The Thruport concept and transmodal rail freight distribution in North America

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Abstract

The concept of flow has become particularly important in logistics and freight distribution. From a simple question of capacity, the issues of timing, frequency and punctuality are now of significant relevance in freight movements since they are part of supply chain management strategies. In particular, transport terminals and freight distribution centers have been the major elements permitting improvements in the efficiency and throughput of commodity chains from global production networks to local distribution. Intermodal transportation underlines a growing integration of freight transport systems brought by containerization. Receiving less attention, transshipments are not only an intermodal (flows between modes) issue, but also a transmodal (flows within the components of a mode) one. Rail transportation in North America is particularly illustrative of the challenges of transmodal operations. While containerized rail freight has experienced a substantial growth in recent years, this growth appears to be reaching serious bottlenecks, particularly at locations where transmodal operations have surged, such as Chicago. The paper investigates the concept of a “Thruport”, a facility designed to handle high volume transmodal rail shipments. The Thruport offers the potential of reconciling time and flows in rail freight distribution from which significant financial, time, energy and environmental benefits can be realized. It is argued that the Thruport represents a step in the evolution of intermodal transportation and containerization for inland transport systems.

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1. Introduction: transmodal rail and freight distribution

The setting of global freight transportation networks is mainly supported by maritime transport which has become highly efficient in terms of costs, capacity and reliability. However, the rapid growth of maritime containerized shipping has placed intense pressures on inland freight transportation systems, particularly rail. In such a context there is a growing recognition that rail freight is critical and there are expectations that rail transport systems will accommodate growing inland freight volumes that road transport systems cannot handle effectively. The question remains about the extent to which these expectations are going to be met in terms of capacity but also in terms of level of service. A particular issue pertains to the requirements of contemporary freight distribution, which is increasingly flexible and time based (Bontekoning and Premus, 2004; Deardorff et al., 2005). Even if rail was conventionally a mode that could not be effectively reconciled with those requirements, this perspective has changed with globalization, containerization and privatization (deregulation). Thus, rail transport is facing a resurgence triggered by a simple matter of growing demand as well as by a new set of conditions affecting the industry, making it increasingly flexible and time responsive, or at least sensitive to those issues.

Issues and constraints concerning the intermodal function of freight distribution are well known (e.g. TRB, 1998). In the context of North America, it is argued that the issue of “transmodal transportation” (movement within the segments of a mode) needs to be addressed further as...
connectivity between long distance rail segments is becoming increasingly problematic. This represents one of the key issues to improve the efficiency of rail freight distribution on such a large system of freight circulation. Additionally, forecasting future freight demand is increasingly difficult to assess because of the uncertainties and complexities linked with globally oriented supply chains, surging energy prices, business cycles, volatility brought by fiat currency systems, the strategies of global freight forwarders (notably third party logistics providers and port operators), congestion and security issues.

The goal of this paper is thus to provide an exploratory analysis of the Thruport concept, a rail-to-rail transmodal terminal which can also act as an intermodal terminal, particularly over the rationale behind its implementation, as well as operational and locational considerations related to such a facility. This concept is introduced as a strategy to achieve a higher level of cost and time efficiency for continental containerized freight distribution in North America. It is also argued that a Thruport represents a logical next step in the evolution of containerization and intermodal transportation for inland freight transport systems and that combined with other strategies such as transloading, rail transportation would be better placed to improve its time performance.

2. A resurgence of rail transportation

2.1. A renewed dynamism

Paradoxically, transport geography has lost its focus on rail at a moment where the industry is experiencing its most significant growth after a period of relative decline. From a well covered field of inquiry a few decades ago, rail transportation and freight has been marginalized from the discipline. Freight issues still remain mostly at the periphery of transport geographer’s concerns and also by transport planners and decision makers in general (Rodrigue, 2006; Bradley, 2007). There has been a preference to investigate the transportation of passengers and by focusing on other modes when freight was concerned. When rail is covered, it is almost exclusively over the matters of passengers (notably high speed trains) and transit (focused on light rail), both of which in the North American setting offers limited potential. For instance, until 2005 only one paper specifically dealing with rail freight has been published by the Journal of Transport Geography and this on the first year of its inception (Heaver, 1993). Other articles have dealt with the issue in a more peripheral manner (e.g. Buchhofer, 1995; van Klink and van den Berg, 1998; Woudsma, 1999).

Then, in 2006 rail freight started to appear on the agenda, with two papers specifically dealing with this issue published, both in the context of Great Britain (Dinwoodie, 2006; Woodburn, 2006). Still, there are few systematic ventures investigating rail freight distribution, particularly within the context of current changes in the geography of distribution with an emphasis on supply chain management (Hesse and Rodrigue, 2004). The substantial growth of trucking and air transport, induced transport geographers to follow these trends and a fairly active branch investigating trucking and particularly air transportation has emerged (e.g. Leinbach and Bowen, 2004).

