Balancing Environmental Performance with Sales Functionalities in Packaging for Consumer Electronic Products

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Abstract

Two major changes are currently taking place in the world of Consumer Electronics. They are, first, the relocation of production to low-wage countries, in particularly China. This results in longer distribution distances, which lead to a higher relative importance of this phase in the entire life cycle. To make this phase as efficient as possible, products should be packed as volume efficient as possible, which means small boxes. Secondly, retail formats for CE products change into large budget-oriented stores selling products in the box. Here the packaging has to sell the product, which calls for bigger, shinier boxes. Obviously the combination of these developments leads to design conflicts. This paper addresses how to manage this design challenge in such a way that the environmental impact of the packaging does not get unnecessarily high.

Keywords

Packaging design, Consumer Electronics, Retailing, Distribution

1 INTRODUCTION

The world of Consumer Electronics (CE) is changing in many respects. On the one hand, distribution distances grow, due to relocation of production to low-wage countries, in particular China. With it, the importance of this phase of the life cycle grows.

On the other hand, the retail of CE products is changing as well. CE products have become commodities, which are subject to impulse buying. This raises the importance of sales functionalities of the packaging.

This development is accelerated by the introduction of so-called 'Category Killers', which are budget shops with a wide selection of products within a limited segment, such as MediaMarkt in Europe. These shops sell packed products from the shelf, with only a limited amount of sales assistants available. Hence the product has to sell itself; or rather the packaging has to.

These developments have their consequences on the environmental impact as well as on costs of packaging and transportation of CE products. Requirements from the different stages in the life cycle are contradictory. Distribution asks for the smallest possible packages to achieve the highest efficiency, while the marketing asks for big and shiny packages. The resulting design challenge lies in balancing marketing functionalities with costs and eco-efficiency. It will be demonstrated that there are both CE products where the logistical efficiency is more important in packaging design and CE products where marketing functions dominate.

In this paper the influence of packaging design on transport efficiency will be discussed, and related to environmental impacts as well. However, most of the attention will be paid to the extent of change in the retail of CE products and its effect on packaging design.

Subsequently, the resulting design challenge will be demonstrated in a case study on electric shavers. Finally the avenues for improvement will be identified, both from a design perspective and a managerial perspective. It is concluded that a sales-impact measurement tool is needed, as this would be a major step towards a tool or method for balancing marketing and environmental/ logistical requirements.

2 LOGISTICAL EFFICIENCY

Many production companies are moving activities to low-wage countries. Particularly China is booming. This means goods are shipped all over the world from China, making transportation distances much longer than they used to be. The idea behind this move to Far East countries is to save on production cost through cheaper processed materials and components and cheaper labour. Hence, with reduced production costs on the one hand and increased transportation costs on the other hand, the relative importance of the distribution phase in the entire life-cycle is increasing. This development is only strengthened by the fact that currently shipping finished goods occurs almost exclusively from China to the West and hardly anyone is shipping in the other direction, leading to an asymmetrical demand of container shipment, which has increased the prices per container shipped to the West dramatically. Logistical managers in industry claim that prices from China are approximately tenfold the prices for shipping to China. Hence, efficiency in this phase is of increasing importance.

From an environmental perspective, packaging has two major ways of creating an impact on the environment. First, packaging requires materials and processes to be produced. Second, packaging dimensions determine transport efficiency. A study of packed CE goods showed that most of them 'cube out' [1]. This means that, when filling a truck or container for shipping, the maximum cargo volume is reached before the maximum cargo weight is reached. Hence, logistical efficiency is determined largely by the volume of the packaging. Hence, the smaller the package, the more units can be shipped in one shipment. And in the end fewer shipments mean a lower environmental load per product.

Furthermore, studies have shown that the environmental impact of transporting CE goods from their place of manufacturing to shops is generally about twice the impact of the packaging material itself [1]. Hence, designing packaging for minimal volume is a sound strategy from a perspective of direct costs and environmental friendliness. This approach differs from the traditional approach of eco-design of packaging, which tends to focus on resource conservation through material reduction (= weight), and even more strongly on material

recycling. This approach is evident from a study of environmental claims made by suppliers of cushioning materials for packaging [2] and also from the European Directive on Packaging and Packaging Waste [3].

