DESIGN AND ANALYSIS OF PACKAGING BOXES AND COST REDUCTION TECHNOLOGY

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A methodology of designing is the packaging box-based on the topology optimization technique is proposed. The packaging box is designed not only to protect from the damage but also take up a volume as small as possible in order to reduce the transport cost. In contrast to the traditional approach which minimizes the acceleration and/or the maximal stress of the panel contained in the packaging box, the proposed objective is to minimize simultaneously the predesignated natural frequency and the mean compliance of a packaging box subjected to a volume constraint. The material properties as well as the finite element model of a packaging box are tested and validated experimentally. The packaging box after topology optimization is evaluated numerically by drop test simulations in terms of acceleration experienced by the panel and volume reduction of packaging box.

Keywords: Supply Chain Optimizers, Package optimization, Single packing

INTRODUCTION

Reduce logistics costs by 10-20% and fulfill your sustainability goals. Traditionally, supply chain optimization has focused solely on container utilization, mode conversion and optimal routing. However, any efficient supply chain must master the logistics network as well as packaging optimization and Damco’s new service offers just that. We have partnered with Supply Chain Optimizers (SCO) to deliver a unique packaging optimization service that combines our holistic end-to-end supply chain development expertise and SCO’s extensive knowledge in packaging design. By implementing packages that suit your end-to-end needs, you will not only eliminate waste and minimize the environmental impact of your supply chain, but also reduce your logistics costs. Proven methodology with no risk for your company and SCO’s proven methodology is based on the following steps:

These projects are offered on a “no cure – no pay” basis and therefore would be of limited risk for your company. SCO will get an agreed percentage of the first year savings. If no savings are realised then we do not receive any compensation. Increasingly, carriers are looking at package cube when pricing transportation. Why? because virtually every form of

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transportation, from airplanes to truck trailers, rail, ocean, and air freight, tends to “cube out” before it reaches its maximum weight capacity. And this recent change is reflected in the ever tightening DIM factors that carriers have introduced over the past two years.

**CUBE OPTIMIZATION**

It means right-sizing your packages and fitting your orders into packaging dimensions that are as small as possible without threatening the integrity of the order. Cube optimization analysis is a study of actual weight versus dimensional weight with the objective of reducing or eliminating dimensional weight charges in favor of actual weight charges (Figure 1). Merchants should conduct a comprehensive and detailed cube analysis with an eye toward determining where these improvements can be made for better package optimization. Cube improvements will result in a number of downstream benefits:

- Less corrugated utilization.
- Lower damage rates due to smaller, stiffer boxes.
- In some cases, billing weights will drop by one lb or more, due to less packaging content.
- Reduce or eliminate dunnage material.
- Better fill rates for ocean containers, pallets, and air freight ULD’s.
- Increased distribution center shelving capacity—more SKU’s in less space.
- Better DC throughput per hour or shift.
- For retail packing, more SKU’s per lineal foot of shelf space.
- For B2C shippers, more units per master pack.
- Lower shipping rates, regardless of carrier or mode.
- Fewer billing corrections carriers typically employ scan tunnels to dimensionalize shipments, and the error rates can amount to 2% or more.

Merchants should consider the following tips regarding package size and construction for any parcel/small package shipper, whether shipping domestically or internationally:

1) Do not exceed weight limit of 150 lbs – separate into component pieces if possible.
2) Packages should be less than 108 inches in length to avoid oversize charges.
3) Do not exceed dimensional limits of length and girth - 165 inches combined to avoid oversize charges.
4) Consider using biodegradable and reusable packaging rather than ‘styrofoam’ and ‘plastic popcorn’ to reduce costs in the environment.
5) Use rectangular shaped packages if at all possible and create a package that can be stacked at least four high for better space utilization.
6) Some companies place RFID tags and impact sensitive devices on their products depending upon the value and fragileness of the items shipping. These devices provide valuable

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This article can be downloaded from http://www.ijmrbs.com/currentissue.php
information on where and how damages can occur and what needs to be done to eliminate the problem. Here is the website of an RFID manufacturer that provides that service.

7) Consider consulting a packaging engineer to minimize the amount of ‘air’ of unused space in a package.

Chainalytics’ Packaging Optimization services provide custom packaging solutions to help you discover productivity, efficiency, and sustainability gains and improve supply chain performance. Using state-of-the-art software and design tools, Chainalytics’ team of packaging consultants offer packaging design, prototyping, and protocol testing services that consider the entire packaging value chain to identify cost saving and sustainability improvement opportunities (Figure 2).

**Figure 2: Chainalytics’ Packaging Optimization**

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<tr>
<th>Packaging Engineering Expertise</th>
<th>Objective &amp; Independent Analysis</th>
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**SCOPE**

This paper will focus on the life cycle of packaging as part of a product, as companies neither create nor order packaging if not needed for a product. Here we will focus on packaging optimization (defined as the trade-off between packaging reduction and packaging requirements and benefits, i.e., recyclability, safety, resistance, transportability, etc.) as far as all the following type of packaging are concerned.

Primary packaging (packaging for individual units to be sold): how can packaging be reduced in a way that it still serves its purposes, from production to waste, passing through distribution and consumption?

Secondary packaging (group packaging, i.e., boxes, family packs): where is the trade off between convenient offer to consumers and ‘overpackaging’? Tertiary packaging (transport packaging i.e. foil, pallets...): what are the best solutions to reuse and recycle without affecting the safe transportation of products? Service packaging (packaging not connected to a specific product, not sold with the product, i.e., shopping bags, wrapping paper): how to reduce the consumption of single-use shopping bags, especially in those countries where they are still handed out for free?

