

## DESIGNERS' KNOWLEDGE IN PLASTICS

Kaare ERIKSEN

Aalborg University, Denmark

### ABSTRACT

The Industrial designers' knowledge in plastics materials and manufacturing principles of polymer products is very important for the innovative strength of the industry, according to a group of Danish plastics manufacturers, design students and practicing industrial designers. These three groups answered the first Danish national survey, PD13[1], investigating the importance of industrial designers' knowledge in plastics and the collaboration between designers and the polymer industry. The plastics industry and the industrial designers collaborate well, but both groups frequently experience that the designers' lack of knowledge concerning polymer materials and manufacturing methods can be problematic or annoying, and design students from most Danish design universities express the need for more contact with the industry and more competencies and tools to handle even simple topics when designing plastic products.

*Keywords: Plastics manufacturer, polymer industry, designer, industrial design student, materials knowledge*

### 1 DESIGNERS, STUDENTS AND MANUFACTURERS IN A JOINT SURVEY

In general, research in product design and design engineering deals mainly with the first stages of a design process such as specification and concept development, while the later stages are relatively sub-explored [2]. This paper, therefore, focuses on the importance of designers' skills and their focus on the materials and manufacturing process selection which often takes place in later stages of the design process. The intention of the paper is to clarify the general importance of process and material knowledge in plastics in relation to the development of the innovative potential which will *grow our future*, but also to point out differences and similarities in the views of students, professionals and industrial partners.

This paper describes how industrial designers relate to the plastics industry and how the plastics industry relate to industrial designers and the importance of designers' and design students' knowledge on topics in relation to plastics materials and plastic production processes. The basic data for this paper was extracted from the web survey entitled '*Plastics & Design – Danish Designers' and Design Students' Knowledge in plastics and Collaboration with Danish Plastic Manufacturers/Plastik og Design – Danske designeres og designstuderendes plastviden og samarbejde med den danske plastindustri*' (The PD13 report) [1] conducted in January/February 2013 with a total of 242 respondents from the following three groups:

1. Industrial Design students at Danish universities (n=91 ~ 37.4%)
2. Practicing Danish industrial designers (n=114 ~ 47%)
3. Development managers from companies in The Danish Plastics Federation (n=38 ~ 15.6%)

PD13 is the first Danish survey to clarify and compare the knowledge and attitude of these groups regarding the industrial designers' knowledge and competencies in plastics. Although the survey focuses specifically on the Danish situation, it is likely that the findings hardly differ from the situation in several other industrialized countries. Danish industrial designers graduate from either schools of architecture, technical faculties or universities with an arts & crafts oriented background [3]. The responses from the practicing designers and the design students cover this variety of study environments and includes students and/or graduates from AAU, AAA, DK, DKDS, KADS, DTU, KEA, SDU & TEKØ. The Danish plastics manufacturers in the survey also represent a wide range of processes and product segments.

When designing plastics products, a direct collaboration between the industrial designer and the plastics manufacturer is often necessary. This is especially the case if resources are not available to

pay external consultants to assist with choosing materials and processes or if there are no available tools for the systematic choice of materials [4], which may be the case in countries like the Danish, because they are largely based on micro-, small- or medium-sized enterprises.

## **2 MODERN MATERIALS KNOWLEDGE AND COMPLEXITY**

The importance of students getting a good knowledge in relevant materials and processes to enhance the creative process in general has been established inter alia by John Lesko[5]:

*'Without a comprehensive knowledge base of materials and manufacturing possibilities, students can only fantasize and flounder along, limited by the ignorance of the subject and oblivious to the variety of possibilities available. With a good knowledge base the student can propose an array of possible design solutions and have some confidence that they can be manufactured.'*

Teaching and research in the properties of traditional materials such as glass, steel, ceramics etc. was for a long time organized in silo structures[6], hence reducing the broad overview on the topic. Ezio Manzini bridged this gap in his materials research in the 1980's [7], providing a philosophical and practical overview of the complexity in developing and using these materials and all-new composite materials that spread rapidly in the latter half of the 20<sup>th</sup> century. He points out that every object is the embodiment of what is at once thinkable and possible. Something that someone was able to both think of and physically create [7]. Manzini explains how matter becomes capable of being integrated in design through supplying cognitive tools and cultural reference, hence adding an updated taxonomy of materials based upon their appearance, cultural meaning and physical properties in a situation where the traditional borders between the different materials and their properties seem to vanish and ready-to-form materials with precisely tailored possibilities seem to be the future.

