Electronic Kintsugi

An investigation of everyday crafted objects in tangible interaction design

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***Abstract* — In the development of enhanced and smart technology, we explore the concept of meaningfulness, tangible design and interaction with everyday objects through Kintsugi, the Japanese craft of repairing broken ceramics with gold. Through two workshops this emergent design research develops an iterative prototype: Electronic Kintsugi, which explores how we can facilitate more human-to-human or human-to-self connection through a hybrid crafted everyday object. We identify three themes: 1) enhancing human connection through embedded or "magic" technology, 2) using everyday objects to prompt personal reflection and development, and 3) exploring transferable design principles of smart products with a device of undefined purpose, and which converges traditional craft and technology.**

Keywords: Craft, Internet of Things (IoT), Tangible Interaction, Everyday Objects

I. INTRODUCTION

This work explores Kintsugi, the Japanese craft of repairing broken ceramics with gold and explores how we can use capacitive touch to facilitate tangible interaction with an everyday, crafted object. We situate ourselves within interaction design and look to craft and tangible interaction related works.

The grounding question for this work asks how can we facilitate more human-to-human or human-to-self connection through a digital/crafted hybrid-everyday object and which design benefits can this offer future technology? We explore this through three themes which emerge in our work about technology, craft and interaction. Much of the recent work within interaction design about tangible interaction has shown an increased focus on traditional craft work [1, 2, 3, 4] and a return to tangible interaction [5, 6, 7] from screen interaction. Despite a focus on the craft and the tangible, in commercial areas a strong focus on app-based interaction, digital displays, and screen based solutions has become the norm, even pushing towards virtual or augmented reality. Meanwhile, a number of critical views about the value of the Internet of Things (IoT) have recently been published [8, 3] and a wave of research and devices around the themes of mindfulness, self-exploration, reflection, and well-being is emerging [9, 10].

In this area of overlap, between screens and tangible interaction, between making devices and traditional craft, between the IoT devices and the mindfulness tools, we find ourselves interested in exploring the potential engagement qualities of non-screen, tangible interaction in the form of everyday crafted objects. We are specifically interested in the physical nature of both the IoT gadgets and the mindfulness tools as they tie into the physicality of crafted objects. We rely on physical objects in our lives and while designing future smart homes, offices, cars, etc, we might benefit from a deeper understanding of how we relate to these physical things. [11]. Núñez Pacheco and Loke elaborate: "A focus on a more reflective approach can offer fresh ways of understanding how the lived body interacts with artefacts, products and spaces" [12]. This speaks to how we can look further into understanding how humans can interact with 'things' and our focus is to take that further and ask how we can facilitate more human-to-human or human-to-self connection through a hybrid crafted everyday object.

II. INTRODUCING KINTSUGI AS A DEVICE TO EXPLORE CONNECTION AND MEANING-MAKING

Electronic Kintsugi was developed as an investigation tool into how we could use everyday objects to explore human-to-human connection, human-to-self connection, and to find if we could develop something which intrigued and engaged people, moving from the IoT (Internet of Things) towards an appreciation and use of crafted, tangible, interactive, everyday objects. Electronic Kintsugi is a platform for exploration and meaning-making, an opportunity to engage with others, and with oneself and to create new narratives. In our work, our context was Japan's artisanal craft of Kintsugi where we developed our work with a Kintsugi artist and our focus was on the tangible, non-screen interaction properties of how a device with an undefined purpose might exist in between these realms of traditional craft, technology and sound.

Inspired by Tsaknaki & Fernaeus' work with Expanding on Wabi-Sabi as a Design Resource in HCI [13] where they explored unfinished craft and interaction design, the authors created a device and facilitated two participatory workshops exploring the Japanese craft of Kintsugi: mending broken ceramics with a precious metal to make them more beautiful and valuable than before. These concepts were adopted with the creation of Electronic Kintsugi: a sound or light reactive piece of repaired ceramics with touch interaction on the precious metal seams. Our interest is in the aesthetics of individuality, human touch, and to explore and respect the tradition of the craft of Kintsugi itself. (Video of Electronic Kintsugi here: https://youtu.be/p5Pu0-gZ3u0).

