the region could be reduced through the use of more "street turns"—the direct reuse of import containers to local export loads.

The potential usefulness of these information systems in enhancing the management of empty container movements is appealing; however, to make these systems a viable solution for rationalizing empty container movements, it is not the mere posting and sharing of information, but the timeliness and reliability of the information that matters. Additional conditions that pertain are discussed below in the sections dealing with the market circumstances of international trade.

All of this suggests that there may be public policy options available that, through encouraging or discouraging certain behaviors, could modify the set of market choices and institutional arrangements that direct the present physical movements of empty containers. The first step in identifying good policy solutions is developing an understanding of the dynamics currently shaping the logistics of empty containers.

Objectives

A key objective of this project is to investigate the current logistics practices of empty containers related to the movement of international cargo through the ports of Los Angeles and Long Beach. This project will investigate two aspects of the existing logistics system for handling empty containers: (1) the physical movement of empty containers, and (2) institutional arrangements and practices that are presently in place. The second aspect of this investigation will be the main focus of discussion. Are current international logistics practices a barrier to rationalizing the regional movement of empty containers? Or do such practices merely represent aspects of the structure of international trade and of market forces working to optimize overall system performance. A more complete understanding of these issues is required if regional policy efforts intending to rationalize empty container movement are to achieve their stated purpose. Based on the above analysis, directions for system optimization and rationalization that would work best to reduce the number and distance of empty container movements are discussed.

Methodology

This research was conducted through a number of surveys and interviews with selected industrial representatives of ocean carriers, trucking companies, terminal operators, and freight consolidators—all entities engaged in providing cargo services through the ports of Los Angels and Long Beach with a focus on trans-Pacific trade (a list of the organizations interviewed is provided in Appendix A). These surveys addressed several issues, including facility operations with details about location and capacity, cargo volume, the number of truck trips generated, typical business arrangements, and current and innovative business practices to improve the management and utilization of empty containers as well as overall container inventory control. The interviews gathered data and obtained opinions from all parties regarding the application of depot direct return and direct off-hired depot solutions, the potential of advancing internet-based systems and virtual container yards, and the possibility of container interchanges, including container reuse and container pooling solutions. Given that the main focus of this research involved institutional and market intelligence and competitive issues that are generally considered to be proprietary in nature, it was determined that personal interviews would likely provided the best means for gaining greater insight and a closer sense of the actual problems pertinent to objectives of this research project.

Dealing with the issues related with empty container inventories and movements is an established aspect of the daily operations of maritime transportation entities. Within the industry, many solution and strategies have been studied and implemented in order to streamline the movement and efficiently manage the inventory of empty containers. From a regional and local transportation planning point of view, however, a consideration of the impact of empty container movements is rather new. To the best of my knowledge, just a few general studies on empty container have been found (see References), and most of these are at a theoretical, as opposed to a practical or application, level of inquiry. At the time when this study was undertaken, it was known the Gateway Cities study on empty containers was also underway. The approach or methodology of the Gateway Cities study was to specifically analyze just the regional movement of containers within the local shipping industry. In relation to and as a supplement to the Gateway Cities study, this study seeks to address the issues and to identify solutions more

broadly and in the context of the global structure of trade and logistics practices. As such, the analysis here places an emphasis on the carrier's perspective concerning empty container movements, and accordingly assesses potential solutions from the carrier's point of view.

The approach of this study is, therefore, somewhat different from that of the Gateway Cities study. As would be expected, some findings of this study contradict some of the findings of the Gateway Cities study. Overall, however, these studies tend to complement one another and as a whole present an optimistic, though realistically tempered, understanding of empty container movements in SCAG region.

II. Current Practices of Empty Container Logistics

The Logistics of Empty Containers

Physically, empty container logistics deals with the movement and distribution of empty containers. As a segment of the whole container logistics cycle, empty container logistics commence where a container is emptied, such as at a consignee's warehouse, and conclude at the point a container is positioned for reloading. Figure 3 shows diagrammatically one complete empty container movement cycle: from a consignee's warehouse to the next cargo loading point (exporter's warehouse). Once emptied, a container may be moved either directly to its next loading point, or to any of a number of intermediate locations. Possible intermediate stops include a carrier's container yard, often located at marine terminal but also at inland depots; shipper (exporter) warehouses; container leasing company depots; intermodal facilities including trans-load facilities; and trucking company depots or container rail yards. Each of these locations represents an alternative flow pattern in the movement of an empty container, and each currently necessitates a different logistics management approach.

In any event, the movement of empty containers is a necessary aspect of the container business. Moving these empty containers efficiently—practically and economically—is a goal of all parties involved in the container business. This is especially true for ocean carriers who are often the owner (or supplier) of most of the containers used in their operations. It is noted that there are two distinctive segments comprising empty container movements—the local or regional segment and the international segment. Most often ocean carrier's bear the cost of repositioning empty containers involved in the international segment, while local movement costs accrue to the customer's account.

Movement Pattern of Empty Containers

As shown in Figure 4a, b, c, in general, there are three possible movement patterns in one cycle of an international container move. In figure 4a, loaded import containers from Asia arrive at a port terminal (movement 1) under a detailed contract between the ocean carrier and the shipper (in this case an importer). The shipment is picked up and delivered by truck to a consignee's warehouse (movement 2) for unloading. After the container is emptied, the empty container is trucked back to marine terminal (movement 3) from where it will be sent back to Asia (movement 4) for the next cycle. This pattern of empty container movement involves both a local/regional segment (movement 3) and an international segment (movement 4). This movement pattern is often defined as the "**repositioning"** of empty containers. Similarly, the movement patterns shown in figure 4b and c are what carriers often call the "match-back" strategy—a strategy in which, instead of repositioning the import empty containers to Asia, carriers try to match local export cargo with available empty containers.

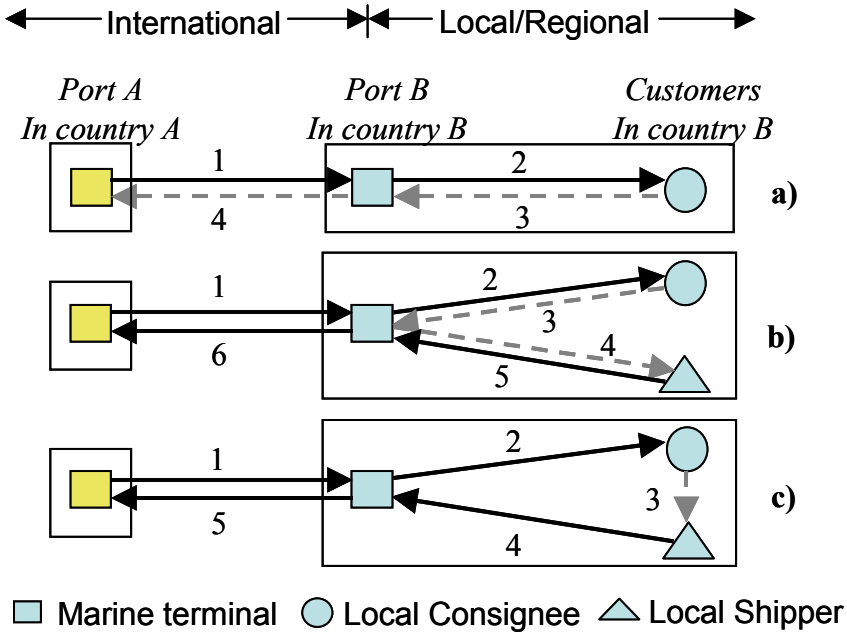


Figure 4: Possible Movement Patterns of an Ocean International Container

This type of match-back shipment is similar to the "**empty container reuse**" concept discussed by the Gateway Cities Study. The differences between scenarios 4b and c are attributed to the inland movement of empty containers. In figure 4c, instead of an empty container returning directly to the marine terminal as shown in figure 4b, the empty container is drayed directly to an identified shipper (exporter) who needs the empty container for export cargo. The loaded container then trucked to marine terminal for shipment to Asia. The movement in 4c is defined by carriers as "**triangulation,**" and as "**street-turn**" by the Gateway Cities Study. This is the method of moving an empty container locally from a surplus location to a demand location without first returning to the marine terminal. This approach could be undertaken with or without an **"interchange**" of the empty container—the process of exchanging contractual liability for a container from one owner/operator to another. In other words, it is the transfer of a container from the responsibility of one party to the responsibility of another.

