Expendable versus Returnable Shipping Containers at Toyota Motor Manufacturing, Indiana, Inc.

By

Thomas J. Goldsby
Assistant Professor of Transportation and Logistics
Iowa State University

Michael G. Goldsby
Assistant Professor of Management
University of Southern Indiana

Robert Martichenko
Contract Manager
Transfreight, Inc.

Brent Buschur
Assistant Manager of Logistics
Toyota Motor Manufacturing, Indiana, Inc.

This case study was prepared for the purpose of class discussion. All events, characters, names, conversations and data are fictitious.

ABSTRACT

In late 1998, Toyota Motor Manufacturing, Indiana, Inc. (TMMI) began manufacturing Toyota's first full-size truck, the Tundra. Before the first truck could be assembled on the line, however, fundamental decisions regarding the inbound logistics and terms of supplier operations and relations had to be addressed. Among the most critical – though often overlooked or assumed – decisions is the determination of the appropriate shipping containers for the delivery of parts and materials from suppliers. This case illustrates the debate surrounding the decision to use expendable or returnable shipping containers at TMMI. The case involves an in-depth quantitative analysis of three different alternatives, including the use of: 1) expendable containers with post-use recycling, 2) expendable containers with post-use disposal, and 3) returnable containers. Readers are encouraged to examine not only the quantitative and cost components of the decision but also the qualitative aspects that affect TMMI, its third-party logistics service provider and TMMI suppliers.

COMPANY OVERVIEW

In 1933, Kiichiro Toyoda converted his father's textile operation into an automotive manufacturing business. This marks the humble beginnings of what would become the world's fourth largest automaker by end of the twentieth century, Toyota Motor Corporation. Joined by his cousin, Eiji Toyoda, Kiichiro began by building passenger cars in the company's infancy. The manufacturer soon turned its attention to truck assembly, however, under order of the Japanese government to assist in the nation's emerging war effort. Toyota operations waned during the war as supplies became scarce. By the close of World War II, the young company found itself on the verge of bankruptcy with a war-torn assembly infrastructure and a cash-poor domestic market (Reingold 1999).

After the war, the Toyodas rejuvenated the company and again directed efforts toward the consumer market for passenger cars. In the early 1950s, production and efficiency guru Taiichi Ohno joined the company and helped implement the renowned Kanban System, the card-based mechanism that orchestrates the "pull" method of inventory management. Rather than pushing inventories forward in the supply chain based upon long-range sales forecasts, Ohno reasoned that only quantities demanded by end-users should be replenished – and only in the quantities depleted *when* they became depleted. This is the fundamental premise of just-in-time operations. Implementation of the pull philosophy minimizes waste, or "muda," of overproduction, time, motion and inventory. By the mid-1950s, the firm had devised efficient methods of large-scale production and introduced the first product of the Toyota Production System (TPS), the Crown. While the product was a hit in car-hungry Japan, sales were poor in large export markets, namely the U.S. A decade later, Toyota experienced much greater success in the U.S. with the Corolla -- a model that remains popular (Reingold 1999).

Today, Toyota is truly a global entity with production throughout North America, Europe, Asia, Oceania, Africa and Latin America totaling 1,645,000 units (projected fiscal year 2000) and sales of approximately 7.4 trillion yen (US$66.7 billion). Table 1 illustrates the company's production and sales volumes [all tables and figures are located in the appendix]. In an effort to further the goal of increased globalization of the company, shares of Toyota stock are now readily available to investors throughout the world. In addition to its existing listing on the Tokyo exchange, Toyota Motor Corporation stock began trading on the New York Stock Exchange (NYSE) and London Stock Exchange (LSE) in September of 1999.

North America has become not only the largest market for Toyota products but also the largest production base outside of Japan. The company operates five wholly-owned auto assembly plants and one joint venture (NUMMI) in the United States and Canada (see Figure 1). Among the newest facilities is Toyota Motor Manufacturing, Indiana, Inc. (TMMI), located just outside the southwestern Indiana town of Princeton. Toyota invested $1.2 billion in the two million square-foot facility to produce the company's first full-size, V8-powered pickup truck, the Tundra. Production of the Tundra began in late 1998.

A theme common to all Toyota operations, TMMI included, is the company's holistic approach to problem solving. TMC seeks the best possible outcome for all affected constituents. This philosophy is expressly stated in the firm's seven guiding principles:

1) Honor the language and spirit of the law of every nation and undertake open and fair corporate activities to be a good corporate citizen of the world.
2) Respect the culture and customs of every nation and contribute to economic and social development through corporate activities in the communities.
3) Dedicate ourselves to providing clean and safe products and to enhancing the quality of life everywhere through all of our activities.
4) Create and develop advanced technologies and provide outstanding products and services that fulfill the needs of customers worldwide.
5) Foster a corporate culture that enhances individual creativity and teamwork value, while honoring mutual trust and respect between labor and management.
6) Pursue growth in harmony with the global community through innovative management.
7) Work with business partners in research and creation to achieve stable, long-term growth and mutual benefits, while keeping ourselves open to new partnerships.

Source: "FY2000 Interim Unconsolidated Financial Results," www.toyota.com

These principles guide the company's relationships with its variety of stakeholders. TMMI embodies this philosophy in its relations with its 2,300 employees and the 132 suppliers that provide more than 2,000 parts that compose the Tundra. In addition, the role of the third-party logistics firm that facilitates the inbound logistics for TMMI is considered in every decision affecting the just-in-time movement of materials to the plant. The third party, Transfreight, Inc., is a joint venture formed by TNT Logistics and the Mitsui Corporation to exclusively serve the needs of TMMI and Toyota Motor Manufacturing, Canada, located in Cambridge, Ontario.

