Disruptive UX for Sustainability

Radically Resolving User Needs Is Good for Business and Environment

Tao Huang[✉]

Southern Illinois University at Carbondale, Carbondale, USA
`thuang@siu.edu`

Abstract. The paper provides a brief discussion of the basic concepts of sustainability, disruptive innovation, systems thinking theory, and design for behavior change literature. It analyzes several business and design cases closely related to UX and HCI that demonstrated various degrees of success in changing user behaviors to improve the quality of our environment and strengthen communities in the following aspects: reducing pollution from fossil fuel based transportation; reducing waste; providing meaningful and gainful employment; and raising awareness, etc. The paper argues that UX/HCI, being the bridge between hardware and software, is fundamental in ensuring the success of any sustainability initiatives. The paper contemplates the cultural shift of material to immaterial by sharing economy in the internet age, which is one of the promising ways to help our society move towards sustainability. The paper also identifies certain challenges and room for improvement in user experience research and design for sustainability. In the end, this paper suggests four directions for radically rethinking user experience and human/computer interaction design for sustainability.

Keywords: User experience design · Systems thinking · Sustainability · Disruptive innovation · Sustainable design · Design for behavior change

1 Introduction

Technology has disrupted many sectors of the business world and in some cases, directly or indirectly made those new forms of businesses good for the environment. This paper presents the concept of "Disruptive UX for Sustainability", an approach in user experience research and design that radically rethinks the paradigms of business with the main focus of making people consume less and recycle more, business pollute less and profit more from new revenue. It goes beyond the usual function of user experience design and research: UX is not only necessary for adding value to any business, but it can also change the landscape by creating new business opportunities that can satisfy the triple bottom lines of sustainability: good for the economy, our society and the environment.

Though in the past two decades, the term "user experience design" (UXD or XD) has been more closely associated with the field of human-computer interaction design,

designers in all fields have been defining and resolving user experience issues for years. For instance, industrial designers must make three dimensional objects more usable for a better user experience. Thus, the study of human factors and ergonomics is a well-established field. As early as 1955, one of the founders of the Industrial Designers Society of America, Henry Dreyfuss, called for industrial designers' attention to anthropometric research and its important role in design [1]. Since then, design considerations of the physical measurements of human bodies have been expanded into cognitive ergonomics and organizational ergonomics [2].

As information technology permeates our daily lives, the research and advancement of UX has real world consequences beyond its usual two dimensional confinement. Generations of thinkers and designers have led the design community towards recognizing the environmental impacts of mass manufacturing. In the age of Industry 4.0, more and more products and services exist in both the physical and digital realms [3]. User experience design is inseparable from all the other design fields and it needs to be concerned of both the physical and cognitive limitations of humans.

In this paper, I propose to use systems thinking to examine how to design for behavior change to build a more sustainable future. There are four directions of rethinking: breaking the path dependency by disruptive innovation, automation to remove barrier, creating platforms to connect people and business, and visualizing information to change perceptions. I focus on business and design examples and possibilities in developed countries, as there is a more urgent need for these countries to adjust their life styles and consumer behavior to ensure a sustainable future for all mankind.

2   Sustainability by Design

The modern concept of sustainability emerged in the environmental movements in the 1960s and the term *sustainability* was adopted by The World Commission on Environment and Development in 1987. The Commission's report defines *sustainable development* as development that meets the needs of the current generation without compromising the ability of future generations to meet their needs [4].

One of the earliest advocates for sustainable design was Victor Papanek [5, 6]. In his ground-breaking books, he wrote that "there are few professions more harmful than industrial design…but only a very few of them… In this age of mass production when everything must be planned and designed, design has become the most powerful tool with which man shapes his tools and environments (and, by extension, society and himself). This demands high social and moral responsibility from the designer. It also demands greater understanding of the people by those who practice design and more insight into the design process by the public… Design must become an innovative, highly creative, cross-disciplinary tool responsive to the needs of [humankind]. It must be more research oriented, and we must stop defiling the earth itself with poorly designed objects and structures…."

Since Papanek, the design community by and large has gradually embraced the concept of sustainable design. There are many tools that can help designers conduct life cycle analysis such as the cloud-based software Sustainable Minds. CAD software

giants such as Autodesk also invest heavily in sustainability solutions such as Auto-CASE (triple bottom line analysis) and Rapid Energy Modeling for buildings. Autodesk also launched a "design-led revolution" for sustainability [7] where they claim "This is the era of design, where human intention, empowered by technology, is re-shaping everything."

In the field of HCI, Eli Blevis is another advocate for sustainable design. In one of his papers, Blevis coined the term Sustainable Interaction Design (SID) [8], stating that "sustainability can and should be a central focus of interaction design." This means that HCI should be more than helping to sustain the current "invent and disposal" model in technology. It needs to encourage more sustainable behavior ("renewal and reuse") [9, 10].

Therefore, the key question we should ask in the field of UXD or HCI, is not that what technology can achieve, but how to apply our arsenal of new tools to change human behavior. Rather than letting business or technology drive the direction of innovation, we must frame and define our problems based on human needs.

