CONTAINERIZATION OF GRAIN: THEORY AND PRACTICE

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In theory, theory and practice are the same. In practice, they are not.
—Albert Einstein

The success of containerization in the past five decades is spectacular. "The container is at the core of a highly automated system for moving goods anywhere, to anywhere, with a minimum of cost and complication on the way" (Levinson, 2006: 2). The advantages of containers have attracted a growing range of products to switch from break-bulk or bulk shipping to containerization. The theoretical benefits of a containerization system of grain handling were set out by Prentice and Craven (1980), Prentice, Kosior and Thomson (1997) and Prentice (1998). It is useful to examine how the theory is being observed in practice, and where current trends are leading.

The first section of this paper sets out the logistical concepts that support the hypothesis for the modal shift of grain from bulk transport to intermodal ISO containers. This is followed by an examination of current practices in the United States and Canada. The penultimate section examines the regulatory and market conditions that determine the pace at which theory and practice become one. The paper concludes with some thoughts on the future of grain containerization.

Logistical Theory

As a relatively new area of study, it is unclear that logistics can be said to contain a body of theory. What does exist is a number of

concepts that guide the organization of supply chains. These logistical concepts can be used to evaluate whether or not changes are likely to lead to improved efficiency. In this case, the two supply chains being considered are the conventional bulk handling system for grain, and the emerging containerized system of grain handling. Some important logistics concepts proposed by Ballou (1992) are used to address the opportunity for containerization.

Mixed systems are superior to pure systems: The benefits of a mixed system become more obvious the greater the fluctuation in the volumes handled. The volume of grain entering the bulk handling system surges as the harvest commences and does not peak until the end of the fall months. Volumes then decline, with a few bumps, until the next harvest. While the annual pattern of fluctuation is predictable, peak demand depends on weather conditions.

The bulk handling system can never afford to offer the capacity that would accommodate the largest possible harvest demand because so much fixed capacity would sit idle during the remainder of the year. A mixed system with a containerized option could lower total cost and address the demand surge that occurs after harvest. This would enable the bulk system to achieve a higher rate of utilization over the course of the year and improve the opportunity for farmers to obtain market access at the peak demand (Prentice and Craven, 2000).

Variety exacts a price: Containerization of grain is not expected to replace the bulk handling system for lower value or generic products. Oilseeds and feed grains do not require segregation to maintain purity because they are going to be further processed in systems that have broad quality tolerances. The principal concern of oilseed crushing plants and cattle feedlots is handling cost. In cases where a bulk handling system can achieve acceptable quality consistency and economies of size, it will continue to dominate.

Where the bulk handling system begins to lose its advantage is when segregation becomes important. As the sophistication of buyers increases and the varietal differences provided by crop breeders expands, the number of products entering the grain handling system is

amplified. Variety multiplies the number of bins required to maintain product integrity and increases documentation costs. Handling small quantities of crops with specific attributes in containers frees the bulk handling system to move large volumes of more homogenous grain in fewer separations. It also assures that specialized products, such as certain oilseed varieties, do not get inadvertently mixed with the larger volumes (Prentice, Kosior and Thomson, 1997).

One size does not fit all: The bulk handling system favours a "push" rather than a "just-in-time" distribution system. The economies of bulk handling depend on moving thousands of tons at once. This could easily satisfy a small miller's demands for weeks, if not months. Receiving smaller shipments lowers inventory holding costs and offers the end user more flexibility to obtain raw materials that suit their needs more precisely (Vido, Prentice and Kosior, 2003).

Some agricultural markets operate with "bulk sales" of generic quality at low prices, and segregated sales of precise quality at very high prices. The beverage market (wine and whiskey) operates this way, but this is less common in the grain market. Some notable exceptions are organic wheat, and soybeans for the Japanese noodle production. In these cases the product is containerized. The ability to differentiate the product allows producers to obtain higher prices.

Delayed commitment: Profits can be maximized by shipping products as far as possible before committing to the final product form. This is done in many industries, the most famous being paint, which is all shipped white, and tinted after the customer has made a decision to purchase. In the case of grain, the ability to obtain particular attributes is lost as soon as the commodity enters the bulk handling system. While it is true that Canadian wheat has a reputation for high average quality, this comes at the sacrifice of blending very high quality with lesser quality. Some foreign millers might be happier to buy the very best wheat and blend it with their local product to obtain the desired flour quality (Prentice, 1998).

