

The significance of systematic approached package design technology

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Abstract: Nowadays, the logistic as a multidisciplinary science, day by day confronts with new problems and challenges. So the systematic approached package design, which methodology needs both engineering and economic knowledge's, demands continuous modifications by the consumers and the more and more severe requirements.

The physical quantitative features of the outer effects in specific cases have to be determined and tested through laboratory simulations, whether the chosen packaging system is adequate for these features, or it has to be modified by an iterative procedure since minimal packaging material usage is achieved, while only minimally necessary product protection is provided. The article deals with the features of different effects in specific cases, and how to build up laboratory simulations.

Keywords: systematic approached package design, laboratory test

I. INTRODUCTION

In a logistic system, when we have to design a "suitable" packaging system, we always meet a many-degree-of-freedom system, where the assistance of common engineering and economic knowledge are not certain to solve or expose the actual development problem. In this paper, I will introduce and investigate why we have to integrate the well-known product development process to the packaging design process method, and how can help the product - packaging suitability tests these methods. In the final part, I try to predict the changes of this process, if the well-known environmental requirements assert part in the process[1].

II. ACTUAL PROBLEMS ABOUT PACKAGE DESIGN TECHNOLOGIES

Nowadays, there is more emphasis on environmental protection, it is an ineluctable challenge to minimize and decrease the packaging waste, which mostly arises from the manufacturing and logistic processes. To solve this big volume and all-comprehensive problem, we have to approach it from two different angles. These are the following:

- The a widespread tendencies of the manufacturing and logistic methods
- The current applied packaging design methods

To solve the above-mentioned problem, we have to examine these methods. In the followings, I give a bold outline of these problems.

Arguments for the increase of packaging material demand: We can sort the arguments as follows:

- *Demographic and life-style changes* which will see an increase in an ageing population, single households, and smaller families that will have an influence upon the types of packaging used for products;

- *Technological changes* where there is expected to be an increase in the growth in electronic and home shopping via the internet that will introduce new demands upon the packaging system;
- *Environmental issues* will remain a major driver including litter and land filling, with the success of the every National Packaging covenant essential;
- *Consumer demands* will force market segmentation allowing products to be packaged dependent upon the demands of a particular group (such as microwaveable products, salad kits, modified atmosphere packaging, pre-cut, pre-portioned, smaller ready to consume products);
- *Supply chain management* will require a quicker more flexible response throughout the entire supply chain with a willingness to share information and develop long-term relationships. So the supply chain became more longer as time, as distance.
- *Manufacturing changes*, cause that the manufacturing systems became divided. The factories of one product can cover continents, so we have to package also the half stuffs and interim products, which caused the growing of packaging material demand and logistic costs.

Problems with package design methods:

Problems with the package design techniques because of the full re-arrangement of the logistic fields have not been solved, because most of the companies use design and development methods only for the products.

What are the problems?

- The product engineers count only the "household" stresses during the development, and don't count the stresses during transportation and handling. These facts increase the demands against the future packaging system.
- These packaging systems are designed empirically with the information arising from one's own or a colleague's experience
- The unknown logistic stresses solved by "over-packing", which cause extra costs, decrease the logistical indices and additionally will not solve the product damages [1], [4].

III. SYSTEMATIC APPROACH FOR PACKAGE DESIGN, AS THE SOLUTION OF SUSTAINABLE DEVELOPMENT?

The challenges of package design

The production companies, which have focused on the developments, are not allowed to forget problems and questions of the packaging, because the packaging development is as important as the product development.

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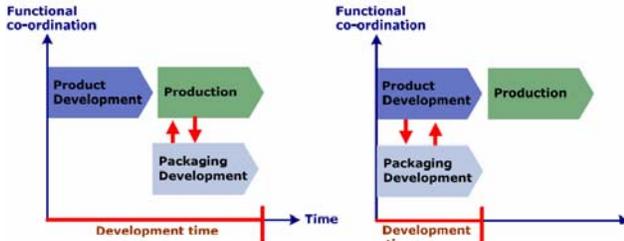


Figure 1. Context of the Product- and Packaging development time (source: Barmklev 2007)

In the figure of Barmklev (figure 1.) we are able to see the importance of the context of the product- and packaging development time. To reduce the development time these have to be connected and as much as possible be integrated [2].