Maritime transportation and containerization have also received attention as vectors of globalization (e.g. Notteboom, 2004). Unlike these rapidly changing sectors, rail freight was perceived as stable and the strategies of its actors well understood, particularly since it was a highly regulated industry, often monopolized by government ownership. The current setting however indicates that rail is becoming a very dynamic industry. After a period of neglect, rail is receiving more attention (e.g. Bontekoning et al., 2004), particularly because of the following:

- There has been a substantial growth in international trade, particularly exports from Asia. This takes place in an environment where many economic sectors are seeking lower production (labor) costs by relocating or sub-contracting their production abroad. The trade-off for lower production costs involves longer distances with more complex commodity chains. For North America, this has increased the importance of gateways providing an interface between global supply chains and national distribution. The resulting growth in long distance shipments is taking place both at the global and national levels. While maritime transportation obviously services global shipments, the long distance national shipments, which are primarily carried by motor carriers, are better serviced by rail transport because of its competitive advantages in terms of volume, capacity and costs. Over this issue, the emergence of landbridges has been underlined as long distance land corridors of freight circulation (Slack, 1990; Rodrigue, 2004).
- Rail productivity has increased following the deregulation of rail transport in the early 1980s (Hensher and Waters, 1999). In North America, mergers and acquisitions of rail networks have resulted in the setting of large carriers able to manage effectively their systems. For instance, rates have declined by about 35% between 1980 and 2000 and fuel efficiency increased by 62% (AAR, 2005). Meanwhile, road transport costs are increasing, mainly due to higher wages, labor shortages, insurance costs, energy costs and also congestion. Again, this reinforces the competitive advantages of rail transport in view of a mode that has gained in market share in recent decades. On a comparative basis, it has been found in the North American setting that rail is 4.3 times more energy efficient (455 ton-miles per gallon), has 4.7 times the capacity (216 million tons per mainline per year) and 1.8 times less costly (2.7 cents per ton-mile) than trucking (Brown and Hatch, 2002). While these cost advantages have been known for a long time, the current setting is prone with additional opportunities that are more time based.
The large volumes of containerized traffic handled at gateways are creating capacity constraints with which the trucking industry has difficulties coping. Accessing major port terminals has become a challenge due to congestion and in many cases additional truck traffic to service additional volumes is simply not an option. In the current port development setting, inland distribution has become one of the key issues (Olivier and Slack, 2006; Notteboom and Rodrigue, 2005). Intermodal rail thus offers an opportunity to ship freight in and out of major port facilities to inland distribution centers.

2.2. North American context

In North America the resurgence of rail has particularly resulted in a growth of ton-miles, favoring the intrinsic advantages of rail as a long distance freight carrier (Fig. 1). This observation is also substantiated by the growth of international trade and of trade imbalances, which accelerated in the 1990s. The synchronism between rail and coastal transportation was broken right after the Ocean Shipping act of 1984, permitting maritime companies to rationalize and consolidate their operations by authorizing intermodal services between ocean and inland carriers (Talley, 2000). This negatively impacted coastal operations (coastal services could be bypassed more effectively) and part of the market, at least the growth potential, was assumed by rail. While port transshipments increased, coastal operations declined as well as the number of barges. This phase of devolution appears to be completed and a higher level of integration between coastal and rail transport systems can be expected, particularly with short sea shipping services.

The substantial growth in rail traffic is not without challenges. On par with major port gateways, inland rail transportation is getting congested, even with the significant capacity benefits achieved by the double stacking and double tracking of several corridors. In fact, additional capacity has almost disappeared from the American rail system. This has the potential to significantly curtail the future growth of the American economy since additional freight transportation demands, on roads as well as on rail, are not going to be fully met (Boardman, 2006). Rail congestion is particularly reflected at major hubs, such as Chicago, that appear to have reached substantial capacity constraints in handling growing quantities of containerized rail freight shipments. Considering the structure of long distance trade, road transportation cannot effectively accommodate additional growth for a variety of reasons, particularly in terms of costs and capacity. From a situation of modal competition between road and rail, there is an emerging complementarity, particularly for containerized shipments. While it costs about $1,500 to move a 40 foot container from the West Coast to Chicago, the same shipment costs $3,000 by truck (Prince, 2006). Average domestic haul lengths have increased by 24.0% and 18.7%, respectively between 1990 and 2003, placing them at 775 km for road and at 1380 km for rail. The growth in the haul length for trucking is not likely to increase significantly due to additional energy and labor costs and empty travels such distances create. About 80% of interurban freight traffic in the United States is carried over distances of less than 640 km. The remaining 20% accounts for 130 million loads per year and this figure excludes international trade shipments that are commonly carried nationally over long distances. This segment of the market offers significant opportunities for medium distance rail as long as the transport time segment can be mitigated. The net advantage of trucking for medium distances is not necessarily related to its speed, but to the intermodal costs and delays at rail terminals, which makes shippers wary of using rail. Any improvements in the efficiency of intermodal rail are likely to change its relation to trucking in a significant manner. It is under such circumstances that the transmodal dimension is of particular relevance.

3. Transmodal transportation and the Thruport concept

3.1. Integrated transport systems: from fragmentation to coordination

With improvements in the capacity, efficiency and reliability of freight distribution, integrated transport systems have become a leading paradigm. The conventional fragmented and sub-optimal freight transport systems have substantially been changed by intermodal transportation and the combination of several modes servicing commodity chains, many of them globally oriented. The advantages of each mode and terminals, used in conjunction, create multiplying effects (Fig. 2).

A process of coordination of freight transport is taking place, from which substantial financial and operational benefits are derived. Several factors can be pondered in this development:

- **Technology:** Containerization is without any doubt the most significant technological factor behind a more efficient coordination of transport modes. Innovations from which additional capacity and efficiency are derived include modes, such as post-panamax containerships or
double-stacking trains, but also intermodal equipment to handle significant transshipment demands. Hard (technical) assets require soft (management) assets. Information technologies have gone a long way to help improve the level of control over supply chains, which includes important aspects such as tracking shipments and managing fleets. The issue of e-commerce has also received attention as a technological dimension, improving freight distribution, particularly with a better interaction between suppliers and customers.

