

# A white paper on round shaped corrugated board packaging

Conventional paper packaging can not easily be made both round and stable

## Introduction

The main purpose of packaging is to facilitate shipment of goods from the producer to the consumer. However, the role of the packaging has expanded and today the packaging should also communicate, advertise and sell the product inside. With modern printing technology, many packages today have high definition print with quality comparable with the prints in magazines. One of the biggest challenges for the packaging as an advertiser is to stand out from the crowd.

The range of products within a certain category is today greater than ever and since the over-whelming majority of purchase decisions are taken by the customers in-store, it is more important than ever for the brands to be seen in the razor-sharp competition.

One of the most important design elements of a packaging is its shape and a unique shape will faster thrill the consumer's curiosity. Research also indicates that consumers seem to prefer curved shapes over sharp angled ones<sup>1</sup>.

Corrugated board is a commonly used packaging material with an expected global annual production of 115 million tonnes in 2019<sup>2</sup>. The reasons to the high usage are among others that it is relatively cheap, has an outstanding weight vs. performance ratio and is considered environment friendly due to that it is made of renewable resources, is recyclable and also biodegradable by nature and hence could help to reduce littering. Littering of the oceans is one of the major current environmental challenges besides global warming and is mainly caused by non-degradable plastic materials.

However, conventional paper based packaging materials such as corrugated board and carton board have problems delivering both a round shape and stability. This is due to the nature of these materials that have been designed to deliver high bending stiffness at low cost.

This white paper serves to give an explanation of how round shaped packaging differs in performance relative conventional brick shaped packaging and also address the opportunities there are to use paper packaging of rounded shape to get shoppers attention in store.

## The effects of round shape on attraction and consumer behavior

In a typical food store, the consumer passes approximately 300 different products per minute which makes it extremely important for a brand owner to differentiate their products and be seen by the consumer<sup>3</sup>. Research indicates that the marketer has less than a second to grab a customer's attention<sup>4</sup>.

*"The First Moment of Truth revolves around the shopper experience and what occurs at the point of decision; the emotional connection, apparent value and compelling points of distinction."*

(Adrian Pynenburg,  
Branding expert and CEO  
Connect Oasis Inc)

The packaging itself seems to be one of the most important factors in purchase decisions made at the point of sales<sup>5</sup> and a unique packaging contributes to the recognition of a company or specific brand. The possibility to create new innovative packages may end up in great advantages for producers, brand owners and consumers<sup>6</sup>.

***“Packaging is the single biggest driver of sales increases in the world.”***

**(Muhtar Kent,  
CEO Coca-Cola)**

There are a number of visual elements to work with when designing a packaging such as size, color, graphical layout, material and shape. In particular the size and the shape affect the judgments and decisions about a packaging. A unique shape will faster thrill the consumer’s curiosity and will more likely lead to a positive purchase decision<sup>7</sup>. Fig 1 shows two examples of innovative packaging shapes, created to stand out on the shelf.

People constantly make snap judgments about objects encountered in the environment. Such rapid judgments must be based on the physical properties of the targets.

***“The physical form or design of a product is an unquestioned determinant of its marketplace success”***

**(Peter H. Bloch<sup>8</sup>, Professor of Marketing, University of Missouri)**



**Fig. 1** A unique shape of the packaging stands out on the shelf and thrills the consumer’s curiosity.

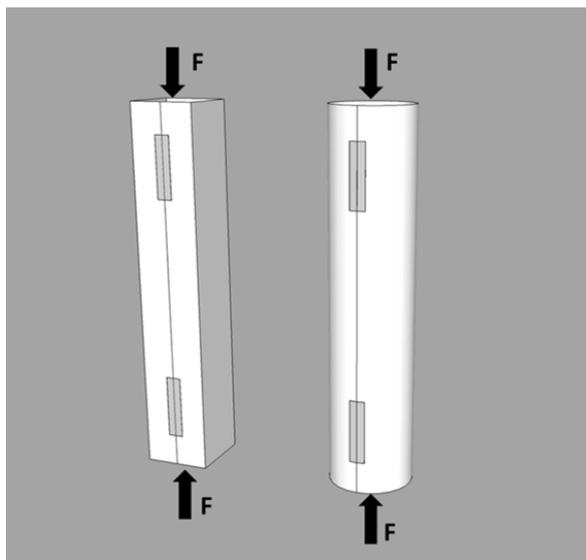
Research from Harvard medical School has showed that the shape of an object has a critical influence on how people react to it. Objects having curved shapes are preferred subsequently before objects with sharp edges since sharp edged objects unconsciously are experienced as more threatening<sup>1</sup>. That curvatures provide positive emotions is also confirmed in research on how humans react on interior design<sup>9</sup>.

