MIT Leaders for Manufacturing Program

Ford Pan-European Durable Containers[1]

Introduction

Europe is Ford Motor Company's second largest market in both vehicle production and revenues. In the last decade, the European governments have been very progressive in implementing environmentally friendly legislation. The European laws include costly disposal fees for expendable (cardboard) containers. In 1995, Ford furthered their Greening Strategy by replacing a significant number of expendable containers with the introduction of reusable durable plastic Folding Large Containers (FLC). A third party supplier, Durable Container Provider, leased and managed the process for the assembly plants and component suppliers. The empty FLCs are shipped from the assembly plant to the suppliers, where they are filled with automotive components, then shipped back to the assembly plants to complete one full cycle. In 1999, Ford introduced a smaller container, called the Folding Small Container (FSC). In 2001, the FLC and FSC pool size is approximately 210,000 and 20,000, respectively. The FLC/FSC Greening Strategy is a cost savings for Ford in the amount of millions of dollars annually.

Occasionally, the automotive component suppliers utilize expendable containers when durable containers are not immediately available. Automotive components cannot be delayed to the assembly plants due to the enormous costs of assembly plant production stoppages, which are approximately $15,000 per minute for Ford European assembly plants.[2] In addition, the European plants discourage expendable packaging because of higher total cost to the plant.

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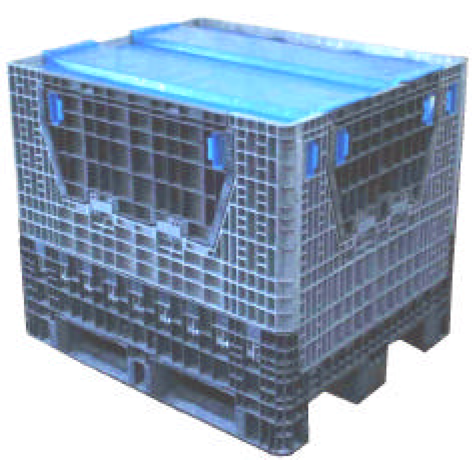
[1] This case was prepared by LFM Fellow Carmelo Anthony Palumbo under the direction of Professor Stephen C. Graves as the basis for class discussion rather than to illustrate effective or ineffective handling of an administrative situation. This case is based on the author's LFM internship and thesis, 2001-2002, under the direction of Senior Lecturer Donald B. Rosenfield and Professor Roy Welsch. All logistic and financial numbers are fictitious and do not represent actual Ford or any Ford supplier's logistic or financial numbers. To purchase copies, please contact the LFM Finance Office.

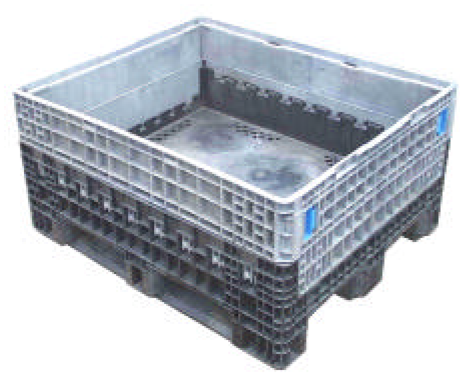
[2] Ford of Europe Manufacturing Finance

In early 2002, the multiyear FLC/FSC leasing contract was concluding. In June 2001, a core team (task force) was formed with the following deliverables: benchmark the existing contract and process, benchmark other industries, and issue a Best-In-Class specification for competitive bidding and sequential contract that eliminates waste and delivers optimal quality, cost, and time.