- **Capital investments**: Freight transportation is a capital intensive sector with high entry costs, particularly for the maritime and rail segments. Rail remains one of the most capital intensive of economic activities. For instance, rail has capital expenditures that accounted for about 18% of their revenue, while this share is about 4% for manufacturing (AAR, 2005). The amortization of modal and infrastructure investments, such as terminals, has to be spread over a significant time period, sometimes over more than a decade. This environment is prone to risks and many potential investors are unwilling to commit capital for infrastructure projects since potential returns are uncertain and may benefit one mode more than the other (I-95 Corridor Coalition, 2004). This is a reason why public interests have often been called to step in, either as sole investors or more often in partnership. Still, freight transport companies are dominantly private entities and must rely on capital markets to finance their ventures. If through a higher level of coordination with other elements of the supply chain a greater volume and stability in utilization can be secured, capital costs can be reduced and financial returns and risks improved. For modal operators such as railways that have vested interests on their network (monopoly or oligopoly) and high infrastructure costs, capital investments for intermodal projects are difficult to secure and remain one of the most significant issues in the development of these projects. The benefits of intermodal infrastructures in lowering capital risk need to be demonstrated.

- **Alliances and M&A**: Coordination also implies new forms of relationships between freight forwarders, such as joint ownership or more simply the potential to share modes and terminals. This was favored by a wave of deregulation of many transport modes in the early 1980s. The Aviation Deregulation Act (1979), the Staggers Act (1980), the Motor Carrier Act (1980) and the Ocean Shipping Act (1984) are among the most significant landmarks in this direction (FHWA, 2005). It became easier for different transport operators to establish contractual agreements and to price services based upon real costs. Mergers and acquisitions within the same mode started to take place, mainly in maritime and rail transportation, but also the emergence of modal and intermodal alliances. Global players managing large freight distribution systems (such as global port operators; Olivier and Slack, 2006) understand well that an integrated approach results in economies of scale and scope.

- **Commodity chains**: The emergence of a globally oriented production structure, often labeled as global commodity chains or global production networks (e.g. Coe et al., 2004) requires a high level of coordination between its elements, from the supply of raw materials to the final distribution to consumers. It is thus expected that global commodity chains impose a corresponding structure of distribution where coordination between modes and different transport systems is required. Under such circumstances, it has been argued that transport demand should increasingly be considered as integrated instead of derived (Hesse and Rodrigue, 2004).

- **Networks**: Integrated transport systems rely on the respective strengths of each transport network. Since networks are expensive to build and operate, linking them promotes economies of scale, efficiency and a higher level of control over freight flows. This can be considered as a multiplying effect where the efficiency of the whole intermodal network is greater than the sum of its parts. The hub-and-spoke structure of airline operations, transloading where the advantages of short distance trucking are combined with long distance rail, and containerized barge shipping are particularly relevant examples of the multiplying effects of combining transport networks.

### 3.2. Transmodal transportation

The function of transshipment is of central importance in contemporary freight distribution. Within integrated transport systems, the time component has become increasingly significant, placing pressures on transport systems to maintain and improve the overall velocity at which freight is circulating. Since modal speed improvements tend to be marginal, it is at the terminal and with the function of transshipment that most of the time and cost benefits are achieved (Rodrigue, 1999). However, the fact that transshipments are concomitantly an intermodal and a transmodal activity appears to have been overlooked and requires a distinction. Transshipment, in addition to being an inter-
modal activity handling movements between modes, also concerns movements within segments of the same mode. As commodity chains became longer and increasingly complex, the pressure on the performance of intermodal and transmodal transportation is being felt. Locations handling these flows, particularly gateways, act as a strategic interface between networks of global and regional dimensions. In this geography of transshipments, connecting different modal segments of the transport system, freight markets and freight forwarders are interacting with increasing efficiency (Fig. 3).

Intermodal operations have received the bulk of the attention, particularly their port and rail terminals segments, as massive investments in those facilities were required to set global commodity chains. However, transmodal operations are comparatively uncovered, the main reason being that until recently they mainly took place within fragmented and regulated national transport systems. The three main modal dimensions include:

- **Transmodal road**: Mainly takes place at distribution centers, which have become strategic elements in freight distribution systems. It is probably one of the few cases where transmodal operations can be combined with added value activities, such as labeling and packaging. Although distribution centers were conventionally warehousing facilities in which commodities could be stored while waiting to be sold to customers down the supply chain, this function has substantially receded. Time constraints in freight distribution impacted on road-based distribution centers, whose function is increasingly related to transmodal operations and much less to warehousing. Thus, the situation has moved from inventory management to flow management. The true time-dependent intramodal facility remains the cross-docking distribution center (Gue, 2001; Gumus and Bookbinder, 2004), which are particularly used by parcel shippers such as UPS and FedEx.

- **Transmodal maritime**: Ship-to-ship transshipments mainly concern offshore hubs such as in the Caribbean, the Mediterranean or ship-to-barge activities. Although in many cases containers are actually unloaded onto a temporary storage facility (commonly next to piers), an offshore hub is functionally a transmodal facility. They have emerged at intermediary locations by offering transshipment advantages in view of costs related to pendulum multiport services coupled with lower container handling cost related to transshipment-only terminals, in addition to economies of scale for feeder ships (Baird, 2002). Transmodal operations have thus become a very important component of contemporary containerized maritime shipping with strategic offshore hubs connecting key segments of the global maritime distribution system. For instance, about 95% of all the containers handled by Singapore, the world’s second largest container port, qualify as transmodal operations.

