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Managing Returnable Containers Logistics - A Case Study
Part I - Physical and Information Flow Analysis

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Abstract This case study paper is the result of a project conducted on behalf of a company, hereon referred to as Midwest Assembly and Manufacturing or MAAN. The company's operations include component manufacturing, painting, and assembling products. The company also purchases a relatively large percentage of components and major assemblies that are needed to support final assembly operations. MAAN uses its own returnable containers to transport purchased parts from suppliers. Due to poor tracking of the containers, the company has been experiencing lost containers and occasional production disruptions at its facility well as at the supplier sites. The objective of this project was to develop a proposal to enable MAAN to more effectively track and manage its returnable containers. The research activities in support of this project included the analysis and documentation of both the physical flow and the information flow associated with the containers as well as some of the technologies that can help with automatic identification and tracking of containers. The focal point of this paper is on a macro-level approach for the analysis of container and information flow within the logistics chain. A companion paper deals with several of the automatic identification technologies that have the potential to improve the management of MAAN's returnable containers.

Keywords Returnable containers; information flow; third-party logistics provider; legal contracts and liability; automatic identification technologies.

1. Introduction

When compared to expandable containers or packaging such as corrugated fiberboard boxes, returnable containers can offer many long-term advantages. Haplin (2000) writes that specific advantages have contributed to the increased use of reusable packaging:

- Long-term and continuous operating cost advantage
- Reduced packaging material costs
- Reduced handling and packaging-related labor costs
- Environmental concerns, including recycling, reduced material usage and waste disposal
- Logistics concerns including pooling, outsourcing, standard load sizes and reduced transportation costs.

Haplin adds "Although the goals for reusable packaging systems are simple, taken as a set, they sometimes lead to a maddening complexity that appears to defy management. Without adequate container management your container assets may just be the most expensive one-trip packaging you can buy."

If not managed properly, the use of returnable containers can significantly raise logistics costs (Rosenau, W. et al., 1996). Twede (2003) captures, in part, the challenge of managing returnable containers: "Managing a fleet of returnable containers is harder than it looks. Companies which excel at inbound and outbound logistical arrangements have not been nearly so successful when it comes to managing their container fleets. Containers are routinely misdirected or lost, and they are rarely tracked in system-wide information systems. Yet it is vital to control such a large and constantly moving investment, to make it match supply and demand. The number of containers needed can be increased by several factors: longer stockholding by the receiver, reuse of the packages by the receiver, the receiver passing packages to another user, and failure to collect the empties and get them into a condition for reuse." Hanebeck and Lunani (2008) have summarized the inefficiencies resulting from improper container management:

- Container cycle time and handling costs
- Excess container inventory
- Container shrinkage and attrition
- Substitute cost.

The problems and inefficiencies outlined above, for the most part, also characterize the state of returnable container management problems experienced at MAAN. Most of the reviewed literature, including case studies, identified lack of visibility as the major contributor to ineffective returnable containers management (Dempsey, M., 2003; Hanebeck, C. & Lunani, M., 2008; Haplin, V., 2000; Johansson, O. & Hellstrom, D., 2007; Kroon, L. & Vrijens, G., 1995; Twede, D., 2003). The literature also focused mainly on the use of automatic identification and tracking technologies for improving returnable container management. While automatic identification can be instrumental in creating the visibility, it is essential that the flow of information and containers be documented and analyzed. Such analysis can then lead to potential proposals, including proper automatic identification technology that can address MAAN's difficulties with the logistics of returnable containers.

2. MAAN Company Overview and Research Activities

MAAN operates on a make-to-order basis and offers a wide range of options for its products. The company's operations include component manufacturing, painting, and assembling the final products. MAAN relies on a number of suppliers for components and major assemblies that are needed to support the final assembly operations. Many of the suppliers use MAAN's returnable metal containers to ship their products to MAAN's manufacturing site and warehouses. These containers are assets owned by MAAN and are designed and engineered to hold particular parts and prevent damages. When all parts from a container have been used, the container is then shipped back to the suppliers. These containers remain empty until the suppliers receive an order for the particular parts they manufacture. These returnable containers rotate continuously throughout the supply chain bringing the necessary parts to MAAN.