***“Time and again, when people are asked to choose between an object that’s linear and one that’s curved, they prefer the latter”***

**(FastCo Design)**

## The effects of round shape on performance and strength

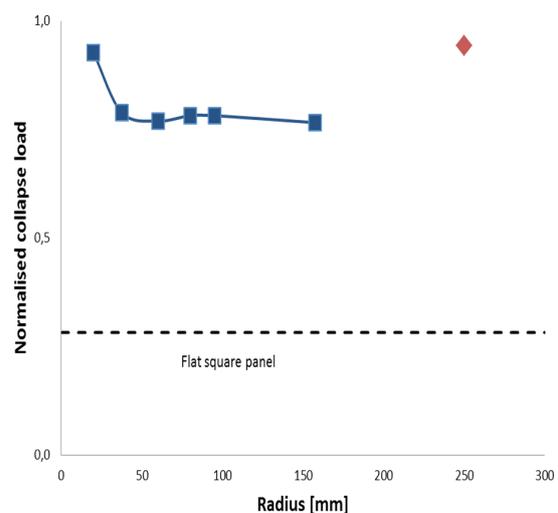
The stacking strength of the packaging is the single most important strength property of paper packaging today and to a large extent governs the price of the packaging. For many years, the design of paper packaging essentially followed trial and error procedures. In the 1950's scientists started to analyze the strength of paper packaging using a more engineering approach<sup>10</sup>. The following decades, design rules were developed that could be used to tailor the strength for a certain packaging according to specifications<sup>11,12,13</sup>. It was established that the strength of packaging is determined by a combination of packaging dimensions and properties of the constituent paper materials. These early work were limited of brick shaped dimensions solely. In nature it is often seen that structures seek to optimize their strength by attaining curved shapes, e.g. the stem of a tree, bamboo or a nutshell are examples of objects with high strength levels per weight. These living organisms have been optimized over millions of years through evolution. There are very few examples of piece-wise flat shapes among living organisms which is due to the relatively weak performance of such structures. It has been a big field of science to



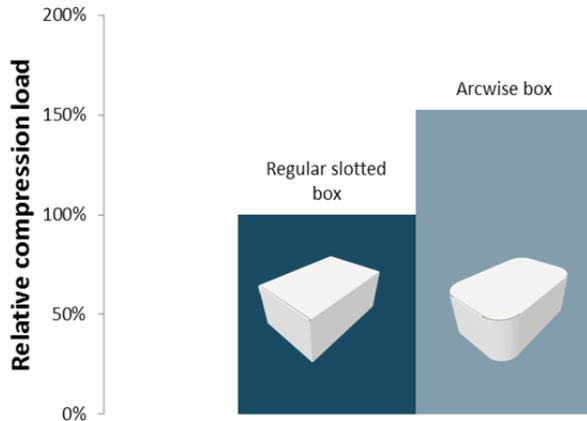
**Fig. 2** Compressive loading of paper columns of rectangular and circular cross-section is an easy way to illustrate the difference between the performance of the structures.

develop structures that is designed according to principles observed in nature, so-called bio-mimicry. It can be shown that the round shapes of nature could have a significant potential to enhance the performance of paper packaging if round shapes are used instead of the conventional brick shape. The advantage in strength can be illustrated by comparing the compressive strength of paper columns of square and circular cross-sections, fig 2.

Upon compressive loading, of the square column, the load soon deforms the walls so that the load is being carried only at the corner edges with the remaining parts of the wall not contributing to the total strength. In contrast, the wall of a cylinder is free of corner edges where the force of a compressing load can become concentrated, so the load is carried nearly equally by all parts of the cylinder. In other words, all parts of the cylinder share the load. Secondly, cylinders do not deform easily under an increasing load so that all parts continue to contribute strength until finally collapsing. The paper cylinders will hold four to five times more load before collapsing<sup>14</sup>. Similarly, fig 3, shows a comparison of compression strength of corrugated board cylinders relative an edgewise compression load of a square panel<sup>15</sup>.



