Challenges and the Road Ahead for Intermodal Freight Terminals

Huynh, Nathan; Smith, Daniel; van Duin, Ron; Dulebenets, Maxim; Sun, Yansuhuo; Schonfeld, Paul;
Hutson, Nathan; Sauri, Sergi; Dau-Ngo, Theresa; Harder, Frank

Publication date
2019

Document Version
Final published version

Citation (APA)
Huynh, N. (Author), Smith, D. (Author), van Duin, R. (Author), Dulebenets, M. (Author), Sun, Y. (Author), Schonfeld, P. (Author), Hutson, N. (Author), Sauri, S. (Author), Dau-Ngo, T. (Author), Harder, F. (Author), & Khankarli, G. (Author). (2019). Challenges and the Road Ahead for Intermodal Freight Terminals. Web publication/site, Transportation Research Board (TRB).
https://trbcentennial.nationalacademies.org/centennial-papers/freight-systems

100 YEARS TRB
MOVING IDEAS: ADVANCING SOCIETY

CENTENNIAL PAPERS

Standing Committee on Intermodal Freight Terminal Design and Operations Committee (AT050)
Nathan Huynh, Chair

Challenges and the Road Ahead for Intermodal Freight Terminals

NATHAN HUYNH, *University of South Carolina*
DANIEL SMITH, *Tioga Group Inc.*
MAXIM DULEBENETS, *Florida A&M University-Florida State University*
YANSHUO SUN, *Florida A&M University-Florida State University*
PAUL SCHONFELD, *University of Maryland*
RON VAN DUIN, *Delft University of Technology, Rotterdam University of Applied Sciences*
NATHAN HUTSON, *University of Southern California*
SERGI SAURI, *CENIT-Polytechnic University of Catalonia*
THERESA DAU-NGO, *Port of Long Beach*
FRANK HARDER, *Tioga Group Inc.*
GHASSAN KHANKARLI, *City of Dallas*

INTRODUCTION

In the early days of the intermodal era, terminal design and operating practices were relatively simple but were constantly evolving to improve efficiency and competitiveness. The TRB Intermodal Freight Terminal Design and Operations Committee (AT050) was formed to advance the state of the art and disseminate the state of the practice by sharing knowledge about rail intermodal terminal design. At the time (early 1980s), rail intermodal terminals were trailer dominated and the industry was in its infancy. There was a need to exchange physical design practices and philosophies between rail carriers, and between marine and rail intermodal terminals. This knowledge exchange became vital as double stack trains came into widespread use in the mid/late 1980s, and containers began to displace trailers in the rail industry. Intermodal terminal design and operations are now facing a different kind of challenge, with escalating volumes, rising customer expectations, and increased community concerns over emissions and traffic congestion. In turn, the AT050 Committee has evolved by both broadening the scope of intermodal terminal issues it addresses and fostering deeper understanding of the processes and technologies critical for the industry's future.

Continuing population growth and growing freight demand have led to a steep increase in freight movement worldwide since the 1970s. Businesses are forced to improve their supply chains to compete in the global market, and to meet customer demands for faster deliveries. As a result, businesses rely on the freight transportation system to provide faster, cheaper and more eco-friendly alternatives. As shown in Figure 1, the conventional method of moving freight utilizes a point-to-point single-mode (e.g., highway) network where origins A, B and C are independently linked to their destinations, D, E and F. The alternative is a hub-and-spoke intermodal network, where origins A, B, and C are linked to destinations D, E, and F via intermodal freight terminals where freight in containers or trailers is transferred between modes (e.g., truck to rail or vice-versa). The freight intermodal network is comprised of highways, railroads, and navigable waterways that link these intermodal terminals together and to local production and distribution facilities. The use of multiple transportation modes increases efficiency by taking advantage of each mode's strengths. Intermodal transportation is usually more cost effective for freight transported over 500 miles, and has a smaller carbon footprint than long-haul trucking. Intermodal freight volume has grown significantly in recent years due to these advantages.