Strategically, the "match back" movement approach, shown in 4b and c, is most desirable from the ocean carrier's point of view, as with this approach they can eliminate repositioning costs and, in most cases, generate additional revenue. However, from the local and regional perspectives, only the "triangulation" or "street turn" movement, that allows the direct reuse of an import container for a return export load, plays a significant part in reducing the number of empty trips, and thereby truck vehicle miles traveled (VMT).

Container Ownership

There are two types of container ownership that currently exist in the market. These are (a) carrier owned and (b) leased containers. Compared to the early days of containerization, as part of a "minimum total cost" strategy, carriers are tending recently to reduce the owned portion of containers in their inventory, with a reciprocal increase in the proportion of leasing containers. However, for the most part, containers are still owned by carriers, with carriers in some cases continuing to own up to 80% of the containers in their operations. Container inventory management has been an important aspect of the container business. Maintaining a sufficient level of containers while minimizing inventory costs (capital as well as maintenance costs) is a challenge to each carrier's day-by-day operation. Logistically, this challenge is even more challenging when surplus and demand points for empty containers typically occur in different parts of the world.

Container Leased Contract

Leasing containers is part of a carrier's inventory management strategy. Carriers prefer to lease containers in a shortage area and off-hire them in surplus areas in order to avoid repositioning costs. Under a leasing contract, the liability of leased containers is stated and transferred to the carrier under specific terms and conditions. Besides these legal agreements, to discourage carriers to off-hire containers at a place where the leasing company doesn't want to receive them (often at the surplus area), pick-up (P/U) and drop off charges (DOC) are applied together with a specific quota—a stated number of containers which any carrier can off-hire at a certain location per month. It is typical that these quotas are small at places where leasing companies face a surplus in inventory. Pick-up charges (P/U) are applied when an on-hire container is leased at a place where inventory is tight. Similarly, drop-off charges are generally assessed when a container is off-hired at a place where inventory is in surplus. Thus, at the time of executing a lease contract, the charge for leasing a container ($/day) is determined principally by the intended pick-up and drop-off locations, as constrained by quota conditions. From the time they take possession, carriers are responsible for all damage or destruction that may occur to those containers.

Container Liability

An Equipment Interchange Report (EIR) is used by industry participants to document the condition of containers at certain points and to establish responsibility for any ensuing container damages. This inspection is required at the point when a container is transferred from one party to another in the process of being transferred and routed for distribution. Terminal and depot gates are often the points used for inspecting the condition of containers whenever they are picked up or returned. Often terminal and depot operators, on behalf of ocean carriers, undertake the inspection and confirm container condition with the truck driver picking up or dropping off the container. Based on the EIR, payments will be made to ocean carriers (and thus to leasing company for leased containers) by the party responsible for any damage and loss.

Empty Container Movements in the Southern California Region

The ports of Los Angeles and Long Beach represent an important gateway for U.S.-Pacific Rim trade, and the physical transportation network supporting the distribution of containerized cargo shipped through these ports is rather complex. This inland distribution network is serviced by double-stack freight rail operations, often for long-distanced destinations (about 60% of total import cargo), and by trucks for local and regional market moves. According to the Gateway Cities study, due to the limited capacity of on-dock rail facilities at the ports, at present 70 percent of intermodal cargo is distributed by trucks to off-dock rail facilities for trans-loading to rail cars, and only 30 percent is accommodated by on-dock rail facilities at the marine terminals. Currently there are 6 off-dock rail terminals serving the port's intermodal cargo. As shown in Map1 represented in yellow circles, they include the Union Pacific's Intermodal Container Transfer Facility (ICTF) in Carson, the East LA (Union Pacific, UP) and Hobart Yards (BNFS), the LATC (UP) near downtown Los Angles, the UP yard in City of Industry, and the BNSF intermodal yard in San Bernardino. The location of these rail intermodal facilities, along with the regional dispersal pattern of numerous customers's warehousing and truck distribution facilities, establish the routing and volume of empty container flows.

Map1. Multi-modal Terminals/Facilities in the SCAG Region

According to the Gateway Cities study, in the year 2000:

- About 716,000 empty container units (or 1.3 million TEU, with 1.85 TEU per unit) moved eastbound from the marine terminals to local or regional inland destinations via rail and truck.
- About 1.9 million empty container units (3.5 million TEU) moved westbound from inland intermodal points, from local consignee warehouses, and other smaller flows back to marine terminal.

- About 80,000 units (148,000 TEU) moved directly between inland locations (cross-town movement), which include local "depot-direct" off-hires of leasing containers, intermodal depot-direct off-hires, and empties reused for local exports.

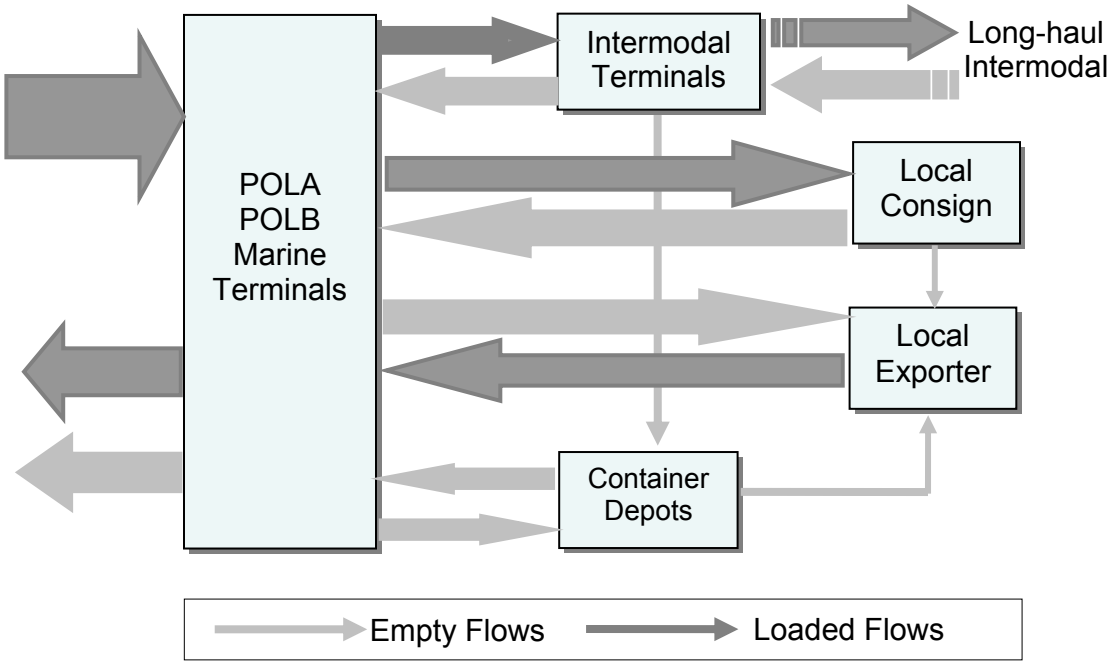


Figure 5: Major Empty Container Flows in Southern California

Technically, the eastbound movements of 716,000 (about 1.3 million TEU) empty containers could be reduced if, out of the 1.9 million empty units moving westbound, 716,000 units could be utilized for local export directly without first returning to the marine terminal.