Figure 1: Electronic Kintsugi in a design expert's home; The Kintsugi artist creating traces; First workshop explorations.

III. Related Works: Exploring the physical qualities of hybrid tangible embedded interaction, through crafted 'things'

The literature review researched works where craft is referenced for the transferable physical qualities of interaction design; material, texture, touch, and recognition of craftsmanship as opposed to the sleek smooth, machined surfaces of our current smart products. We see this as a natural progression from a screen-based society, moving towards embodied engagement, and beyond the swipe-interaction of the "black mirror" (screen) as described by Rose [14]. Three thematic findings informed our prototype and workshop development.

A. Traditional craft as a starting point for exploration

Tsaknaki & Fernaeus explore craft in depth, in a variety of their works, and hereby evaluate the role of interaction design in craft. In their work on Wabi Sabi, Tsaknaki & Fernaeus [13] present the concept of Wabi Sabi; and "approach perfection through explicitly unfinished designs". We embrace the concept of unfinished design with Electronic Kintsugi, deliberately designing an unfinished device to prompt curiousity and exploration of the prototype. In their work with leather, Tsaknaki, Fernaeus, & Schaub [15] explore how leather can be a touch based, rich material for tangible interactions. This work informs how we can look to everyday materials, in our case, ceramics, for stroking interaction, much like the leather interactions of their SoundBox. In exploring silversmithing, Tsaknaki, Fernaeus, Rapp & Belenguer [16] both engaged local artisans and focused especially on the "cultural and historical significance" of the craft, and explored the design "space of screen-less" interactions. This finding informed our choice of working with the Japanese artisanal craft of Kintsugi where we developed our work with a Kintsugi artist and our focus was on the tangible, non-screen interaction properties of how a device with an undefined purpose might exist in between these realms of traditional craft and technology.

B. Designing from everyday things with social implications in mind

In recent works about the Internet of Things (IoT). Cila, Smit, Giaccardi and Kröse [8], Nordrum [17], and Lingel [3] all explore the social significance of the "thing" and suggest that we need not only look at the everyday (home and workplace) but also the social and cultural implications of these everyday interactions with things. Our work focuses on this "thing" and thus, the development of Electronic Kintsugi.

C. Technology & Touch

Significant work has been done in the field of interaction design with regards to touch and in the interests of space we do not cover that here, however the particular work by Cranny-Francis [18] covers a sizeable portion of the touch research done within design. In Semefulness: a social semiotics of touch, Cranny-Francis introduces the experience of touch as 'semefulness' – "multiply significant, physically, emotionally, intellectually, spiritually, politically" [18]. She describes the 'tactile regime' of touch in culture, how it shapes how we engage with one another or to the tools we design and then use. She describes that "Touch is semeful in that it is full of meanings - physical, emotional, intellectual, spiritual and those meanings are socially and culturally specific and located." Here we can begin to touch upon the multi-faceted nature of Electronic Kintsugi. It is culturally and location specific to traditional Japanese craft; it is emotional to some - as an heirloom or a piece of valuable art; it fosters social interaction when acting as Electronic Kintsugi (see section VI. C); and it is physical in nature, it requires touch, stroking, holding the bowl. One ambition of Electronic Kintsugi is to enable meaningful experiences for the participants, and by addressing Cranny-Francis' 'semeful' attributes, we may begin to explore this domain.

D. A focus on audio and playfulness

Schoemann & Nitsche [4] use the "Stitch Sampler", a sew-able musical instrument to focus on embodiment via the act of sewing, and on audio feedback, "to respond to the crafter's personality". These qualities of craft, tangible non-screen interaction, and playfulness with sound inform our process, helping to frame the area we are exploring.

Electronic Kintsugi allows participants to explore the interaction qualities of a hybrid crafted device and consider its potential uses in their lives. We encourage curiosity and unexpected encounters, and reflections of those encounters. This speaks to our objective to inform future smart product design and encourage a tangible, non-screen interface which utilizes craft and the qualities of curiosity and reflectivity.