Folding Large and Folding Small Containers

The FLC and FSC are constructed with high-density polyethylene and share the same base with a width of 1.0 meter and a length of 1.2 meters. The FLC has a height of 0.975 meter and a weight of 63 kilograms, while the FSC has a height of 0.6 meter and a weight of 40 kilograms. Both the FLC and FSC have the same load capacity of 500 kilograms. The most efficient trailer volume utilization occurs with the FLC in the popular Megatrailer (also known as Supercube) that has a width of 2.45 meters, a length of 13.6 meters, and a height of 2.95 meters (the Megatrailer allows for 78 erect FLCs). The FLC/FSC has other advantages over cardboard, like its container wall strength and stackability. Utilizing the Megatrailer, the FLC can be stacked three high without the threat of collapsing under the weight of their contents. When automotive components are shipped in cardboard containers of equal size to the FLC, most often the cardboard containers can only be stacked two high resulting in one third less trailer shipping utilization. In addition, the FLC and FSC are foldable to a height of 0.4 meter to reduce empty container freight. The Megatrailer allows for 7 empties high, which equates to a full truckload of 182 empty FLC/FSCs. Since, FLC and FSC are similar in size and shipping capabilities, they are often substitutes for one another.





Durable containers are also advantageous for ergonomic issues. The FLC/FSCs are often found on the manufacturing shop floor tilted towards the assemblers, who may be subject to ergonomic back issues from excessive leaning. Durable containers made of plastic or steel have the container wall strength necessary to tilt heavy automotive components towards the assembler, as opposed to cardboard containers that may collapse. The fixed tilters will incline the FLC/FSCs approximately 30 degrees. Also, the FLC/FSCs have access doors with hinges and handles mounted into the sides of the containers to further address ergonomic issues.

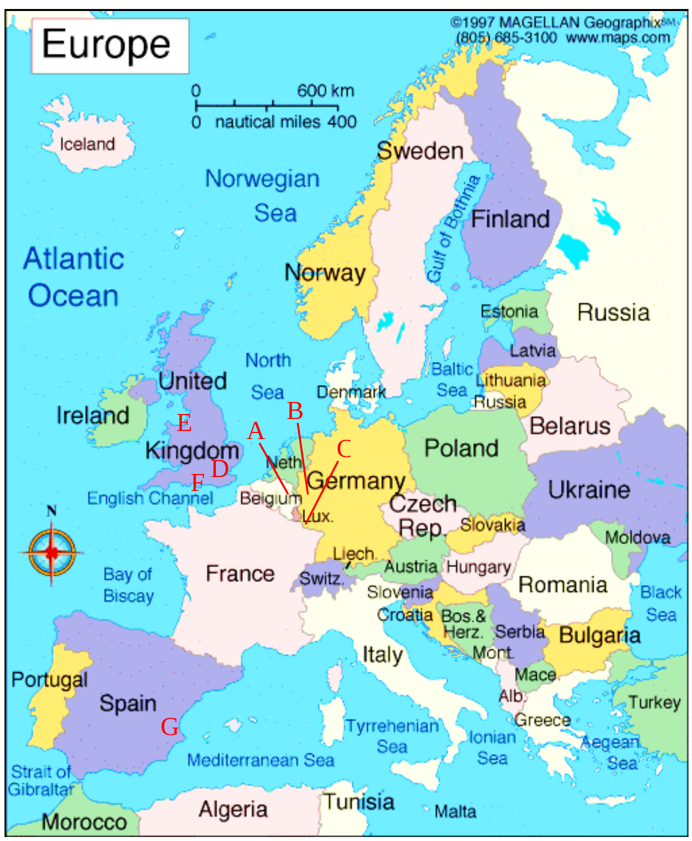
The automotive components are often stacked and separated within the FLC/FSCs by "dunnage", which are made of cardboard or plastic. The cardboard dunnage is recyclable. The plastic dunnage is usually collapsible and reusable, thus shipped back to the component suppliers. In 2001, approximately 10% of the FLC/FSCs utilized no dunnage and 90% did utilize dunnage – 88% of the dunnage was cardboard and 12% was plastic.

Process Overview

Throughout Europe, FLCs and FSCs (FXCs) are filled with automotive components by 270 suppliers and shipped to 7 Ford assembly plants. The containers are transported to and from the assembly plants by Ford transportation and their transportation supplier, Lead Logistics Partner. Many haulers transport containers filled with vehicle components from suppliers to assembly plants and transport empty containers and pallets back to the suppliers. At the assembly plant, the component carrying containers are distributed to the production line side for vehicle assembly. The empty containers are collected and sorted at the Empty Pallet Compounds, which are located on or near the Ford plant shipping docks. The Empty Pallet Compounds will store most of the empty container safety stocks, while other safety stocks are stored in nearby warehouses.

