INTRODUCTION

Löwgren & Stolterman (2004, page no.12) stated that the ‘...designer needs to be critical toward any description of the design process and to appropriate aspects of it rather than adopt it completely’. Here, we advocate the appropriation of techniques in service of subversion, drawing across the disciplinary boundaries of Design, Human–Computer Interaction, and the Maker Movement, illustrated with three design examples. Our aim is to draw into focus the following three aspects of design: (i) looking to cultural artifacts for inspiration, (ii) fabrication approaches that emphasize repurposing and rearrangement of technologies, and (iii) critical reflection.

ABSTRACT

Subversion is a stance that questions, challenges, and transforms extant prevalent social dynamics, potentially mediated by interactive digital media. Here, we discuss this approach, drawing across disciplinary boundaries (Design, Human–Computer Interaction, and the Maker Movement), illustrated with three design examples. Our aim is to draw into focus the following three aspects of design: (i) looking to cultural artifacts for inspiration, (ii) fabrication approaches that emphasize repurposing and rearrangement of technologies, and (iii) critical reflection.

mechanisms such as technology clubs, social networks, free tutorials, and support forums that provide practical information on how to develop and utilize technology. Thus, hacking is as much about praxis as it is about community. This emphasis on community is also present in the closely related, Maker Movement, which advocates the reuse of information and techniques, and the sharing of ideas. The term ‘Maker Movement’ loosely refers to the proliferation of individuals who use both novel (e.g., 3D printing) and traditional (e.g., glassblowing) manufacturing methods to subvert the mass production factory model, and engage directly with every stage of the creation of their customized small batch designs. This movement has been greatly empowered, if not made entirely possible, by a democratization of manufacturing brought about by recent technological advances. Makers encourage users to become creators themselves and question and rearrange existing designs as they see fit (Anderson, 2012). The Maker Movement has afforded prominence and accessibility to hands-on crafting and manufacturing techniques for the actualization of DIY designs. New technologies such as open-source hardware (Davidson, 2004; Igoe, 2011), and 3D printing have been instrumental to the success of making digital objects (Anderson, 2012).

Another aspect of the Maker Movement is how it draws into focus the role of those individuals engaged in creation and small-scale fabrication. Prior debate focused on the roles (in complement or in tension) between ‘design’ as conducted by those with different types of training: those from a Design background (e.g., receiving training from a Design school, typically but not exclusively drawing upon an Art or Architecture context) as opposed to those from a Human–Computer Interaction background (e.g., receiving training in Social Psychology, Cognitive Science, and/or Computer Science). For instance, see Don Norman’s essay ‘Why Design Education Must Change’ (2012). For the sake of brevity, we will not address the issue here except to point out that the role of those in DIY maker spaces is increasingly recognized as one of a serious practitioner, with features of critical engagement and novel, open innovation (as opposed to merely amateur expertise) (Lindtner et al., 2014). And of course there is the flourishing brand of ‘Design Thinking’, as colonized in business schools. The issue of nomenclature for roles in the design process — to wit, who counts as a ‘Designer’ — is likely intractable and irrevocably bound up in issues of professionalization and credentialing. Regardless of label, we feel that those engaged in activities that can be broadly considered design should realize and take up the potential role as powerful social actors that can question and influence social values through their designs. We recognize, as practitioners of research-creation in an academic research lab, that there is a particular impetus to do so. The context of academic practice affords particularly unique opportunities for social activism via the process of design research-creation. Aspects of this context include a different set of process objectives and goals, resourcing via institutional support, and research agency funding (the adjudication of which is quite different from those operating in a business context), the mode of dissemination via peer-review, and the opportunities for deployment via knowledge mobilization and technology transfer.