IV. Methodology

Initially we were fascinated by the idea of Kintsugi and made a basic prototype to explore possible values of Electronic Kintsugi. This work spans from the first prototype to two workshops, one in Japan, and one in Denmark, six months apart.

We present an overview of methods here and then describe each workshop and the findings in the following sections.

A. Workshop 1: Methods

The first workshop was designed in a collaborative process with FabCafe Tokyo and Kintsugi artist, Kurosawa[1] where we combined electronics with an everyday "craft" object with the artisan in this process [16] so they could both introduce us to the nuances of the craft and help us to understand to what we should be paying attention.

Following the process described by Tsaknaki, Fernaeus and Schaub [15] in their leather material explorations, we created a workshop session to explore the properties of Kintsugi and gain insight into the craft, and to investigate how our prototype was received by participants in that context.

We used thin strips of copper tape to conduct electrical current and worked with the Kintsugi artist to carefully overlay the traces of precious metals where the repair had been, to emulate the traditional Kintsugi.

The workshop consisted of two of the authors (one, an electrical and mechanical engineer and the other an interaction designer), the Kintsugi artist, and seven participants of varying electronics skill levels who were recruited through an open Fabcafé Tokyo Facebook event.

During the workshop, the Kintsugi artist presented and demonstrated their process, allowing participants to try their hand at creating Kintsugi. The authors presented their work and the thoughts behind the Electronic Kintsugi. The workshop explored Kintsugi and interaction with it, using two familiar outputs, sound and light, which would act as examples of possible outputs, so that participants were able to extrapolate from this in terms of what the Electronic Kintsugi might be used for.

We conducted the workshop in a focus group style, and did two rounds of explorative, hands-on evaluation. A questionnaire was developed to capture their experience. (Results in section "First Workshop").

B. Second Iteration of the Electronic Kintsugi

Cila, Smit, Giaccardi and Kröse [8], describe the interventionist product, for creating dialogues, which sense, respond to, and interpret data. The Electronic Kintsugi was developed to sense touch, respond to it, and for the second workshop, could interpret data, such as how often it is being stroked.

After feedback from the first workshop, the Electronic Kintsugi was updated to have more responsiveness and a more nuanced soundscape. Programming was done in such a way that we as the users could not predict which type of sound or light interaction would emerge, or how it would progress in order to prompt explorative and playful behaviour with the device. Rather, it had a certain level of ambiguity [19] via the programmed adaptive behaviours, based on how much it was interacted with and for how long, e.g., if it had been left alone, or off for a period.

Several touch-to-sound and touch-to-light reactions were developed for the workshop. Each reaction was taking input from the touch interface[2] and creating a specific output in the form of either light or sound. Light was output on a strip of NeoPixels and sound was synthesized using a software library[3] and output to a speaker.

The light reactions transform a single parameter from the touch interface into a specific light pattern on the LED display. Likewise, sound reactions transform a single parameter from the touch interface to single tones, chords or evolving sound figures.

In the second iteration, we wanted to increase the complexity [20] of interacting with the device so the interaction was less binary, such as a touch = a sound. Instead, it was decided to make the coupling between the input and output less apparent, giving it the autonomy to interpret the frequency of interaction and respond according. Within the second iteration algorithm, there exist five cases for interaction modalities for either sound or light, meaning five for sound and five for light. There is a manual switch on the Electronic Kintsugi so participants can choose if they are interacting with light or sound. These five cases were five variations in types of output cycled through a timer based on interaction. If the user was interacting with the Electronic Kintsugi, then it would remain on that mode longer, until they paused interacting, to not interrupt their flow of interaction. Then it would move to the next mode. Each mode was a variation in output, so for example, for sound, it might be different chords or tones.