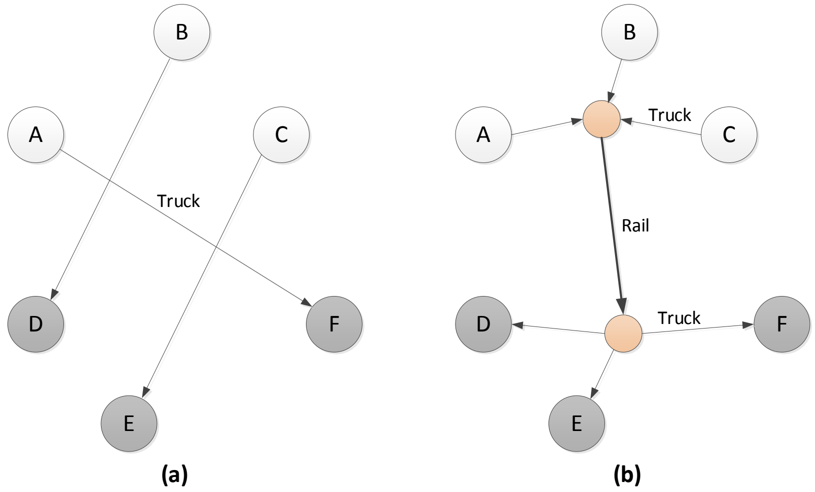

FIGURE 1. Freight distribution networks:
(a) unimodal point-to-point network, (b) intermodal hub-and-spoke network.

According to the United States Department of Transportation's (USDOT) Bureau of Transportation Statistics' (BTS) Freight Facts & Figures 2017, the U.S. freight transportation system moved a total of 18 billion tons of freight valued at $19 billion in 2015. These figures are forecasted to increase to a total of 25 billion tons valued at $37 billion by 2045, an increase in tonnage and value of 41% and 93%, respectively. Truck/rail intermodal movements account for about 7.5% of freight tonnage (BTS 2017). The intermodal share is expected to rise to 11.7% by 2045, emphasizing the need to understand intermodal transportation and maximize the capacity and performance of intermodal terminals. The Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act both noted that freight transportation should promote economic vitality and competitiveness.

Increased freight demand in urban areas has increased pressure on the freight transportation system with direct and indirect consequences of congestion, such as increased emissions, increased number and severity of vehicle accidents, and higher transportation cost. These impacts are exacerbated where a cluster of cities form an integrated region with population of 10 million or greater, commonly referred to as "megaregions" (Harrison et al., 2012). Megaregions present an added challenge to the intermodal freight network because their vehicle-miles traveled has been increasing faster than their surface transportation capacity. International trade in manufactured goods has grown over 100-fold in the last 50 years. Port authorities and private terminal operators have not been able to increase airport, seaport, and inland intermodal facility capacity as needed due to geographic barriers, urban land use developments, and environmental regulations. Consequently, some intermodal terminals have become bottlenecks in the supply chain. Intermodal terminals also face a number of other challenges, including: 1) megaships, 2) changing business practices; and 3) regulation. The environmental and public health impacts of intermodal terminals are growing concerns.

The need for intermodal freight terminals to increase efficiency, reduce environmental impact, and improve supply chain performance will remain relevant for the foreseeable future. Emerging challenges for inland and marine intermodal terminals include increasing container vessel sizes, higher environmental standards, and evolving business practices such as chassis ownership and carrier alliances. To overcome these challenges, it is expected that terminals will leverage advances in terminal automation and big data analytics, implement innovative strategies to increase throughput, and adopt port community systems. The following sections discuss how these factors will improve terminal design and operation.

