Future Craft: How Digital Media is Transforming Product Design

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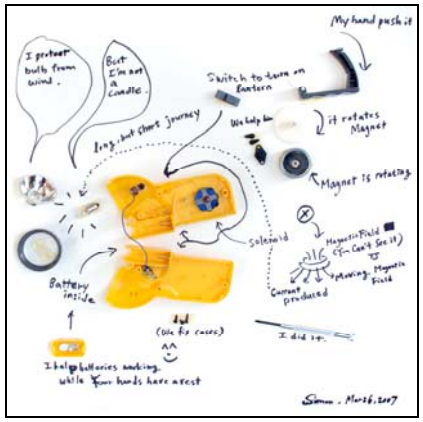

Figure 1. 'Product Autopsy' engages students in a discussion of where and how products are (and should be) made.

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CHI 2008, April 5 – April 10, 2008, Florence, Italy
ACM 978-1-60558-012-8/08/04.

Abstract
The open and collective traditions of the interaction community have created new opportunities for product designers to engage in the social issues around industrial production. This paper introduces Future Craft, a design methodology which applies emerging digital tools and processes to product design toward new objects that are socially and environmentally sustainable. We present the results of teaching the Future Craft curriculum at the MIT Media Lab including principal themes of public, local and personal design, resources, assignments and student work. Novel ethnographic methods are discussed with relevance to informing the design of physical products. We aim to create a dialogue around these themes for the product design and HCI communities.

Keywords
Product Design, Sustainability, Craft, Digital Media, Design Methodologies.

ACM Classification Keywords
J.7 Computer in other systems: Consumer products.

Introduction
The interaction community is increasingly engaged with product design through the growing impact of digital

devices on society and the environment. But the HCI community only indirectly deals with industrial production and design. The time has come for a direct dialogue between these to address the fundamental problems of *what* should be made and *how* to make it. Future Craft is a new design methodology that considers how the processes of design and production can be used to reflect new social values and to change dominant cultural practices. It addresses design as both a process and a result of a process, influenced by technological developments, the socio-economic constraints of the manufacturing process, and the cultural context that gives rise to the need for objects.

Industrial production has fostered vast distances between the sources of products and their users, with often disastrous social and environmental consequences. Designers and engineers usually work far from the factory or the sales floor; and many products can be overly generic, complex, harmful to people or the environment. But the HCI community is increasingly engaged with industrial production through efforts to simplify products, to make processes more efficient, to strengthen communities and individuals and to inform consumers. The depth and complexity of digital devices is motivating major manufacturers to search for a new 'simplicity' in consumer electronics [30]. Last year, a 'Best of CHI' award went to a paper based on the assumption that 'sustainability can and should be a central focus of interaction design.[3]' Advances in personal fabrication techniques and computing in developing countries are spurring the growth of 'fabrication labs' where developing communities can begin to design and manufacture products suited to their needs [21]. Physical and mental illnesses are being addresses through digital wearables and intelligent prosthetics [2,24]. Supply-chain traceability interfaces have been developed to ensure the quality of products, most notably government-mandated tracking of meat in Japan [41] and NGO-sponsored analysis of toxics in consumer electronics [23, 39]. All of these efforts are being aided by the principles of the open-source community, who depend on transparency and shared platforms to foster collective projects to resolve social needs.

The practice of product design is being transformed by these innovations, enabling a new engagement with the public, local and personal issues around industrial production. *Public Design* introduces the newfound capacity of individual designers to develop a global identity, engage in complex issues such as ethics and environmental sustainability, and collaborate across geographic and cultural boundaries of projects. *Local Design* proposes tools for design and manufacture at the scale of individual communities, fostering sustainable, empowering and appropriate products. *Personal Design* offers human-scale technologies transforming the longstanding relationships between our bodies and the world.

Future Craft seeks to apply these emerging tools and processes to the teaching of product design in order to intervene directly in the conception of new objects to strive for social and environmental sustainability. We present the course through a series of themes, interspersed with useful resources and student projects to illustrate the issues and solutions arising from t his methodology. We also cite innovative ethnographic techniques relevant to informing the design of physical-digital devices.

Public Design

The globalization of industrial production isolates consumers from designers and manufacturers, and encourages complex, closed products and resource-intensive and opaque manufacturing practices. Recently society has grown more concerned with the severe consequences of unchecked industrial production, including pollution, resource consumption, toxic products, and unethical practices. Today, companies seeking to differentiate themselves are engaging in public transparency, often through blogs and other on-line services [1]. Novel web services have sprung up to highlight ethical or environmental practices by tracking and publishing their manufacturing practices [10,7]. Web-based publication and software enables designers to engage directly with consumers and producers, while providing an invaluable marketing tool. *Public Design* describes the benefits when product designers create a public identity to become informed, to interact with the marketplace and to offer novel and improved products.

