



STRESS  
ENGINEERING  
SERVICES INC.



# INNOVATIONS IN E-COMMERCE PACKAGING

## Developing Liquids Packaging Design Solutions to Eliminate E-Commerce Leakage

**W**e are entering the most significant revolution in the design of primary and secondary packaging in many decades. Fueled by the rapid adaptation to internet-based shopping, so called e-commerce and m-commerce, the rules of both package and, to some extent, product design are going to change. Gone are the days when products were moved exclusively from their site of manufacture through a Distribution Center, loaded onto an LTL trailer and ultimately delivered to the retailer's shelf via orderly unit loads or reconstructed mixed product loads. Based on the raging success of e-commerce, it is estimated that as many as 87% of all consumers purchased products online, which were transported as individual products or mixed product shipments to individuals via parcel shipping and parcel delivery services of the likes of FedEx, UPS, DHL, USPS and others.



Relatively predictable package loading between the manufacturer and the store shelf.

## The Changing Scenario of E-Commerce

Unlike the controlled world of unit load-based shipping, for parcel delivery, there is no control over the package and product orientation or in-transit loading scenarios resulting in the opportunity for significantly more package and product damage. In the case of liquids packaging, the damage includes not only the individual package but also the other products included in the shipment and other packages in the delivery truck.

For store purchased product, the trip from the store shelf to the consumer's home was historically the most treacherous and uncontrolled segment of the journey. Movement of the product from the shelf into the cart then bagged and placed in the trunk of a car represented the greatest uncertainty with respect to the forces and orientation of the package while in transit. For parcel

delivery the path between the traditional point of purchase (the store) and the consumer's home is dramatically different and far more variable.



Historically, the trip between the store and the consumer's home was the most treacherous part of the package journey.

## Tension is Growing among Product Manufacturers, Packaging Manufacturers and Shipping Companies

- Product manufacturers want the packaging industry to 'step up to the plate' and offer total packaging solutions for e-commerce distribution of their products that prevent damage and are cost effective.
- Packaging manufacturers are trying to communicate to the product makers that "we can't do it all." The product and liquid packaging they are making need to be designed to handle the myriad of new forces and shipping insults that occur in a parcel-focused distribution system.
- The parcel shipping companies are demanding an upcharge and/or additional materials be added to the product being shipped as compensation for/prevention of damage losses in their system as a result of fragile products and leaking packages. In extreme cases they are beginning to refuse shipping even the most benign products based on collateral damage to other packages being handled.



It is reported that as many as 26% of consumers that have made internet purchases have received broken or damaged goods.

The industry most immediately impacted by the online shopping megatrend is consumer packaged goods (CPGs). These producers of non-durable goods such as food, laundry, personal care and health care products can be highly vulnerable to leakage and damage. Undamaged delivery in these categories of products is uniquely important to the CPGs and their brands because 66% of online shoppers believe the packaging of their shipment is a reflection on how much the retailer cares about them and their order. Also, 59% of online consumers believe that the retailer and the package carrier are equally responsible for the damage!

Currently, CPG products and primary packaging are designed for monotonic shipments in unit loads where product/package orientation and loading is well defined and understood. For the most part, product-to-product interaction is not possible in conventional unit load configurations. That game has completely changed in the single and mixed product parcel shipment environment. Loosely packed products in mixed shipment configurations commonly produce damage at levels never seen before.

Industry groups such as ISTA have mobilized to develop new test methodology to aid the CPGs in their laboratory evaluation of packages and their fitness for e-commerce service (FfeS). This is an important and positive step in the overall direction of improved package performance, but is relatively far downstream and reactive in the package design and development process. Package designers and engineers need new technical guidance defining what is required to design a package that will survive the mixed parcel shipping environment.

Stress Engineering Services (SES), a global leader in the design, analysis, failure analysis and testing of packaging and products for the CPG, Pharma, Medical, Outdoor, Grocery and Industrial products industries has focused significant attention on solutions to

e-commerce challenges. One particularly significant problem that needs to be solved is leakage of liquid products from packages. The three areas of significant focus have been:

- *Leaking of liquids packaging*
- *Seal failures in food packaging*
- *Package-to-Package (PtP) and Package-to-Product (PtPd) damage accumulation*



A typical mixed product parcel shipment. There is evidence of product-to-product interactions resulting in significant damage. Additional packaging of the laundry product and shampoo adds significant additional expense.