CURRENT INTERMODAL TERMINAL CHALLENGES

Megaships

The size of container vessels can greatly affect the design and operating characteristics of marine intermodal terminals; transportation system efficiency, productivity and service quality; and overall unit costs. For many years after the introduction of ships designed to transport stacked, standard-sized containers, vessel sizes stayed within the limits imposed by the original Panama Canal locks. The maximum-sized "Panamax" ships were approximately 950 feet long and 106 feet wide (beam), with a 39.5 feet draft. Within those dimensions container ship capacities could eventually reach approximately 5,000 twenty-foot container equivalents (i.e., 5,000 TEU). As world trade increased and especially as more manufactured goods were shipped over long distances from East Asia to North America and Europe, it became clear that ships exceeding Panamax dimensions would be more economical on such routes. Since the 1980s successive generations of ships have had greater dimensions and container carrying capacities. These include "Post-Panamax" ships carrying up to about 9,000 TEU; "NeoPanamax" ships carrying up to about 13,000 TEU; and the most recent "Megaships" carrying up to 22,000 TEUs. It should be noted that the term "megaships" tends to refer to the largest recent ships, and thus has an evolving meaning.

Containership size is based on tradeoffs among many factors:

1. Scale economies – The costs of ship construction, fuel, and especially crews increase much less proportionately with ship size, favoring the use of larger ships.
2. Handling capabilities and turnaround times in ports – The time needed to load and unload ships tends to increase with the number of containers handled at each call, even when additional resources, such as more quay cranes, are used for larger ships. Vessel productivity decreases with greater turnaround time in ports.
3. Waterway dimensions – Ship dimensions may be constrained by channels, rivers, canals, locks, and even sea depths. The largest megaships, which are about 193 feet wide, cannot fit through the new Panama Canal locks (1400 feet long, 180 feet wide, 60 feet deep), although they can still use the recently expanded Suez Canal.
4. Berth and crane dimensions – Berth lengths and quay crane height and outreach at most terminals are insufficient for megaships. Large investments are needed to remedy those limitations but may be unjustifiable at many ports. The channel and berth depth needed to accommodate megaships has increased more slowly than other dimensions. Since container strength standards limit the number of containers that can be stacked above deck, "air draft" has also increased less than other dimensions.
5. Sea route length – Ships serving shorter sea routes spend more of their time in port. Thus, smaller ships with shorter dwell times in ports can achieve higher utilization rates.
6. Demand characteristics – Larger ships need higher demand densities, other things being equal. In recent years, demand densities have increased due to

mergers and alliances among ship operators as well as due to general growth in world trade. The reduced costs of shipping due to larger ships have themselves stimulated trade.

7. Service quality – For given demand levels, service frequency decreases as ship size increases, thus reducing service quality (i.e., longer export dwell time). This effect may be slightly countered by the reduced sensitivity of larger ships to difficult weather conditions and high sea states, which improves their service reliability.

Some of the problems marine intermodal terminals face due to increased ship size include:

1. Determining the “design vessel” to be served – Container terminals must determine the largest ships they plan to accommodate at various planning stages. Political factors and port competition can affect what would ordinarily be a cost-benefit investment decision in terminal design.
2. Berth design and terminal design – Larger ships require longer berths adjoining deeper water, and larger quay cranes with sufficient height and reach. Foundations must also be stronger to support larger quay cranes.
3. Container handling and storage capacity – Additional storage capacity is needed to handle the larger container volumes carried by larger ships. Terminal operators prefer safer and less-costly horizontal expansion where possible, but vertical expansion becomes necessary where terminal footprints are fixed. The capacity and speed of container handling equipment must increase to serve the expanded terminal. Terminal automation is a potential solution.
4. Controlling ship dwell times – With current technology and procedures, larger ships with larger container loads require more time for loading and unloading. Quay cranes cannot work too close together, limiting the number of cranes that can work simultaneously. A megaship may have 2.33 times as many containers per bay as a Panamax ship. In discharging and loading a megaship’ containers, cranes move containers farther vertically and horizontally. There is thus a need for improvements in crane design, berth design, or procedures to speed up container vessel handling. For example, designers have considered berths that serve ships from both sides, and some quay cranes can now handle multiple containers simultaneously.
5. Surface transportation capacity – Increased container traffic and greater volume peaking requires additional port highway and rail capacity.
6. Terminal utilization – Larger vessel and container call volumes create cargo surges that require greater capacity requirements and but reduce overall container yard utilization.

