Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 61 (2017) 87 – 92

www.elsevier.com/locate/procedia

The 24th CIRP Conference on Life Cycle Engineering

Ecodesign and Energy labelling: the role of virtual prototyping

Daniele Landi[a*], Andrea Capitanelli[a], Michele Germani[a]

[a]*Università Politecnica delle Marche, via Brecce Bianche, Ancona 60012, Italy*

* Landi Daniele. Tel.: +39-071-2204797 ; fax: +0-071-220-4797. *E-mail address:* d.landi@univpm.it

Abstract

With increased acknowledgment of global climate change and warming, governments, consumers, and firms are responding collectively to create today's low-carbon economy. The eco-design of products is a crucial factor in the Community strategy on Integrated Product Policy. As a preventive approach, designed to optimize the environmental performance of products, while maintaining their functional qualities, it provides genuine new opportunities for manufacturers, consumers and society as a whole. This article presents an approach to support the designers during the energy labeling phases of products. The study starts with an analysis of the Eco-design regulations and proposes the virtualization of such tests. A case study on the application of the proposed method is described. The study results show that, the use of numerical simulations not only for product design but also during the testing and labeling phase, allowing a significant reduction in time to market and provides the company competition and economic, energy, and time savings

Peer-review under responsibility of the scientific committee of the 24th CIRP Conference on Life Cycle Engineering

Keywords: Design for enviroment; Design optimization; Eco-design; Energy labelling; Energy-related products; Virtual Prototyping.

1. Introduction

There is growing scientific evidence and consensus about climate change and its link to human activities [1]. This concern is compounded by a global rapid growing population, with increased demand for energy, materials, minerals, and food products. Numerous studies show that, for the energy-related products, over 75% of the carbon product is due only to the use phase [2]. These premises push the legislators to develop sustainable models. Sustainable development means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs [3]. The prevention and reduction of environmental pollution and the promotion of sustainable consumption and production (SCP) are fundamental to safeguard the earth's capacity to support life, respect the limits of the planet's natural resources and ensure a high level of environmental protection and improvement. The EU Sustainable Development Strategy (EU SDS), together with the Marrakech Process, form the drivers for the sustainable consumption and production and sustainable industrial policy action plan [4].

"Action Plan" means the development of robust SCP policies that contribute to worldwide sustainability by boosting political momentum, by creating market conditions conducive to low carbon and sustainable technologies, products and services and by encouraging changes to producer and consumer behavior which affects positively on resource efficiency, product performance and eco-innovation. The current European Union legislation already provides the requirements for the environmental friendly design of certain energy-using products under Directive 2005/32 / EC [5]. 'Eco-design' is defined by ISO 14006:2011 as the integration of environmental aspects into product design and development with the aim to reduce adverse environmental impacts throughout a product's life cycle [6]. The extent to which eco-design practices are implemented in industry has been concerning researchers for many years [7]. Recent studies show that companies are still struggling to implement eco-design [8]. The major issues derive from different factors: a

Peer-review under responsibility of the scientific committee of the 24th CIRP Conference on Life Cycle Engineering
doi:10.1016/j.procir.2016.11.144

long time to carry out the eco-design tests, high costs of products prototyping, and difficulties in the implementation and/or evaluation of the eco-design benefits.

Nevertheless, these rules and labels are developed in order to improve the energy performance and to reduce the environmental impact of products throughout their life-cycle and enabling consumers to make informed decisions. Labelling Programmers are designed to modify the selection criteria of consumers by drawing their attention to the energy consumption of household appliances [9]. Driven by these motivations, the companies have developed new methodologies and new design systems based on the use of virtual prototyping tools [10].