From the complexity of package design, we can ascertain that these systematic design methods need overall and detailed information about the product. The packaging system is mostly set-up based on four components: Product (with its critical elements) → consumer packaging → collecting package → transportation [6].

Of course the development time is important. In addition, we have to know the connection points of when and where the components of our product and packaging system are interacting with divergent logistic processes (in different places and times) Saghir's and Hellström's figure shows these interactions between the packaging and the logistic processes (figure 2).

Only from the figures above, can we state that the packaging development is as important as the product development and manufacturing. So we have to accurately defend the product from "logistic stresses", and of course the product-packaging system has to be economical along the logistic chain. In short, this is the challenge of package design

| | | Packaging system | | |
|-----------------------------------|------------------------|--------------------|------------------------|---------------------------|
| | | Primary (consumer) | Secondary (collecting) | Tertiary (transportation) |
| Supply chain Manufacturer members | Filling process | ✓ | ✓ | ✓ |
| | Warehousing process | | | ✓ |
| Distribution centre | Transport | | | ✓ |
| | Receiving process | | | ✓ |
| | Storing process | | | ✓ |
| | Picking process | | ✓ | ✓ |
| | Shipping process | | | ✓ |
| Retail outlet | Transport | | | ✓ |
| | Receiving and shipping | | ✓ | ✓ |
| | Replenishing process | ✓ | ✓ | ✓ |
| | Re-use and recycle | ✓ | ✓ | ✓ |

Fig. 2. The interaction between the packaging system and the logistics processes (source: Hellström and Saghir 2006)

IV. THE PROCESS OF THE SYSTEMATIC APPROACHED PACKAGE DESIGN TECHNOLOGY

Developing a new product - packaging system, we have to take account of the following facts, information and requirements associating with packaging [1].

- *Parameters from the characteristic and the sensitivity of the product* (geometrical sizes of the product, centre of the mass, sensitivity against environmental and mechanical stresses, possible positions, etc.)
- *Merchandizing relations, as the questions about distribution ways* (distances between departure and arrival places, climate zones departure and arrival places, etc.)
- *Information from transportation and material handling equipments* (bearing capacity of the equipments, loading and unloading parameters, loading surface and space, etc.)
- *Questions about the potential useable and suitable packaging materials* (standardized, combined, laminated and special packaging materials, etc.)
- *Standardized transportation packaging devices* (standard packaging devices, pallets, etc.)
- *Regulations and rules of packaging and transportations* (international agreements, national decrees, international standards, Eu directives, etc.)

The design process of the system should be executed with the help of iterative procedure that can proceed from two directions.