3 CHANGES IN RETAIL SITUATION

Next to changes in the distribution of CE goods, the retail situation is changing dramatically as well. Increasingly, fewer and larger retail chains control access to consumer. For instance, in the US, Wal-Mart, Best Buy, and Circuit City, and in Europe, MediaMarkt and Saturn (both owned by the German Metro Group) control increasing market shares. These are retail formats which can be classified as 'Category Killers'. Category Killers are large shops with a very complete collection of products within a clearly defined narrow market. These formats are gaining market share fast, at the cost of small and medium size retail formats that traditionally dominated the CE retail landscape. In 2004 69 new Saturn and MediaMarkt stores were opened in Europe, bringing the total to just over 500 (see also Figure 1). This changeover is illustrated by the following citation from a Dutch newspaper:

"MediaMarkt entered the Dutch market five years ago. Ever since, Kijkshop, It's, Modern, BCC and Expert shiver with fear. The rise of the German discounter was partly responsible for the bankruptcy of the 'Horn' chain and last month for the bankruptcy of 'Megapool', that is even besides the anonymous independent stores disappearing. Experts expect more bankruptcies. In just five years MediaMarkt has achieved more or less the same sales volume as the 75 It's shops, the 54 Modern shops, or the 112 Kijkshop shops. The group of 14 MediaMarkt locations in the Netherlands is to be expanded to 40 shops in the next 4 years. By then MediaMarkt will be market leader by far."

([4], own translation from Dutch)

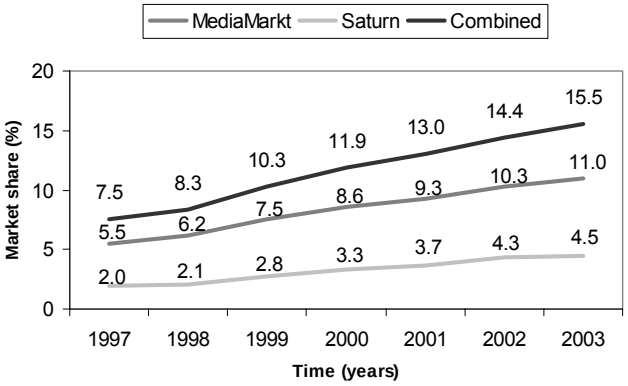

Figure 1. The strong growth of the MediaMarkt and Saturn group as illustrated by market share development in Germany [5].

The retail format of stores like Best Buy and MediaMarkt is very different from traditional CE shops, which strongly affects the importance of the packaging design. Category Killers are typically catering to 'price buyers'. To keep prices down use of floor space is maximized and the number of employees is kept relatively low. In the traditional CE shop products are shown unpacked on shelves or in a cabinet. Customers have to approach a sales assistant which will advise them in their purchase, and subsequently collect the chosen product from the warehouse. In MediaMarkt en Saturn stores the shop floor is used as storage space. Packed products are available on the shelves, and many consumers make their purchase choices without contact to sales assistants. Here the packaging plays a more important role in attracting consumer attention in order to ensure the specific product is noticed and considered by the consumer, to communicate the advantages of the specific product (and brand), and to close the deal. Even though shop assistants can still help consumers if required, many consumers will buy products unassisted. This business practice is illustrated effectively by the following quote [6, p. 185]:

"Consumer electronics has become a low-prices commodity business, so that it is difficult even for speciality stores to make much in the way of sustained profits. A DVD player, for example, is familiar to most consumers, so discounters such as Wal-Mart and Target can pile them high and sell them cheap without having to hire knowledgeable sales and service help. Manufacturers put as much product information as possible on their Web sites (as well as the boxes the products come in), so that the customer is given enough data to make an informed decision, regardless of whether the purchase is ultimately made at Costco or Wal-Mart or Best Buy."