A typical supplier may sell the same parts to multiple companies, so the supplier, very likely, stores and uses containers from many different companies. Occasionally, MAAN receives containers belonging to other companies, and MAAN containers have been incorrectly shipped to other locations and never returned. Additionally, the lack of a system for tracking of containers has created a loophole for making anyone responsible for the loss of containers. MAAN may know it has shipped containers to a supplier, but may not know when or if the containers were ever returned. Even though the returnable containers are not used directly for production, they deliver the parts necessary for production and assembly. Therefore, they are an important component of MAAN's assembly operations. Poor management of the flow of the containers throughout the supply chain could slow or even halt production at MAAN and create storage problems and excessive material handling at the suppliers. The research activities to address problems associated with management of returnable containers at MAAN are summarized in Table 1. The remainder of this paper focuses on studying and analyzing the current system, addressing the problem, and developing recommendations.

3. Analysis of Current System and Problems

3.1. Overview of Current System

Empty returnable containers are either stored outside the MAAN facility or sent to a third-party logistics provider (hereon referred to as 3PL) to be stored. Containers are then shipped to the suppliers when necessary or when enough have been accumulated to ship a full load. At any given time, suppliers may have multiple empty MAAN containers on site. A part order describing part quantities is available through the MAAN Computerized Supplier Network or MCSN, which is accessed by the suppliers. The suppliers ship the parts to the site using containers owned by MAAN. Whenever an exchange takes place, a bill of lading is used. The signing of the bill of lading (BOL) legally transfers the ownership of the goods from one party to the next (West's Encyclopedia of American Law, 2009). Currently, a means to track or communicate the number of containers throughout the supply chain does not exist. The current list of containers is incomplete and inaccurate. When a shortage of containers is noticed, additional containers are manufactured, so MAAN must continuously make new containers to replace the ones that are lost or damaged.

Analysis of Current System and Problems	Research to Address Problems	Recommendations
• Overview of current system • Physical flow • Information flow • Contracts and liability • Physical containers count	• Communication feedback from suppliers • Potential liability contracts • Potential tracking technologies	• Communication and information flow • Supplier liability • Tracking technology

Table 1. Project Research Activities

3.2. Physical Flow through Supply Chain

The physical flow of a typical MAAN container through the supply chain is shown in Fig. 1. Once a container is emptied at the MAAN facility, it is shipped either directly to the supplier or to the 3PL. The 3PL working with MAAN is a third-party company providing logistics, warehousing, truckload and less-than-truckload (LTL) services. The 3PL has a facility in the immediate vicinity of MAAN and assists in storing empty containers and scheduling them to be shipped back to the suppliers.

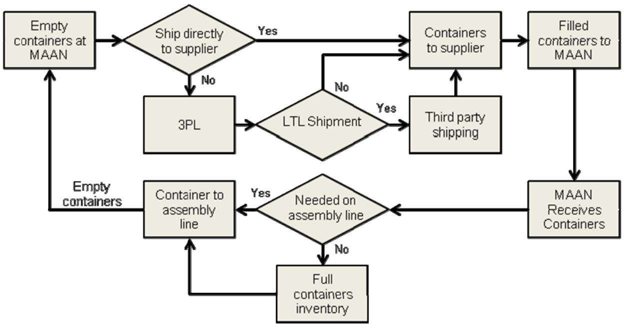

Figure 1. Returnable Container Physical Flow Diagram

If the 3PL receives a container, it is stored in an outside location until it is needed by the supplier. If the containers are needed on short notice, they can be expedited to the supplier on an LTL shipment. An LTL shipment uses any trucking company that has available space and is planning a shipment on a similar route. An LTL shipment can exchange hands multiple times before arriving at the supplier. If it is not an LTL shipment, the containers are sent on an engineered run (see the section titled Information Flow-3PL) which typically uses the 3PL-owned trucks. After the suppliers receive the empty containers, they are filled and shipped back to MAAN. The containers received by MAAN are either placed directly on the assembly line or stored in inventory for future use.