This had the purpose of giving the participant less time to recognize patterns in the behaviour and enhance the user's curiosity. We focused on how the interaction between the participants and the Electronic Kintsugi could be more tightly or loosely coupled, yet also incorporate elements of surprise; and what implications this interaction had for the participants' association to the Electronic Kintsugi as a device, versus as an instrument, companion, or tool.

C. Workshop 2: Methods

The second workshop was scheduled six months after the first, due to travel and revisions to the technology and workshop design.

Approaching workshop two, Wakkary et al. [11] published a work, "Morse Things" wherein they utilised a methodology for engaging design researchers to evaluate their everyday object through having the object in their home for some weeks, and then following up with a workshop with the design researchers to explore the experiences with the object. We adopted this methodology for our work, and asked four design researchers to evaluate the Electronic Kintsugi in their homes for a period of five weeks followed by a workshop. We chose to use this method, in agreement with Wakkary et al. who explain, "A key motivation in our approach was the desire to deepen our investigation by including a wider range of experts that have the

[1] http://www.kurovsya.com/

[2] We followed instructions from: http://www.instructables.com/id/Touche-for-Arduino-Advanced-touch-sensing/

[3] We used this library: https://github.com/dzlonline/the_synth

design expertise to perceive and investigate the nuanced and challenging notions of thing-centeredness."

D. Participant Selection and Introduction to Electronic Kintsugi

Opportunity sampling was used to select experts in design research from different backgrounds, aged 30-38, living in Copenhagen to ensure different perspectives on the experience and imagined future uses. Participants' names have been changed for their privacy. Their backgrounds are crossovers between the fields of engineering, interaction design, dance, performance design, industrial design, robotics, and hardware development.

Participants were recruited by email and it was explained to the participants that they'd have the object in their home for 5 weeks and engage with it for a minimum of 15 minutes per week, spending another 15 minutes per week journaling their experiences. Participants were asked to keep a record of their thoughts and experiences and to both keep these as a document and bring these thoughts to the workshop at the end.

We found four researchers who were available to review the device worked. Our goal here was to invite these experts to explore with us and find out what questions to ask participants [21].

We describe the specific methods we used during workshop 2 in the section "Second Workshop" to maintain continuity and legibility of this work.

V. First Workshop: FabCafe Tokyo

Workshop 1 informed our work and to set the scene for workshop 2. The workshop was conducted in both English and Japanese, and participants could communicate in their preferred language. We used a written questionnaire so participants could answer in their preferred language. We briefly present workshop one and then move to reflect on findings from workshops one and two.

After a brief demonstration of function, the Electronic Kintsugi was explored by participants. They touched the traces with one, two or all fingers, and tried turning the ceramics over, holding it in one hand or two. We explained "the output could be anything, it could start your car, or feed your pet".

Since participants were familiar with the interaction technique after exploring the sound interaction, the light interaction had a much different approach. Participants knew how they could touch it, with one or several fingers and they now focused on light or harder touches, strokes, or resting their finger on the traces. The light was much more unpredictable than the sound. Whereas with the sound, they were acting almost as musicians, experimenting to find patterns and particular notes, with the light it was more about getting a bigger or smaller reaction than it was about the nuances in between these small or large bursts of light. One participant asked, "I want to know how much it's me that is controlling it and how much it is doing on its own".

A. Findings

We highlight several responses here from the questionnaire to inform future researchers in this field who might be interested in working further with this.

- Encouraging senses and emotions
    - Being able to handle the Kintsugi was a special experience, "There is a different feel to a real Kintsugi. It's rare to see the hitting of the device so profoundly." (P-1A) and "We're often not given permission to touch traditional art. It feels good to be encouraged to touch it." (P-1E).
- An interest in other senses: taste, smell, and food
    - One participant who suggested it be used as a bowl to eat from "Japanese people eat with bowls close to their mouth, so I want to see some sound installation when someone is eating" (P-1A) and another who suggested that it could be used for a cat or dog food request device "imagine the cat's tongue licking the Kintsugi!" (P-1C).
- Light – Unpredictable but has potential.
    - One participant noted that the light reminded them of a starry sky and stated, "In a larger, or aesthetically ordered or different setting (night), it would be very soothing" (P-1C). Another participant was inspired and shared an idea "The combination of the craft and the touch with the light feedback reminded me of the challenges of regaining fine motor control in a finger after an accident. The focus required and the tranquillity of the lights may be a fun alternative physical therapy. " (P-1E)
- Sound – Alive characteristics