The Critical Stance

Over the last decade, stances that are rooted in critical theory have increasingly been applied to the design processes and outcomes in HCI. The stance advocates increasing awareness and critical reflection on the hidden assumptions, ideologies, and values underlying technology design, and might be seen as the HCI complement to Critical Design (Dunne, 1999; Raby, 2001). For instance, Löwgren and Stolterman (2004) advocated, through the Thoughtful Interaction Design approach, a stance that not only focuses on technology but also on the context of use, foregrounding the key observation that interaction designers are in the business of affording dynamic processes of interaction (rather than static objects). In their approach, they promote thoughtful and reflective processes that allow the designer to be responsible for the functional qualities of the design product, alongside its other qualities, such as ethical and aesthetic. Another related stance, Reflective Design, recognizes the importance of reflecting on the unconscious values embedded in computing and the practices it supports (Sengers, 2005). This method encourages all stakeholders, designers and users, to use reflection and participate in the critical design and use of digital artifacts. Both of these stances identify the role of the designers of digital technologies as potential shapers of social behavior through these technologies, and thus should bring social awareness to the process. To this end, designers are social and cultural activists, who, through creating designs that question authority, raise awareness and provide alternative points of view. Thus, designers should exercise reflection and ask questions examining different aspects of their design at every stage (Löwgren & Stolterman, 2004; Sengers, 2005).

The activity of critical reflection requires engaged knowledge about the users of the design and the context in which it is going to be used, which can arise from a number of sources. Certainly there is the designer’s own experience. This approach is a common feature in the Maker and Hacker communities in which, oftentimes, designers are motivated to improve or replace an inadequate design arising from first-hand experience. Direct engagement of the interaction designer with their designs can reveal issues that are difficult to detect using other inquiry techniques (Johanasson & Linde, 2005). Reflection on this mode of direct engagement with interaction and design is now increasingly undertaken (Treadaway, 2007; Efimova, 2009). The widespread adoption of user-centered design (UCD) approaches reveals the utility of frequent and longitudinal occasions for user observation and engagement for, among other reasons, access to information. In our cross-cultural design work, we have also employed the approach of using Human Access Points (HAPs) (Marsden et al., 2008). A HAP, originally developed in the context of deploying ICT in developing countries, refers to a local ‘guide’ who is a collaborator in the development of culturally-relevant technological solutions for a specific community.
**FROM RESEARCH TO PRACTICE**

**Synchrum**

**Project:** How might the boundaries between the social roles of performer and audience member be blurred? How might members of an audience be afforded new opportunities to engage with each other and in a performance?

**Discovery:** While travelling in China and India, we became aware of a fascinating cultural object known as the Tibetan prayer wheel. This object (shown in Figure 1, inset) consists of a rotating cylinder, mounted on top of a handle and exists in many sizes. A written prayer is placed inside the chamber and it is traditionally believed that each rotation of the chamber corresponds to a recitation of the prayer. The object affords a special kind of ‘movability’, namely the possibility to produce a circular movement with an object that has a centrifugal force acting upon it. This movement can be experienced as a graceful and meditative repetitive action. The use of the prayer wheel translates an act of faith and intention into a performative action. When undertaken in public, the prayer wheel creates a moment and space for potential inspiration and reaffirmation for both the actor and the observers.

**Development & Fabrication:** Synchrum (shown in Figure 1) is a tangible interface for audience participation in digital performances (Hamidi et al., 2012) inspired by the described characteristics. We employed Maker methods to develop the first prototype and repurposed existing kitchen objects, such as an empty yogurt container for the object chassis, a wooden and metal potato masher for a handle, and a furniture castor with a roller bearing mechanism to provide the experience of a circular and centrifugal force. Small focus group discussions revealed that the roller-bearing castor afforded a graceful and meditative repetitive action, similar to the prayer wheel. For the second iteration of the prototype, we added a more rigid housing, sensors, a microcontroller, and a wireless communication chip. The electronic components, together, served to detect the rotational speed of the user’s circular movements and to transmit a data stream to a central unit, which would assess emergent states among the various Synchrum units (e.g., the degree to which the rotations were synchronized, the distribution of rotational patterns among the units). The central control unit was designed to allow the definition of triggers — a linking of performance output behaviors (e.g., digital audio and video) to certain collective and emergent behaviors among the Synchrum units (e.g., a change of state once a certain degree of synchronization has been achieved). Through this, the performance designer can specify changes to take place in the performance (including performance environmental factors), based on the type of input received from the units. The module was designed to allow for the real-time (during performance) tweaking of trigger points. This design decision, along with several others, was informed from our engaged experience as performers and performance designers, and our knowledge of the diversity of audiences in live performances.