This demanding retail setting has led to packaging that is not solely designed with logistical functions in mind (protection, handling information like maximum stacking height and bar codes). Packaging for CE goods has moved away from dull brown cardboard boxes with black prints to colourful designs with pictures of smiling users on them. Furthermore, packaging for small, trendy products has increased in size (as will be illustrated in section 5). These are products that have short model-life cycles and that have a strong emotional component. They are not merely utility products. Examples would be mobile phones and Personal Audio players. The 'Big-Is-Beautiful'-tendency that exists for these products has negative effects for the environment, namely:

- the use of more packaging materials,
- shifts from cardboard boxes to blisters,
- bigger packages, resulting in less (eco-)efficient transportation.

4 BALANCING SALES AND DISTRIBUTION

Section 2 concluded with the formulation of a design challenge for volume-efficient packaging to achieve efficiency in transportation. The developments described in section 3 present a new design challenge. This challenge lies in balancing the contradictory demands for logistical efficiency and the fulfilment of sales functionalities. These sales functionalities are: attracting the consumers' attention, communicating unique product features, communicating brand value, etc. Next to this there are related retail functionalities like proof-of-newness, prevention of unwanted handling (tamperproof), and prevention of theft (through bulkiness).

These sales functionalities have to do with psychology and consumers' emotions. They are more about packaging *design*, than packaging *engineering*. Here the design performance of a packaging becomes important. This design performance is determined by factors as shape, materials, texture, graphics, colours, photographs, etc.

To illustrate the importance of the different packaging functionalities for different CE products in the current

Packaging Functions ► / Product type ▼	Mechanical Protection	Keeping dry and clean	Containing accessories	Handling	Informing supply chain	Informing consumer	Attract consumer attention	Prevent theft	Proof of newness
TV sets	4	4	2	3	2	1	1	0	0
DVD(R)	4	3	2	1	2	2	3	0	1
Audio sets	4	3	2	1	2	2	2	0	1
Personal audio	4	2	3	0	2	4	4	4	3
Mobile phones	1	3	4	0	3	3	3	3	4
Shavers	1	2	4	1	1	4	4	3	3
Light bulbs	4	3	0	2	2	3	2	1	1

Table 1. Relative importance of packaging functions for several CE products [1].

situation, a study was performed interviewing product managers and packaging designers within Royal Philips Electronics. They were asked to score several packaging functions on their importance in determining packaging design for the products they work with, see Table 1.

From this table it can be concluded that there are two groups of CE products; one group of products with bigger volume where the packaging fulfils mainly distribution related functions like protection, and a second group where the packaging has to fulfil more sales related function, like attracting consumer attention. This "sales-dominated" packaging consists of smaller, trendier products, such as Personal Audio Players. With these sales-dominated products the design performance of the packaging is more important, usually resulting in bigger boxes. This is also confirmed by a study of the volume-index, the ratio between package volume and product volume [1].

$$Volume-index = \frac{Volume_{package}}{Volume_{product}} \quad (1)$$

Here product volume is defined as the maximum height, width and depth of the product in the orientation in which it is transported. Distribution-dominated package designs tend to have volume indices of around 1.8, while small, fashionable CE products may have volume indices as high as 15 to 20, with outliers up to 40. Products within this group are for instance Personal Audio players (e.g. MP3 players) and Personal Care products (e.g. electric toothbrushes and electric shavers).

These high-volume-index packages result in a rather inefficient use of transportation space. If one fills up a container with packed products from this category, only 10 to 20% of the volume of the container will be occupied by products themselves. The rest of the volume is occupied by the unused space in the packages.

This volume inefficiency may lead to the conclusion that insufficient thought went into the balancing of the sales functionalities and logistical efficiency. Indeed, if one takes a look at the absolute package volume, boxes twice or three times the size of direct-competitor products are not unusual. This indicates a lack of integral management. Apparently there are some companies that control this process better than others.

Part of the problem may lie in the internal value chain. The department taking the packaging design decisions may not be the same as the department paying for the transportation from the factory to the distribution centre.

5 CASE STUDY RESULTS

To further illustrate to contradiction between sales and environmental/logistical requirements a case study was performed on electric shavers. Several recent designs were studied for their costs and eco-impact, see Figure 2 [7].