The primary topic of the case, the determination of the proper containerization method for automotive parts inbound to TMMI, is an example that directly impacts the plant, its supplier base and Transfreight. Prior to the startup of the Tundra production line, it was imperative that Toyota establish a standard method of containerization for inbound parts. The alternatives available included expendable (corrugated cardboard) containers and returnable containers (plastic totes). Each container material enjoys its own set of advantages. Corrugated material has served as the industry standard for decades while the use of returnable containers is only beginning to achieve appreciable adoption.

The next section presents a fictitious scenario of the business situation and illustrates the various perspectives maintained by the central stakeholders. It should be noted that all events, characters, names, conversations and data are fictitious.

BUSINESS SITUATION

Karl Mesarosh, TMMI's newly appointed Logistics Manager, was walking back to his office after lunch with his colleagues in the plant cafeteria when he ran into Toyota Purchasing Manager John Estes exiting the stairwell. “Hey, Karl, what’s this I hear about possibly moving to a returnable container system when we start up the line later this year?” asked John.

“Well, I’m not certain that it’s going to happen, but it’s something that I feel we need to take a close look at,” Karl responded.

“Do you have any idea how much this is going to shake up my supplier base? We’re just now getting them comfortable with the concepts of TPS and JIT operations” John replied, starting to raise his voice a bit.

“There's a meeting scheduled for next week. See if you can round up a representative sample of those suppliers. We’re going to have to view this thing from all sides to make sure we reach the best decision for everyone involved,” assured Karl.

“Yeah, you’re right. I’m sorry I got a bit worked up there for a second. I just hope we don’t end up with a revolt on our hands.”

John resumed down the hall as Karl climbed the stairs to his third floor office. He knew that next week's meeting would give all parties involved an opportunity to share their views on the containerization decision to be made. For now, he could only wonder how the eventual decision would impact TMMI's logistics and supply chain operations.

It was a week later, and Karl was now entering Conference Room #314, the site of the meeting. He saw several very familiar faces seated around the table. To his immediate left was Brandt Baughman, the Contract Manager for Transfreight. Seated at other positions around the table were representatives of TMMI and its key suppliers. While informal conversations among the representatives suggested that all groups would cooperate in reaching a consensus, it was clear that deep concerns surrounded the containerization issue that was sole agenda item of the meeting.

At 10:30 a.m. sharp, Toyota Packaging Engineer, James Briscoe, broke away from a conversation, went to the front of the table and announced, "Hello, everyone. Let's get started, please. First of all, I would like to thank all of you for coming to today's meeting. We're going to examine an issue that might be overlooked by many businesses, but it is quite clear from the conversations that I've had with all of you that that is not the case here at Toyota. Specifically, I'd like for us to discuss whether to use expendable packaging or returnable containers in our upcoming truck production. I know you've all got some thoughts on which method of packaging should be used by Toyota, so I'll now open the floor for discussion."

Dave Jones, plant manager at one of Toyota's suppliers, Blues Incorporated, spoke up immediately, "I'll tell you straight up. Going with returnable containers is not a good idea, and I think most of your other suppliers would tell you the same thing." Representatives from a few other suppliers nodded approval to Dave's statement.

"Why's that?" asked James.

Dave responded, "We're serving two other major customers that do not, and may never, use returnable containers. That would force us to use expendables with some suppliers and returnables with you. Besides, our system is not set up for it. We really have no place for storing the returnable containers, so we'd have to reorganize our floor space…"

Steven Dobson, a quality manager from Missouri Industries, cut Dave off in mid-sentence, "It also costs too much money to do. If you're going to make containers that will hold up shipment after shipment, that's going to require them to be pretty sturdy. That also means that we'll spend a lot of time just designing and developing the containers. I just don't think it's cost- or time-efficient. Plus," Steven added a little under his breath, "my sister Susan works at Smith Corrugated Products, so sometimes we get a good discount on expendable boxes."

"That brings up a big question in my mind," snapped Bluegrass Industries' Carole Boyd as the chuckles died down from Steven's last comment. "Who's going to pay for these things?"

James eventually broke a few seconds of silence, "Well, you, our suppliers, will be expected to buy the containers, but you bill us back on a prorated basis with each shipment of parts until the balance of a container's cost is paid in full. We've conservatively estimated that the average life on the returnables will be about three years. You should see the full investment returned to you within twelve to eighteen months. We'll let the accountants figure out the exact rate basis for the payback, but rest assured that you'll recoup

the investment in a timely manner." Once convinced that the group was satisfied with his response to a mission critical inquiry, James continued. "Carole, Steven and Dave have made some good points. It does sound a bit risky switching to returnable containers," James said. "Does anybody think there is anything positive about using returnables?"

Mr. Maruhito, a production engineer, spoke up, "I do, James. I'd like to stress to all of you that here at Toyota we're committed to environmentally friendly production methods. We will be seeking ISO 14001 certification very soon, and that is something very important to us." He then stepped up to the overhead projector and placed a transparency on it [see Figure 2]. Mr. Maruhito continued, "The returnable containers are more consistent with our environmental policy. These containers will dramatically cut down on waste by repetitively being put back into the production cycle."

"But why can't you just recycle the expendable cardboard containers?" quipped Ivis McNeely, customer service manager for Bluegrass Industries. "That's what our other customers are currently doing. They can sometimes generate a nice return on the recyclable material when the market is good."

"That's true," Mr. Maruhito responded. "However, as James has pointed out, we think that we can easily expect a three-year life from a returnable plastic container. Meanwhile, a corrugated container is good for only a single use, perhaps a three-*day* life in our system, before it must be reprocessed and made useful again in some form. So, from a life cycle standpoint, the plastic totes are much more energy efficient by staying in the use-reuse cycle for extended periods of time. So, while we might be able to keep corrugated materials from the landfill, their use would still require much greater energy consumption, and perhaps greater cost – especially when the market price for recyclable corrugated material plummets, as it has been known to do on occasion."

