Abstract

As an implicit subset of industrial design engineering, packaging development and management thereof has long been a changeling, because product and packaging development are usually regarded in a similar manner. At the same time, there is a clear difference between packaging design and product design. The packaging explicitly serves the content and, therefore, in most cases, packaging is of low economic value. For this reason, new packaging design is all too often subject to standard or existing packaging solutions. Besides this, packaging development has specific requirements, because it has to preserve and protect its content, which gives many technical requirements. Other important requirements are based on legislation, market acceptance, the environmental impact and usability.

This implies that education in packaging development cannot be a carbon copy of the education in product development. Often, even more fields of expertise are involved, while having to meet all restrictions related to developing feasible and realistic packages in a shorter time-frame.

This publication describes how project-led education is employed in an educational approach that allows students to adequately address the development of content-packaging combinations in a structured, effective and efficient manner. With this, the development efforts spent on product and packaging can become more in balance, not only doing justice to the separate life cycles of the two, but especially to the benefit of the combined life cycle of the content-packaging combination.

Keywords: Packaging development; education; project-led; methodology

1. Introduction

Within modern society, packaging often plays an imperceptible yet crucial role as it enables the transfer of (food) products from producers to end-consumers. With a growing population and increasing living standards in many western countries, ‘mass consumption’ and the ‘consumer society’ have become platitudes. In such a society, packaging is indispensable. All products around us are packed at least once. Without packaging, the waste of raw materials and products would be immense. Therefore, it is essential to device adequate packaging to protect and preserve the content, while assuring that all required functionalities are effectively represented in the design.

To some extent, the development trajectory of packaging is comparable to traditional product development processes. Within packaging development too, the process revolves around finding an appropriate solution to match the required functionalities, while integrating the many disciplines that are involved. Consequently, it is not surprising that packaging design is often implicitly regarded as a specific subset of industrial design engineering. Nevertheless, the field of packaging does have its own characteristics and uniqueness that makes it significantly different from product development (see also section 2) [1].

Compared to products, packaging does not seem to be very complex, while representing low economic value. At the same time, however, packaging serve the overall content-packaging combination with vital services by providing relatively complex functionalities.
At first sight, packaging development often hides its many complexities. However, the influence of aspects like material, consumer preferences, production line behavior like production & filling speed and batch sizes are consequential. To mention just one example, consumers usually purchase a content-packaging combination because of its content, but the packaging is instrumental in the ability to make the actual purchase and in convincing the consumer in front of the shop shelf. In other words, packaging development aims at the synthesis between many disciplines, whereas the design and development is restricted to aspects such as low costs, high adaptability and a relative short development cycle.

All these aspects explain why it is important to pay significant attention to packaging design in relation to product design. In recognizing this need, the University of Twente, supported by a number of organizations from the packaging industry, established a chair in Packaging Design & Management. Next to its research aims, the chair addresses the education of Industrial Design Engineering (IDE) students as concerns the specifics of design and development process of content-packaging combinations. This paper describes the structure of this education program by depicting important elements of project-led education and learning goals & structure of the different courses related to packaging design and development.

2. Characteristics of packaging design

To elaborate on the differences between product and packaging, a comparison between a shaver and its primary packaging is made (figure 1). As each shaver is assumed to be packed, the quantity of shavers packaging is equal. The blue line indicates the normalization of the product, the bars indicate the relative difference for packaging.

Packaging can be regarded as a symbiotic product, for which limited resources may be used. This may lower the environmental impact, at the same time it adds constraints to the development cycle, thus increasing the complexity. That complexity is also increased by the fact that many standardized packaging forms are used for many different types of content. On the one hand, this standardization enables cost reduction and adds to the maturity of many packaging solutions. At the same time, this standardization may counteract the required flexibility, especially because packaging is in most cases designed and developed after the design and development of the product or content. Moreover, time has a much more prominent role due to the storage life of the content.