One participant remarked, "Craft has character, especially as it ages. How might that character be represented as sound? I feel the sounds were lovely but not aligned with the character of the craftwork. Or maybe it had juxtaposition of sound quality and physical character which enhances the contrast between tradition and technology." (P-1F). Two participants related to the object in an anthropomorphic way, stating "It was like the cup was telling me how he/she's doing. Since Kintsugi part is a past wound, sometimes I felt like it's telling me it had pain." (P-1E).

B. Findings Summary

The workshop provided us with some considerations about the role of art and objects and potential interactivity from these objects. Participants were excited to play with art and traditional craft based objects. They were fascinated by the light and sound output and could extrapolate to imagine other interaction scenarios. They explored the aesthetic interaction qualities and played the Kintsugi like an instrument, using expressive hand gestures to explore the touch interaction. And they could reflect on the role of technology and tradition and how we live our lives:

"Developing a closer, more physical relationship with the objects in our lives feels meaningful. " (P-1E).

VI. Second Workshop: Copenhagen

To prepare for the second workshop, we asked participants to spend 20 minutes in silence [22] to complete a written activity to gather their pre-workshop thoughts and feedback prior to engaging in dialogue.

We used Kujala, Walsh, Nurkka, and Crisan's [23] method of sentence completion to extract these initial reactions. We provided the instructions that participants should answer quickly (20 questions in 20 minutes) and the beginning of the sentence was given, which was then completed by the participant in a way they saw fit. Kujala and Nurkka [24] used categories of user values to classify questions. In Figure 1 one can see the sentences we defined, as per each value category. We tried to make a nearly even number of positive and negative questions, and allowed extra space if they wished.

Sentence Completion Tool

General

- Using Electronic Kintsugi these past weeks has been ____ (1 Word)
- Social values
- I felt a sense of achievement when
- I felt a sense of disappointment when
- I felt like I was controlling the Electronic Kintsugi when
- I felt like the Electronic Kintsugi was uncontrollable when
- I felt connected to the Electronic Kintsugi when it

Emotional/ hedonistic values

- The emotion I felt when using the musical aspect of the Electronic Kintsugi was mainly
- The emotion I felt when using the light aspect of the Electronic Kintsugi was mainly
- My best experience with the Electronic Kintsugi was when

Stimulation and epistemic values

- I experienced curiosity when the Electronic Kintsugi
- I thought it was novel that the Electronic Kintsugi did
- I learned something new when the Electronic Kintsugi
- I was frustrated when the Electronic Kintsugi
- I felt a desire to use the Electronic Kintsugi when...

Growth and self- actualization values

- While using the Electronic Kintsugi I reflected about
- The Electronic Kintsugi helped me to
- The Electronic Kintsugi failed when

Traditional values

- The Electronic Kintsugi fit into my home because
- The Electronic Kintsugi was out of place in my home because
- The Electronic Kintsugi was an interruption when it

A Likert scale [25] was used to determine their reactions to sound and light interactions. We asked participants to rate the light and sound interaction. For light, we asked "I found the light output to be:" and gave one of the scale the value of "Calming" and the other end of the scale "Attention Seeking". For sound, we asked the same, but added an additional scale of "noise" to "music".

We spent the remaining 2.5 hours engaged in a group discussion about their experiences, comparing, contrasting, and exploring possible future interactions.

A. *Findings*

We used mind mapping as a technique to map out the responses from the discussion and journals [26]. We present here the results of the sentence completion as well as the discussion and journals.

