Qualitative/quantitative cross analysis to design eco-pack

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Apresentação

O Simpósio Internacional de Design Sustentável (ISSD), organizado em conjunto com o Simpósio Brasileiro de Design Sustentável (SBDS), é um dos mais importantes eventos científicos da América do Sul sobre a relação do Design com a Sustentabilidade. Realizado a cada 2 anos, teve sua primeira edição em 2007 na cidade de Curitiba-PR, com a organização da Universidade Federal do Paraná (UFPR). A segunda edição aconteceu em 2009 na cidade de São Paulo, com a organização da Universidade Anhembi Morumbi. Este ano (2011), o evento irá ocorrer entre os dias 29 e 30 setembro e será acolhido pelo pela Universidade Federal de Pernambuco (Recife). O evento será organizado conjuntamente pelo departamento de Design (CAC) e pelo Núcleo de Design (CAA) da UFPE e reunirá designers, profissionais, acadêmicos, governo e indústria para discutir conceitos, cenários, projetos, ferramentas e metodologias sobre a concepção e contribuição para uma sociedade mais sustentável.

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Packaging, as a symbolic expression of a brand and of the consumer who recognizes him/herself in the purchased product, is now full of features that go beyond containment and protection, becoming a means of communication and education in the field of environmental sustainability.
Although the principle of eco-compatibility should be long-acquired by now, the market still has many shortcomings from this point of view. The field of packaging design has not been able to renew itself for reduced environmental impacts.
This research starts from the analysis of the criticalities of present industrial packaging to propose a new approach to sustainable design. The basis of this work is at experimental level and its aim is to provide a complete screening of the packaging sector according to specific methodological choices that consider various aspects: from volumes to weights, from materials to components disassembly, ranging from functionality to quantitative relationship between communication and information.
A comprehensive analysis that provides an overview on the state of packaging in terms of eco-sustainability and which can be a real starting point for packaging design in a global sustainability perspective. This innovative perspective generates a totally new approach to the packaging design, from products to distribution systems.

Introduction

Historical problems and actual trends

Packaging, intended as a tool to protect and transport the product of human labor, has gone hand in hand with the history of man since its origin. One can therefore say that the packaging, at a functional level, is the answer to an archaic need of human being. In the last century, this basic nature of the packaging has been associated with a secondary: packaging becomes the symbolic expression of a brand and of the consumer who recognizes him/herself in the purchased product.
The radical change in recent decades has led on the one hand, to widen the functional requirements as a result of the internationalization of markets and the advent of free service, on the other to a greater need for communication.
As a matter of fact, in recent years packaging has been enhanced using new techniques and technologies that have led to a complex version of the product, and thus generated higher impacts on production and greater difficulties in the disposal stage.

Deal with packaging in the interests of environmental sustainability is therefore certainly necessary: now packaging can't ignore the marketing needs, which are undeniable in the current market, but must follow a new optical design that takes into account all stages of packaging life-cycle, optimizing space, processes and materials to avoid waste and reduce the surplus.
Although the principle of eco-compatibility (even for the packaging product) should be long-acquired by now, the market still has many shortcomings from this point of view.
The field of packaging design, in particular, has not been able to renew itself on the wave of the growing demand for reduced environmental impact from the markets and society.
There are many prototypes and lots of research, however very few productions take a reduction in size and materials into consideration, let alone a change to the product to be packaged with to optimise the packaging itself. However it is not only the material aspect that can determine the non-sustainability of a project. Indeed, most of the objects today are or could easily be made of recycled materials and be recyclable, use less energy, use low emission technologies, etc.; instead, what is through-through missing is the input for ethically and environmentally correct behaviour and a good design that rethink object and packaging together to have the best environment requirements.

