Structural Box Design for High Quality Beverages

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Abstract

This study compared two different top designs for a wine box to determine which design gave the structure more durability. The results showed that the Twist 'N Give, a new corrugated wine box design with a twist top, appeared to be weaker. The Twist 'N Give is an alternative choice to the existing corrugated wine box with a traditional tuck top style.

The experimental research method was used for this study. Two samples of each style of top, the twist top and the tuck top, were tested on the Lansmont Squeezer Compression Tester for the peak force and the deflection peak. The test process was destructive.

The results show that the wine box with the twist top style appears to be weaker than the box with the tuck top style. However, additional testing needs to be performed, with a larger sampling of each style of top in order to verify results.

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Chapter 1 — Introduction

A package can convey many things to the customer about the style, quality, product information, and even it's worth. Wine has become very popular to give, but handing an unwrapped wine bottle as a gift is not considered proper. In the places where wine is sold, there are few options provided for wrapping a bottle. To alleviate this problem, the Twist 'N Give corrugated wine gift box was developed. The Twist 'N Give has a unique die line that allows for quick assembly, durability, and a unique top opening that resembles a bow. Designers prefer the look of the new twist top, but are unsure if there would be structural degradation compared to the common corrugated wine boxes with the traditional tuck top. This study asks the question: To what extent is the new corrugated box, the Twist 'N Give, stronger than the existing corrugated wine boxes with the tuck top in terms of the composition and structure?

In the current wine industry, there are other wine bag and box alternatives made with different materials. Some packaging material includes paper sleeves, which are not as durable as other materials. The thin paper sleeve is not strong enough to hold an unopened wine bottle without falling through the bottom and shattering. Otherwise, wine boxes in the industry are made of wood with a handle meant to carry single or multiple bottles. However, most consumers would not purchase a wooden wine box due to the higher price and inconvenience in transportation because of its size and weight. The Twist 'N Give is better because it is made of corrugated material. Corrugated materials are two smooth sheets with an arched layer in the middle.

The purpose of this study is to determine if the Twist ‘N Give is more durable for carrying high quality beverages than existing wine boxes based on the structural design of the top. The sophisticated look of the Twist ‘N Give also adds to the consumer appeal of the wine inside.

Chapter 2 — Literature Review

Corrugated materials are made of two linerboard sheets attached together by another sheet of wavy or sinusoidal material that is glued in between. The curves of the wavy material, known as "flutes," provide the strength of the corrugated board. The board is created by applying a layer of adhesive glue across the flutes, allowing this layer to be securely attached to the outer linerboard sheets at every arch that comes in contact with.[1]

The range of flute styles, provide different levels of strength depending on the frequency. The common sizes, profiled as A, B, C, E, and F, are based on the order in which they were created, not by size. The flute provides strength to the material because they resist bending and compression. The larger flute sizes provide more cushioning, while the smaller flute sizes are better for printing and folding.[2] The C-flute is the most commonly used fluting style, often used for box displays, shipping cartons, and other packaging uses. The second common fluting style for corrugated boxes is the E-flute. The E-flute is thinner, being one-fourth the thickness of the C-flute at about 1/16-inches thick. It also has the greatest number of flutes with 94 flutes per foot, making it very durable and useful for printing high quality graphics. A diagram of the flute sizes is show below in Figure 1.

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[1] "Corrugated Box and Packaging Structural Fluting." *Peek Packaging Solutions*. 2006. Web. 25 Apr. 2011. <http://www.peekpackaging.com/product-showcase-los-angeles-ca-san-diego-ca-phoenix-az/corrugated-boxes/solutions/101-corrugated-box-and-packaging-structural-fluting>.

[2] "Determining Box Structure." *Express Packaging*. 2011. 8 May 2011. <http://webcache.googleusercontent.com/search?q=cache:_i_RHLigzJAJ:www.expresspkg.net/main/index.php/resources/determining_box_structure/+how+does+fluting+provide+strength&cd=4&hl=en&ct=clnk&gl=us&sour>.