III. Possible Solutions for Rationalizing Empty Container Logistics

Reuse of Empty Containers: the "Triangulation" or "Street-turn" Interchanged Approaches

The reuse of empty containers for local export is considered to be a potential solution for rationalizing the movement of empty containers and thereby reducing unnecessary empty trips. Reuse of empty containers is the direct reuse of import empty containers for local export cargo without an intermediate return of the empty to the marine terminal. According to the Gateway Cities Study, in the SCAG region over 1.1 million import containers were emptied in 2000. Virtually all of these containers were trucked empty back to the marine terminal. At the same time, over 500,000 empty containers (or 45% of the total number of empty containers returned to marine terminal) were trucked from the marine terminal to be loaded with local exports. It is estimated that only 2%, or 26,561 units, of empty import containers are currently reused directly for local export. The study hypothesizes that the potential reuse of containers might be increased to 5 or at most 10 percent in 2020, an increase of 160,365 and 427,640 units of reused containers respectively. Accordingly, the number of net trip reductions would be 347,992 trips (with the 5% scenario) and 929,980 trips (with the 10% increase scenario).

According to interviews with several Asia-based shipping lines, the notion of increasing the reuse of empty import containers for local export cargo is nothing new. For many years carriers have been implementing the reuse operation whenever there is an appropriate opportunity for reuse. The ideal situation for the reuse of empty containers is when the exporting customer is also an importer and the commodities imported and exported can be shipped in the same type of containers. The second best case would be where an exporter was geographically proximate to an importer and would be able to receive emptied import containers for loading with exports. Carriers have found that these conditions allowing for the triangulation approach of reuse empty containers are more often found in Europe than in the United States. In Europe, for certain commodities such as electronic and auto parts, import and export companies are often run by the same corporation. Even if this is not the case, there are a number of regional and international logistics and distribution centers (DCs) established as a common feature of the European logistics market that create opportunities for reuse. This market condition is not common in the SCAG region because the locations of importer and exporter in the region are rather dispersed. And even in areas where importers and exporters are proximately located, as is the case in the Gateway Cities area, it happens that most importing companies are not exporters, and vice versa. The most common form of reuse of empty containers in the SCAG region is found between ocean carriers and domestic intermodal operators, especially on long haul traffic between the mid-West to West Coast. One example of such an arrangement is that with the Rail Bridge Cooperation—an intermodal transportation firm.

For ocean carriers, a primary concern relating to the reuse solution lies with liability conditions for the equipment (both owned and leased containers) and the transference of liability between

parties involved in the interchange of containers. The problem deals with how responsibility for equipment damages might be apportioned for containers transiting among multiple users. However, for many cases, this problem can be overcome with well-structured contractual arrangements. For example, North American Auto Parts Center (NAPO) located in Ontario, California is an affiliated export and import company of a Japanese automaker, Toyota. Under a long-term agreement with an ocean carrier, Toyota will undertake equipment inspection at its own logistics center once import containers are emptied, and confirm the condition of empty containers before the containers are transferred for an export load. This practice has been in place for many years and both the carrier and NAPO have benefited from this practice. The NAPO case shows that equipment liability is not an issue for routine customers operating with a secure contract. It also shows that institutional agreements can be easily structured to meet business appropriate market opportunities.

As pointed out in the Gateway Cities study, "to be reused, a suitable container must be in the right place at the right time," meaning in local or regional proximity. This situational aspect of container logistics is even more significant when considered from a global perfective. Assuming that issues of equipment liability can be suitably arranged, research conducted for this study indicates that carriers would be more than willing to interchange or lease out their equipment to another party, even doing so free of charge, if the delivery destination of the shipment involved happens to be a place where containers are in short supply (or shortage area). Under such circumstances carriers would save the repositioning costs of these containers. However, in practice, the repositioning cost of US$ 400 per unit from U.S. to China, for example, that they would save is not attractive enough to encourage carriers to increase this type of reuse operation. As observed by a carrier representative, "why would we risk future business for a small gain, the market is very sensitive (competitive) and timing is everything. We've got to be concerned with the overall operation and not just manage one segment for a little gain."

Market dynamics in the shipping industry are currently such that containers are in a situation of either surplus or shortage in any particular segment of the logistics system. An essential competitive element of the services ocean carriers provide is having a container available to meet customer demands at a particular place and time. Not having sufficient equipment available exposes a carrier to the market risk of a competitor capturing an account by being able to provide equipment as needed. To avoid such risks, carriers are therefore hesitant to relinquish control of containers to facilitate reuse in the SCAG region. In addition, ocean transportation entails uncertainty, both at sea and at ports. Interchanging containers for reuse in an area of general surplus could very well require that more expensive containers be on-leased in an area of general shortage where the pick up charge (P/U) applies. Interchanging containers for reuse therefore introduces uncertainty as to whether those containers will be available when needed at the appropriate places, and reduces a carrier's control over equipment inventory and even business operations. The reuse of empty containers, therefore, though a desirable solution from a local or regional point of view, does not represent a favorable solution to international marine carriers.

Off-Dock Empty Return Depots

Taken from the perspective of local and regional interests, the current practice that requires all empty import containers to return to marine terminals whether empty or loaded seems extravagant at best. However, carrier representatives that participated in this study relate that this practice is in place as part of the carrier's inventory management strategy and accords with current business circumstances. There are number of practical reasons for this practice. Firstly, all carriers have their own container yard (CY) located at the terminal, making it impractical for them to duplicate operating costs for facilities and personnel at inland container depots. Building more inland depots involves greater investments in capital and operating funds, and additionally, it creates a more complicated system for controlling their inventory operation. Secondly, except for leased containers which can be off-hired in the local region when not needed, to keep an adequate supply of containers for their operations worldwide, the same number of containers brought into the U.S. must be relocated back to Asia, regardless of their being empty or loaded. Due to the relative lack of local export cargo, most import containers are shipped back empty. Thus, it is better off for carriers to have these containers returned to marine terminals for their earliest possible repositioning to the area of relative shortage. For those empty containers that are reused for local exports, real time information on export shipments is often not available at the time they are emptied. Accordingly, logistical decisions for these containers would difficult to be made at this point of time. It is thus practical for carriers to have them returned to the terminal as well.

Off-dock empty return depots (off-dock ERDs) were suggested by industry observers [1] as a potential solution for rationalizing the current movement of empty containers in the SCAG region. Under this arrangement, empty containers would be directly returned to an off-dock ERD, as opposed to being returned to the marine terminals. It is expected that off-dock ERDs would serve:

- as a neutral supply point for reusable empties
- to facilitate empty returns when terminal gates are closed
- to add buffer capacity to the marine terminals, and
- to avoid additional trips with off-hired leased containers.

In concept, empties containers would first accumulate at an off-dock ERD, and then be reused for local exports or sorted and returned to a marine terminal at off-peak hours.