Evolving Business Practices

Intermodal transportation and terminal business practices are evolving to meet the challenges described above, and to keep pace with evolving customer supply chain practices. Where once terminals operated independently and relied on motor carriers to reconcile mismatched practices and schedules, the industry is now taking steps toward becoming an integrated system.

Chassis supply remains a sore point as the U.S. industry shifts to a mix of motor carrier-owned and pooled chassis; it is one area in which efficient business practices have not yet emerged. Supply of over-the-road chassis for international container movements by truck has become an issue since 2010, when ocean carriers began withdrawing from the chassis business. A variety of chassis pools have emerged to fill the gap, but legacy links to some ocean carriers and other institutional barriers have hindered efficiency and interchangeability.

Ocean carriers have been consolidating into a small number of alliances that share vessel space and schedules. While enabling better utilization of new, larger vessels, these alliances have also led to inefficiency in chassis supply and empty container management, and the terminals cargo surges discussed above. In the long term, terminal design and business practices will have to adapt to alliance operations.

Regulation

The growing impact of ports and intermodal terminals on society has led to increased government regulation at the federal, state and local levels. These regulations are intended to reduce environmental externalities, improve safety and security, and bolster efficiency.

Environmental Regulations

Most ports and intermodal terminals are located in large urban areas where emissions noise, and safety affect more people per square mile. A number of new regulations are designed to reduce the emissions and carbon footprint of port drayage trucks. Historically, truck fleets serving ports were composed of retired over-the-road trucks near the end of their service life. This practice was rational from an operational cost perspective, given that drayage trucks usually cover short distances and need not be as reliable or efficient long-haul fleets. However, the environmental externalities associated with older drayage trucks are challenging this model. At ports such as Los Angeles, Long Beach, and Oakland, older drayage trucks that tend to pollute more have been banned. Several other ports (e.g., Ports of Tacoma, Seattle, Vancouver, B.C., Houston, Charleston) have used grant incentives to encourage truck owners to scrap and replace older, more polluting trucks with cleaner alternatives.

Noise is another type of environmental externality imposed by freight intermodal terminals on surrounding communities. As more terminals and distribution centers shift to 24-hour operations, noise impacts have increased and disproportionately affect low-income communities. Improved local land use and zoning policies are increasingly being introduced to prevent incompatible land use surrounding intermodal terminals.

Safety and Security Regulations

Safety is a priority for the intermodal industry, and recent regulations have addressed emerging safety issues. The safe condition or “roadability” of container chassis and the safety of rail workers in multi-track facilities have been addressed by legislation and regulation. The mandated use of electronic logging devices for truck drivers, which began in 2018, has far-reaching effects in the intermodal field. There will be a continuing need to address personal safety as terminals grow, their pace quickens, and the industry learns how to blend automated and human operations.

Intermodal terminals are international trade hubs, and the need for security regulations has emerged in recent years. After the 9/11 tragedy, the Transportation Workers Identity Credential (TWIC) program was launched to provide biometric certification of workers and visitors at ports and terminals. All import containers are scanned via radiation portal monitors to detect dangerous, illicit cargo. Congress also passed the SAFE Port Act of 2006 calling for all U.S. bound cargo containers to be scanned via nonintrusive imaging and radiation detection equipment at foreign ports by 2012. The implementation of this mandate has been delayed.

INTERMODAL TERMINAL DRIVERS OF CHANGE

Terminal Automation

Marine and rail intermodal terminals are increasingly turning to automation and digitalization to cope with the challenges they face. Terminal automation is one response to increased vessel size and call volumes, the rising cost of labor, and the intense competition between ports to become the fastest, cheapest, safest, and most reliable. Before terminal automation can be implemented, a digital process map may be designed and tested in a simulated environment (Koegl, 2017). Terminal designers have a choice of automation types and strategies: process automation, incorporation of autonomous vehicles and robotics, and/or implementation of "Internet of Things" to make equipment smarter. One prominent automated marine terminal is the APM terminal in Rotterdam, which has been operating since 2015. It has an annual throughout capacity of 2.7 million TEU, and is equipped with Super Post Panamax cranes, 54 automatic stacking cranes, and 62 automated guided vehicles (AGVs).