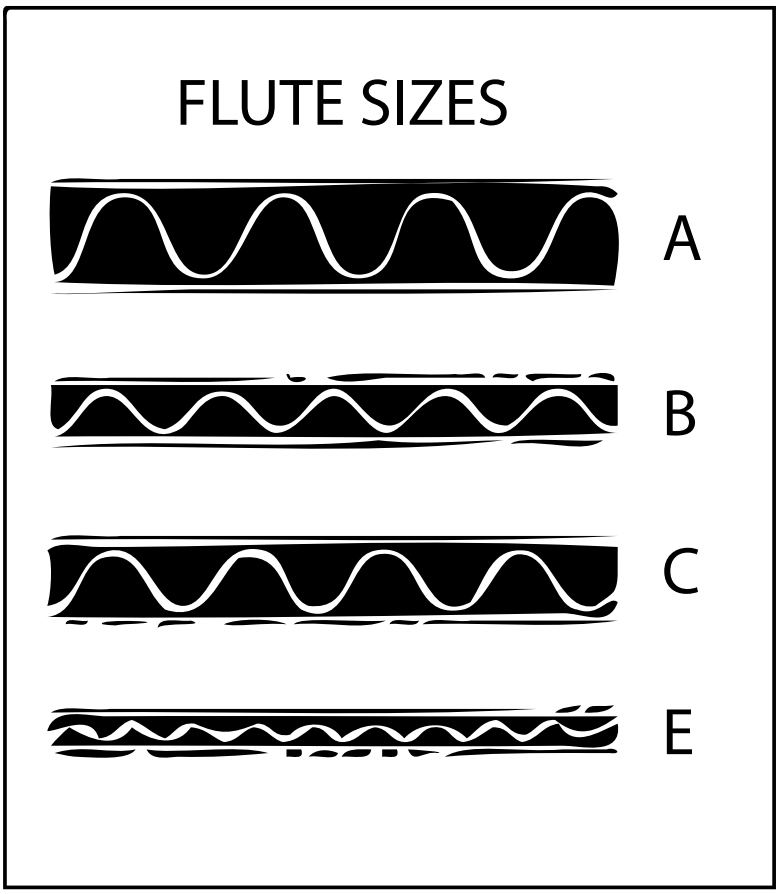

Figure 1. Corrugated flute sizes.[3]

When printing on the corrugated material, the impression is typically heavier where the linerboard is supported by one of the flute arches, leaving the unsupported areas lighter. This causes inconsistency in the printing and the flute lines can be seen. The finer the flute, the better it is for printing because the flutes are smaller and closer together which creates a smoother surface and greater ink consistency.[4]

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[3] "Types of Flutes." *Al Saleem Printing Equipments*. 2010. Web. 2 Aug. 2011. <http://www.alsaleemprintingequipments.com/typesofflutes.html>.

[4] Pinnington, Tony. "Corrugated Industry - in Pursuit of Excellence." *Rigid Containers Ltd*. Brunton Business Publications Ltd., 2008. Web. 8 May 2011. <http://www.rigid.co.uk/resources/types-of-corrugated-flute-and-box.asp>.

The E-flute corrugated material is also easier to fold because it is thinner. As a result, the footprint of the box is also smaller and takes less space to store, making it more sustainable. Sustainability is the capability of enduring and maintaining something at the same level. The idea of sustainability is a huge focus in the corrugated industry. Manufacturers have learned how to reduce the use of raw materials through the creation of more efficient packaging designs.[5] This is accomplished by using lighter or fewer materials. The E-flute corrugated boxes are often used as a substitute to paperboard, which is a thick paper material, because it is lighter in weight but stronger. It is often used for cosmetics, glass, and fragile instruments. This material is also exceptional for making custom boxes because they are easier to cut, bend and fold. Because of the versatility of the material, the Twist 'N Give and existing wine boxes use E-flute corrugated material over the other flute sizes.[6]

Regardless of what type of fluting is used, the structural design of the box is even more important to the overall strength of the box. It is possible for a weaker material with a better

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[5] "Five Reasons Why the Corrugated Industry Is a Great Career Choice." *International Corrugated Packaging Foundation*. 9 May 2011. <http://webcache.googleusercontent.com/search?q=cache:nyZT9SiiaVYJ:www.icpfbox.org/index.cfm%3Fpage%3DWhyCorrugated+less+corrugated+more+sustainable&cd=2&hl=en&ct=clnk&gl=us&source=www.google.com>.

