Empowering Older Adult Crafters to Electronically Enhance Artifacts for Health

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ABSTRACT

Even though older adults possess the skills necessary to create personalized artifacts, as is evident in various crafting groups, a toolkit that enables them to enhance their crafts electronically has not been developed. We present an electronic toolkit designed specifically for older adults that enables them to create their own personalized wearable devices. We recruited N participants (X female, Y male) from senior living communities and crafting groups in a Midwestern city. Participants were ages K to J (median age = M) with no cognitive impairments and were actively making an object with their hands. Z participants completed all parts of the study (X female, Y male). We utilized a modified participatory design method to learn about the needs of older adults and guide the development of our toolkit. We conducted three workshops sessions in which participants 1) taught us about their craft, 2) learned about electronics and 3) participated in a joint brainstorming and prototyping session. Findings? Conclusions/Implications? We cannot easily compare the results of our modified participatory design method as we did not conduct a standard participatory design session. Instead, we discuss our results from the modified sessions in the context of the available literature.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous; D.2.8 [**Software Engineering**]: Metrics—*complexity measures, performance measures*

General Terms

Theory

Keywords

older adults, crafting, electronics, prototypes

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1. INTRODUCTION

Older adults are capable of independently designing wearable devices but an electronic toolkit designed specifically for their demographic has yet to be developed. Maker technology is a burgeoning field and several kits have been developed for children, such as MakerWear [11], littleBits [2], EduWear [10], and MakerShoe [12]. These toolkits are accessible and abstracted to make electronic tinkering easy; however, they are physically constrained with limitations on inputs and outputs. These toolkits are intended for school-aged children and consist of modular building blocks that alleviate connection issues, but also hinder open-ended creation. Mellis et al. [17] eschewed this modular model and created an “untoolkit" designed to appeal to the user’s creativity while avoiding imposing strict construction techniques. While this approach allowed for greater innovation, the result was a less abstracted kit that required a greater knowledge of electronics to use. Other electronic kits have been developed for a variety of ages, such as the LilyPad Arduino [4], circuit stickers [9], and MaKey MaKey (http://www.makeymakey.com/). The latter was evaluated with older adults and while older adults found the kit enjoyable, they had reservations about its suitability for their age [21]. These toolkits are geared towards a variety of audiences but required guidance or prior programming knowledge. We propose a maker toolkit designed to enable older adults to explore the possibilities of mixing traditional craft with technology.

We employed a modified participatory design method in our workshops in an effort to further develop a relationship with the participants and gauge their abilities. Researchers typically determine the needs of older adults and then create something suited to their needs without directly involving the older adults themselves in the development process [18, 24]. Whereas in a participatory design process, researchers involve and elicit ideas from all stakeholders in the study [16, 18]. Our augmented participatory design method includes an initial session in which participants teach us about their craft by presenting various artifacts. We also conducted standard sessions where we introduced participants to electronics concepts and held a joint brainstorming session. Using information gathered from the participatory design workshops, we designed a toolkit that empowers older adults to create and personalize their own technological devices.

Our work contributes the following to the HCI community: 1) a thorough description of our modified participatory design method, 2) a detailed description of the process for creating the toolkit and the contents of the toolkit, and 3) qualitative analysis of participant activities and interactions utilizing the maker toolkit.

2. RELATED WORK

We organize related work into two main sections: creativity and maker technology. We discuss maker technology in two separate subsections: generalized maker technology and maker technology for children.

2.1 Creativity

The use of art as a therapeutic measure has largely been studied in the context of mental impairments such as dementia. Art therapy typically seeks to minimize the social isolation and loss of personal identity that people with dementia experience [18, 24]. However, art therapy does not only compensate for deficiencies in health. Art therapy can encourage sharing of personal thoughts and emotions among people with mental impairments, even in situations where they would normally feel isolated or detached from the rest of society [8,15]. For example, the Third Hand is a practice in art therapy that empowers and enables the desires of the client, encouraging creative thinking without focusing on health deficiencies [14]. We drew upon the concepts of the Third Hand and the importance of inclusion in a larger community when designing our toolkit, ensuring that it promoted creativity and affirmed older adults' abilities as innovators. However, our toolkit is designed for the general older adult population rather than just those with mental impairments.

Engaging in creative activities has proven health benefits. Several studies reported that participating in the creative arts as an adult was associated with higher cognitive function as compared to the control group [7, 19]. Additionally, cognitively stimulating activities can reduce the risk of Alzheimer's disease [23,25]. Participating in creative activities provides health benefits to older adults; however, toolkits targeting this audience have not been developed.

2.2 Maker Technology

One of the most predominant precursors to our work is the development of "Maker Technology," a technology-based extension of do-it-yourself projects. Maker technology is centered around learning by doing, or creating tangible, technological artifacts. If older crafters are given the opportunity to use their physical senses and build tangible artifacts in a familiar context, we propose that they will be more prepared and motivated to build personalized art that betters their health.

Previous studies with designing maker technology and artifacts in general found benefits to working with tangible visualizations. Lazar et al. found that older adults were satisfied by leisure activities that resulted in tangible products, such as knitting [13]. Participants cited the tangible benefits as the reason they enjoyed working with e-textiles [20]. Brereton et al. [3] conducted a study with engineering students engaging in design project work and found that engineers learn by comparing their knowledge of the physical world to unfamiliar theoretical models. Although the study was conducted with engineering students, the results, which point to the importance of physical objects in design, can likely be extended to older adults as well. In addition to the benefits of creating with tangible objects, previous studies have explored the creation of tangible visualizations of health. Running data is transformed with Activity Sculptures into three-dimensional representations, resulting in increased motivation and self-reflection [22].