Theme I. Public Design: Transparency and Collective Intelligence in Design

Readings:
Episodes of Collective Invention by Peter Meyer [33]

Assignments:
-Online Identity: start a blog and learn to embed video, audio and other media
-Open Design: use and improve on an open craft project
-Product Autopsy: use the web to research how where and why a product was made (see fig. 1)

Increasingly designers from around the world are using the internet as a portal to make themselves known, to share ideas and to do business. Blogs and social networks make it possible to become known world-wide for individual projects and to develop relationships with other professionals. Proficiency in on-line publishing, especially blogs, video- and photo-sharing websites is becoming necessary for any designer to exist in the modern design world. More than a webpage, today's social networks are evolving, serendipitous virtual places for people to connect, learn and produce. Once a designer is engaged with the blogosphere, a number of resources become available to enrich research, collaboration and novel means of production and distribution. For these reasons the entire course was taught using a multi-user blog where each student could maintain their own presence within the structure of the syllabus (futurecraft.org).

'Green' and 'ethical' products are highly desirable today, yet few design schools teach how to make them. On-line services can fill the gap by making available vast resources about global ethical and environmental concerns that were once unknowable. Problems with corporate ethics and pollution are being published on-line by NGOs [23, 39, 40, 13]. Governments and universities are providing resources for individual designers to conduct environmental impact analyses [44, 6], while new on-line portals guide consumers toward sustainable materials and products [12]. Designers can study the impact of their decisions and publish them alongside their designs to imbue their products with significance.

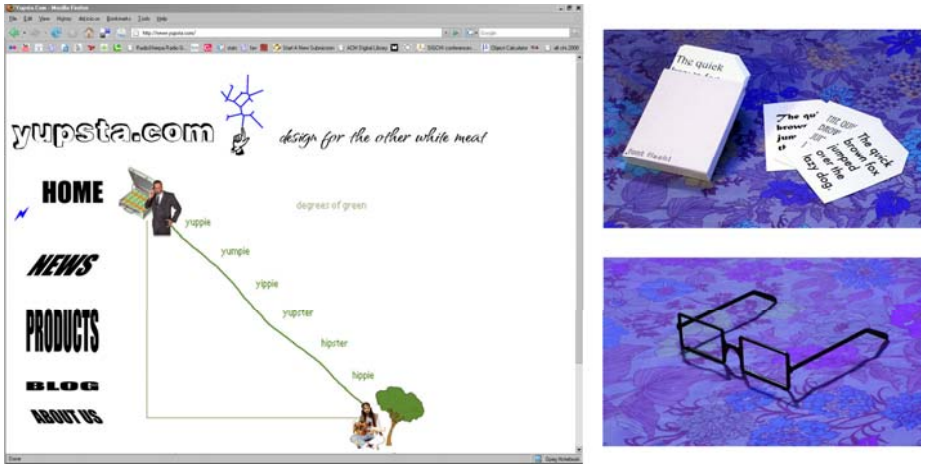

Figure 2. One student's online identity targets the blog community: he carefully selects a market (yupsters: between yuppies and hipsters) and proposes products that could satisfy them (font flash cards, 16:9 glasses), whether or not they are produced.

Transparent business practice stand in opposition to the closed tradition of intellectual property. But many types of products can be better made through open sharing of the design process. Inspired by the 'open source' or 'free' software community, *Open Design* projects use web-based platforms to aggregate the ideas and tools of product design to collectively produce objects outside traditional commercial means [42] These efforts have not been as successful as the free software movement, in part because designers are still not used to presenting their work on-line. One promising new direction is the advent of popular 'do-it-yourself' websites and social networks, whereby designers, hackers and tinkerers can learn to make products themselves and develop an on-line identity through the instructions they post on-line [27]. One successful open design site uses a hybrid of a DIY and open-source model to engage a motivated community in inventing and fabricating low-cost prosthetics [35].

Instead of mass-producing generic objects to somewhat satisfy a lot of people, internet distribution enables designers to target custom-designed products to communities and individuals. Following the 'long tail' model of internet music distribution, where many unique musicians can find their small audiences, on-line sales services allow on-demand manufacturing of small batches of products [37, 30] and direct-to-consumer sale of craft items [14]. These types of sale promote individualized design, including fitted products and functions that more closely match the desires of a group of people. In turn they can have the benefit of promoting local manufacture, avoiding inventory, overhead and overseas manufacturing.