[6] Morgan, Michael. "Manufacturer of Automatic Box Making and Gluing Equipment." *T-ROC Equipment L.L.C*. Web. 28 Apr. 2011. <http://www.trocequipment.com/fyi/index.html>.

structural design to create a stronger box than one made of a stronger material with a poorer structural design.[7]

The structural design of a box is specified by a die line, which is an outline that acts as a template for a package. It is a flat layout of how the box is to be cut from a large piece of material. The die line also consists of marks to show where the material should be cut or folded, as well as where the tabs are placed for gluing the package together. Once the folds and cuts have been made in the designated spots, the tabs would then need to be tucked in and glued to complete the three-dimensional package.

The boxes that were tested both have the bottom style of the Tuck Top Auto Bottom (TTABTM), which is popular in the corrugated box industry. When propping the box up, the base snaps into place because there are perforated pieces that allow for the box to be pre-folded in a way that allows it to snap automatically. This style is often preferred because it has better printability and is easier to put together while on the assembly line.[8] Figure 2 shows the Tuck Top Auto Bottom style.

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[7] Correll, John. "Structural Options." *Correll Concepts*. 2002. Web. 28 Apr. 2011. <http://www.correllconcepts.com/Pizza_Packaging/_home_packaging.htm>.

[8] "Styles of Corrugated Boxes and Packaging." *Peek Packaging*. Web. 28 Apr. 2011. <http://www.peekpackaging.com/product-showcase-los-angeles-ca-san-diego-ca-phoenix-az/corrugated-boxes/solutions/104-styles-of-corrugated-boxes-and-packaging?format=pdf>.