Mr. Yamashi, a quality engineer, then spoke up. "While the environmental aspect of the chosen container is very important, let me also add that the container can significantly impact our manufacturing productivity. For example, it would be much easier for us to plan our production scheduling if we use returnable containers. The handling of corrugated boxes can be very time-consuming and inconsistent. The line workers must move the box to the line from an inconvenient distance, because they do not stack well. Then, the box has to be cut open, which takes time."

"Oh, it surely doesn't take much time to use a box cutter and slit the top of a container open," said Cindy Brewer from Reds, Incorporated.

"Maybe not with regard to an individual box," responded Mr. Maruhito. "But, let's assume that you have 60 assembly line workstations, each opening 50 containers per day. If it takes only 20 seconds to get a box cutter, open a container, and store the instrument for its next use, over the course of the line you have dedicated 1,000 minutes of each day to merely cutting boxes open."

Brandt Baughman of Transfreight added, "True, true, and if I may, I'd like to add to Yoshi's point. From a quality standpoint, we've seen from a handful of suppliers at Toyota Motor Manufacturing Canada that have already made the transition to reusable containers that damage is significantly reduced. The plastic totes are sturdier than corrugated boxes. Plus, they will stack better, allowing us to improve the cube of our vehicles. I guess that sometimes you have to do what's good for the whole even if you hurt some of the parts."

Kevin King, a truck driver for Transfreight, shook his head. "You know," said Kevin, "I've driven trucks for thirty years, and I'll just be honest with you. This is *never* going to work. We were talking with our planners and traffic coordinators at Transfreight, and they told us that we might have to actually unload the empty totes at every stop along our route so that loaded totes can be added to the shipment. It could take up to thirty minutes on that first stop of the day to unload a trailer full of totes, load the supplier's parts and then reload the totes that belong to other suppliers. Our pickup windows are going to be tight enough as it is! Hey, I'm for protecting the environment and all, but we've got to keep things within reason. We all have a job to do, and I think you better consider real strongly whether switching to these reusable containers is worth the hassle."

James turned to Jake Miller, general manager of Kentucky Industries in Frankfort, and said, "Well, it might be helpful if Jake said a few words to us about his thoughts on returnable containers. As Brandt alluded, TMM Canada has been experimenting with returnable containers the last couple of months, and Kentucky Industries has served as one of the suppliers during these trial runs. Jake, what are your thoughts so far about the usage of totes at TMMC?"

"Well, I'm pretty much won over by the returnable containers. We don't have to spend as much time dealing with waste, and the totes are sturdy, but I'm not convinced everyone at Kentucky Industries is as satisfied with them as I am."

"How's that?" asked James.

"For one thing, expendable is still cheaper in the eyes of many at Kentucky Industries. 'Sure, we save some manpower with the returnables,' they'll say, 'but corrugated products have been around a long time, so we should be able to get the boxes much cheaper than the totes.' Plus, we run into another problem."

"What's that?" asked James.

"I have one employee, Freddie, one of our best lathe operators, who threw his back out trying to pick up one of the totes. He probably should have gotten some help, but he thought he could do it alone. The totes misled him, because most of the corrugated boxes don't have grips cut into the side. They're either picked up from underneath by the line worker or moved by forklift. Well, the tote that Freddie tried to pick up had wide grips, so he thought it was a one-person job and the weight of the container was more than he could handle. He's not been too happy pushing a broom around the last couple of weeks, I can tell you that!"

"I bet," chuckled James. "Any other problems?"

"Well, we're always losing a few totes. Every day some disappear, and that causes a few headaches for our inventory staff. I think some of the workers are using them for toolboxes and beer coolers in their home garages, but the biggest problem I see is what could happen in the future. If we should ever run low or completely out of totes, it would shut down production. We can't produce parts if there's nothing to put them in at the end of the line."

"That *is* a problem," said James.

Jake continued, "This is all new territory for most of us. It's hard to get the employees used to these 'just-in-time' concepts. What may work well inside a Toyota plant, can be tough for our employees to understand and deal with. It's clear that the TPS idea of 'lean' operations applies not only to the auto parts but also to the containers used to ship them. I'll be honest, we'd like to have about twenty percent more of the containers on-hand just to be safe but Toyota doesn't approve those extra containers… and won't pay us

back on those extras. Getting away from these cushions is a tough mindset for all of us to change. Hey, I'm all for the returnable containers, but I still have a lot of work to do selling the idea to my people. You might want to consider this when you make a decision."

"We'll do that. Thanks, Jake, for sharing those insights from your experience," said James. "I know your comments today will prove very helpful to us."

The meeting proceeded in diplomatic fashion until 11:55 a.m. The proponents of both methods had made some very good points, oscillating from strong fervor for the traditional expendable packaging to impassioned appeals for new returnable containers. It was clear, however, that at this point, due to the complexity of the situation and midday hunger, the attendees were ready to end the meeting and discuss it more informally over lunch.

James stood up and said with a smile, "This meeting has been very beneficial, I think. It's clear that we're going to have to take a team approach to this problem, as we always try to do here at Toyota. Does anyone have any concluding thoughts you would like us to ponder before we break for lunch?"

Patti Kirk of Reds Incorporated had been quiet throughout meeting, but it was evident she had something she had wanted to say during the last hour. Patti tapped the table with her palm, looked Mr. Briscoe directly in the eyes, and said, "James, you know, I've heard some interesting points made about returnable containers today, but I've been using expendable containers for forty-one years. That's longer than you've been alive. Now that's the way we've always done it, and don't you think that if there was a better way it would have been done by now?"

"Maybe," said James, "maybe." After a brief pause for further comment and receiving none, James concluded, "Well, I'd like to thank you all for coming to this meeting today. Feel free to contact me if you have any questions about this topic. I'll send out an announcement about our next meeting later in the week. Thanks again."