Locally, such off-dock ERD operations would reduce port trips by that number which would otherwise have been sent back out of the ports for export loads (see Figure 5). Also, by allowing for empty trips to occur at off peak hours, ERD operations would help to reduce local traffic congestion and air pollution. As mentioned earlier, due to the current East-West trade imbalance, the greater number of empty import containers would eventually be returned to the marine terminals from off-dock ERDs. Absent of rail service connecting off-dock ERDs to the terminals, off-dock ERD operations will actually generate more truck trips in the region overall. As diagrammed in Figure 6, say 10 import containers arrive at the port and are delivered by truck to

a local consignee's warehouse. These 10 containers are subsequently shipped back to Asia, proportionately with 6-empty and 4-loaded with local export cargo. Scenario 6a demonstrates the current practice which generates a total of 28 truck trips in the region, concentrated between marine terminals and local destinations. With the introduction of an inland return depot, as shown in Figure 6b, 8 trips toward the marine terminal are eliminated; however, a total of 34 trips are then generated in the region. Traffic congestion in the vicinity of the port can be relieved with a reduction of 8 trips, but an additional 6 truck trips would be added in the region. However, as depicted in Figure 6c, should timely information regarding shipments of local exports then requiring empty containers be made available at the point that import containers are initially emptied (t_1), logistical decisions can be made for 4 empty containers. For example, four could be delivered directly to an ERD for eventual export loading, and the remaining 6 containers could be sent back directly to the terminal for repositioning to Asia. Under this scenario, the same total of 28 trips are generated in the region, with 8 trips eliminated from port-related movements.

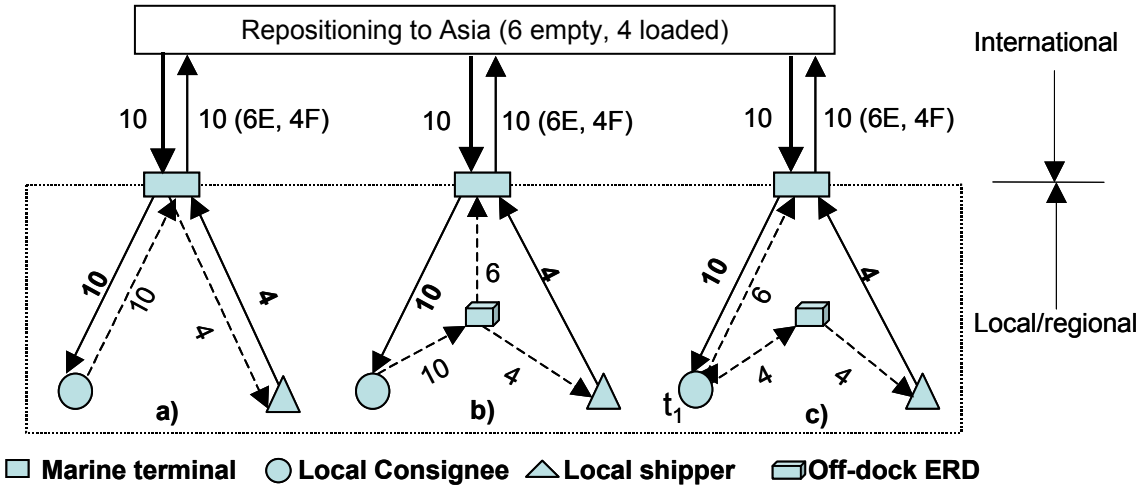


Figure 6: Off-dock Empty Return Depot Scenarios

The combination of off-dock empty return depots with real-time information systems would be more effective in rationalizing the movement of empty containers and would reduce number of truck trips in the region overall. Practically, there is an acceptable time window within which information regarding export shipments must be available for carriers to schedule the delivery of empty containers: how many to off-dock ERDs and how many to marine terminals. At present, this time window must occur within the so-called "free time" allowance (5 days by current practice) stipulated in the agreement between carrier and trucker—a limited free-of-charge time allowance starting from when the container is picked up to the time when it is supposed to be returned to the terminal. Demurrage charges can be incurred (US$ 44/day) beyond this point of time. It is believed that 5 days is too short for identifying export shipment opportunities when the export market is rather limited. More over, with uncertain opportunities for export cargo, carriers tend to limit the free-time allowance and prefer to ship these empty containers back for export opportunities in the Asia market.

Facilities and operational costs are additional aspects that discourage carriers from favoring the off-dock ERD solution. Assuming such off-dock empty return depots were provided by a third party, carriers moving empty containers through such off-dock ERDs would nevertheless incur additional storage and delivery costs for the empty trips to and from the off-dock ERD.

The limited application of the off-dock ERD solution is apparent as well when current practices associated with container chassis are taken into consideration. It is rather unique that in the U.S. market container chassis are often provided by carriers, not by trucking companies or shippers, as is the common practice in Europe and Asia. This practice reflects historical circumstances involved with the invention of containerization, and it also characterizes the movement of empty containers in the U.S. Different from containers, chassis movements occur solely within the domestic market and often within a very limited distance and area. For carriers, chassis in the U.S. are considered as purely local equipment (never going abroad), thus they often limit their chassis inventory. As a result, carriers often request that chassis be returned to the terminal at the earliest possible time, often without a container. Thus, the round-trip movement of chassis occasion a drawback to the potential of off-dock ERD operations in the SCAG region, since they work to generate even greater truck trips in the region overall.

According to study participants, carriers might be likely to accept the direct off-dock return depot option should the overall costs related to container operations at the terminals become too costly and inefficient as a result of limited terminal capacity. In this circumstance, even with additional drayage cost, it would be more economical for carriers to divert empty operation to off-dock depots to take advantage of lower cost services, including storage, inspection and such. In actuality, the continuing trade imbalance jeopardizes the feasibility of off-dock ERDs for reducing truck trips related with empty container movements in the SCAG region. As the number of import containers shipped back to Asia empty greatly exceeds the number of empty containers reused for available local exports, the movement of empty containers involving off-dock ERD would generate more truck trips in the region even though it may succeed in reducing local congestion by diverting empty trips to off-peak hours.

Depot Direct Off-hire of Empty Leased Containers

For leased containers, there are number of designated locations established by container leasing companies to receive off-hired containers in the SCAG region. In current practice, off-hired empty container movements are often more flexible than those of carrier-owned empty containers. In the region, off-hired containers may be trucked directly to a lessor's depot from an intermodal facility or local consignee, as well as from marine terminals. It is expected that all off-hired containers in the region should be directly sent to a lessor's depot without return to the marine terminals. Logistically, depot direct off-hired containers seem to be a desirable solution to rationalizing the movements of leased containers which scheduled for off-hiring in the SCAG region. As discussed earlier, number of leased containers that can be off-hired at a designated location (SCAG region) per month is stated in the lease contract, and this quota often reflects the character of the off-hire region—either an area of surplus or of shortage.

Carriers have readily participated in this direct off-hire activity as it results in substantial savings. According to ocean carriers, however, direct off-hire operations can only be achieved if they are well planned in advance. It is routine that when a ship is approaching the port, leased containers are identified through documentation. From the lease contract, carriers will identify how many containers they are allowed to off-hire in the SCAG region per month, and they can confirm how many containers they have already off-hired, thereby calculating how many containers they can further off-hire in the region in any particular month. At this point, carriers often instruct trucking companies to return these containers to the lessor's depot directly when emptied, instead of returning them to the marine terminal. The depot operator will inspect the condition of containers and report to the leasing company. If any repair charges are incurred, the leasing company will bill the carrier in accordance with the lease agreement.

Off-hire activity is seasonal in nature. In the peak season of international trade, which often lasts from May to September, carriers tend not to off-hire in order to control their inventory level for the export market in Asia and to avoid higher charges for leased containers in this shortage area. Conversely, during the slack season, say from November to February, carriers increase the number of off-hired containers in the SCAG region, accepting the higher cost of drop-off charges (DOC) that may very well be hundreds of dollars higher than standard lease charges ($1.10 to $1.50 per 40' container).

