Open Source Hardware (OSHW) supporting Interaction between Traditional Crafts and Emergent Science: Wayang Kulit over Microfluidic Interfaces

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Abstract

In this paper we will summarize our research into the use of Open Source Hardware (OSHW) as a tool for communicating emergent scientific and technical knowledge via crafts. We were specifically interested in the microfabrication and microfluidic devices, which define the next generation of diagnostic and research tools often inaccessible to the larger public, but also to the scientists from the Global South. We used the traditional wayang kulit theater (shadow puppets) as a model for building microfluidic interfaces, which communicate emergent scientific issues to the larger public while testing the possibilities for DIY microfluidics. This culture-centered approach to design and science communication supports open science and citizen science projects. The prototype of a microfluidic shadow puppets' theater is discussed in the context of previous and future OSHW and crafts prototypes, which support culture-centered design.

CR Categories: J.5 [Arts and Humanities]: Arts, fine and performing; K.8.2 [Hardware]

Keywords: crafts, puppets, microfluidics, open source hardware, science communication, public participation in science

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1. Introduction

The integration of traditional crafts into emergent technological practices of 3D printing [Amit 2013] or e-textile [Buechley and Eisenberg 2013] and similar trends is often discussed in the context of the "maker" and DIY cultures [Nitsche 2014]. This integration explores and supports unique aesthetic qualities [Kettley 2010] or even new design methodologies [Bonanni et al. 2008]. In this paper we would like to extend these views and explore the integration of traditional crafts with emergent microfluidic devices and interfaces as an opportunity for communicating scientific knowledge and supporting interaction between experts and amateurs. Connecting emergent scientific practices and knowledge with traditional crafts, such as Indonesian wayang kulit theater (shadow puppetry), enables us to go beyond user-centric design and explore culture-centered design [van der Veer 2011], but also issues in science communication and public (culturally inclusive) participation in science. Furthermore, we are interested in open source hardware (OSHW) as a specific platform for connecting and translating crafts and indigenous knowledge into new practices and technologies. While some research was done on the use of online tools in supporting communication of crafts knowledge [Cristen et al 2009], very little is known on how open source hardware (OSHW) supports crafts. To understand the unique exchanges between emergent technologies, science and traditional crafts, we will use prototypes developed in several hackerspaces around the world in 2013-2014 by our team (Singapore, Tokyo, Yogyakarta, Berlin, Prague, Zurich, Tel Aviv). We also plan to organize a small hackathon on OSHW and crafts in the Shenzhen hackerspace Chaihuo in cooperation with Seeeed Studio in December 2014. The goal is to discuss cultural-centered design methodologies in the hackerspaces, but also the use of OSHW and crafts for science communication.

2. Microfluidic Puppetry

In this paper we will summarize our research into the use of OSHW as a tool for communicating emergent scientific and technical knowledge via crafts. We were specifically interested in the microfabrication and microfluidic systems, which define the next generation of diagnostic and research tools often inaccessible to the larger public, but also to the scientists from the Global South. In this approach, we are inspired by the work of the citizen science and open science communities of makers and geeks

around Hackteria.org and Lifepatch.org, which represent some early examples of design connecting crafts and OSHW in specific cultural context (Indonesia).

The OSHW as a medium of connecting emergent scientific practices (microfludics and biochips) with crafts was used in series of workshops in 2014 in Singapore, Yogyakarta and Montreal, where we reiterated a prototype for a "Wayang kulit microfluidic shadow theater". We employed folklore and traditional crafts (wayang theater) to create a media archeology prototype of a wayang kulit microfluidic shadow puppets with magnetic particles, but also zooplankton. While the early (April 2014) prototype concentrated on the puppetry aspects, the later prototype (September 2014) researched the use of traditional materials and techniques employed in gamelan music instrument making. While in the early prototype (see Figure 1), we were trying to identify the right materials for microfluidic interaction simulating wayang kulit puppets and movements, in the later reiteration (see Figure 2), we concentrated on the shape of the whole object and its functionality. The wayang kulit microfluidics theater also references the early media history behind zoopraxiscope and early devices displaying motions of organisms, which enabled modern cinema. With this object we are exploring the artistic potential of emergent microfluidic devices as well as their ability to communicate science through wayang kulit and gamelan performances.