One main driver for a standard universal container is based on the empty pallet strategy, where you have a large pool with many different uses for many different industries and all stakeholders benefit from the standardization. When a container or pallet is empty, it is most cost effective to transport it the shortest distance for reuse by anyone. For example, an empty container or pallet traveling on a truck has little to no value. Usually, there is no need to ship standardized empty pallets across Europe or any long distance. The benefits of a durable container strategy with a large standardized container pool and empty container management resulted in the decision that a third party supplier (Durable Container Provider) should own, manage, and lease the FXCs to Ford and their component suppliers.

Ford assembly plants communicate with their component suppliers through an electronic link called the Common Manufacturing Management System (CMMS-3). The suppliers are aware of the projected build approximately a month in advance. The final component orders are confirmed one or two weeks prior to actual production via the Advance Shipping Notice (ASN). The suppliers will ship components in a variety of packaging including the FXC. As suppliers use FXCs, they will order empties from the Durable Container Provider. Communication is handled over the internet with the fax and telephone as backup communication links. The Durable Container Provider not only manages and tracks the containers; they also request empty container movements from the transportation group (Ford Transportation and Lead Logistics Partner). The component suppliers are advised to allow five days for processing plus the respective delivery time.



A – Genk, Belgium | B – Cologne, Germany | C – Saarlouis, Germany
D – Dagenham, England | E – Halewood, England | F – Southampton, England
G – Valencia, Spain

During the twelve months of June 2000 through May 2001, Ford of Europe produced 1.5 million vehicles. The models included Escort, Fiesta, Focus, Ka, Mondeo, and Transit. The production regions are grouped into three regions: German (Genk, Belgium; Cologne, Germany; and Saarlouis, Germany), British (Dagenham, England; Halewood, England; and Southampton, England), and Spanish (Valencia, Spain). The total FXC container movements over the same period were approximately 2.7 million. The number of annual container movements (2.7 million) divided by the container pool size (230,000) yields yearly turns of 11.7. This equates to 31.2 calendar days for cycle time – the amount of time a container takes to travel completely through the process. The European FXC process includes 270 component suppliers, located in 14 countries: Belgium, Germany, the United Kingdom, Spain, Czech Republic, France, Hungary, Italy, the Netherlands, Poland, Portugal, Slovakia, Sweden, and Switzerland. The component suppliers are grouped into four regions: Germany (Belgium and Germany), the United Kingdom, Spain, and the 4th region representing the ten countries of Czech Republic, France, Hungary, Italy, the Netherlands, Poland, Portugal, Slovakia, Sweden, and Switzerland. Container movements to and from German component suppliers represent 25% of the total movements. Container movements to and from the United Kingdom and Spanish component suppliers represent 24% and 21%, respectively. All other suppliers (using the FXC) located outside Germany, Belgium, the United Kingdom, and Spain represents 30% of the container movements. Vehicle production by the three assembly regions is as follows: Germany – 64%, Britain – 14%, and Spain – 22%. FXC movements based on assembly plant usage are as follows: German – 68%, British – 10%, and Spanish – 22%. The container pool requires FXCs to be shipped from region to region. The only region to be nearly balanced is the Spanish region where the Spanish component suppliers require 558,568 FXCs per year while the Valencia Assembly Plant requires 587,403 FXCs per year. The German suppliers require 677,403 FXCs while the three German assembly plants require 1,846,092 FXCs; therefore the German Empty Pallet Compounds, located within the three German assembly plants, have an excess of 1,168,689 empty FXCs that are shipped to component suppliers in non-German regions. The United Kingdom suppliers require 657,961 FXCs while the British assembly plants require only 266,505 FXCs; therefore the British assembly plants cannot support the United Kingdom component suppliers' requirements. The shortfall (imbalance of -391,456) results in the non-British Empty Pallet Compounds to ship 391,456 FXCs to Britain. The closest non-British Empty Pallet Compound to Britain is Genk, Belgium, which is part of the German assembly region. The Genk, Belgium plant is also the least expensive transportation route from the European continent assembly plants to Britain. The container imbalance requires attention to assure the component suppliers are properly supplied from the Empty Pallet Compounds. The region to region shipping not only requires more transportation resources (drivers, trailers, and diesel/gasoline) for the extra kilometers, but the region to region shipping requires more containers for the enlarged container pool to cover the extra shipping days during transportation.