Data and criticalities

From the quantitative point of view, it is interesting to observe the data provided by the National Packaging Consortium (CONAI) for the Italian context. The data show not only an Italian situation but common to almost all industrialized countries, where predominate the same types of waste, manly packaging, and its waste disposal problems.
Therefore, only pausing on the Italian context, household waste are around 30 million tons per year, 11,200,000 tons of these ones are packaging waste (source: CONAI 2010),so about 37% of what Italian people throw away is made up of packaging.
If you look at the data on the material composition of packaging waste, the phenomenon is even more alarming: 37.8% consists of celluloid, 19.9% wood, 18.5% plastic, 18, 7% glass, 4.5% steel and 0.6% aluminum (source: CONAI 2010). Lightweight materials such as celluloid and plastic up some 56.3% of waste in terms of weight. That is the volume and the amount of plastic and cellulose packaging in terms of numbers are very much higher.

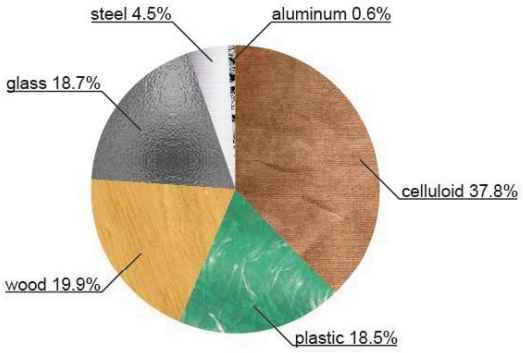

Figure 1: Material composition of packaging wastes in Italy (source: CONAI 2010)

Then, looking at the data for the recycling of materials, about 70% of plastic packaging is collected and the 35.9% have an energy treatment (source: COREPLA 2010), a procedure that still generates a lot of doubts and conflicting opinions on the production of harmful powders.

In Europe, the energy recovery of packaging, however, is the most widely system used to enhance the plastic at the end of its life, but there is a greater awareness about the environmental and economic benefits of recycling plastic. The Duales System Deutschland

(DSD) in Germany is promoting a proper collection of plastic waste in the "yellow bin" containers, to increase the recycling rate of plastics that now is about 33%, compared to over 60% of energy recovery. Switzerland however, that recovers almost 100% of plastics, has chosen to differentiate the plastics collection by creating a separate recycling system for more recyclable plastics, such as PET, which is now almost completely recycled; while incineration is preferred for other plastic wastes (source: PlasticsEurope 2010).

Other materials have higher rates of packaging sent for recycling, but it's clear that recycling by itself can't provide the solution to the problem of wastes.

Analysis goals

The analysis on material is important but cannot solve the problems connected to this complex issue. Thinking about packaging as an intermediary between producer and consumer can be a leverage point to reach important goals. Thus, packaging becomes a real communication instrument of and for sustainability.
Communicating sustainability for the product contained and the packaging itself is currently just one of the innovative factors in this field.
This has nothing to do with seeking stylistic languages that evoke the so-called green, but rather, designing formal and functional solutions that meet the eco-design guidelines, whilst spreading basic principles at the same time (Tamborrini, 2009).
These include, for example: resource values, no waste (which in a time of economic crisis becomes more understandable) and the consistency of qualitative and quantitative values between the contents and the container. These aspects must certainly relate to graphic design in order to disseminate information on product sustainability. In this context, the labelling issue becomes crucial, although not sufficient, because in a complex system it becomes difficult for the end-users to disentangle themselves from the vast amounts of information they need to be conscious consumers. Words and pictures (of course sincere) must be associated with legal brands in order to communicate how and why a product is sustainable. It is not sufficient to use the "magic word", it is essential to explain the reasons that make eco-friendly a product.
How can packaging also lead to ethical behaviour through new features?
Often contemporary and eco-friendly packaging carry out new functions that enhance the dignity of the packaging product, extending its useful life with a positive impact on reducing consumption. In doing so, it is possible to teach the value of objects over time, as opposed to the disposable concept that has long characterised our consumption and behavioural habits.
The simplicity and clarity in the choice of materials and messages certainly encourage some sustainable practices, like the much-loved and hated waste separation. Loved because we are now aware of the ethical and economic action, hated because what should be a simple gesture is complicated by bad design choices that trigger doubts on the materials and fear of making mistakes.
For example, if paper and cardboard packaging are easily recognizable and can be placed in the right bin, the case of composites or laminates materials is totally different, they are often used for aesthetic rather than functional purposes, without considering the end-of-life.