- **Transmodal rail**: Probably represents one of the least investigated segments of transmodal transportation. Most rail systems were built to service specific markets and were heavily regulated. It is only recently that containerization created the need for transmodal functions in rail transport systems, since rail transportation was “forced” to address a new variety of movements, many of them with international origins or destinations. Initially, rail developed greater intermodal efficiencies with maritime and road transport systems, particularly because this represented new market opportunities. The next step places a greater emphasis on developing transmodal efficiencies within the rail system itself. This opportunity is not without challenges inherent to rail transportation, namely the spatial fixity of its infrastructures.

3.3. The Thruport concept

The idea of intermodal rail is quite old as attempts were made in the early 20th century to create intermodal services, but the infrastructure set in place was of low efficiency and several standards existed. With the development of containerization and mechanized intermodal equipment in the 1960s, the emergence of a more efficient rail intermodal system became a reality (DeBoer, 1992). Improvements in the track layout at terminals also helped intermodal operations, namely by having both sides of the track, respectively for loading and unloading operations. In North America, the use of double-stacking railcars was introduced in the 1980s, supporting the setting of high capacity long distance rail corridors, which came to

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1. For instance, the UPS Willow Springs facility in Chicago (opened in 1994), which is the largest land transport distribution center in the United States (linked to a BNSF intermodal terminal), has all its tracks on a “two for one” setting. It is the only one in the United States entirely configured as such and is the most efficient terminal with the lowest operating costs and fastest turnaround.
be known as landbridges. Due to deregulation, mergers and the rationalization of the rail industry, freight rates declined by about 1.3% per year between 1990 and 2003, improving competitiveness and attracting additional traffic. Nonetheless, the steady growth of containerized rail freight has reached a bottleneck by the early 21st century. While rail intermodal container traffic, both ISO (maritime) and domestic, has increased by 58% between 1999 and 2005, the number of trailers carried has actually declined by close to 10% during the same time period. Now that the rail industry has adapted to become an intermodal service provider, improving transmodal operations at major bottlenecks is becoming a priority. It is in this context that the Thruport concept takes its shape.

The term Thruport is a neologism coined by an intermodal equipment manufacturer.\(^2\) It suggests a “seamless transfer of freight” by a reduction in handling and the number of movements required to perform a transmodal container or trailer operation. An analogy can be made with air transport hubs that consolidate and redistribute passenger and freight traffic. Although transmodal air transportation has not been discussed herein because of its limited links with other modes (except trucking), it is in the air transport industry, for passengers and freight alike, that transmodal operations are the most efficient. Since passengers can “reposition” themselves, it becomes a matter of flight scheduling, take-off/landing capacity, gate positioning and baggage handling to insure efficient transmodal operations. Transmodal efficiency has thus been a driving force in the strategy of air carriers, including the selection of hubs and the setting of alliances. The emergence of major hubs is a good indication of their efficiency to accommodate such flows in the air transport industry (Vowles, 2006). Major parcel service operators, following a similar strategy, have also established very efficient transmodal facilities at specific hubs (e.g. Louisville for UPS and Memphis for FedEx).

For any freight distribution activity, there are significant cost benefits in reducing handling operations. This goal is undermined by the geographical reality of freight distribution. Namely, in many freight distribution systems, market, supply chain and ownership fragmentation impose additional transshipments. When these fragmentations take place over a land transport system where rail transport reaches a high volume, efficient transmodal operations eventually become a requirement. Previous research has underlined the setting of a Thruport like terminal remains a possibility that would be more effective as a hub-and-spoke structure that confers a throughput high enough to justify those operations (e.g. Bontekoning, 2001). However, in the European context, this rail distribution structure remains difficult to achieve, a situation exemplified by the failure to maintain a transmodal rail facility at Metz-Sablon in France. Among the major factors that impaired the system was the significant decline in railway service reliability and increased costs by rail operators (Kraft, 2005). However, the North American setting provides a better potential for transmodal rail operations.

3.4. Rationale for transmodal operations

A Thruport is designed to accommodate fragmented markets, supply chains and ownership, notably when this fragmentation takes place at a large scale (Fig. 4):

- **Market fragmentation:** The first rationale behind transmodal transportation is market fragmentation, particularly for the retailing stage. Since retailing leans heavily on global production and national distribution, the system depends on gateways forwarding freight along long distance rail corridors. The gateways (ports for the most part) are limited in number and the markets are excessively diverse. Thus, this represents a distributional setting in which the Thruport acts as a hub where the containers are shuffled to their respective unit trains bound to specific markets. The market however needs to be large enough to justify this level of shipments. The efficiency of gateways to accommodate intermodal traffic would thus be linked with the efficiency of the Thruport. In some cases, the efficiency of ports and inland freight transportation can promote imports more than regional manufacturing, especially if the latter relies on a different and less efficient distribution channel. In a situation of labor costs differences, this may create a multiplying effect making imports even more advantageous since they would offer cost as well as time benefits. On Fig. 4, a Thruport can improve the efficiency of long distance distribution by acting as a location where containerized freight can be fragmented and assembled in batches (unit trains) bound for specific regional markets. In the first case, the volume is sufficient enough to simply be a matter of fragmentation. However, it is more likely that a Thruport would be the assembly and redistribution point of freight coming from several gateways.