### **2.1 Business as Usual or Rational Selection**

This designer oriented materials philosophy adopted by the modern society gives no concrete guidelines to the materials and process selection in practice, and the designer can find it quite difficult to manoeuvre in this jungle of options. Thus, studies show that the designer's selections are often limited by the range of materials that he is already familiar with [8], and this is the case even if the designer is involved in more radical redesign of products or completely new designs where the willingness to consider new materials would be obvious as their dependency on previous solutions is less distinct [9].

C. Maier[10] mentions that the practical choice of materials without a methodological approach can happen in one of these ways.:

- 1: *Use generic data to find the right plastics family and then ask the supplier for a grade that fits, or*
- 2: *Start with grade data and whittle it down to a shortlist by specifying key properties, or*
- 3: *Use whatever you used last time, without ever knowing whether it is the optimum*

C. Maier recommends an alternative method by using the more systematic GRANTA System, which is a refined and very expanded version of M.F. Ashby's pioneering work from "Materials selection in Mechanical Design" [11], in which Ashby presented new models for the evaluation, comparison and rational selection of various parameters for a wide range of traditional and new materials. The websites and the publications and software from GRANTA allow for systematic selection, training (CES Edupac) and research in processes and materials' density, price, chemical resistance and a variety of other parameters such as sustainability. A Danish tool in a smaller scale is the Designsite.dk – a web based tool specifically developed for designers with no deeper material or process knowledge, so that they can gain knowledge and ideas to consider materials and processes which are new or unknown to them.

## **3 THE PD13 FINDINGS**

Even though the number of available materials and composites have exploded from a range of few clear categories where the good designer and craftsman could get an overview of the relevant properties during a professional career, and even though the cultural cognitive anchoring of the materials did not happen faster than the development of new materials [7], the different manufacturers are still organized in relation to few traditional material categories. This is also the case with the Danish Plastics Federation where the members manufacture their own product ranges, act as subcontractors or supply raw materials in both thermo plastics, thermo setting plastics and composites. The Danish Plastics Federation has long been aware of the need for more knowledge in plastic

materials and production methods and supported these efforts 11 years ago with a forum entitled ‘The Plastics Federations Design Club’ and joint events where the Danish manufacturers, designers and design students could network to increase the knowledge concerning plastic design, materials and processes.

### 3.1 Collaboration: Importance and Positive Experiences

In the PD13 survey the three groups of respondents were asked about the importance of industrial designers’ plastics knowledge, and they were asked about their experience from collaborative projects. In addition, the respondents were asked when they found it either problematic or annoying if the designer did not have sufficient knowledge in plastics. Furthermore, all of the respondents were given the chance to answer a short multiple choice questionnaire on various plastics topics in order to clarify their range of general knowledge. In the following, some of the results from the PD13 are presented

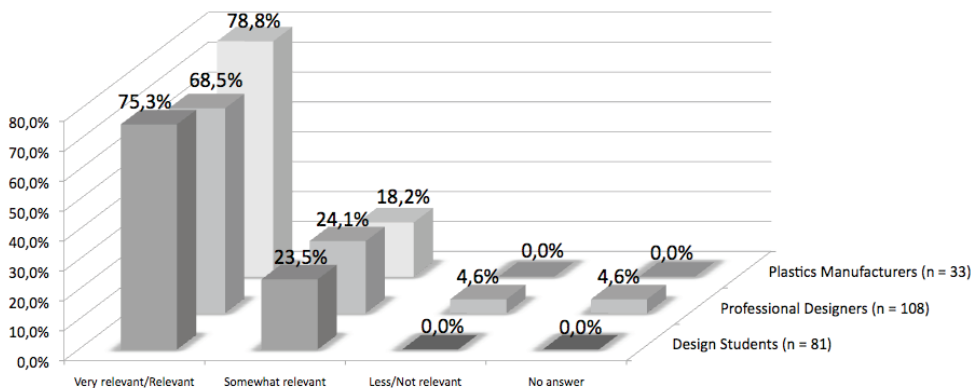


Figure 1. The relevance of the industrial designers’ knowledge in plastics to the innovative capacity of Danish companies

