Parametric Ecodesign

Development of a Framework for the Integration of Life Cycle Assessment into Computer Aided Design

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Abstract

Environmental considerations have become a strategic priority for many companies during the past decade, and the development of new products has had to respond to this trend. Although many methods have been developed for this purpose, much of this effort has found barriers that arise from the nature of the product development process. Life Cycle Assessment (LCA) is the most popular method to evaluate environmental impacts in general, and has been taken as the reference for assessing products. It is considered as the most important tool to integrate environmental considerations into product development. Nevertheless, it has some characteristics that make it difficult to integrate it into the early stages of product development: it is generally a complex time-consuming process, and its results are only practically valid when they are used in relative terms.

Environmental assessment is done by using LCA software; engineering design is done in Computer Aided Design (CAD) systems. Both worlds have strong relations – especially when Ecodesign is to be implemented – but they are not necessarily connected. This thesis wants to link both worlds. A framework to integrate LCA into CAD software is developed; this integration seems plausible and advisable, as has been pointed out in previous literature, although it is not immediate due to the previously exposed problems. The framework developed through this thesis attempts to ease the environmental evaluation of products by providing a parametric model for them. The example of cranes is analyzed in detail after conducting a full LCA for the PK9501, a middle size crane manufactured by Palfinger Crane. A parametric model for the cranes is then established. An environmental evaluation tool is developed containing the parametric model of the crane as its core. The tool delivers an environmental profile of the assembled crane and of each of its parts and compares LCA results with other cranes. It was developed to be used in the design department of Palfinger Crane.

Further researches in this thesis focus on the translation of LCA results into a judgement of how well or poorly the environmental performance of the product is doing in comparison to similar competing products. The concept of *LCP-families* is introduced from which reference ranges can be derived. One of the critical constraints is the need to develop a systematic procedure for comparison. An environmental expert will probably be able to perform this sort of comparison in a qualitative manner. Engineering designers, however, will need much more effort to take decisions based on such patterns. The concept of LCP-families is a general concept which applies to any product.

The next consequent research step was to develop a concept which assures the correct forming of LCP-families. Based on ISO 14040, LCA results of those products can be compared which have the same functional unit. Its formulation might constitute a source of difficulty for practitioners. Additionally, phrasings of the functional unit for the same product might be disperse and therefore provide no uniformity. To overcome these obstacles, a parametric description of the functional unit is aimed by introducing the concept of *functional icon*, in short fuon. A fuon provides limited sets of parameters. It will be shown in this thesis that a proper use of fuons can assure a uniform and comprehensive phrasing of the functional unit.

Once results have been gathered, thoughts were given to how they can be visualized and communicated to the engineering designer. Visualization based on a colour scheme in CAD as well as the use of Ecodesign Decision Boxes (EDB), developed in the master thesis of the author, are applied. The introduced concepts are tested through workshops as well as applied to the product examples of office chairs and cranes. In the last chapter of the thesis a system-architecture for the implementation of the research fundaments into CAD is given.