- **Supply chain fragmentation:** Contemporary supply chains involve a complex sequence of tasks. These tasks are the outcome of a specialization of economic activities and the exploitation of comparative advantages at the regional and often at the global scale. This fragmentation has placed intense pressures on freight distribution systems, including rail, to accommodate the growth in traffic in terms of volume and tons-km. The different stages of a supply chain, ranging from parts and raw materials, to manufacturing and distribution, could benefit from a closer time-wise integration permitted by a Thruport. The benefits would notably involve lower distribution costs, lower inventory levels and a higher level of reliability, notably with timely distributions. There is a potential impact of such a freight distri-

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\(^2\) Jack Lanigan Sr., Chairman of Mi-Jack Products, major intermodal rail terminal designer, operator and equipment manufacturer. The term was first proposed in 1992 at a conference of the Intermodal Association of North America.
duction structure on the locational behavior of production and distribution activities. Rail corridors linked to a Thruport could see the accumulation of activities taking advantage of an improved time/cost structure. On Fig. 4, a simple national supply chain (it could also include international components) can take advantage of a Thruport from a time and cost perspective. This is particularly possible in a context where the flows of a supply chain are part of unit trains that would not have taken place if a Thruport was not present.

- **Ownership fragmentation**: Rail companies have their facilities and customers and thus have their own markets along the segments they control. Each rail system is the outcome of substantial capital investments occurring over several decades. Interchange is a major problem between segments controlled by different rail companies, particularly since many networks were built to gather market share and regional control over rail freight services. Until the last two decades, this did not present too many difficulties since transmodal operations were comparatively small. However, with a surge of transcontinental rail shipments, rail operators are bound to further address transmodal issues. In this context, the Thruport creates multiplying effects. The distribution potential of each operator is expanded since they have better access to the freight markets of their competitors, creating a situation of complementarity. An analogy can be made with network alliances that took place in the airline industry. The outcomes were increased revenue, cost reductions (shared services and facilities), a better level of service and a wider geographical coverage. Rail networks are obviously much more constrained in this process since they have a high level of spatial fixity – by far the highest of any mode. This is the reason why mergers and acquisitions are a more common expansion strategy. They have added numerous efficiencies to the rail system, notably a more centralized control and the reduction of duplicated facilities (e.g. maintenance). Only 7 Class 1 carriers remained in the United States as of 2007, down from 39 in 1980 and 71 in 1970. It is unlikely that additional mergers will take place, mainly due to the size the networks have achieved (diseconomies of scale) and an oligopolistic situation that could trigger anti-monopolistic interventions from the Federal Government. A Thruport would thus be a facility coping with the inefficiencies created by ownership fragmentation.

4. The Thruport facility

4.1. Characteristics of a Thruport facility

Existing transmodal rail facilities are rather small since most of them are operating in Europe (Bontekoning, 2001), where double-stacking is not possible. In addition, they can only accommodate a segment of a unit train, which requires additional composition and decomposition time. To accommodate contemporary double-stacking unit trains, each about 100 railcars in length, a Thruport would need to be a linear structure of about 2.25 miles (3.6 km). Several configurations of the terminal are possible, notably in terms of the number and the disposition of the rail tracks. A pure Thruport could be composed of six tracks, side by side, where inbound and outbound trains can be handled concomitantly. A hybrid ThruPort enables a direct rail-to-rail transshipment in addition to acting as a “two-for-one” terminal. The crane is designed to hold up to three containers at a time, improving the shuffling capacity and reducing the number of potential lifts. The transmodal operations within a Thruport terminal represents a complex operations research problem that optimizes movements considering constraints such as the outbound destination of each container, the disposition of unit trains and the stacking order.

Considering the existing geographical setting of rail freight, a Thruport facility would benefit from being neutral, that is not entirely controlled by a specific rail...
company. Many governance models are possible, such as a private terminal operator or a joint venture between two major rail carriers, but a structure similar to a port authority (a “Thruport authority”) or a consortium appears suitable. In this consortium, several stakeholders can be involved, notably rail companies and terminal operators. Concession agreements and management contracts have become privileged strategies in the development, maintenance and expansion of transport terminals, particularly ports, but many rail terminals are also managed by specialized companies operating on a “per lift” cost structure. A Thruport connecting two different rail carriers would in theory be the minimum, but a higher number would be preferable to reinforce economies of scale and scope, with four or five rail carriers being optimal. It could either be constructed along an existing rail line or on an entire new link in the vicinity of the interfacing rail carriers.

Specific locational constraints also apply to this setting. Since a Thruport is a rail transmodal facility, a minimal interface with trucking is required, although for a hybrid Thruport road accessibility would be more important. This alone provides much locational flexibility as a Thruport does not necessarily require being located nearby a metropolitan area or close to highways. Many of the constraints linked with intermodal terminals are much less acute for a Thruport, since it acts as an intermediary location. Thus, two key problems – congestion and the availability of land – are mitigated by the locational attributes of a Thruport.

4.2. Operational considerations

Currently transmodal rail operations rely on two strategies. The first involves trucking as containers are moved from one rail terminal to another; be it within the same metropolitan area or close to highways. Many of the constraints identified with intermodal terminals are much less acute for a Thruport, since it acts as an intermediary location. Thus, two key problems – congestion and the availability of land – are mitigated by the locational attributes of a Thruport.