3   Disruptive Innovation

Politicians and advocates for sustainability such as Al Gore and David Blood [11] call for a more responsible form of capitalism for a sustainable future (sustainable capitalism), while some sees sustainable capitalism as an oxymoron [12]. While this paper does not intend to expand on that debate and discuss a structural change of the current economic system, it makes the assumption that user experience design must operate within the current economic system where sustainability initiatives are often resisted by the established market.

This led us to the concept of "disruptive innovation". Since Joseph Bower and Clayton Christensen coined the term "disruptive innovation" in 1995 [13], the term has become widely used in describing technological innovations that change the existing market and create new markets. Some disruptive innovations unexpectedly but eventually take over the existing market, such as in the case of Wikipedia (replacing traditional encyclopedia).

Many believe that disruptive innovation is the key to transform the current system and achieve the sustainability goal at a large scale [14]. Especially for the under-served population around the world, this bottom-up approach might create new markets and completely bypass the current unsustainable system. Mosaic, a company established in California in 2012, is a recent example for a startup business with sustainability in mind. As a crowdfunding platform, it connects investors with home owners who need funds to install solar plants. Residential solar installers can also access their finance products. Being such a young company, and with the recent plummeting global oil price having a detrimental effect on the development of clean energy industries, Mosaic's success remains yet to be seen. Nonetheless, Mosaic aims to disrupt the loan market controlled by banks for the sake of sustainability.

Despite the large amount of literature written about disruptive innovation over the years, there is no magical formula that can turn out disruptive ideas or make these ideas

applicable to all businesses or markets. Some scholars also warned that disruptive innovation is "a double-edge sword" because replacing the old system might be expensive and might generate tremendous waste [15]. It might also cause social instability (as in the case of Uber's conflict with the traditional taxi industry).

4   Immateriality of User Experience Design

4.1   Material Reality of Technology

Compared to other forms of design such as industrial design and interior design, user experience design seems to generate fewer physical forms, but is nonetheless supported by a heavily material base [12]. It is important to remember that user experience design creates artifacts (interfaces) and they are sustained by hardware. While the experience might be immaterial or even invisible, it is not detached from the physical reality and has physical consequences. Therefore, there is a design opportunity to modify the user experience to impact the physical world beyond the hardware that hosts it.

4.2   Cultural Shift from Material to Immaterial

Fueled by technology, the recent emergence of sharing economy is one of the most discussed topics in human computer interaction community as well as the ecological economy field because sharing economy is not only framed as an example of disruptive innovation, but also viewed by many as a path that might help the capitalist society to reduce consumption [16, 17]. Sharing economy takes many forms and could be viewed as a part of the overall cultural shift from material to immaterial.

To understand the systematic impact of the sharing economy, this paper will discuss two examples of digital platforms that provide services for sharing items, Uber and Divvy. Unlike its car-sharing predecessors such as ZipCar and Car2Go, Uber, one of the most recognizable, highly valued, and controversial startups in the world, does not own any cars. It encourages the peer to peer sharing of transportation resources, therefore indirectly reduces the desires or needs to own cars individually. It also, arguably, provides gainful employment for the under-employed urban dwellers.

Similar to European companies such as Vélib' in France, Divvy is a business of rental bicycles in a large city (Chicago). It was launched in June 2013 by the Chicago Department of Transportation and operated by Motivate. On Divvy's website, the company shares with the public the data of its operation, including trip start day and time, trip end day and time, trip start station, trip end station, rider type (Member or 24-H Pass User) and members' gender, etc. Since the beginning of their data collection (June, 27, 2013), 759,788 trips were logged in 2013 [18], 2,454,634 trips were logged in 2014 [19, 20], and 2,621,494 trips in 2015 [21], which shows a growing acceptance to the bike sharing system. A larger study analyzing this data with other variables, such as gender, age and most heavily used stations, should yield further insightful results, which is beyond the scope of this paper. Rental bike business like this reduces urban pollution and traffic jams. It encourages exercises and thus helps improve public health.

Another recent noteworthy example for sharing economy is Generation Tux. George Zimmer, the founder of Men's Wearhouse, has launched this new venture at Dreamforce in September 2015. He also launched another business called zTailor, trying to bring the century old business into the startup scene.

These new startups are successful not because they have provided new solutions to common human needs, but because they provide a smooth, easy, and affordable experience to fulfill these needs by connecting people via technology.

Furthermore, sharing economy has social implications as Ezio Manzini has pointed out that designing for sharing could make connections more visible [22, 23]. This might help address the social aspect of sustainability beyond the environmental and economic impact.

5   Radically Redesign the System

5.1   Systematic Changes to Break Path Dependency

Causes and effects in any human society is so complex that to claim that anyone can replicate others' disruptive innovations is naïve. However, it is important that we have an understanding for the long term impacts of design on a system. General systems thinking is a holistic approach to the solution of complex problems such as sustainability [24].