Packaging design and development involves many disciplines; commonly production, supply chain, marketing, purchase, product development and quality assurance are involved in the development trajectory. Often, focus on this interdisciplinary character is insufficient. For instance, in many cases a (graphic) designer addresses the appearance of the packaging without taking the economic and technical feasibility into account [2].

Moreover, although individual packaging have relatively low economic value, mistakes in packaging design and development can have high financial and environmental consequences, because of spoilage of the content during the life cycle.

In summary, it can be stated that the impact of packaging is high, despite the limited resources that are made available for individual packaging. To give an example: an expensive television (approximately € 1,000) usually is transferred from producer to end user by a simple carton box and some Styrofoam filling material, costing approximately € 0,50.

2.1 Aim

While packaging development shares a common basis with ‘traditional’ product development, the new material groups and accompanying production techniques and the relatively strict solution space (including pressure on cost and time as specific dimensions) differ significantly. This means that educating students in packaging design and development may also resemble ‘traditional’ design education. However, the ‘language’ that enables adequate packaging design and development is different. In elaborating this metaphor, students who want to understand packaging need to learn this language and need to be confronted with the consequences of using that language.

3. Project-led education

Industrial design engineers are relevant candidates for the design and development of packaging, because they have experience in designing products and combining multiple disciplines in one project. In the undergraduate program of Industrial Design Engineering at the University of Twente, a project-led approach is employed. This means that students work together in project teams to create realistic product designs while acquiring the required knowledge alongside the project work. The alternation between theory and practice allows students to quickly place problems in a context and to solve these problems adequately. The teachers of the courses are also supervisors of project teams to emphasize the synthesis between the courses and the project. They act as a coach, facilitator and challenger [3].

This education system has advantages compared to the
traditional education system where students have to adopt knowledge by listening to the lecturer and reading supplementary literature [4]. In traditional education, the delivery of theory is important, whereas in project-led education more attention is given to practice by placing students in a realistic engineering environment [4]. Project-led education focuses on the development of the students and their competences [3]. It provides the right environment to combine various disciplines into one project. Important skills for engineers, like project management, team work, allocation of tasks and time, communication and negotiation skills, scheduling and controlling the project and presenting the results can be practiced and developed during the projects. Besides this, it is experienced that project-led education stimulates motivation, engagement, self-activity, self-awareness and the team spirit [5]. It encourages students to think independently and to be able to solve problems adequately [3]. Students are able to quickly adjust to different fields of expertise.

As undergraduate students Industrial Design Engineering have acquired the basic competences of an all-round product developer, they are the perfect candidates in learning packaging design and development. In teaching packaging design and development to graduates, several elements from this project-led approach are very suitable to effectively understand the packaging design and management language within the acceptable time frames. It lays a good foundation for learning all relevant aspects of packaging design and development.

By the project-led education systems, students are familiar with learning new languages. The processes that are needed to acquire a new field of expertise are known and can be employed in the learning process of packaging design and development. Not all elements of the project-led education system are necessary to be employed in the master phase. Students are already familiar with project management, team work, the allocation of tasks, scheduling and controlling a project and presenting results, which means that the focus have to be more on the end result and the argumentation of decisions than on the design and development process.

A connection with practice is an important element in learning packaging design and management. By employing a realistic project, important characteristics of the field of packaging as well as relevant context can be embedded. In using such a realistic scenario, packaging characteristics do not have to be explicitly discussed during lectures but is experienced throughout the whole project, adding the student in learning the new packaging language. Furthermore, with a realistic project and a firm connection to the everyday practice the focus is shifted from the process steps within a development process towards the results thereof and the argumentation that supports that result. In addition, by explicitly also adding some of the downsides of every day packaging practice, interconnection is fostered between product approach learned as an undergraduate and the everyday practice of packaging development.

Project-led education is pre-eminently suitable to quickly learn a new field of expertise without having to focus on too much details. The realistic limitations set by a project and the direct application of theory that is demanded, not only fosters a thorough acquaintance, but also focusses on the overall concept. By directly having to design a packaging and apply the newly gained knowledge of a few material groups, perhaps not all specifics and details of each packaging material group is acquired, but instead the focus is put on underlying design rationale. Translated to the packaging design, the student may not be able to specify each and every technical specification but can specify the functional requirements in relation to the whole. Within future situations with other material groups or production techniques, the student may not know all the details, but does know how to quickly acquire these.