Methodology

According to the Systemic Design method of design that handles the input and output of processes and the relationships between different industrial stages (Bistagnino, 2011), it is essential to make choices regarding packaging materials and functions, in order to define in advance the behaviours that could be triggered and what the collection and disposal channels could be used. This is especially true in a particular historical period characterised by the valuation of local economies, the local production and consumption (Km 0).
So it is clear how complex is the design and how many variables come into play in the production of a sustainable packaging.
To facilitate the design-oriented approach, the Department of Architectural and Industrial Design (DIPRADI), in collaboration with the course on Environmental Requirements of Industrial Products (Faculty of Architecture 1, Politecnico di Torino) founded the Observatory of Eco-Pack

(OEP) in 2005. The OEP conducts a complete screening of the packaging production sector according to specific methodological choices that examine many aspects: from volumes to weights, from materials to the components disassembly, from functionality to the relationship between communication and information. The research team is coordinated by Paolo Tamborrini and is made up of Silvia Barbero, Clara Ceppa, Gian Paolo Marino, Amina Pereno, and Dario Toso.

Categorization of packaging

In order to make an organic and complete analysis, it was necessary to divide the packaging sector in twelve major categories that fit into three different contexts within industrial products are configured, based on different dynamics and fruitive relationship with the consumer.
The first area is formed from the individual context in the strict meaning: it includes goods used in direct contact with the human body. Their use and ownership is strictly personal.
The second area is the environmental one, i.e. all products that are part of the environment in which man lives and with which it interacts in a personal but not exclusive way.
The third area concerns the social; it includes all products that somehow are enjoyed in a context of social interaction.
So the three contexts group the twelve major categories of packaging, according to different dynamics of relation and use. Each category is considered in all its forms and types of packaging, so that a comparative analysis of the various packages belonging to a given type of product provides the first results on the most common types and environmental problems.

Figure 2: Categorization of packaging industry

It is an analysis that provides an overview of the packaging situation with regards to environmental sustainability, as well as a starting point for the design of packages aiming at environmental compatibility.

Analysis tools

The methodological approach consists of a qualitative part and a quantitative one. The first one consider some design parameters that are impossible to quantify, like the coherence in forms or the disassemblity of different materials, and give the first interesting results on a wide range range of packaging, because for each category are considered all typologies of packaging.
The comparative analysis of individual packages belonging to the same type of product, provides the first results on the most common types and on the environmental issues.

Each packaging is analysed through the same parameters:

- disassembly and an exploded view of the package that allows to display the number of components, the kinds of connections and the problems of disassembly;

- analysis of label, that makes possible to identify the areas dedicated to information and communication;
- study of the weight of each single component and of the overall packaging, compared to the the burden;
- identification of materials, display in relation to components weights;
- proper exploitation of volumes, displayed by the cross sectional;
- a brief evaluation on the functionality of the packaging (according to space optimization, protective and conservative functions, packaging usability).
- a brief evaluation on the sustainability of the packaging (according to presence of overpacks, composition and materials, weight and volume ratio between pack and product).

Simplified LCA

The cross analysis of all data provides a map of the general characteristics and of problems of packaging on the market. It is thus possible to identify the major packaging categories for each type of product, in particular the 3 or 4 more representative packaging are identified (according to different materials, connection types, origin and use in the category) to make a simplified LCA, that can be valid for the whole category.
So a simplified LCA analysis, based on Embodied Energy (EE) and Global Warming Potential (GWP), detects the phases that impact the most on the entire life cycle.
A comparison of the results of the complete analysis give the chance to understand the aspects to act upon in order to improve existing packaging and begin the definition of new guidelines to design packaging ex-novo. At last, from an actual scenario of needs, it is possible to obtain specific proposals for each sector, in order to design a new sustainable pack (Barbero, Tamborrini, 2011).

Practical case studies

Some practical cases can better explain how different analysis tools can be used in order to study packaging sustainability.

Disassembly and exploded view of the packaging

Figure 3: Example of an exploded view of a milk packaging

Packaging is disassembled and photographed in perspective to show the types of connections with immediacy and any procedures and problems during disassembly.
Each component is given a name, next to which is shown the material (if this is not indicated on the product, it is detected with the consultation of experts in materials and underlined the fact that is not easy to understand it).