After everyone had shaken hands, the meeting's attendees began exiting Conference Room #314 and headed for the cafeteria. Seth Burris, a logistics engineer, turned to a clearly exasperated Mr. Mesarosh, "That was a great meeting, Karl. This isn't going to be an easy decision. These were some really sharp people making some good points for both sides. We've got a lot of thinking to do."

"Indeed we do," said Mr. Mesarosh. "We can't run a single truck off the line without a well thought-out answer to this container decision."

Over the course of several more meetings and discussions among suppliers, Transfreight and TMMI, a cross-functional team consisting of managers from each organization was formed. The Tundra Packaging Team (or "T-Pack" as it became known) was given the assignment of recommending a containerization system for the new truck line. Reasoning that logistics serves as the boundary spanning activity within and across the represented organizations, Mr. Mesarosh was asked to serve as the team leader. Karl looked forward to his new, challenging responsibilities at TMMI that included regularly interfacing with Toyota purchasing, manufacturing, customer service and packaging as well as directly with suppliers and Toyota dealers worldwide. Leading a team of

supply chain partners to make a decision central to the new truck's success seemed like an ominous task to Karl… especially after only one month on the job.

PROBLEM DEFINITION

Undeterred and realizing that TMMI was only three months away from full-scale operations, Karl knew that an in-depth analysis comparing the different container alternatives was imperative. The analysis would have to be thorough and objective but also expeditiously executed. Given the time constraints, Karl also knew that the study could not embody the more than 130 suppliers that provided TMMI with its 2,000 Tundra parts. The analysis would also have to focus on a small number of containers and not examine all 300 containers and racks used by the plant.

The T-Pack team identified three alternatives as possible solutions to the containerization problem. The first two alternatives involve the adoption of expendable packaging. One possibility is for suppliers to regularly purchase corrugated containers and for TMMI to recycle the containers after they have been used at the Tundra plant. Another possibility is to dispose of the used materials in a nearby landfill. The first step in the quantitative analysis of these alternatives is to determine the number of expendable corrugated containers used annually by TMMI. Upon making this determination, the team can then calculate the annual cost incurred by suppliers, Transfreight and TMMI in each alternative. Finally, the costs incurred by each set of supply chain partners can be summed to determine the system-wide annual cost of the respective alternatives.

The third alternative is to require suppliers to use returnable shipping containers. Rather than using corrugated packaging, parts would be shipped from supplier locations to TMMI in plastic totes (of equivalent size and capacity as expendable counterparts). After use at TMMI, Transfreight would return the empty totes to their respective supplier. Like the two alternatives above, the first step of the quantitative analysis is to determine the number of returnable containers each supplier must purchase. The next step is to calculate the annual cost incurred by each partner in facilitating supply chain operations with the totes. Finally, the team must determine the system-wide cost of this alternative by summing the independent costs of suppliers, Transfreight and TMMI.

While the quantitative cost analysis would be an important element of any recommendation the team reached, Karl knew that the best alternative would not necessarily be the least cost alternative. The team would have to examine the issue from all sides to ensure that the recommendation was best for Toyota and the long-term success of supply chain partners. In addition to interviewing TMMI personnel and employees of its parts and service suppliers, the team visited other Toyota manufacturing facilities and their suppliers to gather the necessary data for the analysis. The specific information gathered over the course of these interviews and site visits is contained in the following section.

ANALYSIS AND ALTERNATIVES CONSIDERED

Karl concluded that several assumptions would have to be made to guide the analysis of the three alternatives. The T-Pack team devised the following assumptions:

- Container demand and operations cost figures are based on an annual production volume of 102,000 Tundra trucks. Assume evenly balanced production over the course of Toyota's production year.
- Toyota's production year covers 51 weeks, 5 days each week, for a total of 255 days. The average daily production volume is 400 trucks.
- The dimensions and carrying capacity of part-specific containers are uniform across the two container materials. For instance, expendable and returnable containers designed for windshield wiper blades would have a similar appearance and hold the same number of blades regardless of container material. Differences between expendable and returnable containers of a given container type would be limited to the weight, durability, damage protection and cost of the container.
- Totes owned by a given supplier must be returned to that supplier. Totes cannot be commingled or shared among suppliers. Totes will be hot stamped with the supplier's name and company logo on the side.
- The same number of customer pickups at the supplier locations (facilitated by Transfreight and destined for TMMI) will be made regardless of the container alternative.

The team decided to examine the prospective usage of four different, common container types. The term "container type" refers to the outer dimensions (length x width x height) of the container. Expendable and returnable containers with the same dimensions are identified as the same container type. As noted above, different parts have unique dunnage (product protection) provisions and, therefore, independent demand. Table 2 provides a comparison of the various shipping containers to be examined in the analysis.

Karl and the T-Pack team also decided to focus their efforts on five key suppliers. Tables 3 and 4 provide information regarding these suppliers, the Tundra parts each supplier manufactures, and their usage of the four container types. Additional information critical to the analysis is provided in the notes below Table 3. Information specific to each alternative is illustrated in the following sections.

Alternative 1: Expendable Containers, Recycling

This alternative requires suppliers to use expendable corrugated containers for shipping parts inbound to TMMI. This is the packaging method that virtually all TMMI suppliers are using to serve current customers. Upon using the container at TMMI, the plant would then gather a week's volume of used containers and ship them to a recycler location.

To determine the number of containers to be used *each year* by Toyota and its five suppliers, the team learned that the following quantities must be calculated for each truck part:

- the number of pieces used per day for each part;
- the number of containers required to meet each part's daily usage (these are referred to as "cycle containers"); and
- the number of buffer (extra) containers to maintain in case of a container shortage at the supplier location.

Suppliers are allowed to maintain a five-day buffer of containers for each part in addition to the cycle containers dedicated to normal usage. The use of the buffer supply is never anticipated and maintained only in case of emergency purposes. The number of buffer containers to purchase should be rounded up to the nearest whole number when a partial unit is determined.

