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LOGISTIC ASPECTS OF THE PLANNING OF PACKAGING

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Abstract: *The most dynamically developing service of our time is freight transport. Millions of small and large packages are delivered every day in different parts of the world, and we can send goods, packages and consignments from practically anywhere to anywhere. As the number of traditional mail items decreases, the desire to send packages increases in parallel, which results the increasing of the number of different freight transport companies. The transmission of goods requires the use of various packaging, against which serious expectations are placed on preserving the integrity of the goods and reducing transport costs. This article reviews the logistical aspects of packaging design, primarily from the perspective of selecting the optimal packaging from a logistical point of view.*

Key words: *packaging, planning process, logistics*

1. INTRODUCTION

The most dynamically developing service of our time is freight transport. Millions of smaller and larger packages are delivered every day in different parts of the world, and we can send goods, packages, and shipments from practically anywhere to anywhere. Just as the number of traditional mail shipments is slowly approaching zero due to the spread of electronic mail forms, the desire to send packages is increasing in parallel. There are attempts, e.g. within the frame of the physical internet, to "digitally forward" physical shipments, but this does not reduce the number of physical freight transport tasks for the time being, and in fact, due to various global impacts (epidemics, energy crises, etc.), the number of different freight transport companies is increasing.

The transport of goods requires the use of various packaging, against which serious expectations are placed on preserving the integrity of the goods and reducing transportation costs.

This article reviews the logistical aspects of packaging design, primarily from the perspective of selecting the optimal packaging from a logistical point of view.

2. PACKAGING

The term packaging is a collective term, as it can mean the packaging device, the packaging process, or the packaging technology used. For the purpose of interpretation, it is important to distinguish the three concepts above.

According to the general definition, packaging is the process following the production of a product, in which materials that are usually different from the original composition of the goods are used to ensure the product's handling in the logistics systems following production and during the final sales process (consumption) [1]. Packaging device is a temporary protective cover of a specific material, structure and shape, usually produced during industrial activity, suitable for containing a given product [2]. Packaging technology means the order

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of all operations within the scope of packaging activity, as well as the methods and tools associated with it [3].

Packaging is of course necessary for a specific purpose, which primarily means protecting the goods during the process of delivery to the consumer. In addition, other functions of packaging are primarily [1]

- ensuring the product's usability,
- ensuring the product's handling,
- ensuring the product's storability,
- protecting the product's quality,
- ensuring the product's marketability,
- reducing the product's harmful effects on the environment, etc.

The packaging can also vary in terms of its appearance (Fig. 1). We can talk about consumer packaging, which "encloses" the product from the beginning of packaging to the start of consumption, or even during it. Unit packaging refers to consumer packaging made by combining identical products or elements with the same purpose into a unit. In the case of collective packaging, a certain amount of identical consumer packaging products are placed in a unit, primarily to facilitate commercial or consumer handling.

We talk about packaging for logistics purposes in the case of transport or storage packaging, which is only used during the given operation, therefore the design of the packaging device is adapted exclusively to the demands arising during the operation concerned.

We should also mention unit loads here, which serve exclusively for logistical purposes and the design of the unit load forming devices is adapted not only to the goods, but also to the characteristics of the serving equipment (e.g. forklift - pallet).

a) Consumer package [4]

b) Unit package [5]

c) Collective package [6]

a) Transport package [7]

Figure 1. Examples for packaging devices

3. PLANNING PROCESS OF PACKAGING

In packaging design, we look for packaging materials, devices and methods that can protect goods from various negative external influences and facilitate their handling in the production, sales and consumer processes [8]. The design process is basically about examining the effects of various influencing factors and analysing and comparing possible options. The most important characteristics that can be used in design are the characteristics of the goods, the effects on the goods, the consumption characteristics and the rules for handling the goods.

The characteristics of the goods determine the internal dimensions of the packaging, its internal structure (filling characteristics and materials, shape and dimensions of the liners, etc.), and the basic properties of the packaging materials used.