**Fig. 3** Normalized collapse load versus radius<sup>15</sup>.



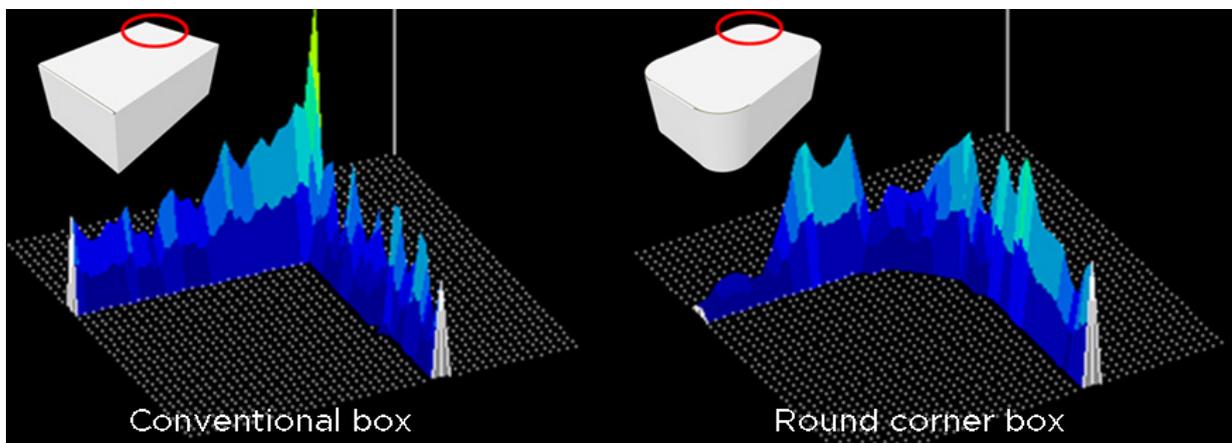
**Fig. 4** In one example, from a real packaging case with a given box size and board grammage, an increase of 53% in stacking strength was achieved by using a box design with four round corners<sup>12</sup>.

It has been seen in investigations that also packaging with rounded corners achieve the good strength properties relative the brick shaped packaging. Fig. 4 shows the levels of compression strength of a conventional corrugated board packaging and a corrugated packaging with rounded corners. It is seen that the packaging with curved corners have approximately 50% higher compression load compared to the conventional brick shaped corrugated board packaging for this specific case.

This is due to fundamental structural principles implying that curved panels are relatively more resistant to buckling compared to flat ones and because of that curved panels provide a higher relative strength compared to structures consisting of flat panels<sup>16</sup>.

When such packaging is stacked on a pallet the flat vertically oriented side panels start to carry load and at an early stage start to bulge. The bulging cause a redistribution of loads on the packaging and loads are carried almost exclusively by a small region in the vicinity of the corners of the box. This behavior can be captured by digital measurement instruments. A result is shown in fig 5.

The main underlying reason to the increased stacking strength of a curved structure is the way forces are distributed upon loading. A curved corner distributes loads more evenly in the corner region compared to a right angled corner, which decreases strength variations between single boxes<sup>18</sup>.



**Fig. 5** Measurement of pressure distribution in the corner region of a top-to-bottom loaded packaging shows clearly that the forces are concentrated to the corner in a right-angled corner while the round corner distribute the forces more evenly<sup>17</sup>.

It has also been observed that the rounded corners do contribute with resistance to shear forces and stability in transit. In tests performed on an Impact Tester (single item transport tester, fig 6), where a top-to-bottom loaded box is subjected to both compression- and shear forces when sliding down an inclined ramp to a sudden stop, a box with rounded corners withstood up to 80% more load before the packaging failed<sup>19</sup>.