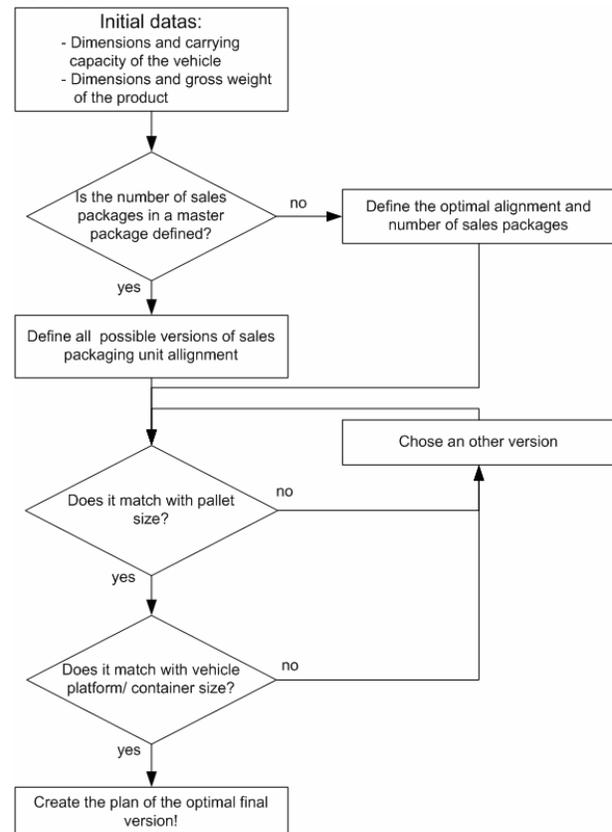


Fig. 3.: Process of package system planning (source: own drawing)

The two directions are [3]:

- geometric dimensions and carrying capacity of vehicle/shipping container platform
- geometric dimensions and weight of sales package

The steps of the iterative procedure is described on Figure 3. The final design of the selected version has to be worked out considering the effects of logistic processes [4].

V. INFLUENCES OF LOGISTIC STRESSES TO THE PRODUCT-PACKAGING SYSTEM

In practice, all kind of damaging logistic stresses may depend on the route of the transportation. In this case, I just mention from these, only the most occurred and the most damageable affects:

Stacking forces

Both transport devices and the heights of the warehouses have got claims to stack each other the transport packages. Most of the cases, the transport packages by pallet, placed to more layer. At practice, they engaged to stacking, but they don't take a count of two kind of important modifier element:

- At collecting forwarding (post, parcel delivery, air freight) several type of individual packaged product placed, whose loadability unknown by the forwarder. This kind of transportation means more transfer and of course more crew changing, so the possible handling information not follows the product. Those firms, which deliver product in this system, should have to regard with the more intensive stresses at the period of the package planning.
- At practice comparatively, the stacking force have been calculated into the flat pallet transportation, but some other facts have been without attention. Commonly the critical load section is that place where the runners of the upper pallet load only the exterior and the center packages, not the bottom layer. This means that in case of the package – product system, that the not loaded packages doesn't take part from the stresses. In the practice, the facts are worse, because several times, the surface of the packages don't cover the surface of the pallet, so bellow the stacked pallet's runners, there is a smaller package surface, which cause higher local load. The other bad factor is that the materials-handling equipments can not put to each other correctly the complete loads, so it can cause local excess load and destabilization. If the runners of the pallet damages or broken, the load transfer ability abate and can cause local excess load. It is often happen, when a transport package stacked improperly and the upper surface of the transport package will be disparate and the loll out packages will be the load transfers.

Laboratory simulating of the stacking stresses done by stacking tester which be able to simulate dynamic and static forces.

Vibration stresses

The continuous and constant vibration stresses are avoid less, during the handling and transport processes. These stresses, can disadvantaging the package – product system and come from the road bumpiness, the unbalanced and moving weights on the vehicles, the spring system of the

transport devices, the characteristic of the keeping on the vehicle on the road and of course its mixture. The vibrations on the load platform are stochastic type, which means that the combination of the vibration frequency and amplitude strongly fluctuating at time. The vibration appears horizontal, length and cross directions and they are lineal line vibrations in isochronal. These free vibrations can exceed the value of acceleration on some frequencies. At these frequencies the load abandon the platform for a moment, which vibrate continually, after the fall back, the load didn't arrive to the same position.

In our Laboratory, it is possible to simulate the vibration stresses by vibration desk with 2 ton capacity. It can reproduce a the signal, which recorded on a load platform during transportation and measured the followings: Temperature [°C], Relative humidity [%], Duration [min], Acceleration in x,y,z dimensions [m/s²].

We can analyze two kind of effect from the vibration tests:

- Fixing system of a transport packaging, to investigate the possible moving or rocking which can cause fatigue stresses.
- Investigation of the resonance effects, which means that the forced vibration develops higher intensive vibration on the package or on its part. At practice, it means 6-8 times higher growing but it is often enough intensive to damage or breakage some kind of critical elements of the product.