However, it is not surprising that many organizations, particularly smaller companies, are confused over the application of virtual (digital) prototyping. An element of confusion surrounding VP is that this technology is synonymous with other technologies already widely utilized across industry and the term itself is loosely applied to a wide variety of activities. The term 'virtual prototyping' is not, in our opinion, restricted to the use of a discrete item of software to simulate the behavior of a real life product. It also encompasses an approach to product development that takes advantage of individual technologies such as computer-aided design and the successful adoption of email technology to build an efficient product-development capability based principally on greater collaboration between designers, engineers, marketers and customers. It is the desire to reduce time to market, cut costs and speed up product development that is driving the exponential development and adoption of VP tools. A requirement increasingly being placed on all companies within an array of industrial supply chains is the need for product-development capabilities in order to respond to the needs of the end consumer.

Therefore is necessary to develop a tool able to support companies during the design phase, capable of implement the eco-design directives, minimizing cost and the time to market. The idea is the development of a methodology based on user-friendly configuration with virtual prototyping tools able to virtually reproduce the performance of the oven. This allows knowing the energy class of the product from the early design phase without to build the physical prototypes.

This approach has been tested on a design of a cooking appliance, the electric oven. It is estimated that there were 185.3 million cooking appliance units globally in 2015 [11] with the market value expected to reach $231bn by 2018 [12]. If we consider the electric ovens in Europe, around 12 million of products are sold each year [13]. Electric ovens are among the least energy efficient appliances, with the efficiency of only 10%–12%. Given that they consume 100–300 kWh per year [14] and that 61% of 213.8 million households in the European Union [15] have electric ovens [16], this amounts to around 26 TWh of electricity per year. Against this background, the electric oven has been chosen as a case study.

In the first part of the paper we report a review of the EU energy regulation. The methodology proposed is presented in section 3. The implementation examples and simulation results are described in Section 4. Finally, the conclusion is given in Section 5.

2. Energy regulation

The combination of Eco-design and energy labeling is one of the most important improvement in the area of the energy efficiency. The EU Eco-design directive establishes that the products connected with energy are obliged to reduce the energy consumptions and the environmental impacts. The EU Eco-design directive [17] establish a framework to set mandatory ecological requirements for energy-using and energy-related products, and it is complemented by the Energy Labeling Directive [18]. Furthermore, Implementing Regulation are issued to specify eco-design requirements for different product categories. Instead, the labels are an important information tool for consumers as they help to quickly communicate information about the product or the production process [19, 20]. For consumers, labels can be especially helpful to identify sustainable aspects of a product as those are becoming increasingly important [21]. All this resulted in the definition of the Energy Label Regulation. If we consider the electric ovens (used as a case study in this paper), from the 1 January 2014, it has been published the Oven energy label Regulation that entered into force on 20 February 2014 (Figure 1). An Energy label and a Product fiche have to be provided for each cavity of an oven and for each hood to be placed into market.

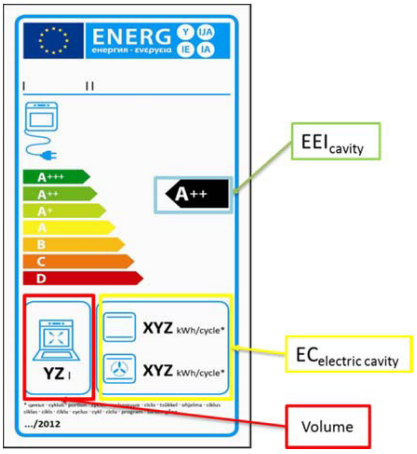

Figure 1- Energy labelling of an oven.

The product's compliance to the regulation is checked by the Authorities through the comparison between the values declared and the ones stored in the technical documentation and between the values declared by the supplier and the ones measured by the Authorities. For each domestic electric ovens, on the label there are included the following data: supplier's name or trade mark, supplier's model identifier, energy source, energy efficiency class of the cavity determined in accordance with the normative, volume of the cavity in liters, cycle energy consumption expressed in kWh/cycle (conventional and/or forced air convection) of the cavity. The Directive classifies ovens into seven categories, from A+++ to D, based on the energy efficiency of the oven cavity.