Process Costing

Ford instructs the Durable Container Provider to maintain FXCs at the component suppliers in the amount equal to five days worth of production, while Ford pays the daily lease fees. Since the component suppliers use “free” FXCs instead of purchasing cardboard themselves, Ford receives the automotive components at a lower price. A cardboard box of equal size to the FXC with reinforced walls costs €23.

The cost of a new FXC is approximately €200. Assuming a five-year life cycle and 218 working days, the generic daily lease cost is €0.183. The annual Empty Pallet Compound real estate cost is €280 per square meter. The FXC has a base of 1.2 square meters and empties are usually stacked 14 high; therefore, the daily Empty Pallet Compound real estate daily cost is €0.110 per FXC.

A failure in the FXC process occurs when a FXC is not immediately available for the component supplier. If components arrive in any container besides the originally specified container, the non-specified container will cause some disruption in the assembly process. For example, the line side process expects a predetermined number of components per container. Material handling replenish intervals are based on components per container for the vehicle mix. When an expendable container is used instead of a FXC, the plant will incur extra handling and disposal costs. The cost impact for a FXC process failure is approximately €45 per occurrence, which includes the cardboard box, disposable fee, extra handling, and inbound freight impact.

Benchmarking

Supermarket Industry

The supermarket industry uses many plastic durable containers for a variety of products like frozen foods, vegetables, and fresh fish. The supermarket chains and their suppliers utilize the containers, while a third party durable container provider will manage the containers similar to the automotive industry. The relatively short shelf life of product poses some real challenges. The durable container providers in this industry usually charge the stakeholders relativity expensive daily lease (hire) fees to discourage the stakeholders from retaining containers, instead encouraging the stakeholders to turnover containers. The strategy of "hot potato" with the containers is necessary to reinforce the desired behavior of getting the product and container to market quickly. The supermarket industry requires intense cleaning of the containers after every use. Similar to the automotive industry, excessive handling of product results in damaged product, for example bruised tomatoes. The supermarket industry, like the automotive industry, will put containers and product directly on the shelf (line side) without re-handling. Unlike the automotive industry, the supermarket's end-user (customer) feels and smells the product along with the container that carried it to market. If tomatoes smell like fish from a poorly cleaned container, the supermarket customer would not purchase the tomatoes. From tomatoes to fish, the cleanliness of the product and container is very important to the supermarket industry. In addition, the container's color, size, and shape are all integral aspects of product marketing. The profit mark up on groceries is small, usually a few percentage points. With very little room for inefficiencies, the supermarket industry relies heavily on inexpensive internet technologies to track containers. The small profit constraints and short shelf life product make the supermarket industry a worthwhile benchmarking exercise.

Milk Industry

The American and British milk industries have done excellent jobs of implementing standardized milk packaging and containers (milk crates). The American milk producers have overcome a huge problem of milk crate leakage (loss/stolen). For many decades, the most popular bookshelf and furniture for American college students was plastic milk crates. American college students are not the only ones who have illegally used milk crates; milk crates have been found in many family garages. In the late eighties, American legislation placed $300 fines for stolen and unauthorized use of milk crates. The warnings were placed on every milk crate. Unfortunately, the warning and dormitory raids were not enough to overcome the market forces for the college bookshelf and furniture or the family garage storage bin. The need to pilfer milk crates by Americans was finally overcome with the help of department stores, who legally sell generic crates to the American public. The British addressed the leakage issue by standardizing a container that has plastic dividers injection molded into the design. The dividers not only protect the bottles from touching one another, but also render the milk crate virtually useless for anything other than transporting milk bottles.