## The Parcel Delivery Packaging Challenge

Over the years, an exhaustive amount of work has been done to measure the energy/forces from all forms of transportation, product movement and distribution center loading scenarios that a product must withstand to survive the journey from the packing line to the consumer's home. For decades these data have been used as the basis for primary, secondary and tertiary package design and development. In the new world of large-scale parcel shipment, characteristics of the energy/forces the package is required to survive have changed dramatically and are far more difficult to quantify in a form that enables the development of design rules.

## Liquids Leaking During Shipment

The challenge associated with liquid package sealing is not, ‘Can it be done?,’ but rather, ‘Can it be done without adding cost while maintaining the identity of the brand?’ SES has explored a range of solutions to the leakage problem considering both conventional and unconventional approaches.

## Closure Sealing Systems for E-Commerce Packaging

In the late 1980s SES was instrumental in the development of the optimized, robust ‘plug’ seal closure system for blown and reamed bottle finishes, that is now the leading liquids closure sealing system for a very wide range of consumer, food, industrial, pharmaceutical and medical liquids. The primary challenges of that development were related to the robustness of the design with respect to maintenance of contact seal pressure in the presence of naturally occurring ‘defects’ and dimensional variability for unit load based packaging. Over time, when executed well, leakage rates for those plug sealing systems when stacked in a traditional unit load configuration could be driven to 0.5%-0.7%. Lesser executions of that sealing system would generally yield results in the 1.5% to 4.5% range. What is occurring now is that the shipment of these same packages in a mixed product parcel shipment modality can have much higher leakage rates with potentially much greater consequences to both the CPG brand and commercial success because they were never designed to operate in orientations and under loads incurred in a more or less random load and orientation environment.

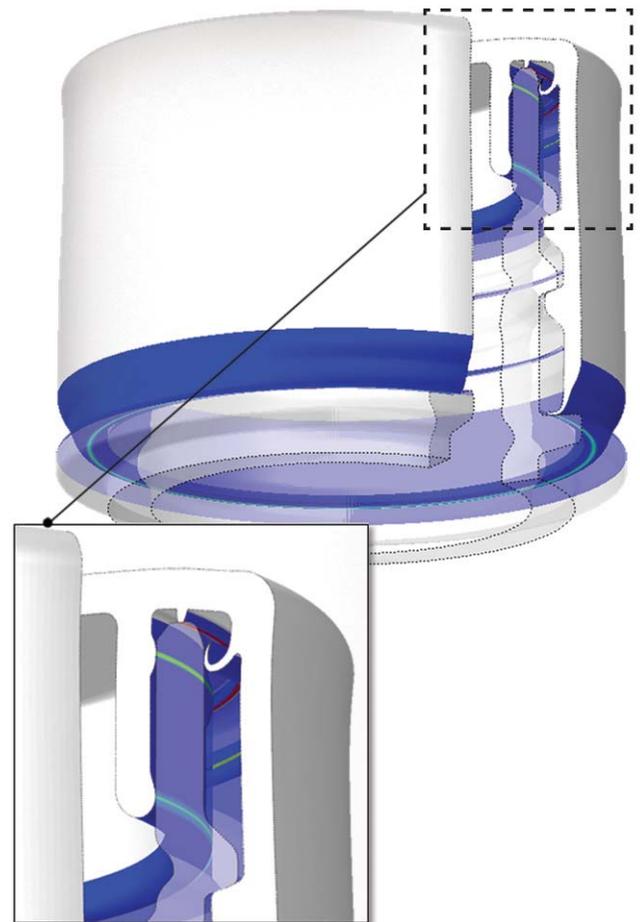
In support of clients struggling with leakage issues in e-commerce, SES has revisited the fundamental performance metrics we developed years ago for conventional sealing bottle and closure systems and applied those fundamentals to a typical e-commerce parcel distribution channel. Figure 1a and 1b illustrate one e-commerce closure design concept, based on historical design concepts, that leverages characteristics of conventional plug seal design, but includes additional, structurally independent sealing elements. The design leverages:

- *Increased plug length to isolate its sealing performance from stiffening caused by the roof of the closure. Its thickness is designed to deliver the minimum contact seal pressure for the largest closure and the smallest finish. This plug design also provides a stable and consistent*