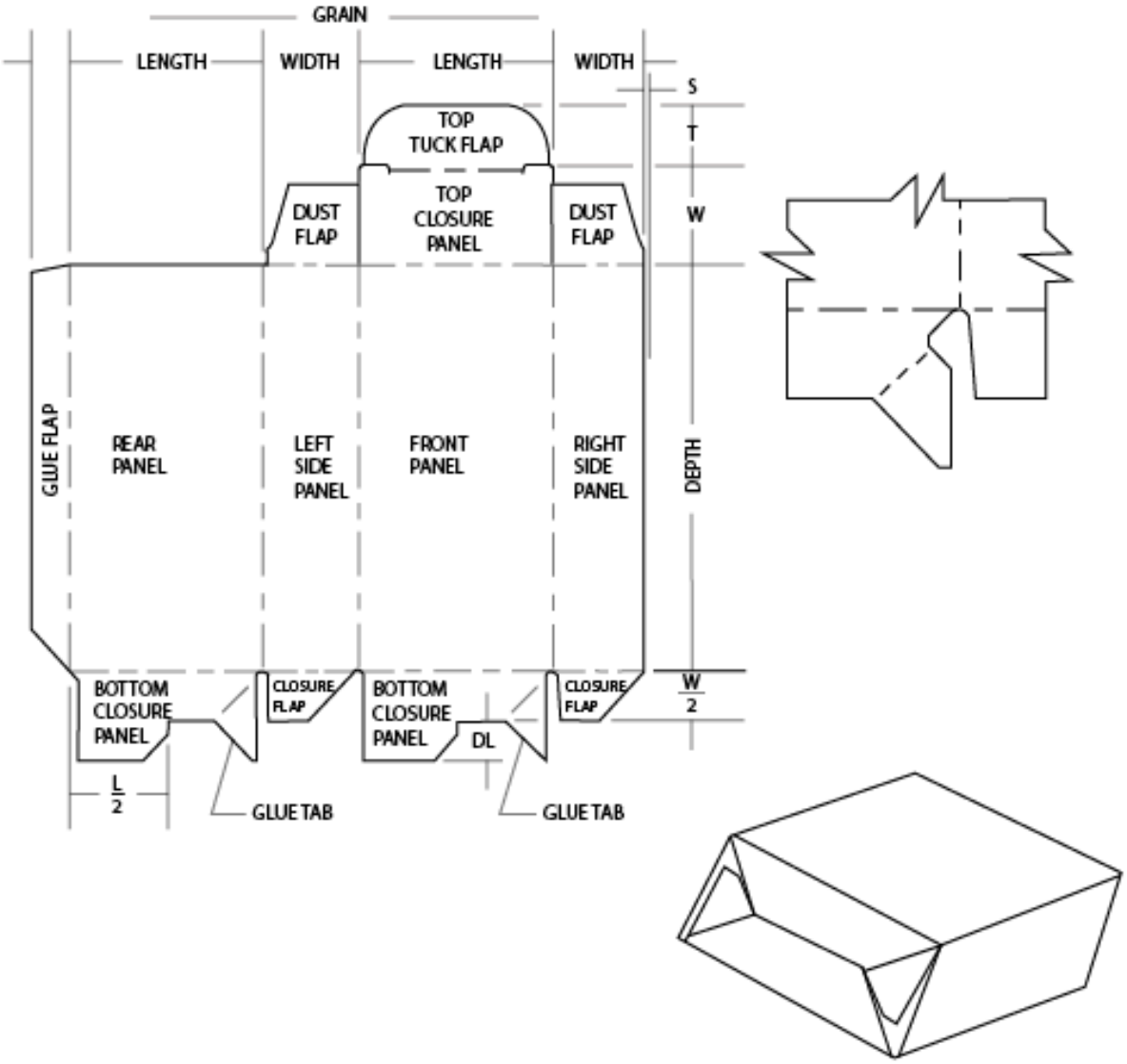

Figure 2. Tuck Top Auto Bottom.[9]

However, for the new box design that was created for this project, the Twist 'N Give contains flaps that twist together and lock rather than having the top tucked in. Figure 3 shows thetwist top of the Twist 'N Give box.

[9] "Folding Carton Styles." *O'PAC Packaging*. 9 May 2011. <http://www.opac-inc.com/folding_carton_styles.html>.

Figure 3. Twist ‘N Give.

The lock at the top will add to the structural strength of the package. Figure 4 shows the traditional tuck top style.

Figure 4. Tuck top box.

Although both the existing and new corrugated wine box are both made of E-flutes, the die cut and structure of the box would determine which box design is stronger and more durable to hold a wine bottle. The Lansmont Squeezer Compression Tester is the standard for testing the overall top-to-bottom compressive strength of the corrugated structure. The material, partitions, and closures are all taken into account in order to quantify the performance when being tested.[10] Not only does the compression test check for the quality of the package, but also the overall strength of the package when placed under distribution condition. The compression test measures the peak load (pounds or kilograms) which is the maximum weight the package can hold before deformation and the amount of deflection (in inches or millimeters) at the peak load.[11] The Compression Test will show which style of the top of the box created a stronger structure.

[10] "Compression Tester-Squeezer." *Lansmont*. Lansmont Corporation, 2011. Web. 14 July 2011. <http://www.lansmont.com/CompressionTest/Squeezer/Default.htm>.

[11] "Compression Test Method and Design Information." *HP*. Hewlett-Packard Company, 1996. Web. 14 July 2011. <http://www.hp.com/packaging/testing/sectab.htm>.

Chapter 3 — Research Methods and Procedures

The purpose of this study is to establish which structural design of a wine box is more durable based on the top of the box. The style of the bottom, the material used, and the size of the boxes were standardized in order to see which top added to the strength of the structure. The tuck top represented the existing wine boxes in the industry while the twist lock top represented the newly created design. Experimental research based on the scientific method was used to perform the research.