One consequence of product design through a public identity is that designers can achieve notoriety for conceptual products whereupon they can choose

Theme II. Local Design: Engaging in the Empowerment of Local Groups

Readings:
- Tools for Conviviality by Ivan Illich [26]
- FAB by Neil Gershenfeld [21]
- Cradle to Cradle by McDonough, Braungart [32]

Assignments:
- -De-Technologize: simplify a product
- -Invent a Material
- -Design for up-cycling

whether to make a physical or cultural contribution. A number of artistic and research projects have become famous through blogs and viral videos, leaving their inventors to choose whether to mass-produce them or publish them in the press. By obtaining hype before going into production, considerable material waste can be eliminated. One Future Craft student created a web persona to his designs to gain internet fame rather than to sell products. He identified a niche (yupsters - between hipsters and yuppies) and came up with a series of conceptual products that are clever enough to be blogged about, but not significant enough to merit actual production (see fig. 2).

On-line services offer new production models whereby products may not need to be designed for disposal and obsolescence. A number of sites have sprung up to encourage re-use and up-cycling, where products gain value after use [18,17]. New services even allow products such as cars to be shared through on-line reservations, foregoing the need to own and promoting durable, re-usable product design. Engaging in new systems of production, distribution, ownership and re-use allows designers to promote truly sustainable products by shifting the dominant models and cultural practices.

Local Design

Design and manufacturing have become concentrated in opposite parts of the world; perhaps as a result mass production under-serves many local communities by favoring high-tech, disposable products and exotic materials. This section considers how the needs and resources of local communities can be addressed by new techniques in design and fabrication. *Mass Customization* opens the door to products designed to suit individual needs as well as a return to a local economy of expert craft. *Mass Craft* offers ways to re-think manufacturing so that high-tech products can be made with low-tech means. *De-Technologizing* is a process of selecting materials technologies that are appropriate to users and local resources. *Up-cycling* considers how materials and products can gain value when they are designed for local re-use. And *Personal Fabrication* combines all of these technologies into a micro-factory that can be installed far from global manufacturing centers.

Three-dimensional scanning and rapid prototyping machines are making it easier to tailor products to individual consumers and under-served communities. Recent initiatives have sought to strengthen community cobblers in Italy by providing laser-scanners in shoe stores and using computer-controlled machines to prepare personalized shoe lasts around which unique shoes can be formed [4]. Hearing aids are made to fit individual ears by a similar method of scanning and 3d printing [19]. Mass customization can literally address the needs of a single consumer, while elevating the producer to the level of skilled craft.

Along with manufacturing, many of the techniques whereby products are made today have moved to a handful of industrial centers. As a result many products today cannot be made outside of the most modern factories. Recent developments in electronics and HCI have focused on simplifying and making universal the means by which we assemble our electronics. Some researchers have discovered way to weave electronics from special cloth instead of using traditional fiberglass and solder [28]. One wheelchair designer has used the internet to distribute plans for an improved wheelchair,

including directions for manufacturing it in any part of the world [45].

The blanket application of digital solutions to product design problems favors complexity, and is based on faster, smaller and more expensive microprocessors. The increasing sophistication of even simple products makes them more likely to be thrown away than repaired. The commodity materials of modern manufacturing are often synthetic, with little hope for local repair or efficient re-use or recycling.

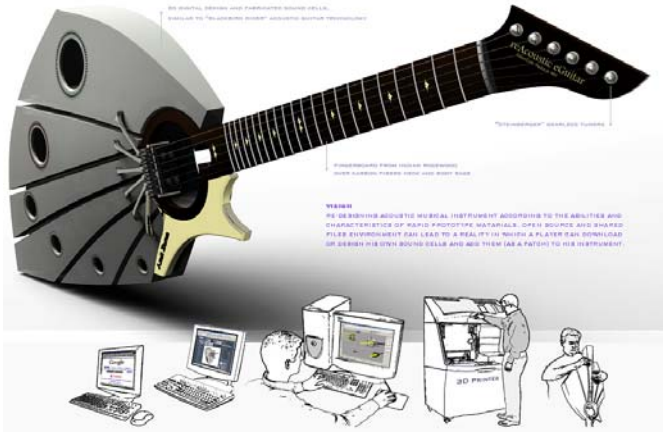

Figure 3. Mass Customization and De-Technologizing: one student sought to make unique-sounding acoustic guitars that could give each musician the ability to design their own sound through custom acoustic chambers joined on a single neck.