Once the number of cycle containers consumed over the course of the year and the number of buffer containers required for each part are determined, the two figures are added together to determine the total number of containers required for that part. This process is repeated for each of the suppliers.

After the suppliers' annual usage level of each container type is determined, attention can then turn to the cost analysis. Given the container counts calculated in the previous stage of the analysis, the annual cost of procuring the containers can be generated. Aside from container procurement, the suppliers are responsible for handling the containers once they are received from the corrugated box manufacturer. Each supplier receives daily shipments of expendable containers (255 shipments per year). One materials handler at each supplier location dedicates twenty minutes to each shipment for receiving and putting the containers in their respective storage location until they can be used on the part assembly line. The labor cost of this handling effort must be determined. By adding the annual costs of procurement and handling for each supplier, the T-Pack team can determine the annual cost incurred by that supplier when using expendable containers. This process is repeated for each of the suppliers.

Transfreight, TMMI's third-party logistics provider, facilitates the inbound movement of parts from the supplier locations to TMMI. With expendable packaging, Transfreight is only responsible for the fronthaul movement from each of the suppliers to

TMMI. The third party incurs a cost of $1.30 per mile for the one-way fronthaul movement. Transfreight then tries to arrange for backhaul loads from other shippers that will generate revenue opportunities on the return trips (therefore the cost of the backhaul movement is not to be considered in this analysis). To determine the total cost incurred by Transfreight, the T-Pack team must consider the number of fronthaul miles covered with each shipment from supplier to TMMI and the frequency of these shipments.

The differentiable costs incurred directly by TMMI with this alternative include: 1) the cost of retreiving, baling and loading the used containers, 2) the value of damaged products due to poor handling or improper packaging, and 3) outbound transportation to the recycler location. The T-Pack team has reasoned that TMMI would have to hire eight full-time employees to facilitate the materials handling requirements of the expendable containers at the plant. These employees would be dedicated to moving the used containers from their location on the assembly line to a storage area where the containers are broken down, baled and eventually loaded on a truck destined for the recycler. The materials handlers would earn $22.61 per hour (average wage and benefits) over a 40-hour work week. The handlers would be compensated for the 51 weeks of plant operation.

The frequency of loss and damaged product with expendable containers is depicted in Table 2. The average value of losses due to product damage would be $600 per occurrence with this alternative. Damage frequency refers to the percentage of shipments (as expressed by the number of customer pickups) that incurs damage as a result of poor materials handling or improper packaging.

The T-Pack team has identified a recycler, Mercury Grissom of Mitchell, Indiana, as the prospective buyer of the used corrugated container material. Mercury Grissom will pay TMMI $65.00 for every ton of corrugated material delivered to the Mitchell facility on a weekly basis (51 times over the year). The revenues TMMI receives from the sale of these materials will be subtracted from the cost of the alternative. The T-Pack team will have to determine the weight of the plant's weekly usage of containers to determine the amount of revenue generated each week and over the course of the year.

The team has also identified EKG Trucking as a firm willing to move the bales of used corrugated material from TMMI to the recycler's Mitchell facility. EKG would charge a flat rate of $400 for each week's shipment.

Alternative 2: Expendable Containers, Disposal

This alternative also requires suppliers to use expendable corrugated containers for shipping parts inbound to TMMI. Rather than recycling as in alternative #1, this alternative calls for TMMI to gather used containers at the end of each week and ship them to a landfill for disposal. The usage and cost characteristics of this alternative are the same for suppliers and Transfreight as those of the first alternative above. Any differences in total cost for this alternative are based on differences at TMMI. Rather than selling the used corrugated materials to a recyler, this option calls for TMMI's weekly disposal of the materials at a nearby landfill. So rather

than TMMI generating the costs and revenues associated with recycling, the T-Pack team must determine the costs of disposal instead. The team identified a landfill in Henderson, Kentucky that would accept weekly shipments of corrugated packaging material. The landfill would charge a tipping fee of $62.00 per ton. Again, the T-Pack team will have to determine the weight of the plant's weekly container usage to determine the sum to be paid in tipping fees over the course of the year. EKG Trucking has agreed to haul the expendable containers to the Henderson landfill for a flat rate of $225 for each week's shipment. The costs incurred by TMMI for handling the material and loss due to shipment damage would be the same as alternative #1.

Alternative 3: Returnable Containers

This alternative requires TMMI suppliers to purchase returnable plastic containers for shipping parts inbound to the truck plant. This alternative would be a dramatic change for most suppliers accustomed to using expendable packaging, particularly with the new truck's production in the near time horizon. After each use at TMMI, these containers would be returned to the supplier for repeated usage until the container is irreparably damaged, lost or otherwise retired. The T-Pack team has confirmed earlier stated beliefs that the average life of a plastic tote is three years.

To determine the number of returnable containers each supplier must purchase initially, the T-Pack team devised the following formula:

$$\text{Cycle Totes } * = \frac{(\text{Part usage/day}) \times (\text{Days in shipping loop})}{(\text{Pieces/container})}$$

* Round up to the nearest whole container

"Cycle totes" refer to the minimal number of totes that are expected to be required by the system. However, with the possibility of loss, damage or delays in returned totes, the team agreed that suppliers should procure an additional five percent atop the minimum cycle tote count for *each part* they supply (again rounding up to the nearest whole container). These additional totes will serve as a buffer against unforeseen conditions in the supply chain.

As with expendable containers, should a supplier have multiple parts that use the same container type (e.g., 1, 2, 3 or 4), they may then be lumped together to determine the total number of containers of a given size (type) to be ordered initially. This process is repeated for all suppliers.