Figure 2 shows the costs and eco-impact of several generations of packaging designs for Philishaves (not including transportation). Figure 2 allows two conclusions. First, that the eco-impact of the packaging is strongly correlated to the costs of the packaging. And second, that there has been a considerable increase in costs and eco-impact over time. This increase can partly be explained by the changes in the retail situation, and partly by increased competition. This increased competition is the result of several brands introducing triple-headed electric shavers after the expiring of the patent Philips had on that system and the subsequent legal battle over the question whether the triple headed shaver could be seen as a trademark [8, 9].

From a managerial point of view, these increases in costs and eco-impact can be justified, if they result in more sales and/or higher margins, which may be the result of a better design performance. However, currently there is no methodology available to *calculate* the design performance. Nor is there a test to *measure* it effectively and efficiently. Available design research methods are either qualitative or, if they are quantitative, only measure part of the design performance (as will be further discussed in section 7). Hence it is difficult to determine whether a certain design change yields enough in terms of design performance to justify the additional costs (see also Figure 3 [7]).

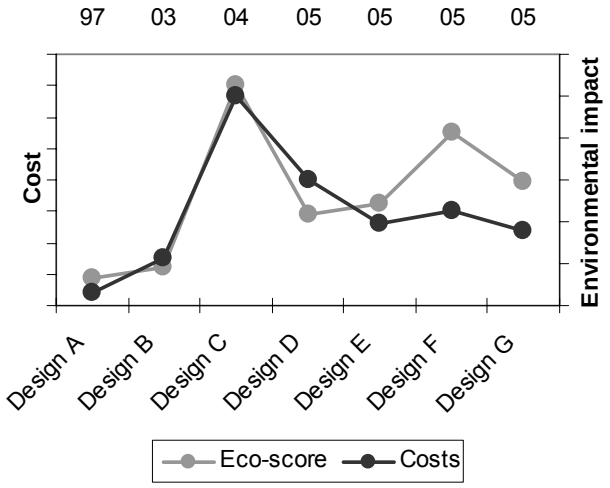

Figure 2. Development of costs and environmental impact over time. Scores are for the packaging only, transportation of the packed product is excluded. Above the figure is the year of introduction of the design.

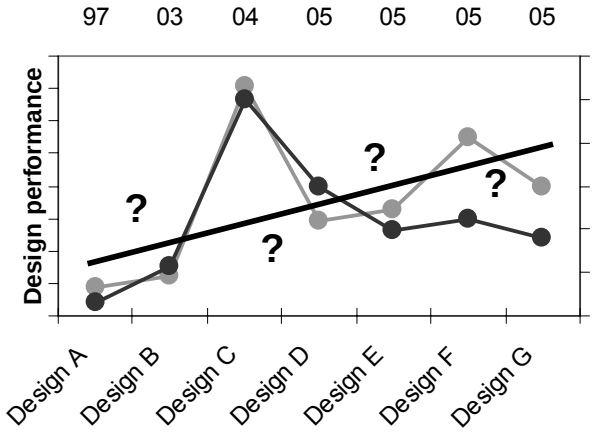

Figure 3. The missing quantification of the design performance. An increasing sales value is assumed, but currently cannot be measured.

This uncertainly about the exact difference in design performance of two or more packaging designs means that product managers and account managers have to rely on their personal judgement of the fulfilment of sales-functionalities in making the business decision of which packaging design to choose. From an environmental and cost perspective this is not desirable, as the likelihood of sub-optimal solutions is strongly increased. This allows for the conclusion that the problem is not simply insufficient managerial attention for balancing sales-functionalities with logistical efficiency, but a lack of data to base such balancing decisions on.

6 MEASURING DESIGN PERFORMANCE

From a managerial perspective the logical step forward would be to develop a measurement tool for design performance. There are already several design research methods that can, and have been used for evaluating packaging designs. Literature indicates that these methods are mainly applied to fast moving consumer goods, probably as these are products that are most sensitive to point-of-sale purchase decisions. They are mainly sold in self-service supermarkets, standing on shelves among their direct competitors. Furthermore prices of such products are relatively low, thus making impulse buying more likely than with more expensive durable goods. Nevertheless, as the previous sections demonstrated, this description is applicable more and more to CE goods as well. Hence methods developed for fast moving consumer goods may also be very useful for CE goods. Therefore a quick review of these methods will be given, focussing on the methods potential for yielding a quantitative design performance measurement.

