An Industrial Designer's Perspective on Future Makers

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Abstract
We present visions of products and roles of designers in the society of future making from industrial designers' perspectives. Our visions are based on the analogy that product ecology will be like local farming for food consumption, where people purchase seeds of goods and grow them as they consume. We illustrate two cases in which users take a leading role in personalizing a product to their needs. The first case, Light-morph-Light, is a product that adapts to the usage environment in a loosely controlled fashion, whereas the second case, Shader Printer, provides precise control over the outcome. We discuss some issues and future roles of expert designers that may be caused by the change in the period of democratized fabrication.

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Introduction
Industrial design has played a key role in shaping mass-produced goods. The designers have been mediators between producers and consumers. They

advocate for end users while they create new ideas for producers, balancing technical feasibility, business viability and people's desirability.

The digital fabrication has made changes within and beyond the industrial design domain. It has offered easy tools for the designer's prototyping. In the analogue period, the help of engineers was essential to concretize early concepts. Easy prototyping by digital fabrication supports reflective practices for designers. The current trend of decentralized manufacturing, enabled by the low-cost digital fabrication devices, blurs the boundary between expert design (performed by those trained as designers) and diffuse design (performed by everybody) [3]. As designers and educators of industrial design, we need to understand our role and contribution in the future of making. We see that the competency of expert design, such as human-centered perspectives for the technology applications, pursuit of creativity, taming under-defined problems, and the ability of integration and communication, are still required by business and society in the future.

In this paper, we present visions on new product ecology and the roles of design as a designer-researcher's point of view. We focus on the following questions. What would be the ecology of products in the future of making? What issues are raised? What would be the future role of expert designers?

Ecology of Evolutionary Products

At present, one of the most popular personal fabrication technologies is 3D printing. The application of 3D printing still remains in simple component fabrication. We see the fabrication method as getting diversified and specialized. The specialization will happen in terms of material, scale, and the context of creation.

An analogy for the relation between producers, products, and consumers in the personal fabrication and automated production is that between sellers of plants, seeds of plants, and farmers. In the agricultural society of the past, everyone was a farmer who grew his own food. Now people buy food from a supermarket as an end product. This may be similar to what we experience with mass produced goods. Nowadays we see initiatives with locally produced food in small quantities, directly delivered from the farm, and future visions of kitchens include hydroponic systems for family food production. A vision of a product ecology would be that people purchase seeds of goods and grow them as they consume, or buy products cultivated by small local businesses. This may be similar to the consumption ecology of agricultural goods where high-quality seeds are purchased to further breed by everyday consumers.

The ecology could be interpreted as an extension of current user-centered design practice in two ways. First, in participatory design, users participate not only in the evaluative stages of design, but also in the ideation of products. Second, evaluation of prototypes in the field, in longitudinal studies in people's homes, becomes an indispensable tool to understand users and the impact of new products. Other than in user-centered design, in the new ecology users take a leading role in shaping the product to their needs, and the distinction between prototype and product will be blurred.

What if producers create seed-like goods, not yet matured? Such goods may have coherent genetic characteristics defined by producers but with the

Figure 1: An example of product cultivated by initial interaction, Light-morph-Light, has a lampshade created by initial lighting condition of the environment. [1]

Figure 1: An example of update-able product, Shader Printer. [4]

potential to grow uniquely. It would be important for producers to consider how to incorporate such characteristics. The consumers would personalize and build meanings as they cultivate the products. The products are evolutionary like a living entity that grows together while interacting with users. It would be possible to define various evolutionary characteristics. For example, the evolution can happen arbitrarily or programmed with genetic algorithms. The amount of control can be elaborated.

We illustrate our ideas on a digital fabrication ecology through two cases in which users take a leading role in personalizing a product to their needs. The first case, LmL, is a product that adapts to the environment of the user in a poetic way, whereas the second case, Shader Printer, provides precise control over the outcome. Together the cases bring aspects of products that we enjoy in the digital domain to the physical domain.

LmL (Light-morph-Light) is a lamp product to examine how this type of new digital fabrication platform can be used in the new product ecology system. We devised a design technique called Self-Morphing Randomness [1], whereby the fundamental characteristics of a product function become the deciding factor in cultivating the product. LmL lamp uses initial lighting condition as the evolutionary characteristics (Figure 1).

The idea of the "shader printer" project (Figure 2) is to make changing the appearance of physical objects as easy as changing the background image on a smart phone [4]. Products are coated with a bi-stable color changing ink that, with a specialized projector, can be activated. Similar to electronic ink, the color-change is persistent, and it only requires energy to change, not to maintain color. However, unlike electronic ink, using smart paint and an external activation mechanism avoids many limitations of embedding electronic displays in products.

With "update-able" products, users can experiment with design and adapt design to their needs. For instance, a fashion accessory is updated for a special occasion, or wallpapers are adjusted to the season or time of the day. We expect that with non-permanent and effortless morphing products, users will be invited and inspired to shape their environment through experimentation.

Issues with product growing with the user

The illustrated product ecology also raises new issues. As home-grown products are likely to be unique and made in the wild, they lack the certification and quality assurance that mass-produced products have. Parallels to home improvement can be made: in case of failure, who can be held responsible—the maker or the designer? We foresee the need for "licensed" professionals required by insurance companies for customizing designs.

Similar to home remodeling, when products are made uniquely, they cannot be returned to the shop, and that will likely require new forms of prototyping and products. Expert designers extensively use prototyping techniques such as "living with prototypes" as longitudinal studies to understand the impact of a product. The growing, adapting, and shaping products could be interpreted as a form of prototyping where the difference between prototype and product will become arbitrary.

Another issue is related to aesthetic qualities of artifacts. Design researchers have discussed how the aesthetic quality of things can be judged [2]. One viewpoint is that the quality is engrained in the things and achieved by certain design principles. If the sense

of the aesthetic qualities requires professional training and to be realized while making, we may question the aesthetic quality of everyday design. We see that the proliferation of SLR camera does not guarantee high-quality photographs. Likewise, a prospect would be that the world of personal fabrication produces more diversified but less aesthetic artifacts.

Future Role of Expert Designers

Different prospects on the roles of expert designers can co-exist. New technologies like collective creativity and deep learning threaten the design profession. It is true that some design practices can be accomplished by digital design aids. Nevertheless, as we see professional cooks play important roles where many people cook by themselves at home, we expect that meaningful roles can be reserved for expert designers. We speculate on some of them here.

The first role of the expert designer is that of practice trainer. Taking into account the farming analogy, it is essential to assist end users during the cultivation period. The delivery of the initial product is not sufficient. Know-how on ways to cultivate the product must be guided. For this, new channels of knowledge transfer may be necessary. It may call for a new design service linking between expert and diffuse design.

Second, expert design will be more specialized in creative integration. Making simple components is easily accomplished by everyone. However, advanced assembly and creative integration may still be challenging without the support from professionals. The integration may by highly contextual. Harmonious coordination among material, structure, function, and scale is highly complex and creative. Expert designers can help with matching the user needs and the fabrication options.

Third, expert designers would deal with new subject matters of design. It could be genetic algorithms embedded in products. Also, designers will be involved in designing customized fabrication tools. End users will creatively use the tools made by expert designers and appropriate the genetic characteristics. Both parties will actively collaborate, stimulating each other.

Lastly, the professional designer will be the advocate of product qualities. This can be done by exemplary design activates or curation. Qualities go beyond the aesthetics and will cover all aspects of people's experience with products and span multiple senses. Practical knowledge on what makes good design and how to create well-designed things will become central concerns for expert designers.

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