

**INNOVATIVE APPROACHES TO TEACHING PACKAGING
DESIGN USING THE EXAMPLE OF MINERAL WATER
SUPPLY CHAINS**

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Abstract

Designing the packaging of a product has many critical factors. In our paper, we present some of them on the example of a simple product: mineral water. In spite of the fact that today not only products, but also supply chains are competing with each other, designers sometimes pay little attention to considering the packaging system not only from the customer and the producer side, but for warehousing and transportation as well. We cover a lot of “what can go wrong” scenarios on the example of mineral water packaging for the purpose of defining the critical points in the supply chain.

Key words

packaging, supply chain, “what can go wrong” scenarios, practical skills

INTRODUCTION

Packaging is the process of enclosing or filling the product in bottles, plastic bags, paper or wood boxes, metal containers, etc. Packaging reduces the risk of wastage, spoilage, leakage, melting and evaporation in the process of transportation and storage. Equivalent to the development cycle of products, the packaging development cycle also effectuates the integration of downstream processes like process planning, production planning and maintenance (1).

Universities' role in today's world is to educate experts in all aspects. We strongly believe that faculties of technology which educate future engineers could benefit from the inclusion of practical classes in their curricula. In the frame of a conventional classroom lesson, it is often impossible to give ‘practical’ examples of sophisticated packaging tests (climate chamber or shocking test equipment), but it is possible to bring a simple bottle of mineral water to the classroom (4).

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PACKAGING – WHY IS IT IMPORTANT?

Packaging is becoming more and more important. Not long ago, people were buying goods in the store in simple packaging, e.g. milk in a plastic bag. Now, we buy goods in sophisticated packaging which includes much information. That's why we say that nowadays, packaging has a lot of different functions, such as protection (from mechanical and climate effects, insects, etc.), function of easier identification, convenience, promotion and innovative ideas (5).

In addition, product branding can be done using recognisable packaging. Also, empty packages have their resale value for customers. Packaging builds the image of the product and its producers. Effective packaging is the source of prestige to its producers. Packaging continues to be more important in the modern shopping environment of growing competition, open display of the product and self-service of the customers (3).

CHALLENGES IN DESIGNING THE PACKAGING FOR A CUSTOMER

When designers in a company prepare a strategy for a certain product, they consider quality, price, environmental effect, transportation, warehousing, waste management etc. Before the product is made, thorough research is needed into the market conditions, customer preferences, possible name of the product and an effective packaging for it. When designing packaging, the first item is the buyer's attitude (buying psychology). Afterwards, physics come into consideration (2).

While doing our research, we focused on the assortment of mineral water readily available in local markets. We found a wide array of different shapes of bottles available with different variations of packaging (in foil). We also inspected the quality of the bottle. Some of the bottles were made of weak plastics and were easy to damage during transport and also during shelf time. Others were of tougher plastics (2).

CHALLENGES IN DESIGNING THE PACKAGING FOR A COMPANY (PRODUCTION AND COMMERCE)

When product research is finished, it is very important to think about the quality of the packaging and its cost. For example (if we take a look at the bottles of mineral water), the bottles can be made of light plastics that is still hard enough to meet all the requirements for the warehouse and transport processes, but on the other hand, if we use harder (tougher) plastics, this can result in higher production costs and more impact on environment (5).

Here, also the packaging of the bottle comes into consideration. For example, if transporting the bottles shaped like a prism, there is not so much air between the bottles like in the case of transporting cylindrical bottles. We used two different water bottle shapes - Zala water brand, which is in a prismatic packaging, and Aqua Natur water brand which has a cylindrical packaging. A package of Zala water contains 20 pieces in a foil (half a litre bottles) and a package of Aqua Natur contains 12 pieces in a foil (5).

A pallet of Zala water contains 60 packages, which equals to 1.200 bottles on a EUR pallet. A pallet of Aqua Natur water contains 95 packages, which equals to 1.140 bottles on a EURO pallet. From this, we can conclude that prismatic bottles are more efficient in regard of spatial consumption than cylindrical ones. Speaking in larger scales, this means that a truck

with 2.42 meters x 16.50 meters, which can transport 39 pallets in one drive can transport 46.800 bottles of Zala and 44.460 bottles of Aqua Natur in one load, indicating a difference of more than 2.000 bottles.

The difference between cylindrical and prismatic bottles packed in foil packaging can be explained with a “Touching points” test. In this test, we take a coloured marker, match one bottle with it and then press the bottle together with the other one. We used two cylindrical and two prismatic bottles. When touching each other inside the foils packages, there is friction between the bottles. The friction occurs in every movement of the packaging. If the packaging is not good enough, it can be easily damaged during transportation (for example in case of road bumps and so on). Results were as shown in Figures 1 and 2.

Based on this test, we can see that prismatic bottles have more touching points. In theory, that means that the friction points are more distributed all over the surface, so the friction is lower than in the case of cylindrical bottles. If taking transport into consideration, we can say that with prismatic bottles, there is less unused space in the packaging itself than with cylindrical bottles. With prismatic bottles, space on pallets is more likely to be better used than with cylindrical ones.



*Fig. 1 Impact on a prismatic bottle (Zala water)
(own source)*



*Fig. 2 Impact on a cylindrical bottle (Natur
Aqua water) (own source)*

We can state that prismatic bottles are more stable and more resistant to horizontal forces than cylindrical ones; but the material quality also comes into consideration here.