B. *Sentence Completion*

We compared the sentence completion responses sentence by sentence and by category. The Electronic Kintsugi was described as "enjoyable, calming, interesting, and different" in the one word descriptions. The findings from participants, ordered by the Sentence Completion Tool headlines [23] were:

General: Participants felt a sense of achievement when interacting with others and felt connected to it when it: "reacted to my own and others touching it".

General: Predictability. They were disappointed and frustrated with the light interaction: "the light interaction was unpredictable, non-responsive and not interesting". It is noted here that in both workshops, the light was reported to be not as responsive as the sound input. Participants in both workshops reported that they were more fascinated with the sound feedback, particularly because there were more nuances in the sound than in the light.

Emotional: Participants described their emotional response as "playfulness and companionship, calming, joy and puzzled" and again highlighted their frustration with the lights, describing them as "underwhelm(ing), disappoint(ing), and distanced".

Two participants referenced the social values and stated that their best experiences were while playing with others.

Stimulation and epistemic: Participants described the changing soundscape, mentioned their desire to use it when someone asked about it.

Growth and self-actualization: Participants described both relaxation and concentration as well as creative thinking and social interaction as outcomes of their interactions with the Electronic Kintsugi.

Traditional values: Participants noted that, as an object in their home, it was "cute and modern", "playful and interactive" and that it "combined ceramics with playfulness".

Finally, in the extra space provided, three responses were thought provoking:

- I kept receipts in it and I liked how it became less precious and more functional
- I wonder if you were tracking my use
- It was a search into new creative possibilities

The Likert Scales gave us the below results, indicating that while results varied, light was generally thought to be more attention seeking than calming, sound was found to be generally more calming than attention seeking and sound was more musical than noisy.

"I found the light output to be:" (Calming = 1, Attention Seeking = 10)	Average rating of 5.75 (Actual Rating Values = 8, 4, 4, 7)
"I found the sound output to be:" (Calming = 1, Attention Seeking = 10)	Average rating of 3.75 (Actual Rating Values = 3, 3, 7, 2)
Extra question for sound: (Noise = 1, Music = 10)	Average rating of 6.25 (Actual Rating Values = 6, 5, 5, 9)

From the discussion and journaling, three primary categories of interest emerged: 1) enhancing human connection through embedded or "magic" technology, 2) using a craft based object in prompting personal reflection and development, and 3) exploring transferable design principles of smart products with a device which has no defined purpose, and which converges traditional craft and technology. In the accounts below, participants focused primarily on the sound based interaction as they were not interested in the light interaction and spent most of their time with sound.

VII. Three themes identified

A. Enhancing human connection through embedded or "magic" technology

There were several accounts of how the Electronic Kintsugi sparked social connections and interactions. Antonio had placed it in the kitchen and he explained that the bowl on its own might not have sparked curiosity but the box did and visitors asked what it was and then wanted to play with it. For Sandra, she was having an evening of entertaining guests, and as they were finally leaving (she was tired), she stood in the doorway, and absent-mindedly touched the bowl as they were putting on their shoes. The guests became immediately intrigued and asked questions and wanted to play with it, which was both charming and exhausting, since, as Sandra explained, she was ready for them to go home, but also happy to play and show them the bowl. For Henry, it was a social life saver as he suddenly found himself spending time with his father in law who doesn't speak much English, and Henry doesn't speak much Danish. The Electronic Kintsugi came to the rescue as a medium they could explore together, without a need for verbal language. Martin explained that he took it on the bus and it was "totally inappropriate" there, it was loud and kept making screeching noises. He was frustrated with it, and imagined if it was quiet and making nicer sounds as it often did (though, not on the bus) then he could have asked others to join in on the playing.

The 'magic' of the object was intriguing to people who didn't know what it was and sparked both play and conversation, even, in Sandra's case, when they should have been leaving. It offered a needed social lubricant in the case of Henry and sparked ideas on how to engage strangers on the bus for Martin. Having an everyday object have 'magical' and unexpected properties, without being a gadget, or being used for some other purpose (a fancy remote, a communications device, etc.) seemed to be the key to sparking this social interaction. Unexpected qualities of playfulness via a changing soundscape was the right recipe for the Electronic Kintsugi.