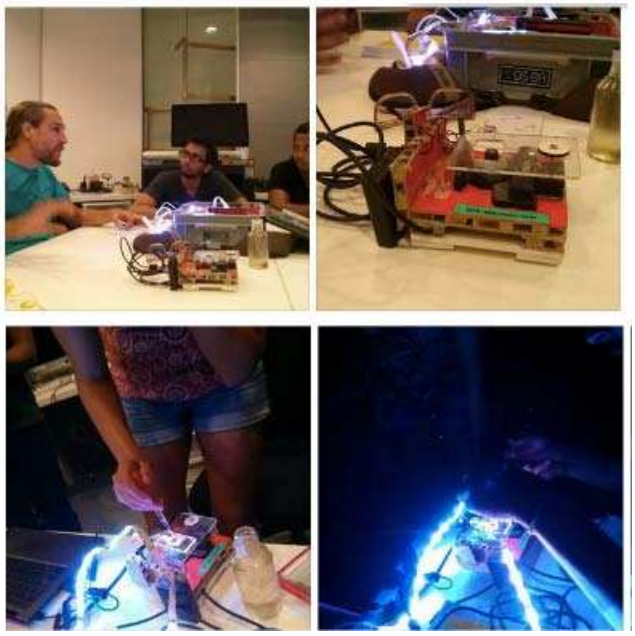

Figure 1. *Hackteria.org workshop on DIY microfluidics at Andreas Schlegel's lab in Lasalle college of Arts in Singapore.*

In the present stage, the prototype is used as a probe into the relation between old, traditional artisan techniques behind instrument making and puppetry, and Open Hardware platforms (Arduino), which were combined with new scientific materials, such as PDMS (Polydimethylsiloxane) molds to build boards, which connect biology with electronics. We used volcanic soil from Merapi volcano for its magnetic properties as a material for the micro-puppets. In the later stage we also experimented with zooplankton as specific biotechnological puppets and future model organisms, on which various substances will be tested in the micro-lab-on-a chip technologies. The magnetic qualities of the volcanic soil formed a type of fractal characters similar to the ones from the wayang kulit plays. The zooplankton, such as daphnia, reminds us of the "punakawans", comical servants to the gods , especially Semar, the mst famous clown and jester, who brings subversive messages to the crowds. We are planning to use these characters recreated on the microfluidic chips to "translate" the old Ramayana and Mahabharata epics into biotechnological activist play on patented genes.

The goal of our hybrid, crafts and OSHW object fo microfluidics theater is to explore science communication in specific cultural context. We are working with a design fiction scenario, where future technologies (microfluidics) serve not only the interests of the industry, but also an old tradition. In this prototype, the OSHW "enhances" the old traditions and objects (wayang kulit and gamelan) with new functionality. It brings the past into the future and explores the terrain between usability, forgotten and new experiences and pure future speculations. We will bring our prototype to the workshop, show its genealogy, but also continue our work in Shenzhen in a hackathon we will organize with Seeed Studio.

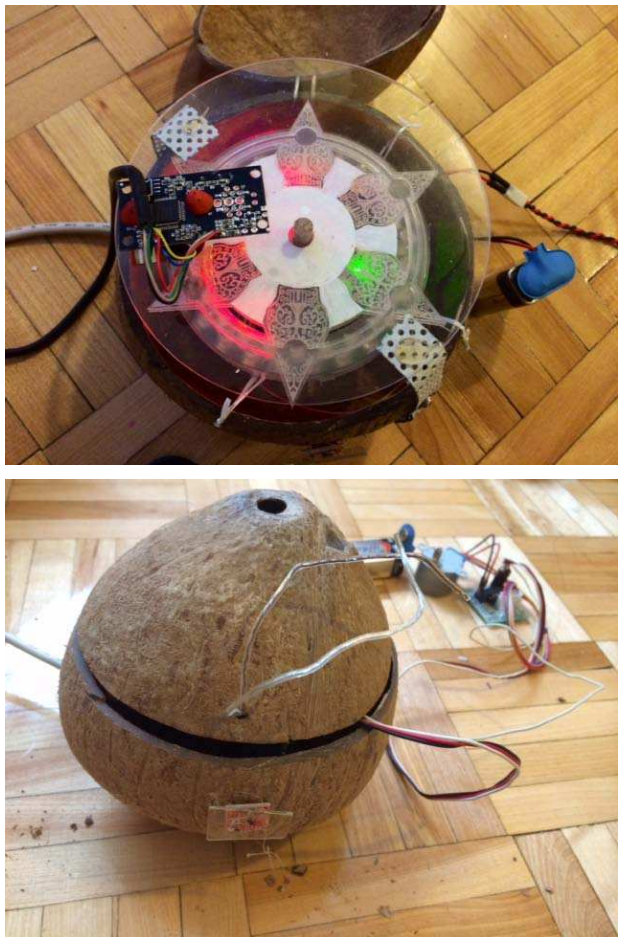

Figure 2. *Justyna Ausareny prototype, Montreal 2014.*

3. OSHW, Crafts and Science Communication

The OSHW was used as a platform for interpreting and appreciating traditional artisan techniques and objects (amulets, charms) in our previous workshops (Tokyo 2013, Yogyakarta 2012, Berlin 2013, Prague 2012, Zurich 2012). In the recent workshops (Singapore 2014, Montreal 2014, Tel Aviv 2014) we used OSHW as medium for connecting and interpreting emergent scientific knowledge in the context of old traditions. These DIY, maker workshops in the hackerspaces were forms of techno-rituals, through which we let participants explore their fantasies surrounding new domains of scientific knowledge, which they connect with their everyday life. The simple amulets or microelectronics based charms (HacKIDemia workshops in Berlin 2013) or even totems (Totematons.org project in Tokyo 2013) embody the expectations and fears related to given technologies and inspired our latest attempts for wayang kulit microfluidic theater. The materialization of fears and anxieties through such OSHW charm and amulet objects are curiosity driven research into future scenarios, which can bridge the divide between the scientific laboratory and the more informal spaces supporting creativity.