Total costs matter: Many logistical systems fall into the trap of sub-optimization because too much focus is placed on one cost at the

expense of the total costs. Shippers that compare only the costs of bulk shipping in railcars and ships to containers can easily conclude that the latter can never compete. However, the costs of storage, handling and inventory carrying costs need to be added to the comparison because the end-consumer must pay the total costs.

Bulk handling systems have large pipeline inventories because these quantities are required to load unit trains and bulk ships. Grain storage at country elevators and port terminals duplicates the storage that exists on farms. In container shipping, the heavier tare weight of the container has to be moved, but the container is also the storage bin. Moreover, containers move much more quickly through the logistical system meaning that less inventory in-transit needs to be financed. Finally, as previously mentioned, just-in-time systems minimize the carrying cost of the receiver (Kosior and Strong, 2006).

Repositioning an empty container adds to cost, but all grain hopper cars return empty, too. The advantage of containerization is the ease of moving freight in both directions. In some traffic lanes, containerized grain can move on the lower-priced backhaul leg.

The bulk handling system has indirect costs that containerization can avoid. Continuous handling causes breakage that opens the grain to quality deterioration and insect damage. Handling damage is accepted for the major grain crops, but is intolerable in special crops like lentils and beans. These products require handling on "flat belts" or in bags. Containerization eliminates damage that could make the product unsalable.

Containerization in Practice

When the containerization of grain was discussed 15 years ago, the largest container ship was in the 4,500 TEU range. Such ships now seem mid-sized, 10,000 TEU vessels are common, and ships as large as 16,000 TEUs are entering service. However, the economies of size in ocean shipping depend on vessel utilization. A downturn in economic growth since 2009 has left the shipping lines with excess capacity and changing traffic balances.

Lower backhaul freight rate opportunities emerge in traffic lanes with excess capacity. The need for return loads has kept westbound freight rates low for container traffic lanes between North America to Asia since the late 1990s. As a result, containerization of grain has been growing.

The examination of grain containerization practice is divided between the United States and Canada. Although the rail and port facilities are comparable in the two countries, differences in crop production, container traffic patterns and regulations are significant.

Prior to 2003, containers were mainly restricted to specialty crops that would not fill a hold in a ship, and feed ingredients like corn gluten meal, bone and meat meal. The containerization of grain in the U.S. began to pick up significantly in 2004 because of the spread that emerged between backhaul container rates and bulk shipping. The rates for bulk shipping responded to the strong demand for scrap metal, while the volume of empty containers returning to Asia became excessive. During this period, grain could be shipped in containers from Chicago at $35/40 per ton, while bulk rates at the Gulf of Mexico were $60/70 per ton. As a result, commercial bulk grain began to move in containers.[2]

The rapid growth of containerized grain exports lasted until 2009. The current state of grain containerization in the United States is observed in the USDA AMS report:

> In 2011, containers were used to transport 7 percent of total U.S. waterborne grain exports, up 2 percentage points from 2010. Approximately 11 percent of U.S. waterborne grain exports in 2011 went to Asia in containers, up 4 percentage points from 2010. Asia is the top destination for U.S. containerized grain exports—96 percent in 2011.[3]

Taiwan, China, Vietnam and Indonesia account for over half these shipments, but their individual shares vary by month.

Grain is transloaded into containers on the east and west coasts of the United States and at interior points that have excess empty containers.

A site visit to Chicago in 2012 revealed that three facilities accept truckloads of corn, soybeans and dry distillers grains (DDG – derived from ethanol plants) for transloading into containers. Two of the transloaders are located adjacent to the CenterPoint Intermodal Center container port, while the third is located with the CN container yard.

DDGs account for about half the grain exported in containers from the United States. This is explained by the surplus of DDG production arising from the ethanol fuel mandate and the difficulty of shipping DDG in bulk. Corn and soybeans are the other major containerized exports. Soybeans account for 30% of containers and corn represents about 20% of containerized exports.

Aside from the movement of identity preserved products, like soybeans for Japan, containerization is treated as a substitute for bulk shipping. DDG, corn and soybeans are transloaded into containers without liners, and shipped. Some concern was expressed about the potential for cross-contamination from prior shipments in the containers, but when the end use is livestock feed, and the amount of potential contamination is small in any case, the risk is considered to be minimal.