4.3. Derived efficiencies and substitution effects

The performance of a Thruport facility is dependent on the gantry crane equipment, its disposition and its level of automation. Discussed here are the operational considerations of the equipment designed by an American intermodal equipment manufacturer.5 The facility has a design capacity of about 250 container transfers per hour (4500 for an 18 h day, considering down time, train switching and labor rotation; 1.64 million per year). This performance is superior to the throughput of a 5,000 TEU container ship being handled at an efficient container port (about 130 containers per hour). Thus, the high throughput of the facility would enable the handling of more unit trains. For example, instead of trains entering and leaving intermodal terminals every 10 to 14 h, having them entering and leaving every 1 to 2 h is possible.3 Trucking companies generally have a fleet ratio of six trailers to one truck, which enables enough flexibility to support the requirements of their customers. With a Thruport system, the higher level of containerized cargo and its faster throughput could lower the trailers to trucks ratio significantly, to about three to one. Further, instead of trailers, chassises would be used, reducing purchasing and maintenance costs.

While the array of benefits conferred by a Thruport remains to be fully assessed by additional research and is outside the scope of this paper, several elements can be identified. They include lower shipper costs mainly due to lower transmodal costs, an improvement in the time-wise reliability of rail freight distribution, gains in rail productivity related to a better usage of existing equipment and lower fuel consumption due to less long distance trucking.

\footnote{Mi-Jack, whose primary focus is intermodal, accounts for over 80% of the crane manufacturing market in the United States, and is also involved in the construction and management of rail terminals. Drawing on their experience of operating over 80 rail terminal facilities in the United States, the company is considering the development of the Thruport concept as an alternative solution to the rail capacity problem.}

\footnote{There are many factors related to this improvement, one being the usage of radars on freight trains to avoid potential collisions. This is particularly important since unit trains would be circulating with a higher frequency.}
and less cross-town transmodal movements (Fig. 5). Other indirect benefits can also be considered, namely reduced congestion related to fewer truck movements, lower emissions (pollutants and noise) and potentially fewer road accidents. In addition to the benefits derived from transshipments in terms of time and costs, a Thruport could substitute for a significant amount of truck movements, both at the short and long distance range of the spectrum. For short distance truck movements, the benefits are mainly derived from less container truck chassis and hostlers movements, both within and between terminals. In this context the benefits are the outcome of derived efficiencies that is cost, energy and time-wise effective.

For long distance trucking, the Thruport is likely to create a substitution effect through a modal shift. Because of improved transmodal rail operations rail freight distribution becomes more reliable time-wise, triggering a shift as shippers opt for rail instead of road. The substitution effect is particularly important in the long run because of the compounding effects of congestion and energy consumption. Aside from alleviating tractor trailer related congestion, the Thruport will concomitantly reduce emissions from the combustion of fuels and improve the safety of highway transportation due to fewer trucks in circulation. Modal shift takes place because there is a clear advantage, as perceived by the users of the system, in doing so. As long as the differences remain marginal, users will continue using a distribution system with which they are familiar. A more efficient transmodal rail system could help trigger a modal shift in commodity chains through substitution. As such, rail transportation could become more integrated with the time constraints of contemporary supply chains, even permitting the handling of temperature sensitive products. More reliable transit times, in combination with radio frequency identity devices (RFID) temperature readings, will make this more likely. There is a growing trend to use of RFID technology for temperature readings while in-transit, which improves the confidence of shippers to meet the expectation of their customers. Doing so, the reliability of the service would improve, implying shorter transit times, higher frequencies and better timing as well as the possibility for the customers to track their shipments in terms of their location and, as importantly, their condition.

![Transmodal rail container transshipment sequence](image)

Fig. 5. Transmodal rail container transshipment sequence. (Figure adapted from a design by Ray Haxhistasa, Mi-Jack Inc.)
5. Transmodal rail operations in North America

5.1. Reconciling time and flows in North American rail freight distribution

Continuity within the North American rail network is far from being practical as major regional markets are serviced by specific rail operators (Fig. 6). Mergers have improved this continuity but a limit has been reached in the network size of most rail operators. Attempts have been made to synchronize the interactions between rail operators for long distance trade with the setting of intermodal unit trains.\(^6\) The issue of ownership fragmentation remains particularly important and dictates much of the locational rationale of a Thruport. Because of the geography of rail ownership, there are nine major locations that appear suitable to begin the foundation of a transmodal rail freight distribution system in North America; six in the United States and three in Canada. Each transmodal hub could act as a gigantic funnel, collecting the freight of all the major gateways, particularly those of the West Coast. In the United States, these locations correspond to changes in rail ownership, imposing an interface between different segments of the continental rail network. Chicago, Minneapolis/St. Paul, Kansas City, St. Louis, Memphis and Dallas/Fort Worth are particularly suitable locations since they are interface nodes in the rail system. In Canada, locations correspond to bifurcations between rail freight bound for/coming from Eastern Canada and that bound for/coming from the American market. Each Thruport is positioned to acting as a hub, collecting, sorting and redistributing the containerized freight along major rail corridors.

The first potential impacts of a Thruport are system-wide (macro). A few strategically located Thruports could help remove millions of truck trailers off the road each year. Better service made possible by the Thruport, coupled with better tracking and monitoring technology, will improve the confidence shippers have about the reliability of the rail distribution system. This is particularly important as it is the decision of shippers to use a distribution system that underlines its real potential. Management pref-

\(^6\) For instance, since 2001 BNSF and CSX have had an agreement to operate intermodal trains between Los Angeles and Atlanta. In 2006 this agreement was extended to include two trains per day in each direction.
North American demand. Better synchronization between global production with the output of manufacturing activities and a notable time gains, it is likely to favor a higher level of customization of the output of manufacturing activities and a better synchronization between global production with North American demand.