Once the number of returnable containers each supplier must initially procure is determined, attention can then turn to the cost analysis for this alternative. Though the cost of the returnable container purchases will eventually be absorbed by Toyota on a bill-back basis, the T-Pack team agreed that the cost should be allocated to the suppliers for the sake of the analysis. The team reasoned that the suppliers must put forth the initial investment in the containers and so they should reflect the cost of the container acquisitions. In addition, the team agreed that the cost of the returnable containers should be accrued evenly over the three-year life of the containers. This provides for a more consistent basis of analysis across the three alternatives.

Like with expendable containers, there are regular handling responsibilities with the returnable containers. Suppliers are responsible for unloading the containers when they are returned from TMMI. The materials handler must then allocate the containers to the location at the end of the parts assembly line for subsequent use. This activity will require 30 minutes of the materials handler's time with each shipment of returned containers. For the sake of the analysis, the team has assumed that the same number of containers are returned with every shipment and that every time a Transfreight truck arrives for parts pickup that empty containers are also returned. In addition to initially procuring and handling the containers, the team believes that twice a year each container will need to be cleaned or mildly repaired in some fashion. The team has allocated three minutes per container for these biannual (twice-a-year) maintenance activities. The materials handling staff at the supplier locations will be responsible for these maintenance activities.

Under the returnable container scenario, Transfreight will facilitate what it calls "milk runs." These routes involve Transfreight trucks domiciled at TMMI. At TMMI, empty containers are loaded onto trucks and returned to the supplier that owns the totes. Empty totes are unloaded at the supplier location and containers filled with parts are then loaded onto the truck. Transfreight has provided the team with the predetermined routes that will serve the five suppliers of interest. Three routes will be used to serve these supplier locations. Figure 3 illustrates the direction of these movements. Table 5 lists the stops, cumulative mileage and frequency of these routes. Additional information critical to the analysis is provided in the notes below Table 5.

Note that Route 3 is composed only of Reds, Incorporated whereas Routes 1 and 2 involve two stops each before returning to TMMI. Mr. Baughman, Transfreight's Contract Manager has assured the team that the routes consider the driving time and distance that can be safely managed by a driver in a single day, and the size of shipments consisting of both empty and loaded containers. Mr. Baughman has also informed the team that it will cost Transfreight, on average, $1.00 per mile to run the designated routes. These routes will be run consistently with TMMI's 255-day work year. Mr. Baughman acknowledges that, on average, once each week an expedited shipment of containers may have to be made to a supplier location (any one of the five locations) to address a shortage in

containers. In these instances, Transfreight will hire an outside carrier to make these emergency shipments at an expense of $800 per occurrence.

The T-Pack team has identified that the only differentiable cost incurred by TMMI with this alternative are the costs of handling containers within the plant and the loss value in damaged products due to poor handling or improper packaging. TMMI will need to hire six full-time employees to perform materials handling functions associated with the returnable containers at the plant. These employees would be responsible for moving empty containers from their location on the assembly line to an area aptly called "ReturnsLand" by the T-Pack team. The materials handlers would then load shipments of empty totes onto Transfreight trucks destined for the supplier locations. Like with the expendable container alternatives, these TMMI employees would earn compensation (average hourly wage and benefits) of $22.61 over a 40-hour work week and 51-week year.

The cost of loss and damaged product with returnable containers is thought to be less frequent (as demonstrated in Table 2) than with expendable packaging. The average value of losses due to product damage would be $400 per occurrence with this alternative. While the returnable container option uses milk routes with suppliers, the number of daily customer pickups is the same as the direct routes in the expendable container options.

Busy with his many other tasks associated with the approaching startup of the Tundra assembly line, Karl has asked you to serve as an ex-officio member of the T-Pack team to conduct the analysis. Determine the annual costs incurred by suppliers, Transfreight and TMMI for each alternative. Calculate the system-wide cost for each alternative. Consider the qualitative issues that are not captured by the quantitative analysis, such as each alternative's impact on product quality, the environment, supply chain relations and customer service. Based upon your analysis, which alternative would you recommend to the team?

Additional Questions for Student Analysis and Discussion

1. Who are the stakeholders in this case? What are their positions with regard to the returnable container issue?

2. What are the pros and cons of possibly switching to reusable containers? How does the decision fit into Toyota's overall strategy?

3. If Toyota believes that returnable containers are such a good idea, why do so many of the parties in the case resist implementing them? How can a firm implement significant change when the change is viewed as threatening by supply chain partners?

Appendix of Tables and Figures

TABLE 1

TOYOTA PRODUCTION AND SALES

Nation/Region	FY 2000 Production (units)	FY 2000 Sales (units)
Japan	3,250,000	1,760,000
North America	1,103,000	1,646,000
Europe	187,000	630,000
Asia (except Japan)	183,000	265,000
Oceania	83,000	170,000
Africa	74,000	126,000
Latin America	15,000	131,000
Middle East	--	167,000
Totals	4,895,000	4,895,000

Source: *Toyota Motor Corporation: Earnings Release, April-September 1999,* presented November 19,1999 by Hideto Ozaki, Director of Toyota Motor Corporation, www.toyota.com

TABLE 2

SHIPPING CONTAINER COMPARISONS

		Weight (lbs.)		Cost per unit *		Damage Frequency (%) **	
Container Type	Dimensions	Expendable	Returnable	Expendable	Returnable	Expendable	Returnable
1	**12 x 15 x 7”**	**0.61**	**2.80**	**$0.29**	**$29.49**	**2.5**	**2.0**
2	**24 x 15 x 7”**	**0.82**	**4.37**	**0.49**	**44.88**	**2.5**	**2.0**
3	**24 x 22 x 11”**	**0.95**	**6.18**	**0.66**	**52.65**	**2.5**	**2.0**
4	**48 x 22 x 15”**	**1.68**	**12.20**	**2.07**	**99.69**	**2.5**	**2.0**