The motive for using containers is almost universally identified as price. During the boom years prior to the recession of 2009, the gap between available backhaul container rates and bulk shipping attracted increasing volumes. Since 2009, bulk shipping rates have collapsed and the container lines have become more alert to any price differences. Grain in containers must compete with waste paper, scrap metal and on the west coast lumber and logs. Grain may be more valuable, but these other commodities can be forced to pay more because they have no competition from bulk shipping.

When asked whether foreign receivers are willing to pay a premium for higher quality received in containers, transloaders' answer is "generally no". Buyers acknowledge that quality is better, and they like this aspect of containers. They are willing to pay a small

premium for containers of certain products (e.g. Number 1 Soybeans), but not for ordinary grain.

The places where containerization works best, in terms of source-loading inland, is at gateway locations with surplus empty backhaul containers, notably Chicago, but Memphis and Kansas City also compete with conventional bulk. Most grain transloaders are located at the ports. Inland shippers away from the gateways that would like to source a container have to pay a premium price for repositioning to their locations.

Inbound merchandise transloading practices encourage the loading of grain in containers at the ports. Asian import logistics costs can be reduced by transloading three 40-foot sea containers into two 53-foot domestic containers at the North American coast for shipment to inland distribution warehouses. As a result, more sea containers remain at the coast. This reinforces the logic of moving grain in bulk to the coast for transloading into containers.

In 2012, the Union Pacific (UP) railroad initiated a new "Plant-to-Port" transload service for grain and grain products at a facility in Yermo, CA. A unit train of grain is moved to the transloading facility where it is met with a unit train of empty containers from the Port of Los Angeles. After transloading, the containers are returned to the port for export shipment.

The competition between source-loading at Chicago, or sending unit trains to the UP facility is a question of backhaul rates. The Chicago transloaders retained a rate advantage in 2013 because container backhaul rates are lower than the equivalent hopper car tariff. While the UP has had some success, the short corn crop in 2012 cut potential volumes. Traffic at the Yermo facility is expected to increase in fall 2013.[4]

The Canadian experience with containerization of grain is different than the U.S. in several respects. DDGs are the largest source of grain products containerized in the U.S., mainly because they are in surplus and are undesirable to handle in bulk. Canada has no surplus DDGs,

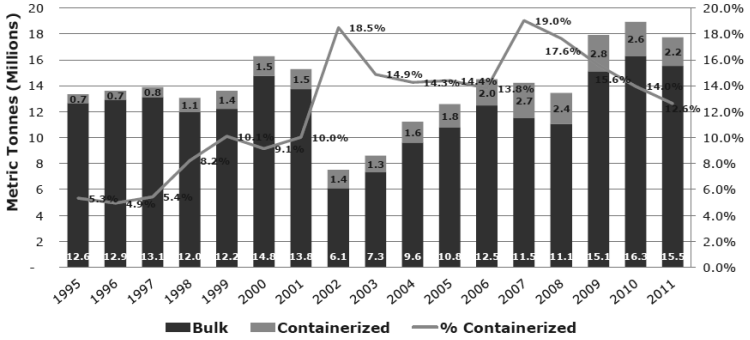
and the biggest crops are wheat and canola, rather than corn and soybeans.

Institutional arrangements are also different in Canada. Until the 2012/13 crop year, wheat and barley exports were under the monopoly control of the Canadian Wheat Board (CWB). The CWB focused on large customers and bulk shipping. While it delivered in containers at the customer's request, this was not a marketing practice it promoted.

Another Canadian difference is the growth of containerized "special crops". In an effort to diversify, and in some cases to avoid dealing with the CWB, Western Canadian farmers embraced new field corps like red and green lentils, yellow peas, mustard and canary seed. From small beginnings, cleaning plants sprung up on the Prairies and agricultural research increased varieties and yields. The seeded area of these crops now averages 5 million to 7 million acres annually in Saskatchewan alone.[5]

Figure 1 presents grain export data for Port Metro Vancouver (PVM) by mode of transport from 1995 to 2011. Containerization's share varied between 14% and 19% in the first decade.