From a carrier's stand point, carriers always want to off-hire at the place where they do not have a good prospect for a backhaul shipment, such as in the southern California market. At the same time, the SCAG region is the place where the leasing companies do not want to receive off-hire containers in order to avoid repositioning costs. Notwithstanding the fact that a major portion of the containers found in the SCAG region are owned by ocean carriers, the quota allowed for off-hire leased containers in the region per month is rather limited. Therefore, truck trip reductions as a result of depot direct-off-hires would be rather small in comparison to the overall truck trips related to container movements in the SCAG region.

Internet-Based Support Systems

Certainly, carriers would be interested in reducing the cost of moving empty containers. Most third-party strategies proposing to do so have focused on improving the means of matching export cargo with empty containers. Using the internet as a tool, these strategies require information regarding export cargo and available empty containers as a crucial element to facilitate potential matches. These third-party strategies, or systems, are fundamentally different than the existing in-house information systems, known as Electronic Data Interchange (EDI), which have been widely established to facilitate communication between ocean carriers, marine terminal operators and their customers and logistics providers. These newly established third-party systems, several of which are being developed, are predicated on the sharing of containers between different carriers:

InterBox*:* An online trading system that enables subscribing container owners (carriers), operators and transport service providers to search information on the availability or need for containers posted by other subscribers to the service. Developed by International Asset Systems Limited (IAS), the system functions as an online "notice board" where carriers and participants can post their requirements for, or availability of, vessel slots and containers. The system is expected to be able to provide global equipment visibility, the exchange of equipment (containers) and vessel slot capacity, and other services using integrated data from diverse carrier and vendor systems within the transport chain [1]. Similar to EDI systems, this system enhances communication and coordination between carriers and their customers along a transport chain. IAS claims to have 75 subscribers world-wide and a daily posting of information on over 2,000 containers; however, the usefulness of this system in reducing empty container movements in the SCAG region remains to be demonstrated.

eModal: An on-line database management system designed to track and provide container information to terminals and truckers operated in the SCAG region. The structure and purpose of eModal is to [1]:

- Integrated container tracking between marine terminals and the eModal website for multi-modal use.
- Provide benefits to terminal and trucking companies by increasing productivity and reducing "turn time" through the use of coordinated availability planning.
- Properly coordinate modal planning to improve the efficiencies in the harbor area
- Improve multimodal coordination using a standardized data system.

This system is not designed to enhance container interchange and reuse in SCAG region. The major feature of this system is the ability to track information on container status and thus provide better scheduling ability for truckers in coordinating with terminals for pick up and drop off of containers. In this regard, the system helps to reduce traffic congestion at terminal gates as well as in the port's vicinity. At present, the application of eModal still focuses on intermodal transport, and particularly the trucking community.

SynchroNet*:* Different from the systems mentioned above, the SynchroNet system is designed to assist only ocean carriers in exploring and cooperating opportunity for match up empty

containers, interchange of equipment (container), and asset management. There are several specific service features provided by this system [1]:

> ***-SynchroBox****:* provides real-time online information on the status of containers controlled by participating carriers. In principal, this information provides ocean carriers with the ability to monitor and identify potential container interchanges as well as to make logistics decisions on empty containers.
>
> ***- SynchroSlot***: provides information on ship slot capacity which assists ocean carriers as well as customers to market and identify available empty slots on any particular shipping route. This feature is particularly successful since, unlike the case for containers, ocean carriers often share ship slots between alliance members and use the information to minimize the cost of repositioning empty container.
>
> - ***SynchroSource:*** similar to the synchroBox, this service provides carriers the ability to explore available container capacity that meets specific origin and destination requirements.

As stated, the major feature of SynchroNet is to support ocean carriers seeking to rationalize worldwide container surpluses and deficits, and to manage the international flow of container capacity through its database called Cooperative Access System (CAS). Recently, SynchroNet Marine, Inc. has developed a new system called SynchroMet, which is designed specifically to facilitate street turns and empty container reuse.

While the business plans of these various third-party information services appear promising, their eventual success will depend on the willingness of subscribers to use and post information on the availability and status of containers under their control in the current market circumstance.

Virtual Container Yard: The possibilities presented by internet-based system have given rise to a new concept: the "virtual container yard." This concept envisions a virtual exchange market as an alternative to actual container yards, a virtual place where container yard functions could take place without the necessity of moving containers to a physical container yard. The key purposes of virtual container yard are to [1]:

- post critical information on cargo and containers status (location, characters)
- facilitate communication between participated parties (motor carriers, ocean carriers, leasing companies and chassis pool operators)
- permit container interchanges and other document process take place without moving a container to the harbor
- assist the parties to optimize decisions regarding container logistics (return, reuse, interchanges).

To utilize the virtual container yard concept, detailed information on a container's status and related business operation are required and must be made available to participating parties, most likely carriers and logistics providers. Research conducted for this study suggests that these virtual container yards will find their market to be limited to small and medium-sized shipping

lines. Often the larger shipping lines have better opportunities to match containers within their own system. Representatives of larger shipping lines commented that they were unlikely to participate in virtual container yard initiatives, believing that doing so might unnecessarily provide smaller competitors some commercial advantage [5].

In summary, (to the extent that existing, or yet to be developed, internet-based information systems can be successfully applied) successful applications of web-based information depends on the willingness of all participants to share business information on a timely basis, and this particularly requires cooperation among ocean carriers. Without satisfying these basic conditions, the role of these systems in rationalizing empty container movements in the SCAG region would be limited.

IV. Are Current International Logistics Practices a Barrier to Rationalizing the Regional Movement of Empty Containers?

The Dynamics of International Trade and Empty Containers

As the port of NY-NJ is the primary gateway for trans-Atlantic trade between U.S. and European markets, the ports of Los Angeles and Long Beach constitute the major eastern terminus for the trans-Pacific trade lane of the Asia-Pacific market. The bulk of imported goods from Asia, approximately 95%, are handled at this two ports complex. The ports' leading imports are goods made in Asia, such as clothing, shoes, toys and consumer electronics, where as leading exports are factory equipment, recycled paper, and raw materials such as plastics and chemicals.

Over the last few decades, concurrent with the economic development of eastern Asia, the United State became the most important market for high quality, low cost consumer products manufactured in Asia. The SCAG region replicates much of the nation in hosting major retail chains like Wal-Mart, Target, and Kmart, as well as others electric and auto parts logistics and distribution centers for goods imported from Asia.

Trading Partner	To US (TEU)	From US (TEU)	Imbalance Index*	Surplus/Deficit (TEU)
Japan	735,589	932,370	1.27	196,781
China (HK)	4,220,962	1,140,815	0.27	- 3,080,147
(China only)	*3,217,310*	*815,011*	*0.25*	*- 2,402,299*
Korea	456,309	392,114	0.86	- 64,195
Taiwan	572,349	283,313	0.50	- 289,036
Macao	32,016	498	0.02	- 31,518
ASEAN	1,124,762	482,233	0.43	- 642,529
Total	**7,141,987**	**3,231,343**	**0.45**	**- 3,910,644**

Source: Reproduced from PIER, 2002

Table1. Trans-Pacific Trade Volume (TEU) by Country in 2001

As discussed earlier, trans-Pacific trade (or East-West trade) has been severely imbalanced (see Table 1), and this trend is expected to continue for the foreseen future. The overall imbalance index (the ratio of westbound volume to eastbound volume) for this market was 0.45 in 2001. By country it shows that, except for trade between Japan and the U.S., it is common that more containers are shipped to the U.S., particularly in the case of China and Thailand (reference Figure 7 and 8). The volume of U.S. exports to China in 2001 amounted to only one forth (or 27% including Hong Kong) of the cargo volume that U.S. imported from China.