In an automated terminal, the quay cranes can be managed by controllers in a nearby office via "joysticks." Containers are transferred from the vessel to an AGV. An unmanned Automated Rail Mounted Gantry (ARMG) crane then takes over the container from the AGV and moves it to the location specified by the terminal operating system. A second ARMG may simultaneously work in the same stacking lane on the landside to deliver containers to waiting drayage trucks. With such a design and process, stacking and delivery become continuous processes in which neither the AGVs on the seaside nor the trucks on the land side need to wait (see Figure 2).

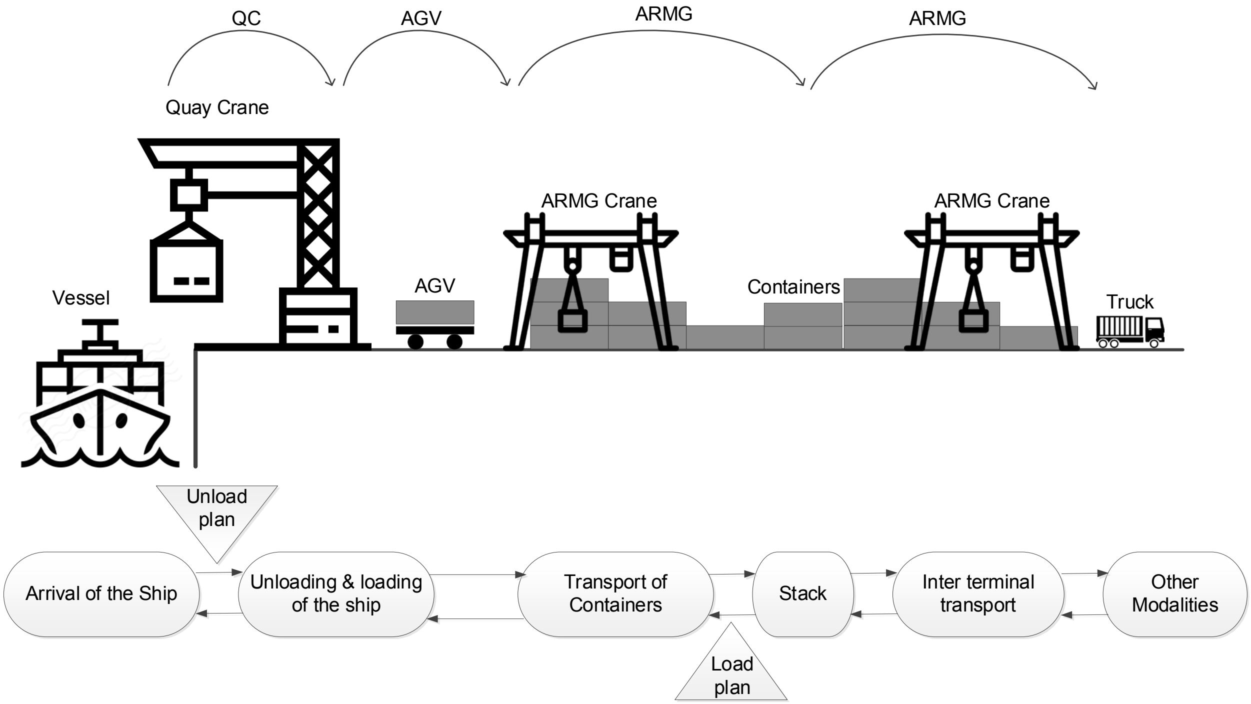

FIGURE 2. Illustration of automated container terminal operations.

Future intermodal terminals may take advantage of autonomous systems for handling inter-terminal and intra-terminal container transport. Such an autonomous system might greatly facilitate empty container repositioning, especially when combined with collaboration and vehicle sharing among competing terminals or a system to coordinate terminal and carrier empty container demand and supply. Future port and terminal designs may include dedicated infrastructure between the container terminals, called "container exchange route", for container transfer via automated AGVs (SAE level 5).