B. Using an everyday object in prompting personal reflection and development

Our experts felt that an everyday object combining traditional craft and technology was important, commenting that they "wanted to come back to it again, it levels up, it evolves over time" (Martin) and "I love that it's not intuitive, you have to spend time with it and get to know it. It's nice that it doesn't have a defined purpose, somehow it's good to just have something nice and electronic in your home, especially with the copper tape, it feels like a crafted aesthetic, you can see craft, and the time put into it, but you can't see code, so somehow this makes tangible the craft of the code". (Henry). Sandra likened it to a "Tibetan singing bowl, you have to hit it just right and there's a pleasure behind controlling that energy". And Martin continued, "The electronics force you into movement, I've never done this with an Ikea bowl".

Bringing together physical and digital materials, considering both the craft of the object and the craft of the code, and, considering the social surroundings that the object inhabits were important aspects of creating a *hybrid craft* [16]. For us, it is the combination of these things which is a significant part of

designing for meaningful interactions and experiences when working with future smart everyday products in the home.

C. The role of an object with a non-defined purpose

The fact that the purpose of the object was open-ended was well-liked, and the participants used this opportunity to explore the possibilities with it. Some of their comments included "I love that it's not intuitive, you have to spend time with it and get to know it" (Martin) and "It was interesting, as a dancer, that I played a lot with the hand movements and did improvised hand movements" (Sandra). It was briefly discussed what it might be like to grow up with an object like this in your home, instead of an iPad or TV, and how that might change your perceptions of how you interact with the world, and come to appreciate objects. Sandra explained "I prefer it as an ornament, something non-connected. It can be a companion, or a container, such as for my receipts." The combination of a non-defined interaction purpose with the functionality of a common object, a bowl, seemed to work well to invite playful and curious interactions. While some experts poured water into the bowl to explore the sound, Antonio took it a step further, and ate his breakfast cereal from the bowl, "it made me aware of how fast I was eating". (Interestingly, in workshop one, this was a suggestion from participants, that it could be nice to eat from the bowls). The choice to use a bowl came from our fascination with Kintsugi and the tendency there to repair bowls, and we learned that as a starting object for this exploration, a bowl has so many inherent properties, something to eat from, to store things in, as a decorative object, as a historical object, it's nice to hold, and it exists in many cultures, and many homes.

Creating an object with non-defined purpose can be one way to encourage curiosity, playfulness and an opportunity for the creation of meaningful or important moments in one's life, especially when there is a human-to-self (self-development) or human-to-human (social) aspect. On the contrary, further interaction design would be necessary once an object moves beyond being something with a non-defined purpose. In this work, our focus on a non-defined purpose is not disregarding designing interactions for a specific context, but rather our focus is on designing interaction concepts at an earlier phase of the project development.

VIII. DISCUSSION

It is worthwhile to revisit Borgmann (as described by Fallman [19]) here, who worried that technology would "turn us into passive consumers, increasingly disengaged from the world and from each other" [19]. Our aim with Electronic Kintsugi, and a focus on designing for ambiguous interactions with everyday objects, is to move back towards each other, towards engagement with familiar objects, towards creativity and playfulness and that it is "not simply [a] neutral means for realizing human ends, but actively help[s] to shape our experiences of the world" [19].

Despite work in academia developing tangible, non-screen devices or criticising IoT (as earlier presented) the products which emerge on-market today are not abundantly reflective of this. These products do not necessarily engage people on a human-to-human or human-to-self level and instead, often cater to fixing a small problem without necessarily considering a more holistic impact. Cila, Smit, Giaccardi and Kröse [8], describe the current approach to IoT as being short-sighted and emphasize the potential for the role of interaction design in new smart things. In our work, we expand on this, and emphasize a need for smart things to perhaps be rooted in craft to enhance meaning-making, to utilize non-screen interaction, and to move towards facilitating human-to-human or human-to-self exploration.