6.1 Focus groups

'Focus groups' is a research method consisting of a extensive group interview with carefully selected participants from the products' target group, usually taking one or more hours. Focus groups have traditionally been widely used as a packaging design research methodology. It has been applied both at the start of design projects as market research and for evaluation of final designs, i.e. a form of disaster check.

A weak point of focus groups is that it does not resemble real purchase situations very well as people do not deliberate about a product for an hour, before buying it or not, at least not with fast moving consumer goods. Hence it may be a reasonable research method for durable consumer goods, where often consumers take more time to reach a purchase decision. As stressed by Gold [10] it is very important to at least place packaging designs next to competitor products, to improve the realism of the setting. Nevertheless, the focus groups approach does not give a numerical output; information about the packaging is generated but performance is not quantified.

6.2 Eye-tracking

There are other methods that do give quantitative information. One of these methods is eye-tracking. The basic idea of the test is to use equipment which is attached to a participants head to measure where (s)he is looking. When performing this test with a section of store-shelves, one can test how many consumers look at a certain package, how long, how often and in what order [11]. The advantage if this method is that it gives quantitative data. However, there are also some setbacks. Firstly, it requires special equipment. And secondly, data on the percentage of people noticing a packaging design, and the time they spend looking at it are not the same as a single-score design performance.

6.3 Tachistoscope (T-scope)

Another test allowing a certain level of quantification is the Tachistoscope (T-scope). This is a method in which a participant is shown flashes of a product. Starting at for instance $1/100^{th}$ of a second, exposures are incrementally increased to for instance 2 seconds. After each exposure the participants is questioned about what he saw. Hence average time scores can be obtained needed for aspects like brand recognition, product type identification and noticing special product features [11, 12]. Where eye-tracking determines where we look, the T-scope focuses on what we have actually seen.

Hence T-scope is a useful tool in cases where product recognition is of the highest importance, such as medicines which may have to be used quickly in an emergency [13]. T-scope testing has also been applied as a scientific research tool, for instance to research the effects of latency of the brain, i.e. whether placement of copy and illustration of the left or right of a package made a difference [14]. Major disadvantage of this method is that its setting is very different from actual shopping environments.

6.4 Semantic differential

This is a method in which participants are asked to score designs on scales between two extremes, i.e. modern versus old fashioned or beautiful versus ugly [15, p.94]. In comparison to eye-tracking and T-scope, Semantic differential will measure how people feel about a package.

6.5 Internet testing

A tool combining these last three measurements would be ideal. It would give quantitative data to what extend a package is noted among its competitors, what is actually seen, and how is perceived emotionally. This would yield the data required to make well funded design choices. However, it would be rather complicated and expensive. And practicality in a business setting, where there is a limited budget, and even more important, where there is only limited time available, is of the utmost importance.

A possible solution may be to make this research internet-based. This would enable participation by world-wide consumers. As it may not be possible to check data on your participants as rigorously as one would usually do, reliability of the test will be lower. However this can be compensated by the number of participants.

Literature describes a case of an internet-based company selling turkeys [16] that had build up a list of 44,000 email addresses of prior customers. Of the 36,000 were still valid, a response rate of 2 to 3% was achieved. This makes a proper sample size, yet the email may have annoyed the other customers, that did not respond.

7 DESIGN APPROACH

Besides working towards a measurement tool, their are also some avenues open from a design perspective to come to a better balance. One is an 'optimisation' approach; the other is a 'radical' approach. The optimisation approach is to accept the requirements set forth by the retail situation without question and to try to fulfil them with the lowest possible cost and environmental impact. This means:

- Selecting environmentally friendly materials (like recycled cardboard, paper-based cushion materials, agriculture-based plastics like PLA, etc.) where this can be done without compromising the design performance.
- being aware of distribution requirements, hence making sure that the final dimensions of the packaging are such as to allow maximum utilization of transport volume.
- Optimisation in the depth of the package. The frontal area of a package may be determined by marketing requiring a minimal amount of space to communicate, or prescribed by the retailer to match shelve dimensions. This allows packaging designers to work on an optimal arrangement of product and accessories to minimise the depth of the package. For example, the authors of this paper studied a package for a MP3-player which could easily be reduced to halve its current volume through this approach.