3.3. Information Flow – MAAN

The MAAN information flow is illustrated in Fig. 2 showing that the flow of information at MAAN begins with the purchasing department. Using the material requirement planning (MRP) system, the purchasing department generates the purchase orders and adds them to the MCSN. MCSN is a network that can be accessed from the internet by MAAN, 3PL, and the suppliers. MCSN alerts the suppliers of a part order and the delivery details. The supplier then submits a pickup request for the order. MAAN is alerted by MCSN to send a truck to the supplier. MAAN contacts a trucking company, giving them stop locations and instructions for shipment. If the trucking company needs to pick up empty containers for the supplier, a BOL is created and sent with the empty containers back to the supplier. Upon arrival of the empty containers, the BOL is signed by the driver and supplier. The truck is then filled with the returnable containers full of ordered parts. A new BOL is created for the shipment and sent with the full containers back to MAAN. The BOL is then signed by the driver and MAAN's receiving department as the containers with parts are being received. Lastly, the parts are added to the MRP system.

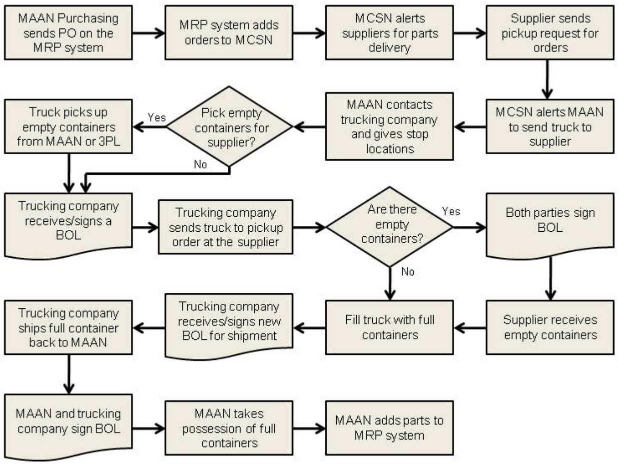

Figure 2. MAAN Information Flow Diagram

3.4. Information Flow - Logistics Provider (3PL)

The 3PL information flow is illustrated in Fig. 3. The flow of information involving the 3PL is networked to MAAN since it receives, ships, and inventories some of MAAN's returnable containers. Each morning, an employee at the 3PL physically counts the MAAN containers on hand. The shipping supervisor is then given the container count inventory sheet. Based on the inventory count, the supervisor determines which containers to ship to the supplier. Containers are chosen to be shipped if there are enough containers to make a full truckload shipment. The outbound shipment authorization paperwork must then be completed. The shipping supervisor also determines if the shipment will be an engineered or less-than-truckload (LTL) run. An engineered run consists of many partial shipments that are being sent to locations along a similar route. In contrast, an LTL run is shipped to a single supplier and most often the truck is not filled to capacity. Engineered runs are more cost-effective since the trucks are loaded to capacity and many destinations are served with one truck. LTL runs are selected in cases when parts are needed on a short notice, ensuring a quick delivery to the suppliers. From that point a unique BOL is printed to be shipped with the containers. If the containers are to be shipped overseas, an e-mail is sent to an external carrier to send a shipping container. The shipping container is then loaded with the empty returnable containers destined for the supplier overseas. If the supplier is located in North America, a truck is ordered through the MCSN system. All the documents are then compiled and sent to MAAN for its records.

3.5. Contracts and Liability

Currently, MAAN does not use binding contracts to hold the suppliers and shipping companies liable for damages or loss of containers. The only type of paper document that is transported with the containers is a BOL that documents the arrival and departure of containers. The document also includes the quantity of containers and goods that were transferred at each point, but this information is not communicated between the parties.
Once the containers leave MAAN, or the 3PL, MAAN does not know whether or not the containers successfully arrive at the supplier. The BOL may take a long time to arrive back at MAAN, or it may be lost in transit or misplaced. The lack of timely communication concerning quantities (or conditions) of containers arrived at the suppliers does not allow MAAN to hold anyone liable for the damage or loss of containers.