With the leakage issued properly addressed, the American and British milk industries capture the greatest benefits of pooling a standard interchangeable milk crate. After milk cartoons and bottles are removed from the milk crate, the milk crate is mixed with other milk crates and no effort is necessary to sort the crate back to any particular milk producer. Most milk crates are treated as generic milk crates. A milk producer may or may not receive his crates back from the supply chain. The milk producers are satisfied with the one-for-one exchange and container deposit method where the containers are mixed, because they all are of equal value and usefulness. The milk crate is an excellent example of a standardized container pool.

Automotive Industry

Of the four industries benchmarked, the automotive industry has the most expensive containers carrying the most expensive products. Also, the automotive industry spends a significant amount of money to track the containers from location to location. These costs are becoming more affordable with the application of inexpensive internet technology.

Besides the FLC and FSC, Ford of Europe utilizes a variety of containers, including the smaller plastic container Klein Ladungs Traeger (KLT). Based on the number of parts, the container percentage breakdown utilized by Ford of Europe are: FLC/FSC – 25%, KLT – 55%, cardboard – 2%, and all other containers – 18%. Some automotive components travel across continents or even across oceans; for these travel routes, cardboard is a viable and cost effective container. Other containers include engine racks and specialized containers like stretched FLC bumper racks. Ford of Europe utilizes four KLT sizes that range from 0.009 to 0.067 cubic meters (0.3 to 2.4 cubic feet). The European KLT container pool is used most by Ford and General Motors, which represent usages of 30% and 60%, respectively. The remaining 10% are non-automotive applications. The automotive industry would prefer empty containers to travel the shortest distance back to component suppliers; hence, a large standardized pool with many uses is critical.

The automotive industry, like other industries, has leakage issues. One inexpensive method to address the pilfer issue is to sell containers within the assembly plants and component supplier locations. Ford Motor Company in Europe has three main plastic container colors: blue, black, and green. Since white containers are not used for automotive components, Ford Motor Company sells white containers at their general stores for non-production uses within the plants. The color distinction allows Ford to police their plants quickly for improper use of durable containers.

Removing Constraints and Encouraging the Right Behavior

Ford has also looked at other strategies to promote efficiencies and Best-In-Class in their supply chain. Automotive components are of higher quality and less expense, if they are handled the fewest number of times within the supply chain. Ford encourages the component suppliers to integrate the FLC and FSC as part of their Work-In-Process to help reduce their costs, since component suppliers' costs are an integral part of the larger Ford supply chain. Some suppliers may find it economically feasible to hold onto containers for time periods longer than five days. Unfortunately, the longer period of time that a component supplier holds onto a container, the less often the container is utilized (turnover) within the supply chain. The lower turnover demands a larger number of containers for the supply chain pool. Ultimately, Ford pays the leasing costs as a function of container pool size. The misaligned incentives have caused Ford and their component suppliers difficulties in the past. One train of thought was to dictate and constrain the component suppliers to the number of containers and to the length of time that they may retain containers. Dictating and constraining any process ultimately results in deadweight loss. The Ford core team reviewed this policy to determine a mutually beneficial scenario for all stakeholders, including the 270 component suppliers. The resulting policy was that the component suppliers would receive containers equal to five days worth of production at no cost to the component suppliers, while Ford pays the daily lease fees. If the component suppliers need containers greater than five days worth of production, then the suppliers must pay a small daily fee per container. Similar to the supermarket industry, the fees encourage the component suppliers to turnover the container assets. However, if the suppliers receive value from the containers being a part of their Work-In-Progress, then let the suppliers pay for the containers at a fair market price. The revenues generated from the supplier fees could be used by Ford to offset container lease costs or purchase more containers to increase the pool size. Thus, if suppliers hold onto containers resulting in a larger pool size, the supplier fees would self-fund the container pool size. Recognizing the fact that suppliers may need containers for longer periods of time and charging them appropriately allows Ford and their component suppliers to cooperate in harmony with the financial and process market forces.

The core team also envisioned a futuristic incentive strategy for the FXC process. The five "free" days worth of production containers that component suppliers receive is potentially constraining and wasteful. The "free" days means no cost to the component suppliers, while the Ford assembly plants pay the actual leasing fees for their component suppliers. The number of five days was determined years ago as an across the board buffer, since the component suppliers are located in many countries. A shared cost savings opportunity could exist for those component suppliers that can operate with less than five days worth of containers. The smaller amount of containers that a component supplier requires results in a smaller container pool, which reduces Ford's container leasing costs. Ford and their suppliers could remove a constraint and deadweight loss from the supply chain in synergy with their yearly objectives. More importantly, the organizational process solution permits Ford and their component suppliers a mutually beneficial cost saving opportunity that rewards participation.