Fig.2 Vibration test on transport packaging

Impact stresses

There are two kind of basic sources of the impact stresses. The vertical impacts are from the falling off of the packaged products, but this is the same stress if a hoisting engine put down the load, very rude. The sources of the horizontal impacts are from the braking, acceleration of a vehicle, and so on. The outstanding high horizontal impacts are, the impact of the ships to the port wall at sea transportation and the gravity switching at rail transportation.

The specialty of the impact stresses, that the number, the characteristic and the intensity of the impacts. They can show very high deviation indeed it is a same transportation link. There are a lot of case, when the occurrence of this effect depend on only human factor. It is very important the

knowledge of the impact stresses, because the protection against it, with engineering solutions and expenditures, are very high.

The laboratory simulating of the impact stresses done by an inclined impact tester and freefall drop tester. The impact sensitivity of the products tested and investigated by a shock tester.

Environmental stresses

In the logistic, the product flow done mostly at outdoor, so the transport duration, the well known environmental effects always influence the product- packaging systems. From our experience, these are the most regular harmful elements: high temperature, low temperature, fast temperature changing, high relative humidity, direct wet, indirect wet (e.g. dew, hoar, rime), sunshine, corrosive atmosphere (e.g. salt sea-fog).

Surely, the climate and the mechanical stresses both affect in same time. We have to count with mostly the above mentioned combinations of the stresses:

To finalize a new product - packaging system we have to simulate the environmental stresses by a climate chamber. These chambers be able to simulate between -40 °C and + 90 °C, with arbitrary relative humidity and with variable sea-salt moisture content.

If we make the mechanical tests after any kind of climatization, we can solve the question of the product – packaging system’s resistance to any occurred climate during the whole transportation [5].

VI. ENVIRONMENTAL TASKS IN THE IMMEDIATE FUTURE

The environmental economy tasks turned into one of the most considerable problems of our life, the actual problems in the field of logistic and packaging, also multiply these tasks. As I wrote the tasks will be solvable, if systematic approached package design methods applied. By this method and by the well-known effects, we also be able to choose the suitable packaging material, the required quantity and quality. These information also can help us to minimise the environmental tasks. As we know the logistic link we also be able to re-think the questions of using re-useable packaging materials and devices.

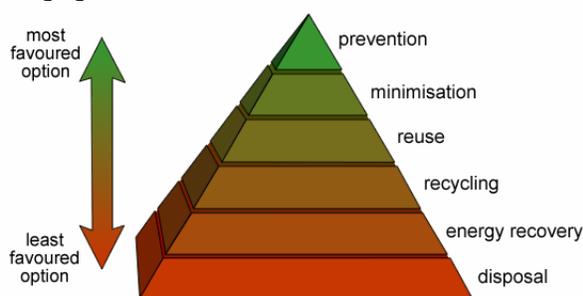


Fig 4. Options to solve “the packaging material as a waste” problem

(source: own drawing)

In the forthcoming years, there will be several directive, statue and standard (e.g. EN ISO 13427, etc) will come into force, which will also complicate the not so simple design process.

During the design process, beside the well known initial requirements and information’s, additionally we have to count with the following environmental principia’s (figure 4.).

The main developments and researches - beside the development of different biodegradable packaging materials, are the investigation of using re-useable packaging devices, which manufactured from the minimal material, which are recyclable.

To apply re-useable packaging systems, we have to re-think and pre-model the full design process, so we have to count more ticklish parameter. These fuzzy parameters (delay in the return packaging, transport and storage costs of the empty packaging, etc.) be able to query applicability of the system [1], [6].

VII. CONCLUSIONS

To summarize, we have ascertained that the packaging and product developments, nowadays, are inseparable and stand together. Although, we face a lot of new problems during product-packaging system design, which can be seen in many well-known product design methods, these product design methods are only useful if we modify them, according to the special fields of packaging. As we know packaging is one of the biggest waste producers, so the environmental requirements put packaging and its methods more and more into the spotlight. I have tried to investigate how we can use the systematic approached package design method, and which are the most severe stresses, we have to count during the design processes.

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