Figure 1 shows how each of the 3 respondent groups rate the importance of the designers’ plastics knowledge for the innovative capacity of the Danish industry in general. [1]

This importance is rated very high as more than 93% in each respondent group rate it as ‘Somewhat relevant’, ‘Relevant’ or ‘Very relevant’. The manufacturer’s rate the importance of the designers’ plastics knowledge a bit higher than the design students and the professional designers, but it leaves no doubt that this area is of great importance in modern design education and in practice.

Only 72% of the plastics products manufacturers mention that they have collaborated with industrial designers (both Danish and non-Danish).

Seventy-five percent of the industrial designers state that they have experience from collaboration with plastics manufacturers, although this figure also includes fresh, new candidates with only little or no professional experience.

More than 40% of the design students at bachelor and master level did collaborative projects involving plastics manufacturers; probably during internships or collaborative study projects.

Therefore, it seems there is a good contact between the Danish plastics manufacturers and the design students and professionals, although there is still room for improvement, and the three parts are generally satisfied with the collaboration, as Figure 2 shows.

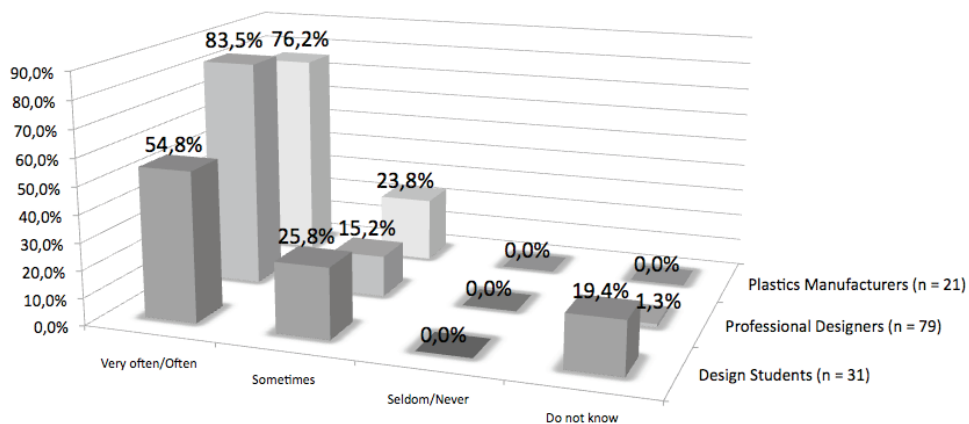


Figure 2. Frequency of positive experiences from collaboration between plastics manufacturers and design professionals/students seen by the 3 parts

The professional designers mention that openness and a helpful attitude are typical for the plastics manufacturers from whom the designers claim to get very competent advice in relation to matters concerning manufacturability and choice of materials and processes.

Some of the companies mention that the designers should listen more to practical experience (probably from the manufacturers), and it is mentioned that *non*-Danish designers in general show more respect for the manufacturers/sales compared to the Danish designers. It is also mentioned that it often causes problems when collaborating with non-Danish partners, despite the opinion that non-Danish designers often have a broader knowledge concerning plastics materials.

The design students do not comment on *why or from where* they have positive experiences from collaboration with the industry, but generally they want to work even closer with the companies on projects and to visit more factories to get more experience than they can get from textbooks or the internet [1].

### 3.2 The Respondents' General Knowledge on Plastics

The multiple choice questions in the questionnaire on *plastics knowledge* were formulated like these samples (A-C):

- A. *LEGO-bricks are typically made of?* (ABS)
- B. *Which material is often used for reaction moulding?* (PUR)
- C. *How many 50 ton injection moulding machines can you find in Denmark?* (200+).