Decades. However, since transmodal operations result in globalization has already induced a major shift in recent centuries also play a role as expertise was developed to manage flows on the previous distribution system and may be difficult to adapt to the new one. The negotiation of new procedures and contracts are certainly tasks corporations are unwilling to undertake if the benefits are not readily apparent. The fact that the existing mode has a proven reliability, even if costly, will also play in delaying a potential modal shift.

A greater shift from road to rail facilitated by Thruport facilities could thus transform North American freight distribution (see Table 1). Time-wise, transcontinental rail shipments could drop from an average of five days to three days with management strategies able to track the movement of goods for the users. What is also particularly important for the shippers is the standard deviation of transmodal operations’ time. In addition to the benefits of reduced time, the time range of freight distribution is reduced accordingly, which implies that its reliability can be improved. For a shipper, a reduction of one day in distribution time is relevant, but if the reduction is not accompanied by a proportional reduction in the standard deviation (uncertainty), then the benefits are not substantial. Potential efficiencies in energy consumption are also notable, since intermodal rail is 3 to 5 times more energy efficient than trucking. Depending on the type of rail cars, locomotives, freight rail capacity, and condition of rolling stock, substantial amounts of diesel fuel could be saved.

The improved efficiencies that would result in North American rail freight distribution with more efficient transmodal operations also raise questions about their impacts on the geography of production and distribution. It can be inferred that such a system would jointly be a factor of convergence and divergence. For freight distribution, it would favor a convergence along the major gateways, hubs and corridors. The agglomeration of logistics and distribution activities next to a Thruport facility, in the form of a “freight village”, would give them direct access to a continental system of freight distribution. For the geography of production, potential impacts are difficult to assess since globalization has already induced a major shift in recent decades. However, since transmodal operations result in notable time gains, it is likely to favor a higher level of customization of the output of manufacturing activities and a better synchronization between global production with North American demand.

5.2. The case of Chicago

Chicago represents one of the most suitable locations for a Thruport. A very high share of the national containerized rail traffic, more than 13.98 million TEU in 2004 (Rawling, 2006), transits through the metropolitan area, which is a point of convergence of six Class I rail operators’ (see Fig. 7). About 70% of the containerized traffic entering Chicago by rail has a final destination that is more than 480 km away, implying a substantial amount of rail lifts. This gigantic rail hub handles about 1200 trains hauling 37,500 rail freight cars every day, which is approximately 50% of the American rail freight volume. About 17,200 lifts per day are performed at the rail terminals of the region (6.3 million per year), of these about 7500 can be considered as transmodal (Fig. 8). In addition, a high proportion (60%) of the traffic is of high-value, underlining the nature of the intermodal traffic handled by long distance rail servicing global commodity chains. Chicago thus acts as North America’s primary consolidation and de-consolidation center; the most important rail chokepoint.

To service these transmodal operations, about 4000 cross-town transfers are made between rail yards each day averaging 40 km each. This accounts for about 130,000 barrels per year in diesel fuel consumption. On average 15,000 daily trucking movements – pick up or deliveries – are performed at the intermodal rail terminals.

The rail terminals handling intermodal lifts within the metropolitan area have inherited locational attributes that well predates containerization. Most of them are located nearby the city core, are difficult to access due to local congestion and have limited room for expansion. The growth of intermodal rail traffic has induced the construction of new terminal facilities located away from the existing clusters, such as Willow Springs, Joliet and Rochelle (the latter is not shown on Fig. 7). This emerging configuration exacerbates transmodal cross-town movements since the average distance between terminals in increasing at the same time.

Modal issues are receiving the priority in improving rail operations, which is fallacious to an extent. For instance,

<table>
<thead>
<tr>
<th>Nature</th>
<th>Scale</th>
<th>Thruport effect</th>
<th>Potential modal shift</th>
<th>Potential energy savings</th>
<th>Potential time savings</th>
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<tr>
<td>Transmodal operations</td>
<td>Micro (metropolitan area; city logistics)</td>
<td>Direct (transmodal benefits); less short distance trucking</td>
<td>20–40% (depending on local rail terminal locations and configurations)</td>
<td>25,000 to 50,000 barrels of diesel per year for a large terminal (e.g. Chicago)</td>
<td>About 1 day (30% to 50%) of transmodal operations (from 1 to 2 days currently); Less uncertainties</td>
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<td>Derived efficiencies</td>
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<td>Substitution effect</td>
<td>Modal shift to rail</td>
<td>Macro (national; commodity chains)</td>
<td>Indirect (supply chain management); less long distance trucking</td>
<td>60 to 120 million barrels of diesel per year (United States)</td>
<td>About 2 days for landbridge shipments (from 5 days currently, including time savings from derived efficiencies)</td>
</tr>
</tbody>
</table>

Table 1

Potential impacts of a Thruport system

7 BNSF (Burlington Northern and Santa Fe), CN (Canadian National), CP (Canadian Pacific), CSX Transportation, NS (Norfolk Southern) and UP (Union Pacific).
UP and BNSF were completing the double-tracking of their California–Chicago transcontinental rail corridors which are expected to be completed by 2008. Some sections will even be triple-tracked. This added capacity is being contrasted with the difficulties faced by transmodal operations in Chicago, which leads to significant inefficiencies such as congestion and delays. In 2003, a strategy was set forward to improve the efficiency of rail flows in the Chicago metropolitan area. The Chicago Regional Environmental and Transportation Efficiency project (CREATE)
calls for the creation of five rail corridors, including one primarily for passenger trains, thus separating the traffic of commuter and freight trains. In addition, rail and road networks will benefit from several new grade separations, eliminating many delays and increasing the operational speed of both systems. Although CREATE is a clear step in the right direction, it does not tackle the essential issue of transmodal operations.