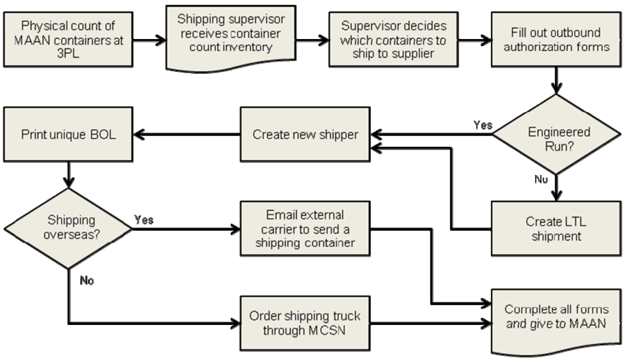

Figure 3. Logistics Provider Information Flow Diagram

3.6. Physical Container Inventory

As information was being gathered about the system, attempts were made to estimate and document the number of containers owned by MAAN, but conflicting data from various individuals resulted in different totals. After much effort, it was determined that this task of counting every container manually throughout the supply chain was nearly impossible. To contact all of the personnel required was simply too difficult. Also, even if an exhaustive list was created, it would provide only a snapshot of that particular moment in time and the list would soon become obsolete because containers are continuously created, scrapped, or lost. In the absence of identification and tracking system, it is very difficult to maintain an accurate count of containers.

3.7. Summary of Problems with the Current System

The analysis of the current system identified a number of problems in various locations, as shown in Table 2. The issue of locating containers throughout the supply chain is due to the lack of a system that can help with tracking and identification of containers. Many containers have been misplaced or lost because there is no way of tracking them. Replacing each lost container costs $1,000. Also, large quantities of containers are being lost due to a lack of supplier liability. Suppliers are not responsible or accountable for shipping MAAN-owned containers back to MAAN. The only form of contract in place is a BOL used to legally exchange the assets. Information pertaining to the number of containers that are sent from MAAN and the number received at the supplier is not communicated.
The lack of timely communication concerning quantities arrived at the suppliers does not allow MAAN to hold anyone liable for the damage or loss of containers. MAAN's current list of containers and quantities is approximately two years old. The list is inaccurate because MAAN has neither an identification system nor a tracking system. Containers are continuously lost and replaced by new ones. When the supply of containers is low, an order is placed for more containers to be manufactured. MAAN also lacks a viable cost-tracking method to document how many new containers have been ordered. Problems directly related to the 3PL also exist. Containers from several suppliers look similar, so distinguishing MAAN containers from others may be difficult. This visual difficulty may result in shipping the incorrect container to the suppliers. Due to the lack of formal job procedures at the 3PL, occasionally MAAN containers are misplaced.

	Locations		
Problems	**MAAN**	**3PL**	**Parts Suppliers**
Losing Containers	x		x
Poor Communication	x	x	x
Lack of Liability			x
Inadequate Containers in the System			x
Difficulty Locating Containers	x	x	x
Difficulty Identifying Containers	x	x	x
Inaccurate Count of Containers	x		
Lack of Containers Cost Tracking	x		
Shipping Incorrect Containers		x	x
Lack of Formal Job Procedure		x	

Table 2. Problems/Locations Matrix

An inadequate quantity of containers in the system is a major contributing factor to many problems. When shipping empty containers to the suppliers, planned engineered runs are rarely executed because containers and time to create a run are scarce. Lack of containers at a supplier forces an excessive number of LTL shipments. LTL shipments have a greater chance of losing or damaging containers because multiple exchanges occur before the containers reach the suppliers. LTL shipments result in increased shipping costs, material handling, and human errors due to multiple handlings.
Other problems are occurring at various MAAN parts suppliers. Occasionally, suppliers have difficulty

identifying and locating MAAN containers, so they use other containers to ship products. In the past, parts have arrived at MAAN on competitor-owned containers, and, likewise, MAAN containers have been sent to other companies. Once the containers are sent to another company, there is no way to know where they have gone and a minimal chance they will ever be returned. Poor communication is a problem across the entire supply chain. MAAN does not know how many containers are in transit or are stored at MAAN, the 3PL, and the suppliers. A supplier has no knowledge of how many containers are in transit and whether or not the available containers are adequate to ship parts to MAAN. The lack of containers has interrupted production at the supplier sites, as well.

4. Research To Address Problems

The research activities to address the problems were divided into three distinct areas of (1) communication feedback from suppliers, (2) exploration of potential liability contracts, and (3) identification and tracking technologies.

4.1. Communication Feedback from Suppliers

A brief survey tool was developed to solicit feedback from a group of randomly selected suppliers. The suppliers were asked to provide feedback about their communications with MAAN and the 3PL about containers shipping and receiving processes. The responses mirrored many of the concerns and issues that were addressed in the literature concerning returnable containers and included shortages of containers at the suppliers leading to delayed shipments, multiple handling of products, and increased production delays.