4. Courses in packaging design and development

The education in Packaging Design and Management at the University of Twente is explicitly subsumed under the specialization track Management of Product Development as our aim is to make Packaging an explicit, integrated, subset of Industrial Design Engineering rather than a specialization on its own. In doing so, common ground is shared and the interconnection between packaging and product development is strengthened. The packaging specific elements are educated in two main courses, a selective subject and the final thesis.

To illustrate the differences between them, figure 2 shows the contribution of each course to the overall IDE qualifications. The first course, Packaging Design and Management 1, is aimed at learning the new packaging language, whereas the second course, Packaging Design and Management 2, is aimed at applying the language in context. The elective course, Packaging Design Evolvement, is for students who want to deepen a specific aspect of the language and the final master thesis is aimed at not only achieving a well-considered, realistic and feasible packaging concept, but also at employing their scientific approach to extend the packaging language.

4.1 Packaging Design and Management 1

Within the introductory course, students are taught the basics of packaging. In 140 hours (5EC) of project work, supported by a combination of lectures, company visits, self-study and supporting assignments the characteristics of the
field from different perspectives is shown. In learning the packaging language, focus is on the following learning goals:

- Apply the knowledge and understanding of the functions of the packaging for a specific design and align these with the vulnerabilities of the corresponding products.
- Apply the knowledge and understanding of the realization process, characteristics and applications of the main packaging materials glass, plastics, metal and paper/cardboard to the design of packaging.
- Identify the strategic functions of packaging and attune the packaging design to the marketing needs of the (end)user regarding design, usage and environment.

For their project, the students have to develop a realistic packaging solution for a combination of perishable and non-food content. The combination of perishable and non-food content is crucial as it necessitates two important characteristics of packaging design: the extra dimension time or shelf life that is important in the development of food as well as the application of various material groups. The packaging knowledge, and especially the basic knowledge about materials and production methods, should be applied to the final packaging solution. Furthermore, the design of the packaging must be attuned to a chosen brand, target group and envisioned environment. In support of the adequate execution of the project, the basics of packaging are lectured: functions and life cycles of packaging, packaging materials and production methods and packaging amidst multiple aspects (usability, sustainability, costs). Alongside the lectures, two excursions to a food company are part of the course. These visits give the students a better understanding of practical situations and the consequences for the production environment when packing food products.

Several assignments are part of the course to aid the student in developing the final design. For example, the impact of different graphical elements is investigated and the differences between primary packaging secondary cardboard packaging are explored. Other assignments are realistic problems from the companies that are visited. For a successful completion of the course, students have to include the requirement specification, material specifications, secondary and tertiary packaging, production and filling process, use situation, graphical design and a rough costs estimation in the final packaging design.

A summarised example of the result of this course is shown in figure 3. The project result is a detailed and founded description of the final design and the information about the supply chain and the production processes.

4.2 Packaging Design and Management 2

While the overall structure of the second course resembles the setup used in the first course, the focus is shifted towards applying the newly learned packaging language in a realistic setting that is strongly connected with industry. This is reflected in the key learning goals:

- Create a valid, detailed and challenging packaging design within the boundaries set by the corresponding product, materials, industry and client.
- Create a sound requirement specification, based on the role of packaging in the complete life cycle of a content-packaging combination and the diverse functions the packaging fulfills.
- Predict the interdependence between design and process conditions and translate into the packaging design.

The project is linked with a relevant assignment from an industrial partner. By accurately simulating the client-design agency relation, the company is closely associated with the project and the student learn to cope with real challenges and limitations set by the company. Throughout the project there are several contact moments with the company in which various aspects of the client-designer relation are practiced: a kick-off in which the company introduces itself and the assignment, two weeks later a first elevator pitch in which the students present their first ideas to the company and a final presentation of the work as if it was the final round of the pitch.