Figure 1 1995-2011 Grain Exports Containerized vs. Bulk



Source: Port Metro Vancouver

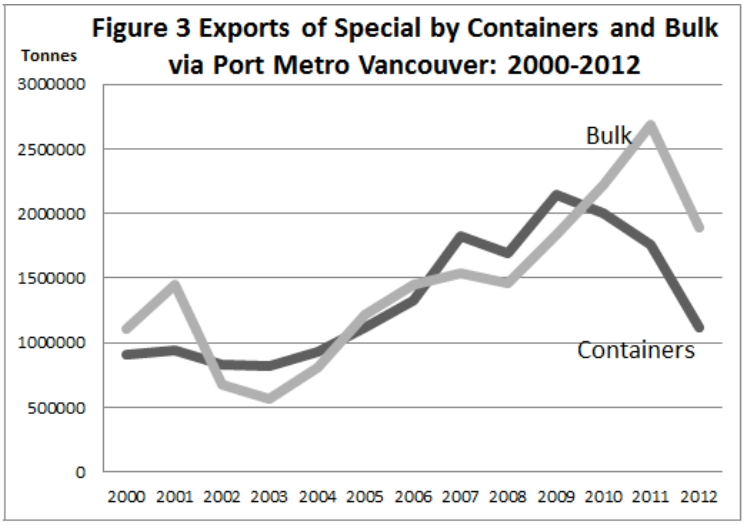
Since 2008, the percentage of grain exports in containers through PMV has been declining. This is consistent with the comments of transloaders in the United States who observe that the shipping lines now price backhaul container rates for grain with an eye to bulk shipping rates.

Figure 2 presents the Baltic Exchange Panamax Index from 2000 to 2013. Between 2003 and 2008, bulk shipping rates increased significantly, such that it was less expensive to move grain to Asia in containers than conventional bulk shipping. After 2009, bulk freight rates dropped to below the 2000 rate level. The container lines are also experiencing excess capacity, but container rates have recovered somewhat more since 2011 (Damas, 2012).

Figure 2 Baltic Exchange Panamax Index

Chart created with NeoTicker EOD © 1998-2007 TickQuest Inc.
Source: www.investmenttools.com

All the Canadian special crops (e.g. red lentils, mustard) can go in bulk to the large importers using "soft handling" technology. Special crop shipments through PVM are reported for both bulk and container exports. Figure 3 presents the data for the years 2000 to 2012. Containerized shipping increased significantly during the years when bulk shipping rates were rising rapidly. Following the recession when they fell dramatically, the shares in containers and bulk reversed.



Source: Courtesy: Port Metro Vancouver

Transactions costs are an important advantage for bulk handling. A 10,000 ton shipment requires the same amount of paperwork (letter of credit, B13, ocean bill of lading) as a single container. When the bulk rates are less per ton than shipping in containers, the economics favour large shipments that are split up at destination. When the bulk rates move up, container shipping increases because so many more buyers become accessible.[6]

The increase in the number of buyers intensifies competition. A bulk shipment in a Panamax ship may be handled by 5 or 6 large import buyers, who split up the cargo to supply many smaller domestic

buyers. When the product goes in containers, the number of buyers available expands to hundreds. This creates opportunities to establish niche markets and form new loyalties.

Inspection and grading costs, like the costs of transactions, favour conventional bulk handling. Grading is redundant for containerized grain because it is never mixed and can be traced back to its origin. The reason for grading is generally a case of the buyer and seller wishing a third party to adjudicate the quality. Depending on the number of containers, the inspections in Canada cost approximately $100 for 3.5 containers. In the U.S., the inspection fees are $1.50 to $2 per ton. This is about 10 times more than the equivalent inspection costs for bulk shipping.

Source-loading of containers in Western Canada is more expensive than transloading at the Port of Vancouver because of the repositioning charges. Although shippers prefer to load at source because of greater control over damage, security, etc the costs are unfavourable (MariNova, 2006). A new domestic repositioning program (DRP) has emerged following the changes in the cabotage restrictions on containers. This follows the theory as described by Prentice, Vido and Kosior (2009).

The railways now drop off 40-foot west-bound empty containers from Toronto at Regina, Saskatoon, Edmonton and Calgary for loading with grain. These containers are brought to Vancouver for transloading into 20-foot containers. The DRP containers replace boxcar movements that are slower and less economic. Whereas the boxcar might take two weeks to move from northern Saskatchewan to Vancouver, a DRP container from Saskatoon is delivered in ~4 to 8 days.

Reconciling Theory and Practice

Total Costs Matter according to theory, but in practice it appears that only the differential of costs between bulk and container shipping rates is necessary. Quality is appreciated, but the driver is price. With the world population at 7 billion, *One Size Fits All* is apparently the

case for the majority of the international grain trade. Better quality is nice, but few buyers are willing to pay higher freight rates for quality. The primary competition between container and conventional bulk handling of grain is price.