4.2. Potential Liability Contracts

A number of on-line documents provide examples and features of liability contracts that could be incorporated into the BOL (U.S. Air Force, undated; VICS, 2005; VICS, undated). The Voluntary Interindustry Commerce Solutions Association (VICS) offers extensive guidelines and detailed examples of a BOL. A contract could include a statement similar to the following: “The carrier or party in possession of any of the property herein described and listed below shall be liable as at common law for any loss thereof or damage thereto.” Additional statements and information can be included to contractually bind the supplier and ensure responsibility for the MAAN-owned returnable containers.

4.3. Potential Tracking Technologies

A companion paper (Maleki, R. & Meiser, G., 2010) which includes an extensive review of the literature provided the foundation for evaluating the suitability of different AutoID technologies for management of returnable containers owned by MAAN. The paper outlines the use and features of AutoID technologies that have potential for use by MAAN. Also included in the companion paper is an economic analysis that estimates the costs of the systems and annual maintenance as well as the potential savings that would result from reducing the number of returnable containers that are lost every year. The review of literature, performing economic analysis, and the feedback received from MAAN’s management, supports the notion that incorporating a tracking technology can improve visibility and effectively track containers throughout the supply chain.

5. Recommendations

Three recommendations have been identified for MAAN to address the problems associated with the management of returnable containers: (1) improve the current communication and information flow, (2) ensure supplier liability, and (3) implement a tracking technology.

5.1. Communication and Information Flow

The first recommendation for solving the container logistics problems at MAAN is to improve the communication and information flow throughout the supply chain. This core problem must be addressed before incorporating any other solutions. The area of the information flow that needs to be improved is the communication between MAAN, the 3PL, and the supplier pertaining to when and how many containers are being sent to the supplier. The supplier does not have knowledge of the quantities of empty containers being sent to them. When the suppliers do not have enough containers on hand, they email MAAN requesting more. At that point, it is too late for the parts to be shipped to MAAN on schedule.

A way to ensure that the suppliers will have an adequate amount of empty containers to fill the orders would be to implement container communication into MCSN. MAAN and the 3PL would enter quantities of containers being shipped to the suppliers. MCSN would alert the supplier how many containers are in transit. If the number of containers in transit is not adequate to fill the orders, additional containers would be requested by the supplier via MCSN. MCSN would alert MAAN and the 3PL that the suppliers do not have enough containers to fill the orders, so more containers could be sent. When the empty containers have arrived at the destination, the supplier would confirm the shipment in MCSN. When the supplier ships full containers back to MAAN, quantities would be entered in MCSN. MCSN would then alert MAAN that a number of full containers are being shipped to them from the supplier. MAAN would confirm the shipment in MCSN when it arrives. This additional information flow through MCSN would allow the supply chain to collectively know the number of containers in transit and when additional containers are needed.

To implement the communication and information flow recommendations, MAAN needs to incorporate the needed changes into the MCSN system that would allow for the capabilities detailed earlier in this section. After the changes to the MCSN are completed, there would need to be training for all of the employees of MAAN, the 3PL, and the suppliers that use the MCSN.

At the time of writing this document, there was no requirement to estimate the monetary costs and benefits associated with these recommendations. However, based on the feedback received from the MAAN's management, when compared to the savings resulting from the improved communication and information flow, the costs associated with incorporating changes to the MCSN would be minimal.

5.2. Supplier Liability

The current BOL lacks the proper language to hold suppliers liable for damages to, and losses of, containers due to their negligence. Also, based on the feedback received, it was clear that the supplier would not be liable since there is no way to prove exactly what container was lost or damaged. One way to ensure this accountability is to integrate a contract into the BOL stating the suppliers agree to accept full liability for any lost or damaged returnable containers. A simple modification to the current BOL would be adequate. A small section would need to be added stating that that supplier's signature on the bill means that the supplier agrees to pay for lost or damaged containers. With a contract in place, if a container is misplaced or damaged, the supplier would be responsible and contractually bound to reimburse MAAN for the value of the container. For the "supplier liability" recommendation to be effective, it is essential that a system for unique identification and tracking of the returnable containers be put into place.