Connected and Autonomous Vehicles

Connected and autonomous vehicle (CAV) technology is poised to impact trucking in significant ways. For instance, Mercedes-Benz has developed a semi-autonomous truck prototype that has operated in driverless mode at speeds of 50 miles per hour on German highways. Subsequently, other parties and companies have followed this initiative and launched other prototypes. CAV is also expected to enhance automation within intermodal terminals and between terminal facilities.

In the shipping industry, it is expected that unmanned ships will lead to significant changes. Lower emissions, lower operating costs and increased security are some of the expectations. The technologies needed to make autonomous ships already exist; however, their implementation will not be immediate. The challenge lies in finding the optimal combination of these technologies in a cost-effective manner for the marine environment (Rolls-Royce website, 2016; Levander, 2016). Some of the main initiatives that are currently leading the development of the autonomous ships are: the MUNIN project (2013-2015), the creation of the Forum for Autonomous Ships in Norway and the establishment of the autonomous ship testing area in the Trondheim Fjord in 2016, and the AAWA Initiative (2015-2017).

Big Data

Big data applications have great potential for improving the design and operations of intermodal freight terminals. Although no single unified definition exists, “big data” is largely characterized by three Vs: volume, variety, and velocity. Big data applications allow different types of data from a variety of sources, including both structured data and unstructured data (such as internet webpages, texts and videos) to be collected and analyzed together. With major breakthroughs in artificial intelligence and advanced computing, analysts in many domains are designing big data analysis techniques (1) to discover hidden patterns, correlations, and other insights from big data, and (2) to convert such insights into better decision-making. By revealing values and patterns in cargo, vehicle, and infrastructure data that are undetectable with traditional data-processing tools, big data applications can provide with both qualitative insights and quantitative support to terminal designers and operators. There is a growing need to improve big data processing and access speeds to enable more dynamic or real-time decision-making in terminal operations.

As with other industries, the intermodal freight transportation industry has begun to harness big data (e.g., smart card data, bar code data, radio-frequency identification data, satellite-based location data), to improve productivity, reduce costs, and boost operational efficiency. For example, U.S. Xpress, a major motor carrier, can monitor real-time vehicle performance, driving behavior, and environmental information with sensors installed in trucks. Simply tracking and recording such data is not sufficient to improve the company’s revenue or reduce cost. With real-time information, U.S. Xpress managers could better understand how the drivers were driving and why some trucks were running empty, and make corrective decisions to optimize truck operations. The resulting annual fuel cost savings alone were estimated to be $20 million (Techtarget.com, 2012). Another good example is the use of multiple data sources in managing connections between transportation modes. If an inbound cargo plane is expected to be delayed (according to weather data), highway vehicle and shipment data can assist managers in matching aircraft holding time with truck schedules and downstream processing to minimize delay to both vehicles and cargo. Various machine learning algorithms can be used to learn from available datasets and produce reliable predictions in a timely manner (e.g., the estimated vehicle arrival time, Wang et al., 2018). Improved prediction results could in turn help achieve more desirable decision incomes, including the reduction of overall delays and the improvement of decision robustness in uncertain environments.

Global positioning system (GPS) is another source of big data where data analytics are needed and have been widely used in recent years, including identification of bottlenecks at freight facilities and estimation of different freight facility performance indicators (Flaskou et al., 2015; Dulebenets et al., 2017). Other sources of big data on freight movements among various states, counties, and metropolitan areas by modes (e.g., Freight Analysis Framework, Commodity Flow Survey, TRANSEARCH, and others) are provided at the aggregate level, while GPS data can be used to identify and analyze individual vehicle movements (Flaskou et al., 2015). The latter can assist transportation planners and relevant stakeholders with determining truck trip origins, intermediate stops (e.g., cargo pick/drop-off at intermodal terminals), duration of stops (e.g., truck turn times at intermodal terminals), and truck trip destinations.