The more radical approach is to split the two phases of the life cycle and design different solutions for both. This would result in efficient multiple or bulk packaging for long-distance transportation, and repacking into final sales-packages close to the point of sale. This strategy is called packaging postponement. It is for instance applied by HP, with the goal of maintaining flexibility in the supply chain [17]. However it can also be applied as an environmental optimisation strategy [2, 18].

8 DISCUSSION

When working on a new packaging design, there are several possible situations that can result from proposed design concepts. Relative to the current packaging, costs and environmental impact can go up or down and design performance can go up or down. If design performance goes up, while costs and environmental impact go down an undisputable improvement has been achieved. Likewise a design proposal with higher costs and lower design performance is clearly deterioration. The difficulty occurs when design proposals achieve higher design performances at the cost of higher environmental impacts, or lower environmental impacts at the cost of lower design performances (see Figure 4). In Figure 4 the design performance is plotted against the costs. It can also be plotted against the environmental impact, but as was demonstrated in section 5, environmental impact of packaging and costs of packaging are strongly related. Hence costs were selected, as these are easier to communicate to product managers.

To make these different situations manageable it is necessary to know how much design performance is sacrificed for a certain saving in costs and environmental impact, or how much a certain improvement in design performance is going to cost financially and environmentally. Calculating DP/€ or €/DP scores for different design options would help make design decisions. A diagram as Figure 4 can help visualise the effects of proposed packaging concepts. However, this requires a quantified design performance.

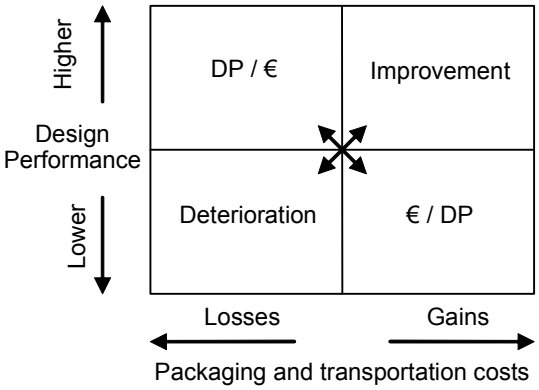

Figure 4. The four directions of design changes as compared to the current packaging, which is at (0,0). Based on the eco-efficiency directions [19, p. 262-263]

Currently design performance is not quantified. Nevertheless, design performance is the winning argument in the design battle for a lot of CE goods. Logistical efficiency and, resulting from that, environmental performance are of lesser concern. Even though consumers name too much packaging waste as their number-one annoyance when it comes to unpacking CE goods [20], boxes are not getting smaller.

9 CONCLUSIONS

Managers, faced with the described developments in retail, sacrifice logistical efficiency, in order to obtain a better design performance. The environmental impact of the packaging is of minor importance. This development is particularly strong for CE products that are small and trendy, such as Personal Audio players.

Hence, when striving for more eco-efficient packaging (for instance from the perspective of an environmental business support unit in a major CE company) one needs a wider scope than simply environmental impact. Eco-design is of minor importance compared to design for functionality. The packaging needs to fulfil its functions first, so it can generate sales, and only within that framework can environmental optimisation take place. The problem, however, is that there is a limited understanding of the fulfilment of sales functionalities by CE packaging (i.e. the design performance).

Hence, environmentalists can campaign for eco-friendly packaging, yet if the issue understanding design performance is not dealt with adequately, it can not be balanced with environmental impact.

It can be therefore concluded that to be achieve a proper balance it will be needed to develop tools to measure design performance.

Current and future research at the Design for Sustainability lab at Delft University of Technology is directed towards these goals.

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