5.3. Tracking Technology

The final component is to integrate identification and tracking technology into the system. It is first necessary to improve the communication flow and ensure supplier liability, and then incorporate a tracking technology. Compared to other tracking technologies, the bar code system automatic identification technology provides the optimal method to manage MAAN returnable containers through the supply chain. This recommendation, as detailed in the companion paper was based on a number of factors including compatibility with current system, implementation cost, and potential annual savings.

5.4. Recommendations Summary and Solution Matrix

Table 3 shows the problems/recommendations matrix identified as a result of researching the current system for the handling of returnable containers in MAAN. All of these problems were detailed in previous sections and their impacts at different locations; MAAN, 3PL, and suppliers were also highlighted. The matrix captures the impact of three recommendations on each of the problems. For example, the problem of losing the containers can be greatly reduced if an automatic identification and tracking system is implemented, a contract of liability is created, or the MCSN system is improved. Another example is that the problem with an inadequate number of containers at the suppliers can be reduced by improving communications and through the use of the MSCN system. Individually, each of the recommendations has the potential to improve the management of the returnable container system. Implemented as a group, the recommendations provide the greatest impact on the system by providing MAAN and its suppliers and the 3PL with better visibility and tracking of the containers throughout the supply chain.

6. Summary and Conclusions

This paper reflects a research project done on behalf of a manufacturing company that was experiencing difficulties in tracking and managing its returnable containers. The company uses returnable containers to transport purchased parts from some of its suppliers. The company does not have an effective system in place for tracking and locating these containers in the supply chain. The inability to effectively track the containers has created many problems and negatively impacted the company, its logistics provider, and suppliers. As part of the research project, the information and physical flow of containers through the supply chain were documented and analyzed. From the analysis, a number of problems and their relationship to the company, logistics provider, and suppliers were identified. The overarching problem was inadequate visibility of the containers throughout the logistics chain.

To eliminate or reduce the problems, three recommendations were proposed. One was to improve the communication and information flow by adding additional capabilities to the existing computerized supplier network, which could improve the continuous tracking of the number and locations of containers in the logistics chain. These improvements would result in more efficient planning by the company, the logistics provider, and the suppliers. The end result would be reducing shortages of parts, late shipments, and excessive transportation costs.

	Recommendations		
Problems	Improve MCSN	Liability Contract	Tracking Technology
Losing Containers	x	x	x
Poor Communication	x		x
Lack of Liability		x	x
Inadequate Containers in the System	x		
Difficulty Locating Containers	x		x
Difficulty Identifying Containers			x
Inaccurate Count of Containers	x		x
Lack of Containers Cost Tracking	x		x
Shipping Incorrect Containers	x		x
Lack of Formal Job Procedure *			

* *This was communicated with the 3PL during the early stages of this project. A recommendation was made to develop and implement standard job procedures to help with better tracking of containers.*

Table 3. Impact of Recommendations on Problems

At the time of conducting this project, the company was accepting the container losses and damages as part of doing business. The second recommendation was to implement supplier liability contracts through the incorporation of a legal statement in the bill of lading. Implementing a supplier liability contract can reduce the number of lost or damaged containers. With the supplier liability clause in place, the suppliers would be accountable for returning the company-owned containers and reimbursing the company the costs associated with loss or damage of containers due to their negligence.

The third recommendation was to incorporate an automatic identification technology to help with tracking the containers. Based on criteria such as implementation cost, compatibility, location capability, labor requirements, read range, and power requirements, the recommendation was made to use a bar code system for identification and tracking of individual containers. The analysis and documentation of different automatic technologies as well as selection criteria for recommending specific technology for the client company is the focal point of a companion paper (Maleki, R. & Meiser, G., 2010)

The three recommendations can improve the management of MAAN returnable containers. The recommendations, if implemented, will enable the company to track and locate the containers in the logistics chain, maintain an accurate container inventory, and reduce the number of containers that the company is losing. Collectively, these changes can minimize the total number of containers in the logistics chain, leading to a significant savings. The recommendations can also help the suppliers to improve their delivery and reduce the handling costs caused by multiple handling of the products. The recommendations can also reduce the transportation cost and occasional shutdowns caused by shortages of parts.

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