We further emphasize the role of a device with an undefined interaction purpose, as opposed to the very specific devices emerging on market today such as smart candles[4] (controllable via app) or smart hair brushes[5].

Although we needed to use copper tape to achieve the conductivity, in the future we would like to explore which material properties would allow a Kintsugi artist to create something more conductive using the traditional precious metals. Given this, the most significant aspect was the conceptual consideration of how one might interact with an object which had been created by an artist, but is otherwise an 'everyday object' (one which we might find in our homes anyway, such as a bowl).

Returning to Cranny-Francis' semefulness, we can see the aspects of physical, emotional, intellectual, spiritual, social, and cultural [18] in the Electronic Kintsugi. We essentially augment a crafted object with technology, with the aim of created an enchanted [14] everyday object with a historical, crafted background which is open to interpretation and explorative play. The role of an enchanted [14] everyday object is especially important to consider in a world of increasing IoT gadgets. Considering a future vision of connected everything, we feel it is important that we do not become too focused on the technology, such as having RFIDs under our skin [27] or being laden with smart tablets, smart watches or smart water bottles; but rather, that we embrace humanness.

We want to create devices which provoke thoughtful and critical reflection, and engage people on a tangible level; not just a screen asking if you've been mindful today [28]. When considering the design of new 'smart' objects, we should perhaps ask, "does it need to be connected, and if so, why?", or "how can I enhance the existing values in this everyday object?" A door handle for example, doesn't just open a door, it is the literal door to coming home from work, relaxing after a long day, seeing your family again, and more.[6] The affordances inherent in everyday objects are many and it is our job as interaction designers to not only invent new technologies and uses but to consider how to support these values and avoid turning the objects in our world into cloud-connected gadgets.

Electronic Kintsugi embraces new technology and established craft practices, emphasizing curiosity and playfulness while facilitating interaction between people and the self. Furthermore, we felt that the aspect of craft was a key

[4] https://www.ludela.com/

[5] https://www.kerastase-usa.com/connected-brush

[6] From an interview with designer Carl Alviani (http://meaningfuldevices.vanessacarpenter.com/2017/08/10/anything-but-personal-is-a-failure/)

identifier in what made the everyday object special. The history and delicate quality of the Kintsugi had multiple reactions, the participants in Japan were intrigued that they were allowed to play with a piece of art, and the participants in Denmark were eager to engage with, and learn more about Kintsugi. Our primary concern was the investigation of a non-screen, tangible everyday object coming from a place of craft, and in future work we hope to further investigate how we could work with a Kintsugi artist to create a fully functional piece of Electronic Kintsugi, with capacitive traces in the piece.

IX. Conclusion

In this work, we have presented Electronic Kintsugi: an exploration in how an everyday object (a bowl) in combination with artisanal craft (Kintsugi) and electronics (conductive sensing) could result in more human-to-human connection and human-to-self development. Through two workshops, one in Japan with a Kintsugi artist and participants, and one in Denmark, with design research experts, we explored the properties of this Electronic Kintsugi, an interactive object with no defined purpose and two main interaction outputs - sound and light. We found that sound as feedback was of significant interest due to its nuanced nature and reactiveness, and between workshops, the sound was programmed to evolve over time with use.

Using copper tape, we augment a traditional, crafted object, namely, Kintsugi with electronics, and call it Electronic Kintsugi, creating an open platform for play, exploration and development. In future work, we hope to continue work with Kintsugi artists to find a material which can be used in the craft practice, which would also be conductive enough for Electronic Kintsugi.

We identified three categories of reflection from our studies with participants, and areas which future smart products can look to, to enable more meaningful interactions between human and human and human and device. These categories are: 1) enhancing human connection through embedded or "magic" technology, 2) using everyday objects to prompt personal reflection and development, and 3) exploring transferable design principles of smart products with a device of undefined purpose, and which converges traditional craft and technology.

Finally, we discussed that as interaction designers, we would like to focus on embracing humanness in future technology designs and could look to the values and affordances inherent in everyday objects to bring out these values and design for these moments in our lives.

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