We fabricated several copies of the prototype and then arranged for a public performance within which it could be used. During the digital video-based, interactive performance, entitled ‘Liberation’, members of the audience engaged with each other and the performer using their movements. The performance was mounted at two showcase events. The interface was also demoed as an interface to a collaborative musical game for children.

![Figure 1. First prototype of Synchrum (left) and second prototype (right), with an example of a Tibetan prayer wheel (inset).](image)
Reflection:

Empowerment: We observed the use of Synchrum during the performances. The users became engaged with the performance and were observed to engage with the performer and to entrain to one another’s movements, confirming our conjecture about the importance of Synchrum’s performativity and physicality. Synchrum allowed a way for the audience members to shift their attention to one another, to interact with each other, in the context of the performance. Through this, Synchrum empowered the audience and afforded a process whereby the audience had a say in what happens on stage and in an augmented environment. The audience does not have to be silent, motionless, and passive but can participate and collaborate with each other and the performance.

Our Digital Tapestry

Project: How might a traditional form of collaborative poetry be instantiated using a digital platform, to bring together geographically distributed collaborators? Does Facebook provide a sufficient level of trust, as needed by participants to engage in poetry performance?

Discovery: Collaborative poetry is a style of poetry in which poets collaborate to write a poem together. The tradition of collaborative poetry has existed in many cultures from ancient times to today (Duhamel et al., 2007) (Keene, 1995). It is an art form in which, oftentimes, the artist is both audience and performer.

Development & Fabrication: We developed a project entitled Our Digital Tapestry to explore the ideas of collaborative poetry (Hamidi and Baljko, 2012). The work is intended to be a provocation. We decided to simply repurpose an extant social media platform, Facebook. We chose Facebook because of its already established popularity (hence, providing an existing group of artists in the first author’s friend community) and its ability to connect people over long distances. By simply redefining the status field of the profile, the page was turned into a virtual stage.

Again, our first-hand experience as performers and artists informed many decisions in the design of the project. For example, we knew that performing with others requires a strong sense of trust, and is encouraged by being aware and interacting with an audience. Hence, we decided to host the project on the first author’s Facebook homepage where only his friends and associates could view the artwork-in-progress. In order to address the factor of trust and vulnerability, we decided to restrict participation to only those who knew the first author first-hand and had became friends on the social network previously.

A longitudinal activity was designed wherein a Facebook page was ‘seeded’ with an opening segment and would be left open for four weeks. The opportunity was then given for collaborators to post subsequent segments, possibly responsive to the most immediate or earlier segments. The poem, thus, developed segment by segment, over time.

Reflection: Over four weeks, nineteen poets from five different countries contributed to a multilingual multimedia poem.

Repurposing: We felt that this project demonstrates the key idea of reuse. We refrained from unnecessarily developing new code and simply redeployed an existing technology in a novel application. In this case, technologically, nothing novel was created: no prototypes were made, nor were any codes written. The only novel element was a change in perspective and the reuse of an existing platform.

Empowerment: Previous research has shown that the lack of social and physical status cues can foster relationships that transcend offline social barriers (Wellman, 1996). Many of the collaborators expressed their preference for performing poetry online rather than in person and mentioned that they found this kind of mediated collaboration less intimidating. The project also, clearly, shows the potential of social networks to facilitate collaboration that transcends geographical and cultural barriers. Many of the poets were from the Middle East, where it is very difficult to have access to an international audience, let alone collaborators, and there are many social and political controls in place that can limit expression and performance opportunities. By bringing the artistic dialogue to a virtual space, the project was able to transcend authority and subvert existing hierarchies and boundaries.