*application and removal torque characteristic.*

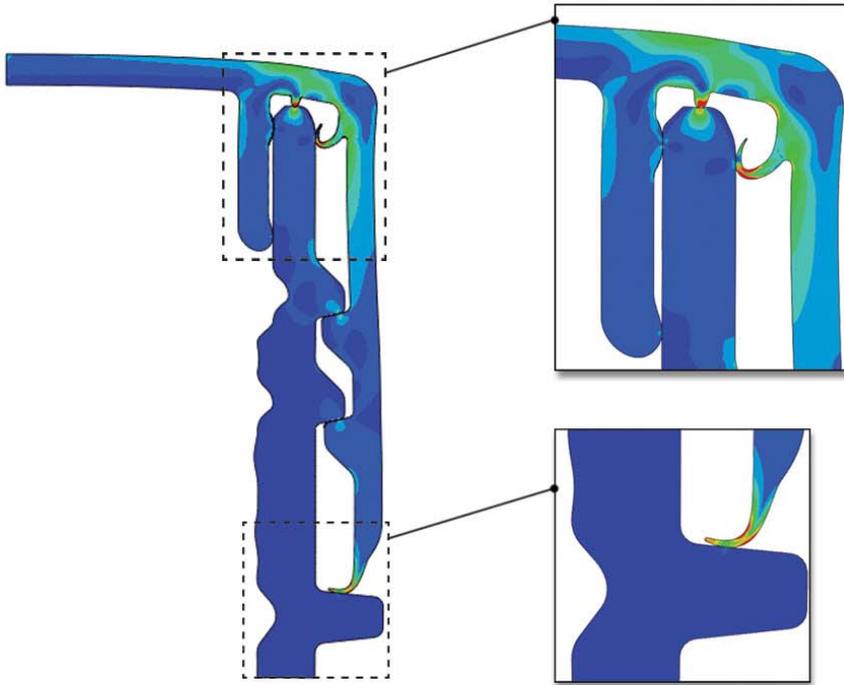
- *A nub seal has been designed as a torque-decoupled redundant primary seal.*
- *A tertiary compliant radial seal has been added to engage the outer surface of the finish.*
- *A compliant skirt seal has been added as a ‘belt and suspenders’ seal to act as a final liquid barrier between the bottle and the contents of the parcel.*
- *The inevitable consequence of this sealing system is, if executed correctly, a relatively small increase in removal torque. SES’s internal design company, \*HELP Design Co., has developed ways to improve the ergonomic features on the e-commerce package to aid the consumer.*

**Figure 1a: E-Commerce Closure Design**



This concept leverages characteristics of conventional plug seal design, but includes additional, structurally independent sealing elements that limit the amount of additional torque.

**Figure 1b: E-Commerce Closure Design**



Predictive analysis methods were used to determine the sealing characteristics for the range of injection molding and blow molding variability.

**Figure 2: Package Design for E-Commerce**



A rigid bottle designed for e-commerce may be more cube efficient, but still make reference to its retail counterpart.



## The Development of a New Tool for E-Commerce Mixed Parcel Package Assembly

Stress Engineering Services is currently developing a physics-based approach to mixed product parcel package assembly that instantly analyzes the specific product and package contents of the e-commerce order and develops a unique, robust package packing solution for that particular mix of products for parcel shipment. The method, currently dubbed “E-Commerce Mixed Parcel Packaging Logic Model” relies on an array of physical attributes of the packages/products being shipped in a particular parcel order, including mass, material, stiffness, shape and fragility. Physics-based analysis of the products and the likely consequences of their potential interactions during shipment enables the calculation of a minimum packaging material and cushioning materials configuration for that mixed parcel. The packaging solution is delivered immediately to the packer at a packing station where a small assortment of preselected, pre-cut materials are available to enable assembly and shipment of the parcel.

The Parcel Packaging Logic Model leverages many of the common, low cost materials and structures currently available from the manufacturers of protective cushioning supplies. The Model identifies the most appropriate packaging materials and their placement in the parcel as well as any special



The E-Commerce Mixed Parcel Packaging Logic Model helps the packer choose the best packing material and cushioning for the shipment.

considerations that were identified in the analysis. The packer is presented with a graphical illustration of the parcel packaging solution.

The benefits of the “E-Commerce Mixed Parcel Packaging Logic Model” include:

- *Ability to rapidly generate a packing assembly roadmap for the packer that will protect the products from damage better than all alternative means.*
- *Reduction of parcel packing to an ‘informed-routine’ resulting in minimal mistakes and simplification of packer training.*
- *Reduction in damage claims and cost.*
- *Optimization of protective packing costs.*

**For Solutions to your E-Commerce Packaging Challenges**

**Call SES Today at 513-336-6701**



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