Eighty-three percent of the professional designers, 55% of the design students and 92% of the plastics manufacturers gave the right answer concerning the LEGO-bricks. This percentage of correct answers is not surprising as the LEGO brick is the most well-known Danish designed plastics item, but only 39% of the professional designers, 15% of the design students and 65% of plastic manufacturers answered correctly when asked about the reaction of moulding materials. The reason could be that this process is not taught sufficiently or not taught at all in the Danish design programs, which is stressed by one responding PU-manufacturer.

The question about the number of small moulding machines was answered correctly by all plastics manufacturers, while only 30% of the professional designers and 11% of the design students gave the correct answer.

These replies reveal that the technical/production knowledge in the designers does not cover some issues that might seem rather obvious if you work *in* the polymer industry. But this does not represent a problematic issue in itself, and as more plastics manufacturers respond: they would not expect industrial designers to have deep knowledge in plastics technology anyway. [1]

Rightfully, one could ask whether the designers' lack of knowledge concerning plastics materials and processes actually constitute a nuisance or a problem in the collaboration with the manufacturers on the development of new plastics products. We asked all three respondent groups about this and the answers in relation to *materials* knowledge is shown in figure 3.

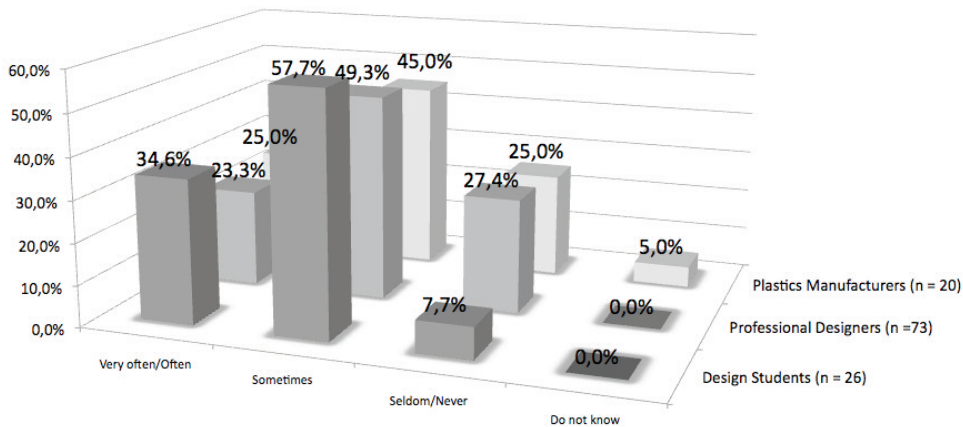


Figure 3. Have you experienced that it was annoying or problematic that 'The Designer/You' knew too little about plastics materials?

Of the designers working with the Danish plastics industry 27,4% claimed that they seldom or never experienced this situation, while more than 23% found themselves in this situation often or very often. The plastics manufacturers had approximately the same experience, while 32% of the design students found themselves in a situation where the lack of knowledge was annoying or problematic. These figures do not illustrate that the *knowledge* of 68% (100% minus 32%) of the students or 72% (100% minus 28%) of the *knowledge* of the professional designers' were satisfactory. The answers really show how severely they *feel* the lack of knowledge in practical project work. The design students might experience the lack of knowledge less embarrassing or irritating as they are in a learning situation, and because they are quite used to situations where they do not have the proper knowledge or experience.

### 3.3 The Designers' Knowledge Gap

A very broad picture appears when looking at the topics mentioned by the students and the professionals. They were asked to prioritize the topics and more detailed information on these priorities can be found in the PD13 survey, but some general tendencies will be described in the following.

One out of four professional designers mention the general problems they have with finding the right material in relation to specific properties or use as a first or second priority, and they give approximately the same priority to the problems with choosing the right process or knowing the limitations and specific possibilities for available processes. The design students find the lack of general knowledge in plastics materials most annoying or problematic, and surprisingly they rank the inability to estimate the price level of plastics materials or processes next. This factor is also ranked highly among the professional designers and the manufacturers, while the lack of knowledge on environmental aspects or sustainability are ranked lower by all respondents.