We observed the importance of OSHW as a tool of creating such magical objects (charms, amulets) in Japan after the Fukushima Daichii disaster [Kera et al. 2013]. Bringing open source lamps to people in the affected areas was not a purely utilitarian task, but more an attempt to bring a feeling of safety after trauma, a symbolic control over the circumstances. It is an example of an almost "magical" function of the hardware, which is even more obvious in the case of the DIY Geiger counters. Like indigenous culture fetishes, these objects have a type of 'magical power' to provide comfort in times of uncertainty. People monitoring radiation around their houses and neighborhood were aware that they are not protected from the physical effects of radiation, but psychologically and mentally they felt protected from the uncertainty and chaos. These objects created a hope that they can manage and improve their circumstances. The DIY radiation monitoring devices created in the Tokyo hackerspace enabled a basic control and comfort, because people also felt supported by the global community in their efforts to get data. The Totematons.org project in 2013 attempted to embody these tendencies by connecting traditional Japanese craft (Himeji windchimes) with Geiger counters. Around the same time, several HacKIDemia workshop explored the Harry Potter inspired OSHW projects on amulets and charms.

In the most recent workshops in Tel Aviv (2014) we explore the traditional, Renaissance techniques of etching and their relation to Printed Circuit Boards techniques of photolithography and etching. The artisan, often hand-made Printed Circuit Boards (PCBs) behind most open hardware experiments in art and design, but also the emergent nano- and Microelectromechanical systems (MEMS) in the professional microelectronics industry brought a paradoxical return of the traditional printing techniques of intaglio, such as etching and lithography. The Renaissance intaglio used copper or zinc plates (and sometimes iron) to scratch or etch the image with diluted acids, which was then pressed onto the paper with ink to print maps, works of graphic art and images in books. In the present, intaglio is marginalized and used mainly as an anti-forgery prevention in banknotes, passports and other documents. Instead of dying off with the printing press, it is experiencing a strange comeback in the microelectronics industry, where intaglio is used to create circuit boards. The present intaglio techniques etch circuits with acids, but also X-ray, Ion beams, UV light, various light-sensitive chemical processes and even plasma. They etch lines on the conductive materials, which serve as layers of complex circuits feeding all our digital technologies. While traditional prints experimented with perspective and representation, these present intaglio "prints" make routes for the movements of electrons, direct and control current and resistance, but also amplify, switch and transform energy in the transistors and light-emitting diodes (LEDs).

We are using one of the first etchings by Albrecht Dürer called "Landscape with a Cannon" to superimpose a circuit design for an amplifier over it. His etching technique , but also the iron as a material of choice, summarize and even predict the military fantasies behind all future intaglios. Dürer's 1518 etching depicts a Turk standing prominently in the foreground to symbolize the geopolitical threats next to a large cannon on a four-wheeled gun carriage. The much admired landscape on his prints, which engulfs everything from mountains to villages and ports on the sea, performs the Renaissance perspective, but it also served as a test ground for his future work on fortification. In 1527 he published a famous treatise on fortifications, Etliche underricht zu Befestigung der Stett, Schloss und Flecken (Several instructions for fortifying towns, castles and small cities), where on one of the last pages we can see the same cannon along with a detailed proposal and drawings of permanent artillery fortification. With our artistic PCB referencing this early etching by Albrecht Dürer we are exploring the uncanny relation between military technologies and innovation, but also learning and discussing the various PCB design techniques.

4. Preliminary results

The preliminary research into crafts, traditions and OSHW led to the 2014 project on wayang microfludic theater, which connects the various themes related to fantasies and fears from emergent scientific techniques and knowledge. By staging microfludic shadow puppets to perform and address our fears from biotechnological patents we explore the possibility of various microfluidic materials and techniques. While the interaction between traditional crafts and science supports the goal of communication and public involvement in emergent scientific issues, the OSHW is an ideal tool for integrating various old and new materials and technologies and democratizing them for open science and citizen science projects. The format of DIY workshops in the hackerspaces, in which technologies are democratized through OSHW can also support the involvement of the public in open science and citizen science projects.

5. Acknowledgement

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