There were five steps to the Scientific Method. First off, the problem is identified and defined. Secondly, a hypothesis is formed. Thirdly, data needs to be collected, organized, and analyzed. Then, conclusions are formulated based on the results of the data. And lastly, the research needs to be repeated, verified, and modified.[12]

To begin the scientific method, the problem identified was that the existing wine bottle gift box was not as durable as it could be and that a new design may be stronger. A hypothesis was used to predict that the Twist 'N Give twist top would create a stronger package than the existing tuck top style.

For the third step, which was collecting, organizing, and analyzing the data, the compression test was performed. Two samples of the Twist 'N Give twist top and two samples of the tuck top

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[12] Levenson, Harvey. *Some Ideas about Doing Research in Graphic Communication.* 2001. p19-21

were collected. The boxes were tested one at a time. Each box was then placed on the platen of the compression machine. Next, the top platen was lowered until it touched the top of the box. After, a five-pound pre-load was added to ensure that there was contact between the platen and the top of the box. The compression test began as pressure was being applied from the top. Each of the samples were tested on the Lansmont Squeezer Compression Tester. Once the peak force and the deflection peak were measured for each sample, the averages were determined.

For the fourth step, formulating conclusions, the results were examined to see which top style made the structure stronger. The last step was achieved by repeating the test and comparing the new results to the previous results.

Chapter 4 — Results

The purpose of this study is to determine if the Twist 'N Give is more durable than existing wine boxes based on the structural design of the top. Two samples of the twist top and two samples of the tuck top were tested on the Lansmont Squeezer Compression Tester. The Squeezer slowly added constant pressure to the top of each box until the box was deformed. The peak force, in pounds, and the deflection peak, in inches, were collected and the results were organized into Table 1, shown below.

	Peak Force (lbs)	Deflection Peak (in)
Tuck Top 1	279.8	0.35
Tuck Top 2	345.9	0.32
Twist Top 1	321.6	0.34
Twist Top 2	257.8	0.36

Table 1. The results of the Compression Test for two box styles.

The averages were then determined and inputted into the table below, Table 2.

	Peak Force (lbs)	Deflection Peak (in)
Tuck Top	312.85	0.335
Twist Top	289.7	0.35

Table 2. The averages of the results of the Compression Test for two box styles.

Chapter 5 — Conclusion

The results from the test show that the twist top appears to be weaker compared to the tuck top. It also appears that once compressed, the twist top experienced more damage than the tuck top. For this project, only two samples of each style of top were tested. However, more testing would have to be conducted in order to verify this conclusion. In order to make a more thorough box strength determination, a minimum of five samples of each style of top would need to be tested.[13] However, it was impossible to get access to five boxes of each style for this project.

Once additional testing is concluded, it will be clear whether the twist top structure is inferior in structure to the tuck top structure. Upon completion of a second stage of testing, if the twist top proves more durable, then the Twist 'N Give would clearly be a better choice to present the wine in because it is aesthetically pleasing. If the twist top and the tuck top are about the same in the amount of compression thy can withstand, then it would still be better for the wine to be presented in the Twist 'N Give because it resembles a gift more than the plain tuck top look. However, if the structure with the tuck top is able to withstand more pressure, then continuing to use the existing wine boxes to present wine would be a better choice.

The main function for the wine box is protection for the wine bottle, with appearance being a second priority. Because of this, the durability of the box may be the most important. Although the twist top provides an attractive appeal to the box, the tuck top appears to be sturdier based on

[13] Singh, Jay. Personal Interview. 5 July 2011.

the two samples that were tested. But with additional samples tested, the twist top may actually be stronger and prove to be a better package for carrying the high quality beverage inside.

In many cases, because these gifts are handled and given in person, the wine boxes do not require maximum structural integrity. As a result, the twist top box may provide sufficient protection for the wine bottle even though it may not have an overall strength that is greater than the tuck top.

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