The answers from the three groups of respondents show a clear desire to get more general knowledge on plastics and plastics manufacturing during the education. Many of the respondents gave suggestions on how to improve the industrial designers' knowledge in the area, and the suggestions fell mainly in three categories:

- A. More collaboration with and visits to plastic manufacturers
- B. Better hands-on databases and instructive videos on the internet
- C. Better and more in-depth courses and local material libraries

## 4 CONCLUSION

The PD13 survey shows that the students, the professional designers and their partners in the plastics industry all clearly stress the importance of the designers' plastics knowledge for the innovative potential of the Danish industry. Plastics, in general, is widely used in modern production and it is a basic material for the industrial designer when designing products to *grow our future*, but the PD13

also reveals that all groups of respondents find that the designers' lack of knowledge in the area to be problematic or somewhat annoying. One could ask, how deep the knowledge of the industrial designers should be in this complex area, but the PD13 shows that the respondents in general do not expect the designers to be familiar with advanced materials or complex matters such as sustainability. Typically, better general knowledge in relevant materials and production methods, constraints and possibilities would be sufficient to qualify the designers in collaboration with others to create the products needed. There are some tools available, and therefore it seems an easy task to increase the designers' knowledge in the existing educational programs. Each university might have their own reasons for not prioritizing this effort, and the question of financing or simply lack of knowledge about this schism might be among them. This situation might prevent a more dynamic innovative design culture in the long run and might keep the designers in a position where they still just use the materials they already know or decide upon simple data sheets and a limited systematic approach.

## REFERENCES

- [1] Eriksen K. *Plastics & Design – Danish Designers' and Design Students' Knowledge in plastics and Collaboration with Danish Plastic Manufacturers /Plastik og Design – Danske designeres og designstuderendes plastviden og samarbejde med den danske plastindustri* (The PD13 report). 2013 ( Department of Architecture & Design, Aalborg University, Denmark)
- [2] McMahon C.A., Reflections on diversity in design research. In *Journal of Engineering Design*, Vol 23, Issue 8, 2012. pp.563-576. (Taylor & Francis).
- [3] Eriksen K. and Knudstrup M.A. The Danish Revolution in Design Education. In *Proceedings of the 10<sup>th</sup> Engineering and Product Design Education International Conference, Universitat Polytechnica*, Barcelona 2008. red. Anna Clarke; Mike Evatt; Peter Hogarth; Joaquim Lloveras; Luis Pons. pp.97-101. (Design Society).
- [4] Sancin U. and Dolšak B. Decision Support Systems for Designing with Polymer Materials – Current Challenges and Future Expectations. In *Efficient Decision Support Systems – Practice and Challenges From Current to Future*. 2011. Ed. Chiang Jao. pp 493-508. (InTech, Shanghai, China)
- [5] Lesko J. *Materials and Manufacturing Guide, 2.Edition*, 2007, (John Wiley & Sons).
- [6] Silva A.; Pereira-Medrano A.; Melia H. and Ashby M.F. Materials Education: adapting to needs of the 21<sup>st</sup> Century. Presentation at 4<sup>th</sup> International Symposium for Engineering Education, 2012. (University of Sheffield, UK)
- [7] Manzini E. *The Material of Invention*. 1987. (The Design Council, London, UK)
- [8] Haudrum J. and Mortensen N.H. Ten Studies of how process Selection is carried out in the Stage of Design – A Pilot Project. Report, Institute of Manufacturing Engineering, 1993 (Technical University of Denmark, DK)
- [9] Lenau T. Material and Process selection Using Product Samples. In *Advanced Engineering Materials* 2002,4 no.6 (Wiley-VCH Verlag, Weinheim, Germany)
- [10] Maier C. Mapping the Polymer Universe. In *British Plastics & Rubber*, Aug 2002 (MCM Publishing, UK)
- [11] Ashby M.F. *Materials selection in Mechanical Design*, 1992 (Pergamon Press, Oxford ,UK)