Estimation of accurate truck turn times at freight terminals is a challenging task. With GPS data from trucks, intermodal terminal operators and motor carriers can accurately track truck time spent inside and outside terminals. The Southern California Harbor Trucking Association now publishes GPS data-based truck turn times for the terminals at the Port of Los Angeles and the Port of Long Beach on a monthly basis (BTS, 2016). GPS data collected from trucks have been also used to improve transportation and air quality planning at the Port of Houston (Farzaneh et al., 2018). In that instance data revealed that trucks generally operate at fairly low speeds with an idling time of approximately 185 minutes per vehicle. Furthermore, the trucks generally operate at temperatures below the optimal for the selective catalytic reduction functionality, which means that the NO_x emissions reduction benefits might not be fully achieved.

Freight movements typically involve significant interactions between shippers, logistics companies, terminal operators, and receivers. Some studies have used GPS data from drayage trucks to develop tour-based models for freight transportation planning in the vicinity of ports and intermodal terminals. For instance, You (2012) analyzed GPS data from 545 drayage trucks serving the San Pedro Bay Ports in Southern California. A set of tour-based models were proposed in that study to capture drayage truck behavior. The proposed tour-based models, based on the GPS data, demonstrated their effectiveness and could be used to reduce terminal gate congestion, decrease truck turn times, and mitigate the associated environmental impacts.

GPS data can also be used for assessing the surrounding transportation network (Dulebenets et al., 2017), which can be critical, as transportation network capacity shortfalls and bottlenecks may prevent trucks from timely terminal entry and exit and adversely affect terminal throughput. These examples demonstrate that big data analytics can assist intermodal terminal designers and operators address looming operational challenges. Although big data processing is difficult and challenging, its potential is enormous for improving intermodal freight terminals of the future.

Adoption of Non-Traditional Strategies for Increasing Throughput

The widespread use of truck appointment systems at port container terminals offers an opportunity for terminal operators, drayage firms, and beneficiary cargo owners to plan their operations rather than simply reacting to circumstances, and ultimately to collaborate through port portals and community information systems. However, in the early stages appointment systems have had unintended consequences, and the industry will need to climb a steep learning curve to realize their long-term potential.

Terminal operators are extending operating and gate entry/exit hours to increase effective capacity, meet customer demands, and reduce local traffic impact. At ports, operators have implemented a variety of fee and funding mechanisms to cover the added cost of night operations and bridge the gap between cargo volumes that now require only a single shift, and future volumes that would fully utilize multiple shifts.

Industry stakeholder and observers have long speculated that marine intermodal terminals could operate more efficiently under a last-in/first-out “taxi” system in which the next drayage driver took the next container, rather than hunting for specific containers each time. These ideas have been implemented as “free-flow,” “peel-off,” or “speed gate” operations at multiple ports and have been well-received in limited applications to date. Expansion of this potentially valuable business practices depends on reconciliation of terminal operating goals with customer supply chain requirements, an institutional rather than technical challenge.

Introduction of off-terminal staging yards and related “second-tier” intermodal facilities has increased effective terminal capacity in many instances. Besides enabling terminals to better cope with cargo surges, these second-tier buffers allow motor carriers to serve port terminals in one fashion and serve customers in another, rather than trying to link incompatible systems directly. These off-terminal facilities may be the key to wider use of free-flow operations.

Information and Communications

The challenges above cannot be met, and the improvements cannot be realized, without parallel advances in information and communication. The ultimate value of big data is in the information it makes available to intermodal terminal designers and operators, and that value is multiplied when the information is communicated and shared. The industry needs to know the demands a new facility will face; the identity and legitimacy of industry participants; the expectations of customers and carriers; and the availability of resources to meet expected demands. The emergence of port data portals and port community information systems (PCS) is a major step on the path to better information and communication. A PCS is an electronic platform that connects the various systems operated by the organizations that make up a seaport or inland port community. The PCS enables intelligent and secure exchange of information between public and private stakeholders in order to improve the efficiency and competitiveness of the port communities. With the possible integration of blockchain technology within the PCS, security could be even further enhanced.