Any labels are indicated with arrows to show which symbols are used and where they are located to understand if they can be easily seen and understandable. An appropriate legend indicates their meaning.

Analysis of label

On the label are identified the areas dedicated to information (useful data to allow consumers' aware choice) and communication (spaces dedicated to the brand and visual suggestions aimed to communicate the product value).

Next to each label are listed the percentage of information, communication and space considered neutral.

Figure 4: Example of a label analysis

In addition, are highlighted thermal welding and points of glue, which are irreversible connections and contaminate materials, making more difficult to disassembly the packaging and separate different materials (e.g. paper with plastic or different plastics).

Study of the weight of each single component and of the overall packaging, compared to burden

componente	materiale	peso
vasetto	PS	16 g
sigillo	alluminio	1 g
coperchio	PS	2 g
TOTALE		19 g

Figure 5: Example of a table with weight of each component

Each component is weighed and added to a table in order to compare the weights of single parts and materials. This will show the materials and parts that most affect in determining the weight of the packaging.

Proper exploitation of volumes

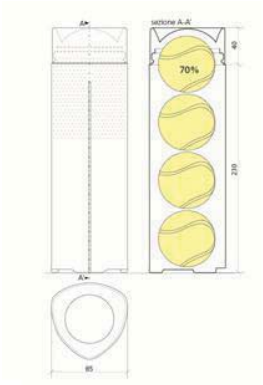

Figure 6: Example of geometrical views with indication of volume percentage

The packaging is represented with orthogonal views and geometric sections.
The section highlighted the product and the percentage of fullness in order to determine if shapes optimize spaces in the pack.
The same metric scale is used for all views and geometric exploded in order to make an immediate and realistic comparison between different packaging and different disassembly.

Brief evaluation on the functionality and sustainability of the packaging

Specifying the main features of the packaging sustainability, we have also to consider the package needs of product and use of it. The pack will primarily have a practical function that must be taken into account in the assessment of sustainability.

Figure 7: Example of evaluation icons and their meanings

In the evaluation of the package must therefore answer a few important items of sustainability and functionality that go to sum up and complete the above analysis:

- Optimization of spaces (shapes exploit spaces in storage phases and in shelf disposition).
- Protection and preservation of the product (pack effectively protects and conserves the product in relation to the needs of the same one)
- Ease of use of packaging (the pack is handy, easy to open, re-closable or reusable, etc.)
- Use of overpacks (presence of overpacks having a practical function or only an aesthetic and communicative function)
- Composition and materials (pack is made by a single material or by several ones; if made by several materials, single parts can be divided which kind of connections are used)

- Weight and volume ratio between pack and product (pack is designed proportionally to the product, it's heavy or oversized relative to contents).

Overall analysis

All the analysis tools are applied to 6-12 packaging for each category, selected from those on the market, according to different materials and technologies being used. So as to have an overall view on the category.
The comparison between the packaging let determine the main problems of the category; so designers has a complete view of critical issues to be resolved and if types of packaging to avoid or favor.
Even in the choice of graphics, are highlighted possible problems related to insufficient information which leads to an emotional purchasing decision, without awareness.

Comparing different categories in turn, let identify the most critical ones which a designer has to design carefully: a special framework allows the comparison between the analyzed packaging to evaluate the different types of pack and highlight the most critical ones from the point of view of environmental sustainability, as well as giving an overall assessment of the whole category.

Figure 8: Example of a complete analysis of juice packaging's

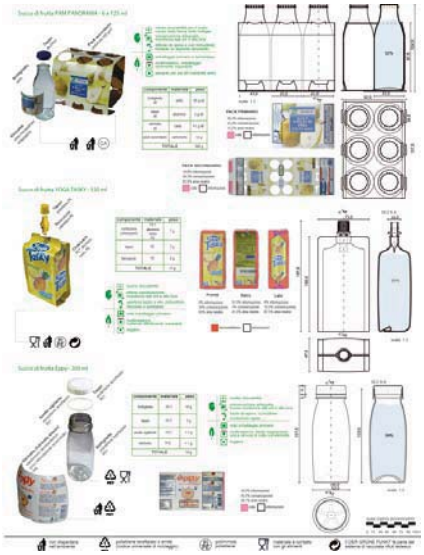

Figure 9: Example of a comparison framework

Simplified LCA

The simplified LCA analysis is performed on the 3 or 4 most significant packaging, to detect what are the stages of the packaging life cycle more impacting on the environment.