Logistics Modeling

As previously mentioned, the FLC and FSC are similar in size and shipping capacity and often are substitutes for one another. If a component supplier does not have FLCs available but does have FSCs available, the FSCs would be used as temporary replacements, and vice versa.

If a component supplier had neither FLCs nor FSCs, the components would be supplied in cardboard and Ford would incur expenses of €45 per occurrence. The container substitution is problematic for Ford, but much less troublesome than dealing with cardboard boxes. In order to simplify the analysis, the FLC and FSC data is combined in Tables 2, 3, and 4.

Most third party container leasing contracts are based on a daily lease rate. The more containers in the pool, the more the Durable Container Provider could possibly earn in revenues. A FXC safety stock is needed to cover for variances especially during model launches, which have exceptionally high container variances. Too many FXCs would result in excessive daily lease and real estate costs. In addition, the regional container imbalance must be effectively managed. For example, the Valencia Assembly Plant had on an annual basis 28,835 extra FXCs, of which some were being shipped to the UK to offset their imbalance. Unfortunately, the travel time from Valencia to the UK is approximately 5 days. Fewer containers in transit would result in a smaller container pool. The preferable route for the UK imbalance would be from Genk, since this transit time is only 1.5 days. The extra Valencia containers could be shipped to German suppliers, who could in turn back feed the three German assembly plants, including Genk. What Ford needed was a holistic shipping template for the FXC process that addressed the container imbalance and delivered optimal quality, cost, and time.

Table 1 below contains the shipping times in days from the assembly plants to the component suppliers grouped by country.

Table 1: Transit Times In Days

Suppliers	ASSEMBLY PLANTS						
	DAGENHAM	GENK	HALEWOOD	KOELN	SAARLOUIS	SO'TON	VALENCIA
Czech Republic	9	5	8	5	5	10	8
France	4	4	5	3	3	4	4
Hungary	5	5	6	5	5	5	8
Italy	4	3	5.5	3	3	4	4
Netherlands	3	1	5.5	1	1	4	3
Poland	8	6	9	6	6	9	8
Portugal	5	5	5	5	5	4	2
Slovakia	9	5	8	5	5	10	8
Sweden	5	6	5	6	6	5.5	6
Switzerland	5	6	6	2	1	5	5
Belgium	2	4	4	1	1	3	3
Germany	3	5.5	5.5	1	1	3	3
United Kingdom	1	1.5	1.5	3	3	0.8	5
Spain	5	5.5	5.5	4	4	6	1

The component suppliers will fill FXCs as per the demand from the assembly plants. Table 2 contains the average daily FXC movements from the component suppliers to the assembly plants.

Table 2: FXC Movements from Suppliers to Assembly Plants

	DAGENHAM	GENK	HALEWOOD	KOELN	SAARLOUIS	SO'TON	VALENCIA
Czech Republic	14	178	0	44	309	27	186
France	17	624	24	40	678	126	388
Hungary	4	103	1	8	54	2	27
Italy	39	184	10	97	103	23	64
Netherlands	0	67	0	0	23	5	13
Poland	0	21	0	0	2	0	44
Portugal	4	21	1	9	22	2	36
Slovakia	0	5	0	0	2	0	1
Sweden	0	0	0	0	14	0	8
Switzerland	0	16	0	0	0	0	0
Belgium	0	61	34	2	326	0	40
Germany	148	845	0	358	794	57	436
United Kingdom	232	603	66	391	1,064	183	473
Spain	92	531	25	241	611	84	973
Average/Day for Europe	12,360						

Empty FXC transportation costs (per unit basis) from assembly plant to the component suppliers are listed in Table 3. These prices are generic shipping prices and do not reflect Ford nor their haulers actual prices.