The characteristics of the packaging must be chosen to resist the stresses that occur during handling. These effects can cause negative qualitative or quantitative changes in the goods. During handling, the goods can be exposed to mechanical, physical, chemical, biological, climatic, logistical or other effects.

On the user and consumer side, many factors must also be considered that can significantly influence the physical design and selection of materials of the package. The effects of consumption habits can appear in different ways on the elements of the package (e.g. holding by hand requires a special shape), but the effect of aesthetic aspects cannot be neglected (colour choice, fashions, etc.).

Some elements of the handling and use of goods can also be shaped by goods handling rules, which can result in strict constraints during design. Such rules can include various legal regulations (e.g. food packaging), manufacturing regulations (e.g. limited shape, size), commercial regulations (e.g. mandatory content elements - instructions for use, etc.).

As a result of design, different packaging alternatives may appear, and when evaluating them or selecting the optimal version, different packaging objective functions can be used, which can be

- minimum packaging size,
- minimum packaging cost,
- minimum material requirement,
- simplicity of the packaging process.
- higher level of consumer service,
- suitable for different logistical aspects (e.g. adjustment to loading surface, storage location),
- suitable for recycling aspects (reusable package, renewable materials, easily recyclable materials),
- etc.

During packaging design, different tasks must be performed, which can be separated based on their role in the packaging. The individual design steps are not independent of each other but require a unique approach.

Based on the relationship between the tasks, we can define different design levels (interior design, exterior design, logistics design, commercial design) and individual design tasks (material selection, dimensioning, content design, exterior design, etc.), the relationship of which is illustrated in Fig. 2.

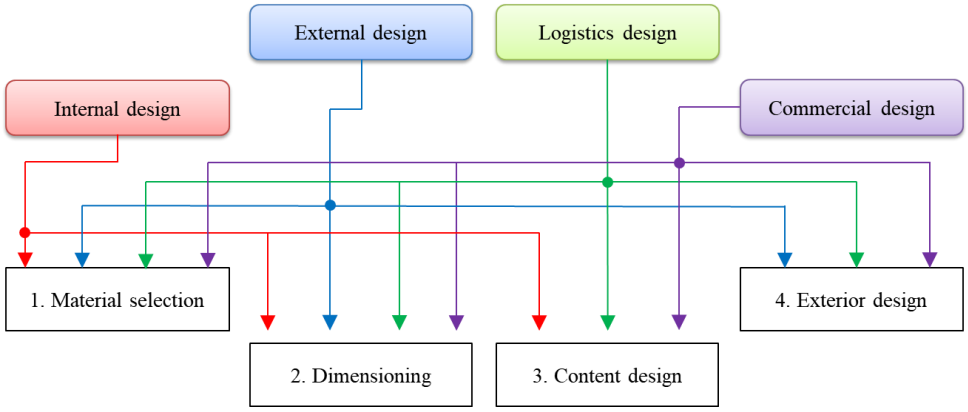

Figure 2. Relations of the design levels and main tasks of packaging

4. LOGISTIC ASPECTS OF THE PLANNING OF PACKAGING

Logistics design of packaging basically means taking logistical aspects into account during the design of packaging. Logistical aspects appear everywhere in the design of packaging, but they cannot be applied in all consumer or unit packaging. Consideration of logistical aspects can be:

- indirect,
- integrated,
- direct,
- exclusive.

We speak of an indirect (hidden) logistical effect when the design is not based on a logistical principle, but there are also logistical design elements (e.g. stability). It usually helps with handling or the implementation of marketing goals (placing labels), but it also indirectly fulfils logistical goals.

While packaging design integrated with logistics, general packaging (e.g. stability) and logistical goals (e.g. stacking) appear together. This often occurs in the case of collective packaging and unit packaging (an inherently integrated process). In such cases, the design process integrates packaging design and logistical design elements (e.g. design and space filling, see Fig. 3).

In packaging design that includes direct logistical elements, the logistical design tasks are clearly visible and separated (e.g. access to individual products – easy separation). This is most common in the case of collective packaging, where logistical aspects also play a prominent role in the design of internal, intermediate elements.