The analysis of simplified LCA is usually based on two parameters: Embodied Energy (EE) and the Global Warming Potential (GWP). EE indicates the amount of energy (MJ) that is used for processes that lead to the transformation of raw materials into finished products.

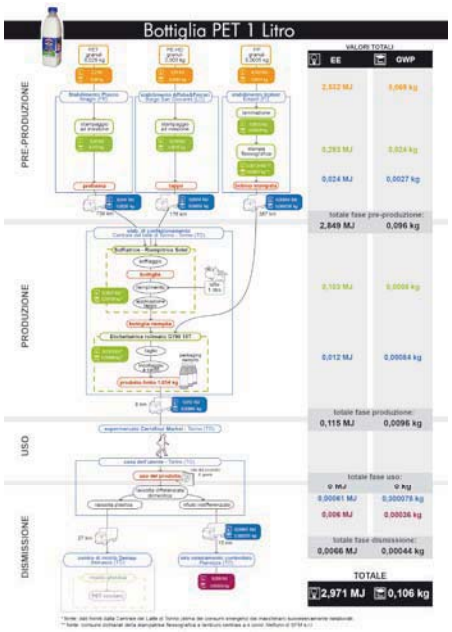

Figure 10: Example of LCA flowcharts

The GWP indicates the impact made by the emissions of carbon dioxide and other gases responsible for the greenhouse effect.
The sources from which we obtain data for analysis are different, but the principal is generally the Cambridge Engineering Selector (CES), that includes also an analysis tool (EcoAudit), which calculate the values of EE and GWP.
The flowchart illustrates the different stages of the product life cycle: pre-production, production, transportation, use and disposal.

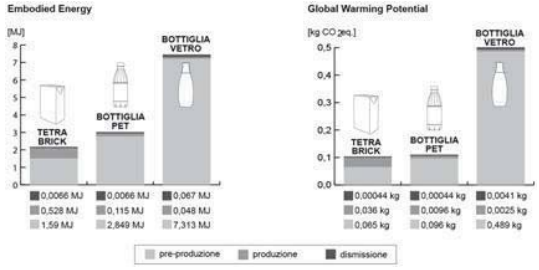

Figure 11: Example of comparison charts

Comparing data analysis results we can understand the most impacting elements of pack life cycle therefore on which aspects we may act to reduce the overall impact of the packaging. Finally the composition of the needs of packaging to propose a set of eco-guidelines for the design of a sustainable pack. The guidelines are a good starting point for those who would design a new packaging, assigning priorities to different design addresses, still maintaining the integrity of the product.

Conclusion

The packaging design is a highly problematic planning field, from the point of view of environmental sustainability: the quantitative data show huge criticalities regarding packaging waste in our landfills and waste collection centers. As we have seen, only to recycle the wastes isn't suffice but must get to the root of the problem to solve it. A sustainable packaging design can undoubtedly make easier recycling and at the same time avoid or minimize the creation of packaging waste. Because of wide range and complexity of the sector, quantitative reports are not a sufficient tool for the designer who must deal with environmental problems and several packaging needs of products.
The method we developed and presented here provides an important assessment tool for a designer, combining quantitative and qualitative aspects, in terms of sustainability and functionality of the package.

With appropriate operating and improving margins, the analysis tools we used allow to create a full screening of the industrial packaging sector, in order to provide useful information on each type of product category and then create the design ecoguidelines. Indeed, not only numerical data are provided but also practical and qualitative observations on impacts and the needs of all the products in order to effectively illustrate critical issues and provide a valuable starting point for design.

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Method of Life Cycle Assessment (LCA) of materials and processes involved in a wooden furniture manufactured in the North Plateau of Santa Catarina, southern of Brazil