*Fig. 6 The Impact Tester, used to evaluate packages in conditions similar to those on a pallet in a braking truck.*

## **Bendable corrugated board enables material reductions**

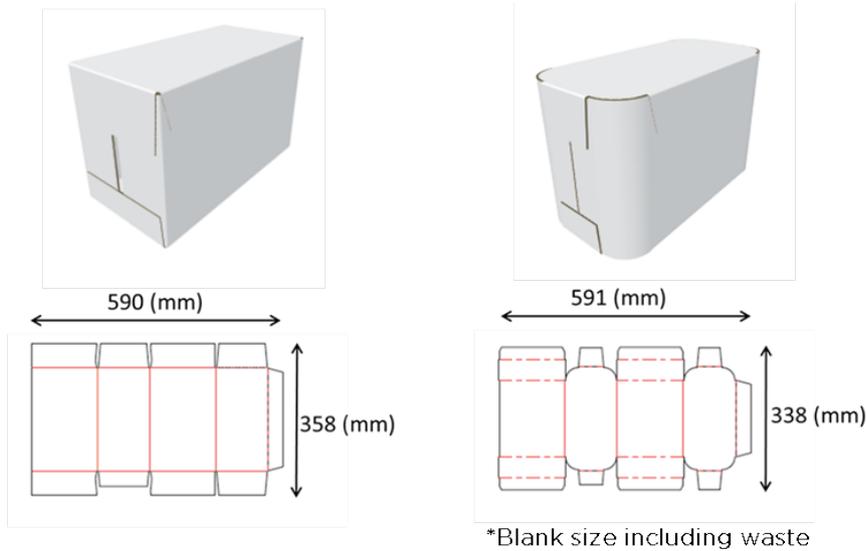
By using bendable corrugated board it is possible to combine the great advantages with the material, such as the improved strength vs. weight ratio and environmental profile, with the advantages of curved designs. Except for the increased sales that could be expected with a more attracting packaging design, there are other benefits in the cost area.

As described previously, the curved corners increases stacking strength compared to a regular brick shaped box, which implies that for a given target strength, up to 30% material reduction is possible, depending on box dimensions and constituent materials.

Another positive result of such light weighting due to the better strength vs. weight ratio is a reduced carbon footprint which is affected of both the improved transport efficiency and the reduced material usage<sup>20</sup>.

A round corner packaging is also more material efficient “area wise” since the perimeter of the packaging will decrease relative a brick shaped packaging. In fig 7, a conventional wrap around packaging has been replaced by a similar solution with rounded corners, giving room for a board area\* saving of 5.5 %. The ruler length of the die-cutting equipment is most often reduced as well since the perimeter of the box normally is shorter using curved corners. Moreover, the corner creases disappear. In the case described above, the ruler length is reduced with 21% by changing the original square design to a curved one.

Stretch wrapping of pallets are common in the distribution chain of all kinds of products. An often occurring problem with stretch wrapping of rectangular stacks of packaging is damaged corners since a high tension is needed to keep the stack into one unit during transport. With round corners, the stretch wrap will sweep smoothly around the stack and enable a high tension to be used in the wrapping operation without damaging the corners, fig 8.



**Fig. 7** The "round corner" wraparound solution gives room for a board area saving of 5.5% in this particular case.

**Fig. 8** Sharp angled corners can often be problematic in stretch wrapping with high tension (left hand side). The round corners distribute the load over a larger area and damaged corners are avoided (right hand side).



## Conclusions

The global packaging market seeks cost effective packaging systems that are robust and yet can attract consumer's attention in point-of-sales. It has been shown in several investigations that round shaped packaging have a potential to attract consumers attention. Some say even that man's preferences for round shape are hard coded in our genes and that is due to that the round shapes signals a lack of threat. The round shapes have also a significant benefit when it comes to strength and performance. In nature objects seeks to optimize their strength by attaining curved shapes because of the inherent strength of such shapes. There are numerous examples of that in nature such as the shells of nuts or the hollow cylindrical geometry of the bamboo stalk.

By utilizing bendable corrugated board it is possible to produce packaging with round forms, which creates both an attractive as well as a material effective packaging. The main underlying reason to the increased stacking strength of a curved structure is the way forces are distributed upon loading. A curved corner distributes loads more evenly in the corner region compared to a right angled corner. This distribution of loads brings many advantages compared to brick shaped packaging. It makes the packaging very strong in compression and in shearing. Further, the variation in strength for round shape packaging is very low compared to brick shaped paper packaging.

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