The Port of Rotterdam has one of the most successful examples of PCS technology deployment, where it not only developed a channel for efficient exchange of information between private and public sectors, but also developed applications such as Pronto, which helps ship agents design more efficient plans for ship services, Navigate, an online route planner, and NextLogic for handling inland container shipping. It is envisioned that future PCS will serve as conduits for intermodal transactions and collaboration. Advances in predictive analytics may enable these systems to forecast near-term operational needs as well as allow intermodal terminal managers to plan and prepare rather than react and cope.

CONCLUSIONS

As intermodal freight volume grows, ocean, rail, and motor carriers will seek to simultaneously increase capacity, control costs, and meet stringent customer demands. Intermodal terminals will play a critical part as either efficient buffers and transfer points, or as bottlenecks, depending on how well their capacity and performance can keep pace with growth. In facing the challenges ahead, intermodal freight terminals will need to effectively integrate efficiency and environmental goals under the pressure of escalating volume and service demands. Fulfilling that objective will likely require increased automation at and between terminals, exploitation of big data analytics, large investments in terminal infrastructure and “smart” equipment, and compliance with stricter environmental regulations. In an environment of limited resources, limited terminal footprints, and limited community tolerance for externalities, none of those advances will be easy. Collaboration and data sharing intra-port will be needed, as will adoption of advanced technologies and management techniques.

The objective of the TRB AT050 Committee is to propose research, share research findings, sponsor special activities, and provide a forum for transportation professionals to discuss today’s and tomorrow’s issues involving intermodal freight terminal design and operations. In this role, the committee members and friends have actively sought to share research findings and best practices at the TRB Annual and Mid-Year Meetings and its publications. The role and mission of the Committee is more important than ever in the current environment where automation and autonomous vehicles may transform the transportation industry. As intermodal terminals evolve and transform, the Committee will continue to fulfill is fundamental role in keeping its community of researchers and practitioners abreast of developments worldwide.

REFERENCES

1. Bureau of Transportation Statistics, 2016. Port Performance Freight Statistics Working Group Summary of Meeting of July 15, 2016. https://www.bts.gov/archive/port_performance/meeting_minutes. Accessed Jan. 18, 2019.
2. Dulebenets, M.A., Pujats, K., Deligiannis, N., Golias, M.M., and Mishra, S. Development of Tools for Processing Truck GPS Data and Analysis of Freight Transportation Facilities. Presented at 96th Annual Meeting of the Transportation Research Board, Washington, D.C., 2017.
3. Farzaneh, R., Johnson, J., Ramani, T., Jaikumar, R., Meyer, A., and Zietsman, Z. Collection and Analysis of Vehicle Activity Data to Improve Transportation and Air Quality Planning. A report prepared for the Houston-Galveston Area Council and the Port of Houston Authority, 2018.
4. Flaskou, M., Dulebenets, M.A., Golias, M.M., Mishra, S., and Rock, B. Analysis of Freight Corridors Using GPS Data on Trucks. *Transportation Research Record: Journal of the Transportation Research Board*, 2015, 2478: 113-122.
5. Harrison, R. Johnson, D. Loftus-Otway, L., Hutson, N., Seedah, D., and Zhang, M. Megaregion Freight Planning: A Synopsis. Texas DOT Final Project Report, No. FHWA/TX-11/0-6627-1, March 2012.
6. Koegl, C., (2017). How Siemens Uses Simulation to Automate Ports. Interview at TOC Europe 2017, Amsterdam, The Netherlands.
7. TechTarget. 2012. 'Big Data' Analytics, Mobile BI Apps Help U.S. Xpress Truck More Data. https://searchbusinessanalytics.techtarget.com/video/Big-data-analytics-mobile-BI-apps-help-US-Xpress-truck-more-data. Accessed Jan. 18, 2019.
8. Wang, Z., Fu, K., and Ye, J. Learning to estimate the travel time. In Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, pp. 858-866, 2018.
9. You, S. Methodology for Tour-Based Truck Demand Modeling. Dissertation, University of California, Irvine, 2012.