Rafigh

Project: How can speech interventions be initiated and deployed in a more timely fashion? Once a speech intervention is indicated, how can it be deployed more effectively? How might highly repetitive and boring speech exercises be made more appealing for children?

Discovery: Clinical speech interventions can alleviate or even eliminate different speech disorders in children, but they ideally should be deployed early and intensively. There are a number of barriers, however, both in identifying when intervention should be deployed and in how the intervention is deployed. In terms of early deployment, delays often occur due to bottlenecks in the screening process. The process requires a high degree of clinical specialist involvement, by the Speech Language Pathologist (SLP), in one or more one-on-one sessions, during which natural speech from the child must be elicited. The elicitation of natural speech from small children in a clinical setting takes time and requires a relationship to be established with the child. In terms of how the intervention is deployed, barriers often arise because it can be challenging for a family to undertake the at-home exercises that are a component of an intense intervention. We undertook a number of interviews with SLPS, which revealed that many children, otherwise unmotivated to perform at-home exercises, are highly motivated to use their speech in the context of games in which tangible toys and video and audio prompts were used.

Development & Fabrication: We identified that the opportunity that a SLP could effectively perform screening using recorded speech samples, provided the samples were elicited
appropriately. We also identified the opportunity to develop digital interactive toys and games to support at-home speech therapy exercises. Whereas previous attempts at this have failed due to shortcomings in speech recognizer technologies, our insight was that the inducement and feedback components of the engagement could be abstracted away from each other. We decided to focus our development efforts on a digital toy that would simply engage a child’s speech (rather than try to analyze it and provide feedback). It would simply record speech samples, to be reviewed by an SLP at a subsequent opportunity. We called the toy Rafigh (the word for ‘companion’ in Persian), a digital, interactive toy to aid with speech elicitation and evaluation (Hamidi & Baljko, 2014). Figure 2 shows Rafigh.

We decided to use a mushroom colony (Back to the Roots Company, 2009) as a component in the toy. We were inspired to incorporate a living interface for Rafigh on the basis of our observations of children’s engagement and fascination with living things. The mushroom colony grows considerably within ten to twelve days. We chose this particular product because of the relative short growth cycle of the mushrooms and the potential for manipulating the colony growth rate via control of the amount of water administered. The toy was augmented with electronic components to implement a conditional watering mechanism (e.g., that would be activated when the child responds to SLP-defined prompts from the toy). Other components were added, such as a bubble blower-machine and video display, which could provide other forms of feedback. Speech samples from the interaction are collected and monitored by the SLP at a later time. We use the Arduino microcontroller (Igoe, 2011) to control the actuators in the toy and use the CMU Sphinx open-source speech recognition engine to detect speech (Lamere et al., 2003). Rafigh does not attempt to automatically analyze speech; rather, it is responsive to speech and engages the child in a dialogue with the mushrooms.

The first prototype of Rafigh engages the child in the caring of a mushroom colony. In our pilot studies, the toy effectively elicited the child ‘speaking’ with the mushrooms.

**Reflection:**

**Repurposing:** The mushroom colony acts as a living slow-media feedback display that responds to input speech. Our approach involves remixing existing technology to create a new digital design. Many of the components are open-source and/or are inexpensive.