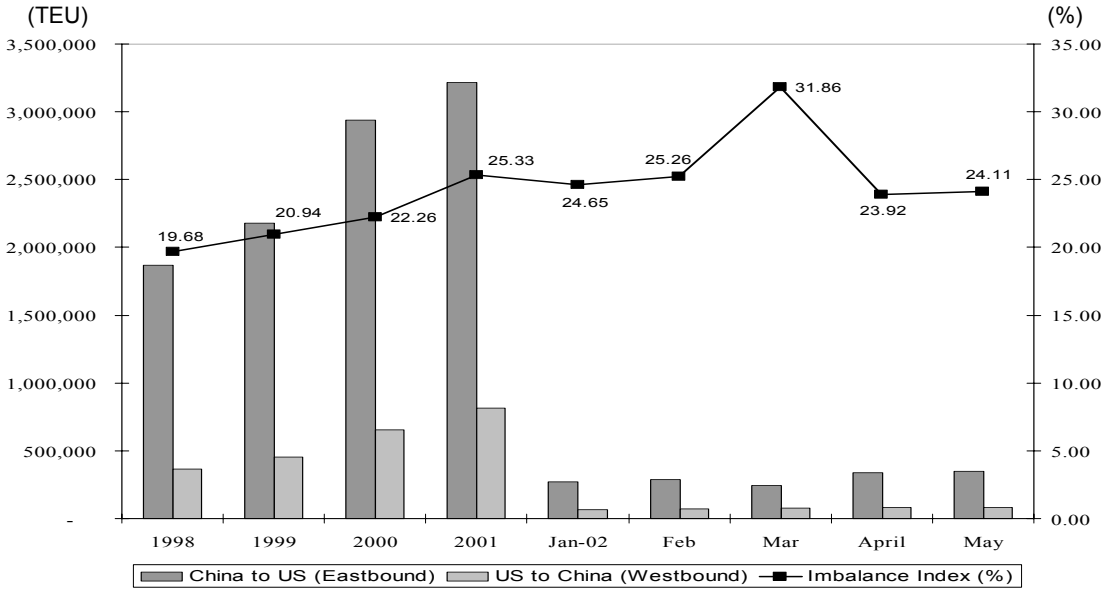


Figure 7: U.S.-China (without HK) Trade Volume (1998-2002)

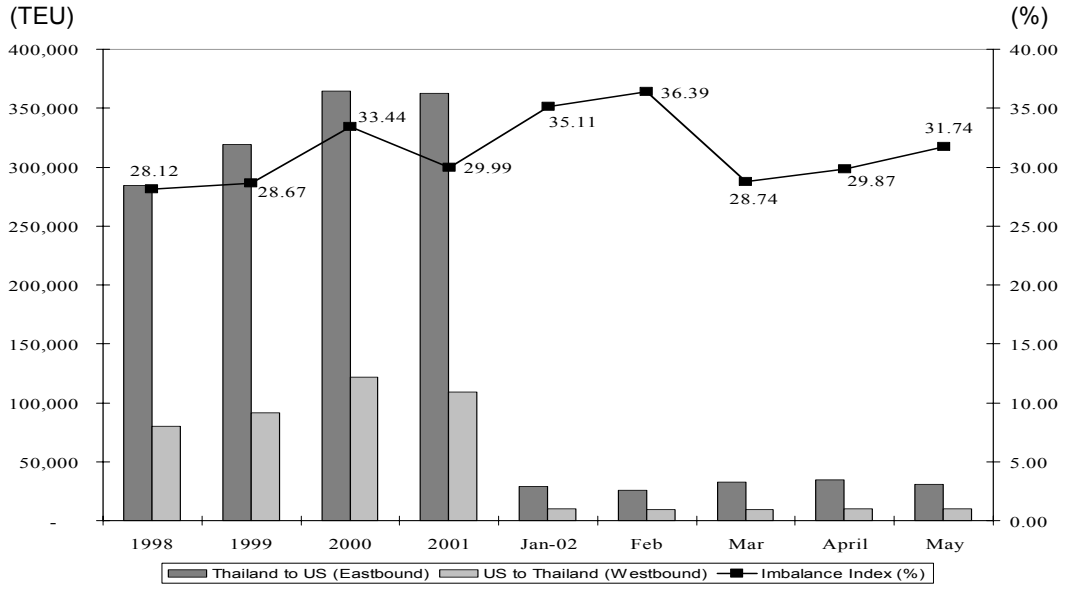


Figure 8: U.S.-Thailand Trade Volume (1998-2002)

As a result of this imbalanced East-West trade dynamic, Asia, and especially China, is always an area where empty containers are in demand, while the SCAG region is an area where empty containers are in surplus. The export opportunities found in Asia, and the critical deficit situation for empty containers in that region, explain the need for empty containers to be relocated to Asia as soon as possible from the SCAG region. For carriers, shipping back empty containers is far

less than an ideal situation; however, doing accords with market realities and allows carrier's to optimize the value (productivity) of containers in the context of their overall operations.

Although it is not considered as a part of this study, the same surplus-deficit situation can be observed in the trans-Atlantic market. The volume of U.S. imports from Europe is far higher than the reverse, leaving the eastern U.S. with a surplus of empty containers as well.

For ocean carriers, this large imbalance between export and import volumes in international trade represents an exogenous variable to the optimization of their container logistics operations. In other words, the current pattern of empty container movements in the SCAG region is not purely the result of institutional practices found in the region; rather they are an expression of role this market segment plays in the prevailing dynamics of international trade. As such, pending a change in the underlying dynamics of trade, all of the solutions proposed for rationalizing the movement of empty containers in the SCAG region will be limited in their application.

Market Structure and Logistics Practices

Most ocean carriers operate worldwide; their services, however, are often segmented by trade lane markets, such as the trans-Pacific market—serving trade between the U.S. and Asia, or the trans-Atlantic market focusing on trade between the U.S. and Europe. Consequently, container logistics are managed by trade lane, and container inventory control within a trade lane is the most important management function of a carrier's daily operations.

For service industries there are two basic competitive strategy options or sources of market power: either be the low cost provider or seek premium pricing by differentiating your services. The more successful companies incorporate a blend of these strategies as appropriate for different aspects of their operations. In retailing, for example, large box retailers will often acquire merchandise from the same vendor or share common distributors and elements of the distribution network: they do not however share their storefronts—the strategic element that differentiates them from their competitors and attracts (captures) customers. Likewise, ocean carriers frequently share ship slots and terminal facilities within an alliance to maximize the utilization of capital assets (low cost strategy). The strategic element that captures customers for carriers, or their storefront if you will, is the service of having a container available at the right place and time. Containers are therefore not considered as capital assets per se, but rather as differentiators of service and the basis for premium pricing strategies.

The idea of virtually sharing information about the location of empty containers and export loads in need of these containers is undoubtedly appealing, and initiatives, like eModal, Synchronet and Interbox have demonstrated that such services are technically viable. A likely limiting factor to the growth potential of these internet-based information systems, however, is the reality that in any particular area, such as the SCAG region, all carriers are confronted with the same situation of having too many empty containers and too few export loads. Similarly, in deficit area such as in China all carriers have a need for empty containers. These circumstances, combined with the service aspect and storefront character represented by containers in this fiercely competitive

market, make information about empty containers and export opportunities commercially valuable and, therefore, proprietary in nature. The sharing of information about customers and containers would be analogous to Wal-Mart and K-Mart sharing the same retail outlet: they might just as well be one company.

