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Tomohiko Sakao and Mario Fargnoli

[pull-quote: " Mass customization, defined as "design and manufacture of customized products at mass production efficiency and speed" (Anderson 1997), can allow manufacturers to provide customer-dependent value while bearing costs that are only marginally higher than for the mass production of standard products. … The incorporation of MC criteria into ecodesign opens up important opportunities. "]

Customization in Ecodesign [heading level 1]

Ecodesign has had a tendency to focus on regulation issues and on the technical aspects of design and production, i.e., how to incorporate additional requirements from an environmental viewpoint and to realize a physical product. In doing so, it appears to have focused less on customers. In other words, ecodesign seems to have been dominated by a product-push approach. In line with this, methods developed for ecodesign to date have been relatively poor at addressing the customer aspect. We offer some thoughts about how a demand-side approach might be pursued.

Indeed, companies have been pressured to consider more about how to attract customers in ecodesign. Due to the ever stricter environmental legislation, green attributes increasingly have to be viewed as default inputs for a large number of products. Therefore, merely following current ecodesign methods is often insufficient for maintaining environmental competitiveness (Stevels 2005). Many of the environmental properties of products supported by those methods are becoming established in response to regulation or legislation with which manufacturers must comply. Thus, designers have to focus on differentiating properties in order to attract customers, guaranteeing at the same time the often dynamic improvement of environmental performance requested by the law.

Looking at a competitive market in general, mass customization (MC) has been one of the most promising strategies for manufacturers to attract customers. Mass customization, defined as "design and manufacture of customized products at mass production efficiency and speed" (Anderson 1997), can allow manufacturers to provide customer-dependent value while bearing costs that are only marginally higher than for the mass production of standard products. In carrying out MC, a common "platform" is often utilized for a product family with exchangeable modules and/or a process of adjusting the platform. A well-known example of such products in industry is sport shoes, whose shape is adjusted depending on the shape of customers' feet while still realizing the economies of scale and the efficiencies of modern manufacturing while still realizing the economies of scale and the efficiencies of modern manufacturing . MC works well in this case because every foot is different and yet the increased cost of responding to those differences is bearable. You may also have experienced buying a mass-customized product; e.g. a pair of glasses whose lenses are in accordance with your eye sight and whose frame is adjusted to the shape of your face. Maybe, a car of your preferred color and with some exterior parts you chose.

The incorporation of MC criteria into ecodesign opens up important opportunities. Environmental quality is actually perceived differently from one customer to another, especially when obvious economic value for customers – such as energy savings – is not presented (Sakao 2009). This means that varying specifications of a product family with some environmental characteristics implemented differently could fit into varying needs of different customer segments in a better way. This is a positive factor, making MC work effectively in ecodesign.

As a matter of fact, several solutions having this double effect have already been put on the market. For example, a Japanese manufacturer introduced a new cellular phone in the national market in late 2005[1]. Its shell is made of bio-plastics, obtained from corn and plant (kenaf) fibers. This solution was designed especially for a segment of women ranging from their 20s to 40s, presumably on the idea that this segment appreciates the higher value created using this material, e.g., potential reduction of CO_2 emissions and "feel of a natural material". For another category of customers, a different type of shell made out of ordinary plastic was prepared sharing other parts as a platform. Another example is a house as a product, where a customer can select either insulating glass or single glass. The insulation performance of the house is different. Customers can choose the window type depending on the climate of the location and how they value the different characteristics.

Opportunities in Ecodesign Research [heading level 1]

Bearing this in mind, an immediate question might be: How does MC influence the environmental impact of a product, e.g., does the variation in product characteristics improve or diminish overall environmental performance? Such a research question could be tackled using life cycle assessment tools. In addition, what variety in customer value do environmental characteristics create depending on different types of customers? This may be dealt with using knowledge developed in quality engineering. Yet, an important challenge emerges—how to support these design activities. It is well known that most potential for reducing the environmental impact of a product exists in the design activities, since it is indeed in these phases where the main environmental properties of the product and its impacts are determined. Beside this, the need to simultaneously improve the product's competitiveness in the market certainly requires an effective design strategy, one which is balanced among environmental and technical concerns and the customer's needs and wants.

Needless to say, to carry out MC strategically and effectively, manufacturers must understand a product's value in the design phase, which depends on customer types. In the ecodesign field, only a few studies have tackled such a challenge (e.g., Finster et al. (2001)). In particular, MC implementation in the earliest design stages has not been investigated widely, bringing to light the difficulties of manufacturers in shifting from the "end-of-pipe" approach to the more effective "front-of-pipe" approach. As a matter of fact, ecodesign has been regarded in many cases as having a negative impact on the "traditional" properties, such as safety, reliability, and aesthetics, and it has been feared as an additional cost that companies have to bear.

These challenges can be overcome bearing in mind that the earlier environmental features are systematically incorporated into the product development activities, the more effectively the final product appears, both from the producers' and customers' point-of-view. Starting from this basic design rule, it has to be recognized that customers' appreciation of a product is based on its value (economic, functional and emotional). Thus, the effort made by manufacturers to increase the product's value should be integrated with the attempt to improve the product's environmental performance.

Such an activity in the early stages of the product development process can be supported considering customization issues as an input to product planning activities, i.e., pushing designers to evaluate customization needs as requirements for product development. This implies that the product development framework has to be modified, introducing from its initial stages (i.e., the planning phase) a strategy able to bring to light which interventions can improve both the varying environmental aspects of a product and at the same time its value for customers (e.g. by means of the use of design issues for modularity, material differentiation, etc.).

Toward Further Development of Ecodesign [heading level 1]

Considering the need for strategy in the earliest stages of ecodesign, what we first must do is find out what constituents such a strategy should contain. The word "strategy" here is intended to mean "the approach that manufacturers adopt for the purpose of selling their ecodesigned products". Obviously, it should include to whom their products will be sold, i.e. customers. It should also answer the question of how the product will be competitive, e.g. what is the value of the product from the customer perspective. The strategy should also contain environmental characteristics as one important element of a product. As a matter of fact, it is important that a systematic connection, and preferably no contradictions between these items, is developed in order to make the value of a given environmental characteristic appreciated by customers.

Incorporating this new strategic instrument has the potential to lift the ecodesign process to a higher level, which can be represented by an "augmented" ecodesign process. This is a novel and a key opportunity for companies' success, enabling designers to deepen and enrich the information of concerned customers so that they can more easily accept the product. In fact, one might argue that such an approach has been already investigated by several researchers, e.g. the use of environmental quality function deployment (QFD, see e.g. Sakao (2007)). These approaches propose tools that incorporate customer requirements in parallel to environmental requirements at an early stage of product design. However, they also assume homogeneous customers and do not provide methods equipped to address the dimensions of customer variety, and thus to manage dynamics of customization (e.g. mechanisms for adjusting a product platform). Therefore, it is impossible to achieve such an "augmented" ecodesign process merely with those approaches.

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[1] See http://www.nec.co.jp/eco/en/annual2006/02/2-1.html.