**Figure 3: Trends in GDP, Packaging Consumption and Packaging Disposal in EU-15, from 1998 Baseline**
OPPORTUNITIES

Optimization of packaging as part of the environmental footprint of a packed good has a positive impact on costs of material, logistics and working hours for both producers and retailers. The benefits that can be passed on to consumer are considerable. As packaging is a crossover issue through the entire supply chain, retailers and suppliers can show, as they already do (e.g., GPPS), that collaboration and industry driven approaches can provide improvement of the environmental performance of the supply chain. Both at global and European level initiatives have been taken between retailers and manufacturers to optimize packaging collaboratively, e.g., Consumer Goods Forum Global Packaging Project15 and ECR Europe/EUROPEN Guide16 and, for paper, cardboard and wood packaging, certification systems such as FSC and PEFC are widely used to ensure the sustainability of raw resources (while FSC also ensure sustainability of recycled resources).

Improving the packaging of products requires a life cycle thinking approach and also depends on technological developments. The quest for more efficient packaging systems stimulate innovation? Shared solutions (between industry and policy makers) regarding packaging and packaging waste can strengthen the single market and safeguard the principles of free movement of goods. Differences at production, infrastructure and consumer behavior level still exist amongst member states.

Move towards a resource-efficient society, as advocated by the European Commission in its Resource-efficiency Flagship initiative17, by increasing the recycling rates and strive to close the loop of the EU economy, with the aim of reducing waste generation and using waste as a resource.

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BARRIERS

There is a trade-off between packaging reduction, and product protection and logistics requirements. Recycling facilities and collection systems differ enormously within Europe by country, by region and by town. As a result the recycling of used packaging is not always available to consumers and retailers.

Lack of resources within Member States who did not yet establish rules or guidelines for Companiesto proof compliance with Essential Requirements.
LEVERAGING THE SUPPLY CHAIN THROUGH PACKAGING

The efficiency of any company’s supply chain is a factor of the network [how far the product moves and how many times it is handled] as well as the physical characteristics of the product [shape, size and density].

While many consultants work on network optimization we are the only ones who focus on packaging optimization; we have completed projects for more than 500 clients over the past 25 years, in many instances we reduced client costs by millions of dollars. Some of our packaging clients include:

Our success in packaging optimization lies in understanding the relationship of packaging to transportation and warehousing operations. For example, many experienced logistics executives do not realize that all small package carriers such as FedEx and UPS and LTL truckers like YRC base their billing rates on these product factors:

Density, stowability, susceptibility to damage, ease of handling and density is the key factor, making up more than half of the weighting. Thus by designing the shipping case to fit pallets and trucks better we are able to impact the key rate factors and reduce logistics expenses for our clients. Here are some real world examples of how we make our clients more efficient:

Our client’s Asian supplier was stuffing 1,472 cases into a 40’ container. By revising the layout of retail units in the master case we were able to increase the container count by 17% to 1,722 cases. Essentially an extra 250 cases will now cross the Pacific for free every time our client purchases a container load. Our mail order client was using 10 different case sizes on customer shipments. Computer analysis proved that 16 case sizes was optimal for lowest total cost but only 3 of the original sizes were proper for our client’s operation; we had to spec 13 new case sizes for them. The end result was that corrugate and dunnage cost declined 20% and freight cost declined 14% the first year. Our 3PL client was quoting a project to build sample kits but was concerned they could not get their costs down low enough to win the business. The customer had specified a single shipping case to our client for 11 varieties of samples. Our analysis showed that utilizing 3 sizes of shipping cases increased cases per pallet and shipment density so much that handling, storage and freight collectively declined by $3 mn…on a no-charge sample program. We showed a large manufacturer of electrical components how to drive down total costs by changing pallet patterns and increasing storage heights. This change more than doubled our client’s handling expense but maximization of storage space and truckload utilization generated so much cost reduction that total costs declined by 23%. While the projects shape up a bit differently our packaging optimization specialty has application to both manufacturers which ship product in corrugated boxes or bags as well as pick-pack distributors which pack into corrugated boxes prior to shipment.

Shelf Ready – Retail Ready – Display Ready Packaging

Today we are seeing a major push in Canada and in the US to implement shelf ready, retail ready and/or display ready packaging by many of our CPG clients. We have positioned ourselves well for this with multiple resources that have experience with these initiatives. One team...
member managed the conversion of a major CPG company to these packaging forms as part of his company’s ECR-EU initiative so he brings years of real life experience in this arena to projects. Another team member delivered a packaging approach for one of our clients that eliminated corrugate completely.

**SUMMARY**

Packaging can create a new total product. Variations in packaging can make a product saleable in various target markets. A specific package must be developed for each product. Both under-packaging and over packaging can be expensive. Although the final customer remains the ultimate factor, the packager also must remember the needs of wholesalers and retailers. A small retailer might prefer smaller package units that a supermarket operator would resist. Both promotional and protective packaging can cut total distribution costs. To customers, the main significance of brands is an assurance of quality. This confidence leads to repeat purchasing. For marketers, such ‘routine’ buying means reduced promotion costs and increased sales. The decision depends on whether the costs of brand promotion and honoring the brand guarantee can be covered and made profitable by higher price or more rapid turnover, or both. The cost of branding may reduce other costs by relieving pressure on the other three Ps.

In recent years, the strength of manufacturers’ brands has declined and dealer brands have become more important. The dealer labeled-products may win in the battle of the brands, because dealers are closer to customers and may choose to promote their own brands. Branding gives marketing managers’ considerable latitudes. They can add brands and use individuals or family brands. Ultimately, however, customers express their approval or disapproval of the total product (including the brand). The degree of brand familiarity obtained is a measure of management’s ability to carve out a separate market, and has considerable impact on Place, Price and Promotion decisions.

**REFFERENCES**