De-Technologizing considers how little technology is necessary in a product, including the replacement of active components with innovative form and material design. By simply eliminating many of the parts of a conventional product far more sustainable practices can be established. One researcher has developed a solar-powered printer that does not consume ink in an effort to eliminate consumables from these wasteful devices [15]. A famous combination solar-powered and hand-cranked radio was developed to provide rural residents of Sub-Saharan Africa to be informed about health and safety. One student proposed a voltmeter consisting of a magnetic fluid in a vial, able to indicate current when it moves in response to the magnetic field emitted by the circuit.

Because many products are designed to be disposable, localities distant from production centers must rely on constant importation. *Up-cycling* is a process whereby products can gain multiple functions after the original one is complete, usually through the addition of labor. One famous example is a beer bottle which was made rectangular so that, after use, it could be used as a brick in construction [36]. Design for up-cycling requires careful consideration of local needs and resources so that products live out their intended second lives instead of being thrown away.

Personal Fabrication Laboratories (Fab Labs) are a combination of mass customization and mass craft which can empower communities to design and build their own devices, regardless of complexity, in a local shop with widely available materials [21]. Some rapid prototyping machines can now repair themselves, so that a remote shop can keep itself working without depending on foreign parts [38]. Advances in these

techniques could lead to simpler, less toxic electronic products as well.

One student explored the topic of Local Design by questioning the electric evolution of guitars. He pointed out that electric guitars can only evolve through more sophisticated hardware and software, but that acoustic guitars offer rich opportunities for new sounds through simple physical manipulation. He proposed a system for making custom acoustic guitars by conjoining different, custom-designed resonance chambers on a common bridge (see fig. 3). Musicians could create their own instruments by mixing and matching resonant chambers from an on-line, shared repository. As a result, the materials and sounds can respond not only to the craft and materials but also the cultures of individual places.

Personal Design

Human-centered design has emerged as one of the tenets of contemporary design, and decades of studies in ergonomics have taught designers to revere the form and abilities of the body as the standard for analysis in interaction [43]. Yet our notion of the body is changing. New technologies are allowing our bodies to become enhanced, augmented, expanded in functionality and altered in form. This section considers how the changing concept of the body, and our associated identities, alters how and what we strive to design for ourselves and the nature of digital products made to be worn and used by the body.

Fashion designers have long addressed the notion that what we wear and carry projects an image of our identities. Yet much of the state of the art in 'wearable' technologies, such as the MIThril [9], focuses primarily on innovation in technologies for computation, sensing and networking but appears to disregard the cultural associations and reflection on image of a cyborg aesthetic. Ubiquitous & embedded technologies are allowing our devices to become more and more a part of us with increasing mobility and pervasiveness. In the space of digital device design, the line between body, clothing and object is blurring. The question is arising of what is human, where the body ends and a device begins. In the case of implants or prosthetics, the boundary between assistive technologies and aesthetic statements is blurring.

Figure 4. One student with a chronic sports injury created a garment for body awareness - a sweater, stitched with a pattern offering directions for folding into a back support device. Embedded vibrating motors occasionally remind the user to move and reorient his posture.

Prosthetics which can be seen as fashion accessories such as the many legs of model and athlete Aimee Mullins [34], designed in a range of aesthetic and functionality similar to a wardrobe of shoes, or prosthetics can be designed to allow the human body

Theme III. Personal Design: Engaging the Individual Physically and Emotionally

Skills:
-wearable design
-new ergonomics

Readings:
Crantz, Galen. The Chair: Rethinking Culture, Body, and Design [8]
Holt, Steven & Skov, Maria. Blobjects and Beyond: The New Fluidity in Design [25]

Assignments:
- Create an object which is custom tailored to an individual
- Design a device that transforms the relationship between the body and the world

greater capabilities, superhuman, such as Hugh Herr's rock climbing legs [24]. In addition, wearable technologies formerly seen as medical or therapeutic, can converge with fashion, such as in the project TapTap, or in the class project Body-Awareness Device, a fashionable sweater which doubled as a therapeutic and posture awareness prop designed by a student with a chronic sports injury (see fig. 4).