**Empowerment:** Rafigh provides an opportunity for the user to care for a living being. Many toys and computer games such as Tamagotchi (Bandai Co. Ltd., Japan, 1996), and Nintendogs (Nintendo Co. Ltd., Japan, 2005) have engaged children in interacting with virtual pets. Research shows that engaging real rather than simulated pets and plants can be beneficial to both parties (Lamers & van Eck, 2012; Isai & Viller, 2010). We aim to empower children and give them responsibility and control over a living interface. We believe that caring for a living being will be a meaningful and enjoyable activity for children and will motivate them to practice and use their speech. Previous research has shown that interacting with pets and plants can have many benefits for children (Levinson, 1980; Bergesen, 1989). Further, regularly attending and taking care of a pet fits in well with a child’s daily routine and can provide repeated reinforcement with potential benefits for speech practice (Pollak et al., 2010).

**DISCUSSION**

In recent years, access to rapid prototyping methods, such as 3D printers and open-source hardware platforms, has lowered barriers to the design and production of digital artifacts. In an academic lab setting, we have benefited from these technologies for their power in early prototyping, and for their power as teaching tools in Human–Computer Interaction. This phenomenon, for us, has also triggered a re-examination of the role and responsibility of the HCI researcher. Each new technological tool and technique, from small microcontrollers to virtual worlds, serves to increase the repertoire of digital media with which individuals can create novel interactive objects. These new developments oftentimes reduce or elimi-
nate barriers to use (knowledge barriers and cost barriers, as these tools become more user-friendly and cheaper to source). These expanded/elaborated roles (Designer, HCI researcher, DIY maker) also serve to expand the slate of activity that might be broadly construed as design. Sometimes, renaming or decontextualizing an existing technology is enough to transform it into a new entity and for it to afford new interaction opportunities. This, in turn, serves to rearrange and retrofit of extant knowledge among community members. Given all of this, the question we face now is not whether something can be made, but rather why should it be made (Ries, 2011). In our examples above, we shifted from a solution-oriented approach to one that finds significance and meaning in designs that support and encourage specific values. This approach emphasized the role of ethical and aesthetic choices, in addition to functional ones. We have drawn upon historical cultural artifacts as sources of inspiration. In the examples above, a key component was involving the community of the user, as motivated by our belief that there is valuable knowledge latent in a user’s community.

Subversion, as instantiated in a digital interaction, can afford the user within his or her community and context an opportunity for empowerment. One way to accomplish this is by encouraging and actualizing social practices, such as collaboration, democratization, and creative expression, via interactive activities that are mediated by digital media. However, the relative value of various social practices has its basis in culture. Extant cultural artifacts can be an effective way to identify such social values and be inspired by them. These artifacts, which are simply the ‘technologies’ of a prior time, reveal values that may be relevant to current, digital design contexts when seen through the lens of cultural anthropology. The re-imagining of existing technology, as inspired by historical cultural artifacts, is only natural as these artifacts are the ancestors of digital designs. Two different, yet complementary, veins of activity inspire our approach. In one vein are the approaches informed by critical technical practices, such as Reflective Design (Sengers et al., 2005), and Thoughtful Interaction Design (Löwgren & Stolterman, 2004) that advocates the application of critical theory and reflection to design. In the other vein are the Hacker-Maker approaches, with their emphases on sharing, challenge to authority, and playful cleverness.

**SUMMARY & CONCLUSION**

In this paper, we have discussed subversion and empowerment, drawing across disciplinary boundaries (Design, Human–Computer Interaction, and the Maker Movement). Our aim is to draw into focus the following three aspects of design: (i) looking to cultural artifacts for inspiration, (ii) fabrication approaches that emphasize repurposing and rearrangement of technologies, and (iii) critical reflection. Cultural artifacts afford a point of inquiry into the sources of latent knowledge from the user and their community, and to incorporate engaged knowledge arising from contexts of use and underlying social processes. The Maker and Hacking communities have shifted beyond amateur expertise and offer techniques for the reimagining and rearrangement of extant technologies. Finally, critical reflection is necessary in the examination of how interactive digital media affords interactions that question, challenge, and transform extant prevalent social dynamics.

**REFERENCES**


Mushroom Kit (2009) Back to the Roots Co. Ltd., USA.