Table 3: Empty FXC Freight Cost from Assembly Plant to Country

	DAGENHAM	GENK	HALEWOOD	KOELN	SAARLOUIS	SO'TON	VALENCIA
Czech Republic	€ 10.38	€ 4.51	€ 11.85	€ 3.82	€ 3.73	€ 10.97	€ 15.62
France	€ 5.54	€ 2.15	€ 5.68	€ 2.65	€ 2.15	€ 4.80	€ 7.99
Hungary	€ 15.18	€ 7.01	€ 16.65	€ 6.32	€ 6.22	€ 15.76	€ 15.62
Italy	€ 9.30	€ 5.05	€ 10.77	€ 4.46	€ 3.37	€ 9.89	€ 7.63
Netherlands	€ 6.09	€ 0.98	€ 4.90	€ 1.37	€ 2.37	€ 4.01	€ 9.81
Poland	€ 13.71	€ 6.86	€ 15.18	€ 6.23	€ 7.13	€ 14.30	€ 17.44
Portugal	€ 14.20	€ 11.75	€ 15.67	€ 12.31	€ 11.70	€ 14.78	€ 5.72
Slovakia	€ 13.71	€ 6.01	€ 15.18	€ 5.32	€ 5.45	€ 14.30	€ 16.35
Sweden	€ 9.89	€ 8.43	€ 10.57	€ 8.13	€ 9.25	€ 10.87	€ 23.00
Switzerland	€ 7.15	€ 3.26	€ 8.62	€ 2.67	€ 1.57	€ 7.74	€ 9.44
Belgium	€ 4.76	€ 0.12	€ 4.90	€ 0.56	€ 1.67	€ 4.01	€ 9.08
Germany	€ 4.90	€ 2.36	€ 6.36	€ 1.86	€ 1.43	€ 5.48	€ 12.71
United Kingdom	€ 3.88	€ 4.87	€ 3.93	€ 5.32	€ 6.43	€ 4.20	€ 16.35
Spain	€ 11.75	€ 9.57	€ 13.22	€ 9.34	€ 8.43	€ 12.34	€ 0.81

The amount of empties available at the Empty Pallet Compound depends on the container ratio per vehicle (Table 4) and the production standard deviation for that vehicle (Table 5). Some extra empty FXCs are necessary to act as the safety stock for the container process. The Dagenham Fiesta utilizes on average 1.13 FXCs, and the daily standard deviation is 63.38. The daily standard deviations in Table 5 below have been generated for educational purposes only and do not represent actual production standard deviations. Genk has artificially high standard deviations to represent the downtime occurred from a new model re-tooling and line speed acceleration.

Table 4: Average Daily FXC per Vehicle Model

Plants	DAGENHAM	GENK	HALEWOOD	KOELN	SAARLOUIS	SO'TON	VALENCIA
Models	Fiesta	Mondeo Transit	Escort	Fiesta	Focus	Transit	Focus Ka
FXC Ratio	1.13	1.86 2.06	1.00	1.12	2.33	2.06	2.33 0.93

Table 5: Daily Standard Deviations of Production Vehicles

Plants	DAGENHAM	GENK	HALEWOOD	KOELN	SAARLOUIS	SO'TON	VALENCIA
Models	Fiesta	Mondeo Transit	Escort	Fiesta	Focus	Transit	Focus Ka
Production Std Dev	63.38	151.25 49.10	16.10	55.60	96.62	44.27	37.95 25.42

Problem 1:

The component suppliers need to receive enough empty FXCs from the assembly plants to fulfill inbound demand to the assembly plant. Minimize the total empty container transportation cost while assuring enough containers to the suppliers.

Problem 2:

a) What is the overall lease cost for the empty container shipping routes of Problem 1?
b) What is the average leadtime for the routes of Problem 1?
c) What is the minimum leadtime possible?
d) Minimize total transportation and lease cost.

Problem 3:

a) Accounting for the container variability from Tables 4 and 5, develop a safety stock for each assembly plant to maintain a service level of 98% for the component suppliers.
b) How does the safety stock impact container pool size and transportation?
c) Develop for Ford a holistic FXC shipping template that addresses the container imbalance and delivers the optimal quality, cost, and time.