To the extent that premiums for quality are available, the driver is risk. U.S. grain shippers note that they can receive 10–20% price premiums over Brazilian soybeans because the grading and inspection system guarantees better quality perception. High food grade soybeans put through the conventional bulk system can be mixed with lower grade soybeans. Consequently, food grade soybeans are shipped in containers.

Delayed Commitment can forge new traffic patterns. In China, the containerization of feed is a means of addressing two problems. Space for intensive livestock production is becoming scarce at the coastal provinces. This is increasing the desire to move inland. At the same time, Chinese manufacturers want to move production to the interior provinces where labour is less expensive. The manufacturers need empty containers to ship out exports and the inbound delivery of feed in containers solves their repositioning problem. This could make feed a backhaul shipment all the way from the interior of North America to the interior of China.

Variety exacts its price, but the documentation and inspection costs are more for containers than the conventional bulk supply chain. This may also apply to traceability. In Canada, the system of Kernel Visual Distinguishability for wheat has been replaced by a certificate system. The certificate system seems to be operationally successful in the bulk system. For bagged products, and small volume shipments like organic wheat, however, containers offer lower overall logistics costs. This also applies to feed ingredients. DDGs are described as dusty, smelly and in volumes too small to fill a ship's hold.

Mixed systems are superior to pure systems. The availability of empty backhaul containers presents an opportunity to lower the total cost of moving grain to some export markets. Where empty containers are in surplus at inland locations, they are used, even if they just substitute

for conventional bulk shipments of corn and soybeans. Where containers are available for backhaul loads at the ports, the railways move bulk hopper cars of grain to the coasts for transloading in containers. At this point, neither the buyers nor the sellers may be maximizing the full benefits of containerization, but they are certainly seizing the opportunities to save money.

Future of Grain Containerization

Has the containerization of grain reached a point of maturity and will now be characterized by slow growth, or is a rise to a new level of container use only waiting for the next cycle of high bulk shipping rates to trigger increasing volumes?

No definitive answer is possible at this time. The success of grain containerization is highly dependent on backhaul freight rates, which is why shipments to Asia account for most of the volume. Container shipments to Europe, South America and Africa are generally only made for special crops that require higher quality handling. However, the direct substitution of conventional bulk for bulk in containers suggests that only the differential in shipping rates restricts the use of more containers.

The conventional bulk handling system is very mature. While some extra efficiency might yet be found, it is difficult to improve on unit trains and material handling systems. To the extent that improvements are possible in the bulk handling system, the capital barriers are significant. In contrast, the barrier to entry for transloading containers is low. The technology is simple and an efficient scale is easily reached. Any significant profit incentive is going to attract new entrants and more locations for transloading containers.

Competition between conventional bulk and containers has been moving in favour of containers for some time. The average size of container ships is continuing to grow and the absolute size may not yet have been reached. Bulk freighters may enjoy similar economies of size, but the diseconomies of inventory holding augers against larger shipments. The availability of low cost communications and lean logistics practices favour just-in-time delivery. At the present

time, the higher unit costs of transactions and inspections of containerized grain give the bulk handling system some protection. It seems only a matter of time however, before a new transaction system is developed for containerized grain that reduces these costs.

The impact on containerization of removing the monopoly of the CWB may be a useful indicator to watch. Australian exporters have been successful in shipping wheat in containers and their efforts have introduced the benefits of receiving small cargoes to buyers in Asia. Milling wheat is a desirable grain for containerization because its quality attributes are variety and location specific. Consequently, traceability and identity preservation are desirable. One crop year is insufficient to test the impact of the new marketing freedom accorded to Canadian wheat exporters. If significant volumes of Canadian wheat begin to move in containers, this will signal that the erosion of conventional bulk handling's share is far from ending.

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Endnotes

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[2] Personal interviews were conducted with two U.S. transloaders: Mr. Bo DeLong, DeLong Co. Inc. and Mr. John Roetter, International Transload Logistics

[3] http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5102367 accessed February 2013

[4] Personal interview with Matthew G. Bosch, UP Railroad

[5] *2011 Special Crop Report: Statistics*. Saskatchewan Ministry of Agriculture. www.agricuture.gov.sk.ca

[6] Personal interview with Brian Atkins, Western Transloaders