We can speak of exclusive logistical packaging design if the logistical planning objective functions dominate during the design process. Generally, stacking and handling aspects are the main design tasks and are most common in transport and storage packaging, or in unit load formation. Here too, the design process integrates the packaging design (e.g. protection) and the logistical design (dominant) elements (e.g. shape and fit of intermediate elements).

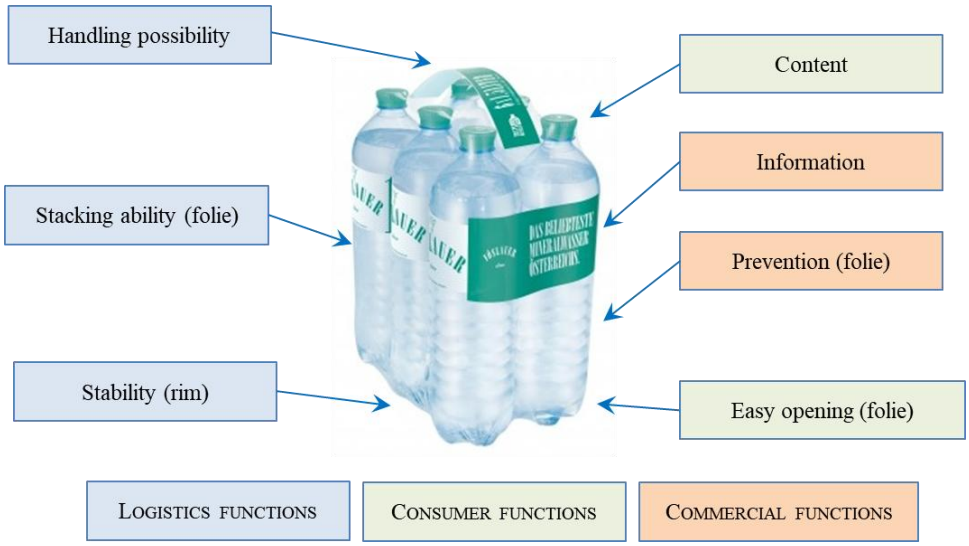

Figure 3. Logistics and non-logistics design aspects, based on [9]

Another important aspect of logistics packaging design is the selection and optimization of packaging that fits the logistics processes [10]. Primarily, the design of transport and storage packaging, as well as unit loads, falls into this category.

For these packages, logistics design includes the design of the external and internal structure and internal elements of the packaging, the selection of packaging materials, and the design of logistics properties (stackability, label readability, space filling, handling characteristics, number of pieces that can be loaded, etc. see Fig. 4).

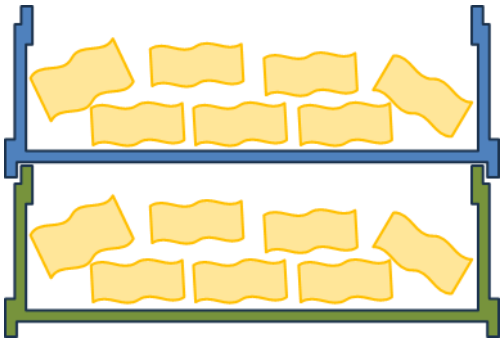

Figure 4. Stackable racks for transport of bulk sacks

5. CONCLUSIONS

The transportation of goods requires the use of various packaging, which has serious expectations regarding the preservation of the integrity of the goods and the reduction of transportation costs. During packaging design, we look for packaging materials, devices and packaging methods that can protect the goods from various negative effects and facilitate their handling in various processes.

Logistical aspects appear everywhere in packaging design, but they cannot be enforced in all cases. Logistical packaging design basically means considering logistical aspects during the design of packaging, which appears in different forms during the design.

This article presented the logistical aspects of packaging design, primarily from the perspective of selecting the optimal packaging from a logistical point of view. Our goal is to help in the design of logistical packaging, or consumer or collective packaging with better logistical properties.

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