The projects are done by groups of three or four students. This provides for a more in-depth concept in which all relevant aspects can be elaborated upon. More importantly, it also encourages the students to practice the packaging language with each other and discuss the design and approach as if they were a packaging design agency. The final concept has to meet the expectations of the company as well as the learning goals of the course. Consequently, the bar is raised as they have to create a valid, detailed and challenging
Packaging design within the boundaries set by the corresponding product, materials, industry and client. The interdependence between packaging design and process conditions need to be translated into the packaging concept. A beautiful futuristic design in which no real thoughts has been put on the realization, is not sufficient for this course. All project teams have to include important aspects like costs, sustainability, usability, feasibility, barrier properties (packaged product), supply chain, production and filling lines, and material specifications.

For the students to be able to successfully apply the language, the strong practical and realistic perspective requires some additional foreknowledge. This means that the students have a basic understanding of the development and management processes of packaging and understandings on life cycle assessments. So in the application of the new packaging language, the integration of product and packaging knowledge is a prerequisite.

Throughout the course (guest)lectures in combination with company visits provide the necessary theory and background. Topics that are elaborated on are for example design methods, marketing proposition, packaging production lines, functional specification and legislation. The company visits are more tailored to specific elements of the packaging design process. For instance, during the visit to a cardboard testing institute, the designs of the students are tested.

Figure 4 shows a result of last year in which the students had to develop a metal food packaging for the premium market which take advantage of the characteristics of the material. The packaging solution shown is a metal container that serves as packaging, cake tin and serving tray in one. Next to a detailed concept, the students have described the realization trajectory complemented with a plan in which the needed changes to the clients production lines were described and the cost-price was calculated. A proposal for a brand identity, variation and market introduction completed the overall concept.

4.3 Packaging Design Evolvement

Packaging Design Evolvement is a capita selecta, a selective course in which students can deepen individually some aspects of the packaging language. While students freely choose these aspects to a large extent, the chosen subjects and approach have to meet one of the learning goals of the course:

- Researching a packaging related field or subject and apply the findings adequately in a realistic context
- Analyze, apply and engender existing and new methods in the governing of processes in product development

As deepening a certain aspect is the central theme, a PDE has a strong research character with a corresponding scientific approach. This encourages the students to not only critically analyze a certain field or subject, but also work on their reasoning. Connection with current research at the chair is made where possible, acquainting and involving the students within the research and development side of the industry.

Results show a wide variety in assignments, covering a broad range of topics. Research has been done in the field of consumer perception, in which graphical designs of gable top packaging where compared to consumers decisions; sustainability, in which the life cycles of normal and bio-based PET-bottles were compared; and usability, in which a qualitative testing method covering both the cognitive and physical aspects of opening a packaging.

4.4 Final assignment

The final assignment is a graduation project which accounts for 45 ECTS or 1260 hours. Well-nigh all graduation projects are done in collaboration with industry. During this final assignment, integration is emphasized, the packaging
Evaluation

Graduation students of the master Industrial Design Engineering can participate in three different courses to specialize in the field of packaging. Besides this, thesis projects can be executed at a company in the field of packaging. In total, 50% of the Master’s program can be covered by packaging related subjects. The aim of the chair Packaging Design & Management is to professionalize the packaging language and using this language to develop adequate and appropriate content-packaging combinations. As demonstrated, this application area requires specific attention since it is fundamentally different from traditional product design. By adopting relevant elements from project-led education, being the quick alternation between theory and practice while avoiding excessive attention for detail, students are able to learn this new field of expertise in a relative short time-frame. As can be concluded from the results of the packaging courses, students are able to develop realistic and feasible content-packaging solutions. They not only learn a new language, but they show in their final assignment that they can use this language to achieve a well-considered, realistic and feasible content-packaging design. The end result and the argumentation of decisions is more important than the process, since the students can employ the design engineering skills they have learned in the undergraduate program.

References