Global logistics practices are essentially an expression of the prevailing international economic order, and as such transcend the reach of regional regulatory policies. Addressing regional concerns about the movement of empty containers may therefore require a consideration of solutions that can be effective at an international or global, rather than at a regional, scale.

V. Conclusions and Recommendations

Conclusions

The current volume and pattern of movement of empty containers in the SCAG region expresses current imbalances in international trade and competitive market pressures in the transportation services industry. While carriers are cognizant of the efficiencies and cost savings that could be gained through a rationalization of empty container movements, the business opportunity costs associated with a shortage of empty containers for customers in Asia far outweigh the likely gains of rationalized empty container movements in a particular region. Essentially, carriers are willing to tolerate the regional inefficient movement of empty containers and bear repositioning costs as a means of optimizing the overall performance of their global inventory operations. The present structure of international trade, with its imbalance in the east-west flow of imports and exports, works to achieve economic efficiencies on a global scale. And though seemingly inefficient from a regional perspective, the movement of empty containers plays an essential role optimizing worldwide economic performance.

For ocean carriers, the true value of a container is realized through the service it provides to shippers of cargo by being at the right place, at the right time. Providing this service is key to differentiating a carrier from other competitors, and for capturing and retaining customer accounts. This service aspect, or "storefront" character, of containers makes information about empty containers and export opportunities commercially valuable and, especially in a fiercely competitive market, proprietary in nature.

Taken together, the dynamics of international trade and competitive world markets work to shape global logistics practices—a situation that suggests that public sponsored strategies seeking to increase the reuse of empty containers, although desirable from a local or regional point of view, may not present a commercially attractive option to marine carriers or the global logistics community. Accordingly, the efficiencies gained through local or regional solutions, such as depot-direct return and direct off-hire, are likely to be relatively slight and too limited to justify public sector efforts intending to increase the reuse of containers to a level much beyond that point attainable by the free market itself.

In a similar vein, the applications of technology being advanced with the idea of virtually sharing information about the location of empty containers and waiting export loads appears promising in the long-run, and may provide significant value when the condition of the market is right. However, in the short-run it would be prudent to acknowledge that the growth potential of these systems is constrained by existing market conditions, which will in-turn limit the potential these initiatives have for rationalizing empty container movements in any particular region. Current circumstances of the market are that, in the SCAG region, all carriers are confronted with having too many empty containers and too few export loads: the reverse of this situation occurs in China. Thus the inherent idea in virtual systems of being able to match one carrier's surplus with another's deficit in a local geographic area does not seem to be plausible.

From a view of the global logistics system as a whole, wherein areas like the SCAG region represent sub-systems of a world-wide network, it can be seen that solutions designed to optimize the performance of a sub-system could easily work to degrade performance of the system overall. This being the case, it would seem reasonable to argue that optimal solutions should contribute positively to performance of the global logistics system.

Global Empty Container Logistics Strategies

It is clear that the ultimate goal of an empty container logistics strategy is to reduce the number of empty container trips and thus vehicle trip miles (VMT) for empty containers in the region. As pointed out by this study, however, carrier's perceive the SCAG region as a sub-system within their overall system of global logistics, and therefore have a different view on the benefits of rationalizing empty container movements in the region. The ultimate aim of carriers is to globally optimize container logistics. It is suggested that solutions capable of achieving this aim warrant further investigation.

Provision of Chassis

As discussed earlier, the logistics of chassis in the region is another aspect complicating the problem of empty container movements. Most carriers that participated in this study consider chassis ownership and management to be an added cost factor to their operations in this region. As opposed to containers, the movements of chassis are entirely local in nature, and would therefore be consistent with the pooling concept of interchangeable or grey-boxes. A chassis pooling system would provide commercial incentive to carriers to transfer the role of chassis provider to third party operators (e.g. trucking companies). With more study to develop a detailed system and arrangement of pooled chassis logistics, the benefits of rationalizing chassis operations would contribute to easing congestion near the ports and reducing regional VMT.

Collapsible Containers

The research conducted for this study shows that most of the current strategies seeking to deal with empty containers focus mainly on reducing trips. For carrier's, however, these strategies would not necessarily ameliorate the costs of repositioning empty containers. Looking at the problem from the global perspective, and considering that the repositioning of empty containers cannot be completely eliminated, the concepts being developed for collapsible or foldable containers might represent a potential solution to minimizing both regional and international movements. The potential cost savings of operating collapsible containers extends beyond the lowering of marine and surface transport costs: since several empty containers can be folded and handled in one package, incremental break-down and assembly costs can be off-set with the efficient use of space (at terminals and aboard ships) and reduced trucking, handling, and storage costs. Most importantly the regional perspective, adoption of this technology would radically reduce truck trips and regional VMT.

The idea of foldable containers is not new, several conceptual designs have been proposed and two of these are currently being introduced to the market: (a) the Six-in-One container, and (b) the Fallpac container (cargo International, 1990, 1991, 1992). The Six-in-One (SIO) container is a fully dismountable 20-ft dry container, that, once dismantled, can be folded and stacked six-high and interlocked to the exact dimensions of a standard 20-ft container (TEU: 20ft x 8ft x 8ft 6in) as showed in Figure 9.

Figure 9: Six-in-One Container (Six-in-One Container Company, S.A.)

The Foldable container was first introduced into the market about seventeen years ago by Six-in-One Container Co (SCC), a Swiss cooperate. Since then, the company continues to improve the feature design of SIO to improve its characters as well as to reduce manufacturing cost. To fold a container a three-person team with a forklift is required. SCC claims this process takes approximately 15 minutes and handling productivity is from four to six containers per hour [5].

The Fallpac container is technically quite different from the SIO. The Fallpac is a 20 ft container which combines dismountable and collapsible features. The roof of the container is dismountable, the remaining elements are foldable. Four folded units can be stacked inside a fifth assembled unit for empty transport which has the same dimensions of the 20ft standard box. To fold and unfold the container, two people and a forklift are required. According to the Swedish manufacturer, the box can be folded within 10 minutes. There have been many improvements in design features of Fallpac containers, including a prototype of a fully automated version have been launched recently.

Conditions for the success of collapsible containers are related to three aspects: the costs and quality of the product, the market orientation--meaning the logistics concept that is used, and the marketing of the product. The technical design and other features of collapsible containers are continuing to evolve and are incorporating modern technologies. Manufacturing costs of a collapsible container should be in proportion to those of a standard container [5]. Folding and unfolding containers induce additional handling costs and require special equipment. Fortunately, cost savings elsewhere in the logistical chain should compensate for these additional costs. In order to compete with standard containers, collapsible containers should be compatible with

standard containers in terms of external dimensions, tare weight, strength and stiffness, water tightness and other technical features such as simple folding and unfolding, robustness, and the safe bundling of a package of collapsed empties.

An important aspect affecting the performance of the collapsible container is its adoption by the industry. The cost effectiveness of these containers needs to be verified, and the operational and organizational demands they will place on the total logistic chain needs to be fully understood.

According to one recent study (see Rob Konings at et), there are four basic logistics concepts applicable to collapsible containers that can be distinguished:

- Port-to-Port Concept
    - One sea trade lane: point to point transport
    - Long distance over sea transport (deep sea)
    - Transport of folded containers between two seaports (container depots)
- Maritime Worldwide Concept
    - Repositioning between continents
    - Long distance over sea (deep sea)
    - Transport of folded containers between two seaports (container depots)
- Maritime/Continental Worldwide Concept
    - Repositioning within and between continents
    - Long and medium distances over sea (deep sea, short sea) and overland (land bridge concept)
    - Between container depots in the hinterland
- Door-to-Door Worldwide Concept
    - Transport between and within continents (fine-meshed network)
    - Long and medium distance over sea and over land
    - Transport of folded containers between customers and container depots in the hinterland, between container depots and seaports.