The best example to illustrate a key characteristic of a system, path dependency [25, 26], is the design of computer keyboard. Based on the QWERTY layout of typewriters invented in the late 19th century, the technical issues resulted in this layout has no relevance to the modern design any more. Millions of people spent millions of hours learning to type on this layout. Inefficient? Probably. But because the layout has been a standard for typewriters for over a century, it is impossible to break this path dependency. Even the keyboards on our smart mobile devices follow the same design. The solution, is not to design a new layout of the computer keyboard, but to radically rethink the design of Input/Output device. Virtual reality devices such as Oculus Rift presents such opportunity.

Indeed, disruptive innovation should create new paths, instead of trying to break the old path dependency. Since the early dawn of graphic interface design, there has been the notion that the virtual appearance must match the physical reality so our users can navigate in the digital environment. Though Apple's iOS 7 (launched in 2013) and beyond practically announced "the death of skeuomorphism" in design, references to the physical world in the digital environment will and should never go away entirely. But the future of user experience design depends on the majority of technology users develop the cognitive understanding of a digital interface, supported by the touch screens or motion capture devices or whatever new technology. I have seen young children try to swipe the information boards erected in a Nashville zoo, pretending they were interacting with these static objects like they would with smart phones and tablets. These "digital natives" as Sir Ken Robinson called them [27], will increasingly blur the lines between digital and physical worlds. Their reality might always be "augmented reality".

5.2   Automate Behavior Changes

There is a common notion in UXD that good user experience should be intuitive and unobtrusive [28–31]. I propose that designing an optimal user experience for sustainability might mean designing away the interactions entirely. So the "disruptive innovation" does not disrupt the users.

Because wasteful behavior are most likely created by habits (under cultural influences), not by intention [32]. However, changing these behavior takes conscious efforts. Design can change these behavior by automation, making changes much easier to perform, instead of demanding for additional efforts that always makes changing our lifestyle for a more sustainable future feels like a lot of work. Whatever devices or software it may be, it should give the users the cue to call for changes, eliminate the obstacles to accomplish the changes, and provide satisfying feedback to encourage the users to stay on track [33]. Indeed, automatic energy and resource saving devices have been in use for decades, such as faucets and toilets equipped with infrared sensors or simple mechanical timers. Passive house movement also has been around since the late 1980s. The challenge for user experience designers is to identify the behavior that could be automated and fit that automation seamlessly into users' everyday routines.

It is also worth mentioning that this invisibility of technology might backfire in some user scenarios, therefore it is important to still offer the option for user controls [34]. In Kara Pernice's article about her experience with Nest [35], she states several of the energy-saving automatic device's flaws, including the difficulty to adjust the routine schedule. While the design of the device is praised by many, its experience leaves some users unsatisfied. In addition, privacy is also a major concern in the age of ubiquitous computing.

5.3   Platform Generation

Many examples of disruptive innovations are about creating platforms to connect people and business, such as the aforementioned Mosaic. What user experience design can achieve, is to ensure a platform created for sustainability is easily accessible and usable. The business and design opportunities often lie in the connections that are previously overlooked.

For example, one of the main problems faced by the electronic car producers, is trying to build a large public charging network to satisfy users' charging need. From the user experience point of view, electrical car owners have the most difficulty charging their cars on longer road trips, away from their home or office charging base. This routine often coincides with the need to find lodging. Therefore, it makes sense to involve hotels in the building of these charging station networks. Star Charge [36], a company based in Changzhou China, established a crowdsourcing platform to allow businesses (such as parking lots and hotels) to provide spaces to install charging stations as a form of partnership. As partners, these businesses share the profits of the charging service, while also earning the additional benefit to their main business. The company has the goal of establishing 10,000 charging stations for electric cars all over Mainland China in the first two quarters of 2016.

5.4   Make Decisions and Outcomes Visible

Nicholas Makelburge states that "the global economy has taken us far from the real impact and consequences of our decision [37]". It is easy to fall under the illusion of the immateriality of technology if what it takes to support such an infrastructure is hidden from users. People are more willing to make behavior changes when they clearly see the outcomes of their decisions [38]. In this age of big data, visualizing data might have surprisingly effective impact on sustainability.

One of the leaders in the Home Energy Management (HEM) [39] market segment is Opower [33], which helps utility company reach their customers with more understandable bills and encourage them to be more energy efficient by comparing their energy usage with neighbors and their previous year's usage. By visualizing the previously hidden information (comparison among users), Opower claims that they are able to achieve up to 3 % energy savings. The noteworthy part of Opower's success is that its design philosophy is based on user centered design principles, focusing on "the touch points that matters the most".

Following the same line of thoughts, banks or financial management websites such as mint.com can easily add functions to allow user to generate a reliable and accurate carbon footprint report for a household from utility bills and credit card bills, instead of relying solely on self-reporting. Such reports can also include comparison with other users and suggest improvements. While no physical intervention is delivered in this process, the change of user perception will clearly benefit the users as well as the environment.

6   Conclusion

Sustainability is not radical, it is a mandate for our survival. It is also not anti-business or anti-prosperity [12]. Radically redesigning user experience for sustainability is not only about redesigning websites or software so that they will be more efficient to use, or redesigning technology-driven hardware so that they are more energy efficient, but is about to create the behavior changes that is desperately needed to promote sustainability in human society.

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