*** While dunnage characteristics may be specific to a given part, assume that the cost is the same for all containers of the same type.**

**** Refers to the percentage of shipments (as expressed by the number of customer pickups) that incurs damage as a result of poor materials handling or improper packaging.**

TABLE 3

SUPPLIER INFORMATION

Supplier	**Location**	Parts Supplied	**Pieces/ Truck**	**Container Type**	**Pieces/ Container**	**Days in Shipping Loop**
Bluegrass Industries	Lexington, KY	Shocks	4	3	8	5.5
		Steering column	1	3	5	5.75
		Steering wheel	1	3	5	5.75
		Lugnuts	24	1	100	5.5
Blues, Inc.	St. Louis, MO	Stereo system (tuner/CD/cassette)	1	3	8	6.5
		Stereo speakers	4	4	12	5.5

Kentucky Industries	Frankfort, KY	Instrument panel molding	1	1	50	7.5
		Interior quarter trim (pillars)	2	2	6	5.5
		Interior door handles	2	2	12	6.5
		Exterior door mirror	2	3	6	6.5
		Interior rearview mirror	1	3	32	7.5
Missouri Industries	Fenton, MO	Over-fender plastic	4	4	12	5.5
		Glovebox	1	4	4	5.5
		Center console	1	3	4	5.5
		Fuel tank protector	1	3	20	6.5
		Fuel tank cap	1	2	12	6.5
Reds, Inc.	Cincinnati, OH	Front grill	1	4	5	5.75
		Passenger side airbag	1	3	4	5.5
		Shoulder-strap seatbelts	2	2	6	5.5

- Note that while the individual parts provided by a given supplier may use the same container with regard to size/dimensions, the containers designated for one part cannot be used interchangeably with those of another part. The dunnage (the interior of the container designed for product protection) of each container is specific to the part it holds. Therefore, the demand for a given container must be determined by looking at the independent demand levels of each part.

- "Days in Shipping Loop" refers to the number of days a container is committed to a given shipment before it can be returned to the supplier location for reuse in subsequent shipments. The length of time a container is captive in the shipping loop varies by the capacity of the container and the usage level of the parts.

TABLE 4

SUPPLIER INFORMATION (CONTINUED)

Supplier	Mileage to TMMI	Employee Wage and Benefits ($/hr)	Shipments per day to TMMI
Bluegrass Industries	192	17.50	3
Blues, Inc.	174	19.38	3
Kentucky Industries	170	16.25	3
Missouri Industries	195	15.94	3

Reds, Inc.	223	20.00	2

- **Transfreight facilitates all customer pickups destined to TMMI**

TABLE 5

TRANSFREIGHT ROUTE DESIGNATIONS

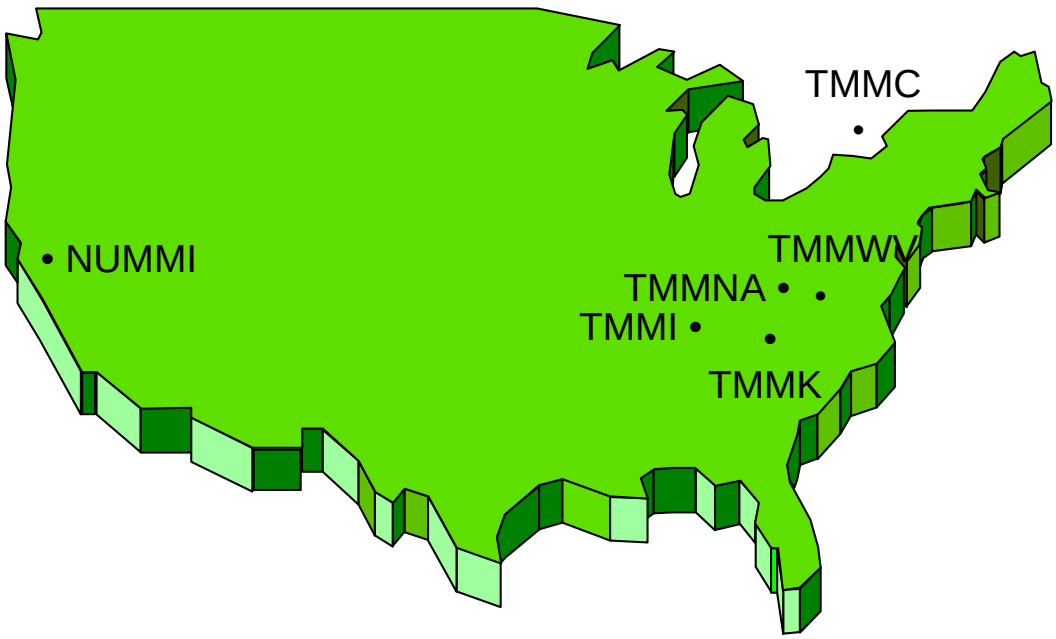
	Origin	**Stop 1 (cumulative mileage)**	**Stop 2 (cumulative mileage)**	**Stop 3 (cumulative mileage)**	**Frequency of Route** (runs per day)
Route 1	TMMI	Blues, Inc. St. Louis, MO (174 miles)	Missouri Industries Fenton, MO (253 miles)	**TMMI** Princeton, IN (448 miles)	**Three times daily**
Route 2	TMMI	Kentucky Industries Frankfort, KY (170 miles)	Bluegrass Industries Lexington, KY (195 miles)	TMMI Princeton, IN (387 miles)	**Three times daily**
Route 3	TMMI	Reds, Inc. Cincinnati, OH (223 miles)	TMMI Princeton, IN (446 miles)	--	**Twice daily**

- Assume a five-day work week and 51-week work year (255-day work year) at all locations (including TMMI)

- Routes only apply to shipping with returnable containers – shipments with parts contained in expendable packaging are one-way (from supplier location to TMMI) though the number of customer pickups (shipment frequency) is assumed to be the same across options (see Table 4 for direct mileage to TMMI from supplier).