Finding an appropriate location for a Thruport facility is likely to be one of the most difficult tasks in its implementation since many interests are at stake and a “neutral” location remains elusive. A suitable location would involve the interface of different rail operators. A preliminary analysis of potential locations for a Thruport terminal (Rohter, 2006) identified six sites (Fig. 8). They either correspond to existing terminal facilities that could be expanded and converted or brown field sites (abandoned steel mills in this case) that have available land and good rail access. Most of the locations are along the Indiana Harbor Belt Railway, the largest switch carrier in the United States. It handles the great majority of the rail interchanges between the major rail carriers connecting to Chicago. A particular advantage of this line resides in its accessibility to all the major transcontinental rail corridors.

A significant caveat to a Thruport system concerns the use of direct unit trains that do not require reassembly, particularly in light of the growth of transcontinental rail traffic. This potential is however limited by the capacity of the rail facilities at gateways to assemble such trains. For instance, the capacity of Los Angeles’ rail yards, the most important gateway of the West Coast (San Pedro ports; Los Angeles and Long Beach) is very limited for such operations, unless a Thruport facility is established to handle the flows of the Alameda rail corridor. Transloading is increasingly viewed as a strategy to help alleviate the empty container problem (Prince, 2006), but this would require the development on new inland rail terminals with good rail and highway access. In such a setting, the growth of transloading opens additional opportunities for Thruports nearby major port terminals. Thus, two major types of Thruport facilities could emerge, one specializing in transmodal operations (a pure Thruport) and the other supporting transloading (a hybrid Thruport).

6. Conclusion: 21st century rail freight distribution

Aside from a remarkable evolution of maritime freight distribution, the transformation of inland transportation is an ongoing process that started with the setting of landbridges. After more than two decades of containerized rail corridors, North American freight distribution is facing acute inland capacity problems at its chokepoints. This situation is exacerbated by the realities of ownership fragmentation of rail networks. Fluvial transportation has a limited capacity to alleviate these chokepoints because of obvious geographical constraints, although some containerized attempts have been made where possible (e.g. New York).

In this context, the Thruport concept presented in this paper can be of strategic importance to mitigate the contemporary challenges in transcontinental freight distribution. It takes advantage of the strengths and weaknesses of each mode and enables them to service the distribution segments for which they are the most suitable. For rail, it offers a higher capacity (particularly with doublestacking), is more energy efficient, has fewer emissions, and involves lower labor costs. There are simply no other alternatives for continental freight distribution in North America. For trucking, its convenience, flexibility and point-to-point services are clashing with escalating wages and fuel prices, high insurance costs, and the shortage of drivers. A reduction in long distance trucking would go a long way to mitigate the labor issue by using the labor force more locally and more productively. There is a growing recognition by truck operators that rail is not always a competitor, but can become an efficient partner. Carriers are being increasingly supportive of a higher level of integration with rail. The evolution of logistics has made many of them view themselves as freight transportation companies rather than solely trucking companies. Any infrastructure improvement, whether highway or rail, that promotes their service or lowers their costs (insurance, wages, maintenance and repair of tractor trailers, capital investment, and solve the shortage of drivers) is likely to be accepted. Under such circumstances, the Thruport represents a unique opportunity to build more efficient intermodal relationships between rail and truck transport systems. As the Thruport reduces interchange activity at the current terminals, the railroads will have more operating real estate in terms of additional capacity to capture additional freight volume. Unlike most major transportation infrastructure projects, the Thruport and the new rail infrastructure has the ability to quickly achieve returns on investments because of efficiencies and cost reductions. This has the potential to attract much needed investments in modal and transmodal rail operations. It is however from the perspective of commodity chains that benefits can be derived with an increased velocity of the freight, leading to known advantages related with lower levels of inventory and higher turnover.

8 The Alameda Corridor is a 20-mile-long rail high capacity freight expressway linking the port cluster of Long Beach and Los Angeles to the transcontinental rail terminals near downtown Los Angeles. It was built to provide a better rail access to the port cluster which is the most important in North America both in terms of the volume and value of its containerized traffic. The Alameda Corridor consists of a series of bridges, underpasses, overpasses and street improvements that separate rail freight circulation from local road circulation.

9 For instance, J.B. Hunt, one of the largest trucking companies in North America, advertises itself as “The Transportation Logistics Company”. http://www.jbhunt.com/.
The Thruport could act as the foundation of a new continental rail freight system that is adapting to the realities of 21st century, notably a better time performance demanded by contemporary supply chains and higher throughput to handle growing containerized flows. This reality is also facing peak oil and surges in energy costs, challenging logistical practices and freight distribution systems. The higher the energy prices, the more demonstrable are the derived efficiency and substitution effects of a Thruport. A Thruport, or a system of Thruports, would help mitigate this ongoing paradigm shift in freight distribution. Once there are enough Thruports to accommodate the increased volume, railroad assets would be better utilized, multiplying the productivity of rail operations and conferring a rail freight system adapted to the requirement of contemporary shipping. A new equilibrium needs to be achieved between the major components of inland freight distribution in North America and elsewhere in the world.

References