The most straightforward concept is that of port-to-port, which would be suitable for use in a trade lane with a permanence imbalance. With these routine shipments, a certain level of expertise could be developed in the folding and unfolding process, thereby increasing productivity and reducing assemble/disassemble costs. The maritime worldwide concept is particularly concerned with the repositioning of empty containers between continents, and is best justified where a large number of containers are involved. The number of parties involved in the logistics chain is rather small (e.g. shipping companies, terminals and seaport depots). The maritime continental worldwide concept applies where further optimization of repositioning is contemplated. Here, a larger number of parties are involved in the logistics chain, including inland operators and inland depots. This concept works best with a considerable volume of containers suitable for the transport of various products. The door-to-door worldwide concept assumes that needed empty containers will be transported in the folded state, meaning containers can be assembled and disassembled anywhere; at the carrier's depots, terminals, inland operators (truck company depots), intermodal yards, shipper/consignee's warehouses, and foldable

container lessor depots. In this sense, the volume of containers does not necessarily have to be large, but they must be suitable for various types of products.

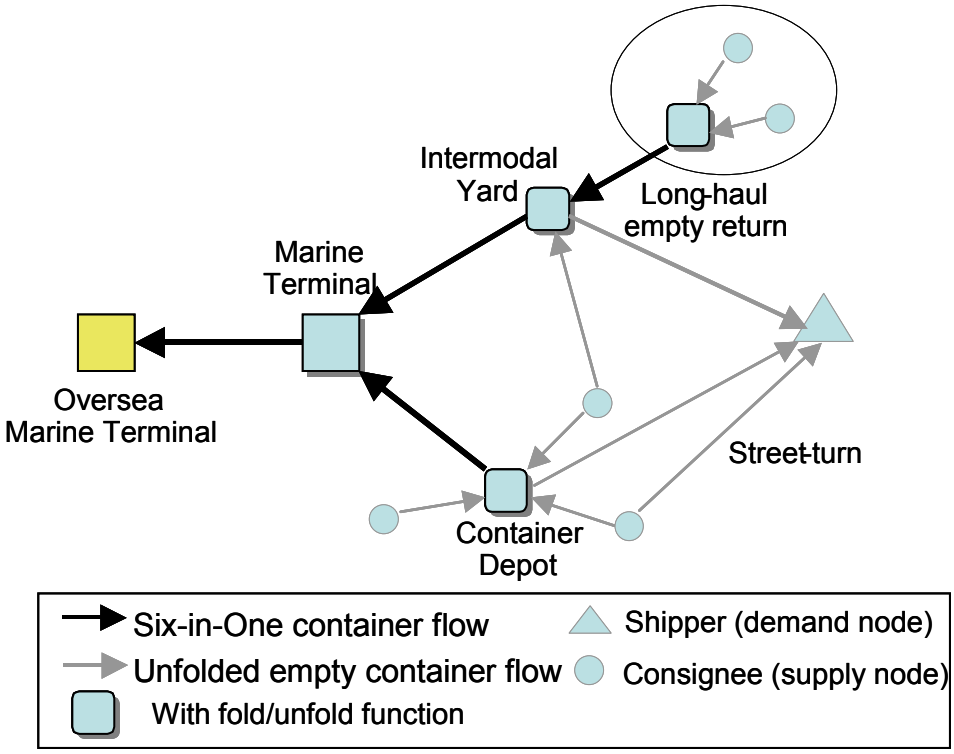


Figure 10: Conceptual Movement of Empty Collapsible Containers

The distinctive and special requirements of collapsible containers suggests that they would work best where economies of scale can be achieved, meaning the number of locations where folding/unfolding would take place should be limited. This is not only necessary for realizing repositioning cost savings, it also provides an incentive for investing in specialized equipment and works to develop the expertise and experience required to reduce the particular costs involved.

With such conditions, until the use of collapsible containers expands further the most promising market opportunities for its use would be in a logistics chain with a limited number of links containing closed loops [5]. These conditions clearly impose a number of restrictions as to likely areas of application. For example, the door-to-door concept is not feasible at this point because collapsible containers have not been developed (and may never be) to the level that they could be folded or unfolded easily at anytime and anyplace. Accordingly, using collapsible containers may not reduce the individual trips to and from the end customer: real benefits, however, can be achieved by reducing trips between inland depots themselves or between terminals and inland depots. The movement of empty collapsible containers is conceptually diagramed in Figure 10. As diagramed, suppose that the inland transportation network consists of four types of nodes, each representing different entities involved in empty collapsible or standard container movements. (A) Container depots: terminal CY and inland depots including intermodal rail yard

and inland CY—these depots also function as unfold/fold container processing points. (B) Supply nodes: often make up by consignee's warehouses. (C) Demand nodes: local exporter's warehouses. (D) A Pool Depot: storing empty collapsible containers which may be bought, sole, leased or borrowed. Under this network arrangement, empty unfolded containers can move from a supply node directly to a demand node, or can be gathered at container depots (A or D). At inland depots, containers that need to be repositioned to Asia, for example, will be folded and packed. The six-in-one containers now can be either trucked to a marine terminal or to an intermodal rail yard. At the intermodal rail yard, together with other empty collapsible containers (unfolded or in six-in-one pack) hauled back from the mid-west or east coast, these six-in-one containers will be transferred by rail to a marine terminal. Facilitated by an on-dock rail facility, this option would benefit the region in reducing overall and near-port truck trips.

The economic advantages of collapsible containers seem evident (for more details, see Rob Konings et al, 2002). This innovative concept is still copping with commercial skepticism that seems concerned particularly with the technical performance and the complexity of the fold/unfold process of collapsible containers. A logistics concept in which collapsible containers were incorporated into a system combining their use with standard (conventional) containers would be an interesting study and one worthy of further investigation. Subsequent research efforts will hopefully focus on the development of this concept.

Appendix A: List of Interviews

Mr. Masashi Morimoto, Director of Marketing, Port of Los Angeles, 2001.

Mr. Yuji Yamamoto, International Transportation Service (ITS), Container Stevedore and Terminal Operator, 2001.

Mr. Larry Cottrill, Planning and Research Division , Port of Los Angeles, 2001.

Mr. Anthony Shortwell, Market Research Economist, Port of Long Beach, 2002.

Mr. Kerry Cartwright, Manager of Transportation Planning, Port of Long Beach, 2002.

Mr. Kunihisa Watanabe, Port Promotion, Terminal Management Division, Tokyo Port Terminal Public Corporation, 2002.

Mr. Masafumi Shinoda, Maritime Expert at the Japan Maritime Research Institute (JAMRI), 2002

Expert at Mitsui OSK Lines, Port and Terminal Office, 2002

Expert NYK Lines, Container Business Department, 2002.

Expert at China Shipping Lines, Business and Strategies Units, 2002.

K-Line's Experts at Container Business Departments, Business Planning and Strategies Units and Information and Public Relation Group, 2002.

Shipping Line's Representative at Toyota's North American Part Center, 2002.

Expert at Union Pacific Railroad, 2002.

Additional Interviews at Stakeholder Meeting, August, 2002:

- Mattel, INC. (import, export, global logistics).
- Total Terminals International, LLC.
- Transport Express (Import & Export Logistics, Distribution, Consolidation and Storage, and Surface Transportation).

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