FIGURE 1

TOYOTA'S NORTH AMERICAN AUTO ASSEMBLY PLANTS



TMMC: Toyota Motor Manufacturing, Canada, Inc.
Cambridge, Ontario, Canada

TMMI: Toyota Motor Manufacturing, Indiana, Inc.
Gibson County, Indiana

TMMK: Toyota Motor Manufacturing, Kentucky, Inc.
Georgetown, Kentucky

TMMWV: Toyota Motor Manufacturing, West Virginia, Inc.
Putnam County, West Virginia

TMMNA: Toyota Motor Manufacturing, North America, Inc. (Headquarters)
Erlanger, Kentucky

NUMMI: New United Motor Manufacturing, Inc. (joint venture with General Motors)
Fremont, California

FIGURE 2

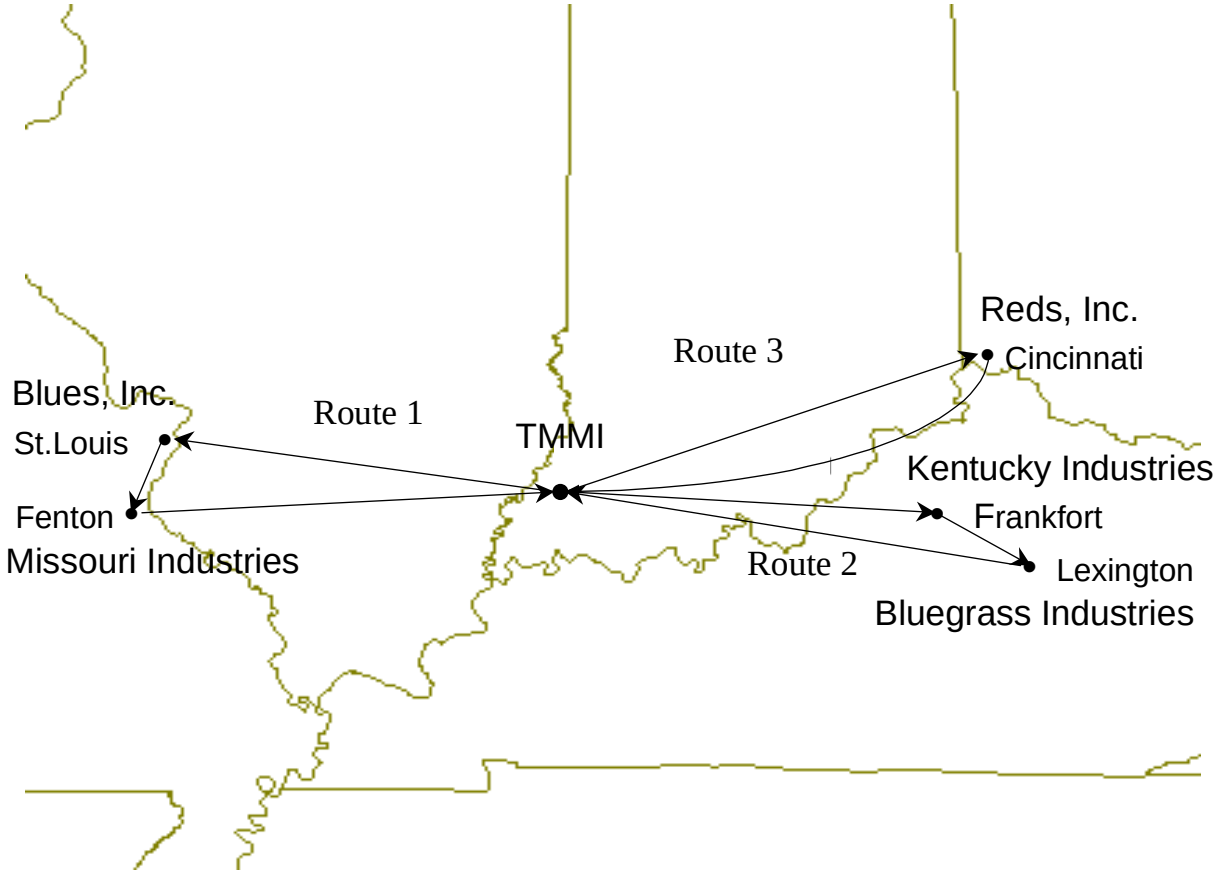
MR. MARUHITO'S TRANSPARENCY

TMMI Environmental Policy

"As an environmentally responsible member of our community, Toyota Motor Manufacturing, Indiana, Inc. (TMMI), an automobile manufacturing facility, is committed to the protection and preservation of the environment by minimizing our impact on the environment through pollution prevention and continual improvement. We strive to maintain 100% compliance with all relevant legislative and regulatory requirements as well as with other requirements to which our company subscribes."

FIGURE 3

ROUTES FOR RETURNABLE CONTAINER SHIPMENTS



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Toyota Motor Corporation: Earnings Release, April-September 1999, presented November 19,1999 by Hideto Ozaki, Director of Toyota Motor Corporation, www.toyota.com

For those interested in further reading on the topics of logistical containerization and reverse logistics, the following books and articles are suggested:

James R. Stock, *Development and Implementation of Reverse Logistics Programs* (Oak Brook, IL: Council of Logistics Management, 1998).

Wendee V. Rosenau, Diana Twede, Michael A. Mazzeo and S. Paul Singh, "Returnable/Reusable Logistical Packaging: A Capital Budgeting Investment Decision Framework," *Journal of Business Logistics*, 17, no. 2 (1996): 139-165.

Leo Kroon and Gaby Vrijens, "Returnable Containers: An Example of Reverse Logistics," *International Journal of Physical Distribution & Logistics Management*, 25, no. 2 (1995): 56-68.

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