Wearable technologies also have the power to create and manipulate our cultural relationships with each other and the outside world. A Future Craft class project, Political Prosthesis, commented on the gesture of the handshake, one that is commonplace in many cultures, but intimate in others. The sleeve of a business shirt was retrofit with a cuff woven in a method creating a 'Chinese finger trap' for two people engaging in a handshake (see fig. 5). The project documentation suggested how the appearance of a device could evoke an unspoken attitude toward the gesture of the handshake and notions of personals space and cultural custom. Another Future Craft project, Connection Coats (see fig 6), addresses issues of social isolation with sets of coats that zip together in unexpected ways, to allow users to hold hands in wintery climates or have private face to face intimacy in a public setting. The set for a mother and child first fits a pregnant woman, then zips off to hold the baby as in a sling and finally transforms to a hand to hand connection, reflecting equally on the changing social as well as physical relationships between the two.

Figure 5. The Political Prosthesis was created as a commentary on the gesture of the handshake, commonplace in many cultures but intimate in some. The sleeve of a business shirt was retrofit with a cuff woven in a method creating a 'Chinese finger trap' for two people engaging in a handshake.

In the design of interactive objects, the layered multifunctionalism of many devices is removing the ability to prescribe a particular ergonomic form appropriate for the device's usage. A device that functions as a camera, a phone and a PDA offers three unique relationships to the body in terms of physical usability. In many cases such a device takes the lowest common denominator form, a rectangular box.

Designers must question the usability cost of multi-functionality, as suggested by Buxton [5], and apply new technological ideas, in areas such as context-awareness or physical transformability, which offer solutions to aid ease of use, engaging technology in the spirit of universal design.

Figure 6 Connection Coats featured a series of jackets designed to zip together in unexpected ways creating situations for intimacy in public environments

Product Ethnographies

When exploring the three themes, the question remains of how designers evaluate and critique the products they are creating. Traditional product design often preaches the value of 'need' based design, positioning products as answers to desires designated by the end user, with the assumption that user observation becomes an integral part of the process of design. While this remains useful in its convention, the advent of new media technologies are changing what and how products can be produced, stimulating previously undemonstrated needs and desires.

Within the HCI community, several innovative methodologies are emerging to address untapped techniques for inquiry. The idea of 'cultural probes' [20] provides a way to access environments that are difficult to observe directly and capture the essence of a situation, the results of which provide designers data to be interpreted in open-ended analysis, as much for information as inspiration. Transfer scenarios [29] , presented at CHI 2007, is a way of grounding innovation in marginal practices, using outliers of the norm as keys for how to incorporate new technologies into our lives in appropriate and desirable ways. Innovative studies, such as Forlizzi's work on the social nature of robotic products in the home, provide designers clues as to the unintended outcomes of products' functionalities [16]. Ethnographic studies can also be used as a tool to reflect back on the state of design itself. In the Future Craft course, one student trained in glass blowing conducted a study designed to examine the nature of hand-crafted objects in contrast to industrial production in his discipline. He was questioning the importance of an artistic original, he produced a video which documented turning himself into a glass blowing machine for a day and attempting to sell his objects outside of Crate and Barrel. As part of the design practice, Future Craft posits that product designers need to be their own ethnographers, continuously evolving and appropriating methods of evaluation for their discipline, both as tools in the design process as well as reflect back on objects made.

Figure 7 A series of laptops designed as cultural commentaries provide different types of survival kits for contemporary life

In addition, emerging trends such as 'critical design' [11] are demonstrating that there is a category of products which can be created to illuminate a cultural or societal idea, engaging the power of a product concept as a talking point of critique. These products allow designers to communicate to the world through objects, a language which they are most familiar. Critical design allows for the creation of products whose functionality rests in their provocation-- how new technologies can be misused or re-appropriated, future thinking on technologies which are proposed but not yet realized, or simply as a reflective tool on our relationship with technology products. One student in the future craft course designed a series of laptops as commentaries (see fig. 7). When opened, instead of finding a keyboard and trackpad, each provided a set of tools for a specific situation, such as in one, a fishing line complete to sushi making supplies, a statement on the laptop as survival kit in today's world.

Conclusion

Future Craft is a curriculum that explores the wide-ranging effects of digital media on the kinds of products that we make as a society, in the hope of addressing and resolving many of the worsening problems surrounding industrial production. Novel technologies and interactions make possible a wide range of improvements toward social and environmental sustainability. At the same time the questions of product design need to be addressed by the interaction and engineering communities so that innovations are targeted to improving the health of global and local communities and individuals. Our experience teaching this class suggests that the types of products we design can benefit from a continued dialogue between the domains of HCI and product design.

Acknowledgements

We would like to thank students of the Future Craft course and members of the Tangible Media Group at the MIT Media Lab

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