CHALLENGES IN DISTRIBUTION

Distribution has a specific role in logistics. If the product is not available when a customer wants to make a purchase, this can be reflected as both, loss of reputation of the store as well as the loss of profit for both producer and seller (5).

Another performed test in our research was the “Foil finger” test. The quality of the foil used for strapping together a certain number of the same product must be appropriate. This means it has to withstand all the handling operations throughout the supply chain. During our research, we found that a single package of mineral water is moved or touched eight times during its journey from the production plant to the end customer. This means that the foil must be strong enough not to brake during handling. The handling is mostly done by lifting the single packages by hand. In the testing itself, the foil tore on average during the 3rd or 4th lift.

The test was done by lifting the package with different combinations and number of fingers on the same packages of mineral water as in the previous test - Zala package of 20 bottles and Aqua Natur package of 12 bottles. We started the procedure with one finger. Here, the pressure was the highest and the foil tore after the 1st or 2nd lift. The second foil test was with 2 fingers. We found it to be the best way to pick up the pack, because it is easier, more comfortable and does not damage the foil. After the 3rd lift, the foil tore. The third test was with four fingers. It is good for the foil, but it is not comfortable for the person performing the handling. In this case, the package withstood the handling.



Fig. 3 Foil test using 2+2 fingers
(own source)



Fig. 4 Foil test using only one hand
(own source)

Transportation

Transportation in this era is definitely a necessity, but it is also very expensive. Another test we performed is the “Temperature” test. We took samples of both types of mineral water tested, Zala and Natur Aqua. We assume that during winter, the pallets with the products are exposed to open climate conditions for at least a part of their journey (depends on the length of the transportation) and this can have an impact on the product. We tested the effect of winter conditions on the water by keeping it at the temperature of 5° Celsius. We made three different tests – exposure to low temperatures for an hour, for 2 hours and for 3 hours. We then checked the effects of the “winter” climate on the bottle content. The results were as follows [2]:

RESULTS FROM FREEZING TEST (own source) Table 1

TIME	ZALA WATER	NATUR AQUA WATER
1 HOUR	nothing happened	nothing happened
2 HOURS	about 5% frozen	about 10% frozen
3 HOURS	about 70% frozen	about 95% frozen

Warehousing

Warehousing and stocks present an expense to any company. The more stocks a company has, the bigger the warehouses are needed to store goods. Even though “just-in-time” production is excellent on paper, it is really hard to achieve in everyday life. Sometimes, the warehouses built and sheltered are not enough to store all the products, so some of the goods have to be stored outside, for example under a tent or in the open air. We also have to consider the demand on the market. Mineral water is one of the products the demand for

which seasonally changes: people drink more water during summer time and less in the winter time.

During the winter and summer time, there can be a lot of sudden climate changes influencing the products during transport. For example, if the temperature in a warehouse is 25° and there are 50° or 60° Celsius in the truck, that can result in a shock. The same applies to winter time - if the temperature inside the warehouse is 25° Celsius and -10° Celsius outside, it is also a shock.

Another test performed was the “Drop” test. Here, we threw two different bottles, the prismatic and the cylindrical ones, from different heights and monitored the damage. The drops were made from 1 meter, from 2 meters and from the 6th floor, approximately from the height of 12 metres. From the height of 1 meter, there were no physical changes on any of the bottles. The height of 2 meters led to some physical changes on the bottles, the plastics was damaged, but there was no evidence of leaking from the bottle. When dropped from the highest point, the prismatic bottle got damaged in the first trial, and the cylindrical bottle showed no changes in the first trial. In the second trial, the cylindrical bottle was damaged.



Fig. 5 Damage on the rectangular shaped bottle (own source)



Fig. 6 Damage on the cylindrical shaped bottle (own source)

Waste management

Waste management is one of the issues in logistics, which are very important from multiple points of view. First, the environmental aspect has to be considered for preserving the natural environment as well as in regard to recycling capabilities. If we choose the right way to handle our waste, we can help the environment and the planet.

However, what is the best way to handle our waste? In logistics terminology, it is called waste management. Some of the waste is used in power plants, some of it is used for recycling and some is biologically degraded. These are all ecological ways to manage the waste. The final test in our research was the “Compression” test with a machine squeezing the bottles together. The test was made with three bottles of each shape to get an average result. The result was that the cylindrical bottle is much more squeezable than the prismatic bottle.

CONCLUSION

In this paper, we described a lot of factors connected with packaging and the supply chain. The task was how to demonstrate to university students the importance of different packaging aspects in handling processes. The tests that are presented in the paper can be easily accomplished in any classroom and can attract the attention of students. What is more, it is possible to extend this application to the field of e-learning studies.

The learning-by-doing method based on personal experience (dialectic approach) is able to help in education and training of students to get the required specific viewpoints and develop their innovative and cooperative skills and competencies.

The main outcome of the presented research is that, during the classroom lessons, it is clearly seen that in spite of the increasing supply chain competitiveness, designers sometimes pay only little attention to the packaging system, not only from the customer and the producer's point of view, but the warehousing and transportation aspects as well. There are many logistics cost saving possibilities, like adjusting the size of packages to the dimensions of EUR pallets, and designing the packaging system according to the real physical prerequisites and climate effects alongside the supply chain.

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