While designing toolkits to introduce children to electronics and encourage the creative development of tangible objects is a burgeoning research field, there is a dearth of toolkits designed specifically for older adults. littleBits is one example of kits catered towards school-aged children [2]. They consist of pre-programmed electronic modules that snap together with magnetic connections, allowing participants to "play with electronics without knowing electronics" [2]. MakerShoe and MakerWear explore this vein further, allowing children to plug hexagonal modules into shoes and other items of clothing to create different effects [11, 12]. Quilt Snaps is a textile-based toolkit developed to expose children to electronics [6]. These kits allow children to be creative without fully comprehending the concepts of electronics, a crucial aspect of Maker toolkits. The field of maker technology for children is expanding, but these kits are unsuitable for older adults as the applications are centered on children's interests and the method of connections limits the possibility of fully integrating the modules into pre-existing household objects.

The maker toolkits for children were often more effective when the children were invested in creating their wearable. Eduwear, a toolkit designed for the construction of wearable technology, capitalizes on this principal by enabling children to create personally meaningful artifacts [10]. Building on this finding, Anathanarayan et al. found that children who spent over 90 minutes creating their wearable device used it more often [1]. While these toolkits were designed for children, we utilize the principle that creating a personally meaningful device results in greater use of the device in our toolkit for older adults.

Maker technology has also been developed for a broader audience. Circuit stickers are pre-programmed modules connected through a common substrate and designed for prototyping purposes [9]. Circuit stickers provide a novel interface but are somewhat untested for integration in three-dimensional spaces. Some maker technology, such as MaKey MaKey has been studied with older adults, but while they enjoyed playing with the technology, they "felt the kit was target more for others and not themselves" [21]. When older adults were working with MaKey MaKey, they [w4:sp] were not brainstorming potential applications, but rather noting that they would like to share the experience with their grandchildren. Mellis et al. [17] describe an "untoolkit" as a toolkit that appeals to the user's creativity and encourages the artistic design process to a greater extent than traditional kits. The "untoolkit" required some programming knowledge, limiting the audience, and was designed for two-dimensional spaces, limiting the applications. Our toolkit builds on these previous craft approaches to technology but is designed to fit the needs of older adults, rather than the general population.

In addition to maker technology, wearable technology has been developed for adults. The LilyPad Arduino allows for easy creation of e-textiles as the electronic modules can easily be sewn into fabric and connected with conductive thread [4]. Our toolkit builds upon this advance by providing older adults with the necessary materials to build wearable devices. Buechley and Eisenberg discuss new techniques for attaching electronics to textiles to create wearable devices, such as PCBs, electronic sequins, and socket buttons [5]. Electronic sequins and socket buttons make it much easier to sew electronics into textiles and are utilized within our toolkit.

3. BACKGROUND

To establish rapport with the crafting groups and better understand the needs and abilities of older adults, we conducted initial observations with five distinct crafting groups and administered a survey.

3.1 Observations

We recruited older adults from a midwestern city and the surrounding area by reaching out to recreational centers, senior centers and assisted living communities. Our target populations was groups with at least 40% of their members over the age of 65 and whose aim was to craft a tangible object. We selected older adults creating tangible objects as a form of extreme case selection. We are developing a toolkit that combines electronics with crafting and older adults currently creating tangible objects are capable of using their hands, enthusiastic, and creative.

At the beginning of crafting sessions, researchers introduced themselves and received verbal consent. No incentives were provided. We observed five distinct crafting groups and 45 participants (44 female). Over 10 weeks, we attended a total of 23 hours over 12 separate sessions. We visited each group at least twice for an average of 2 hours at a time. Researchers conducted ethnographic-style observations during sessions. Three researchers, two not associated with observations, iteratively analyzed the observation field notes using an affinity diagram method.

The observations of older adult crafting groups lead to three major themes: group structure, group support, and artifact sharing.Group structure was split into three categories defined by the overall function of the group - independent projects, collaborative projects, and class style. The way groups supported their members came in several different forms. The most common form of support was facilitating help between participants. Some groups had a show-and-tell style session that helped members elicit feedback from each other. Supporting beginner crafters was also a crucial function of these groups, but the groups differed in terms of who was expected to help. Each group shared artifacts they crafted differently, both within the group and to others outside of the group. Sharing within the group was often done to solicit feedback on a project and provide validation that a crafter belonged there.

3.2 Survey

To complement our observations, we conducted a survey exploring older adults' habits, their interest in technology, and their interest in health. We recruited participants from the observation groups and through social media. Participants from the observation groups took a paper version and participants recruited online took an electronic version.

Our target population for the survey was anyone over age 18 who was creating a tangible object. We allowed for a broader age range for comparison between ages. We collected 142 unique responses. Forty-one were over the age of 65 and 137 were female. The respondents had a wide variety of primary crafts, but most were knitters(65), sewers(22), crocheters(20), and quilters(11).

From our survey we learned about older adults' preference in how they craft. One notable difference between older adults to those younger than 65 is that a higher percentage of older adults looked to magazines to help and online videos and social media less.

4. METHODS

The goals of our methods was to understand the needs and abilities of older adults and then design a toolkit specifically for them. We conducted a modified participatory design workshop consisting of three sessions, where we learned about older adults crafting habits, taught them about electronics, and held a joint brainstorming session. After fully understanding the needs of older adults we designed an electronic maker toolkit specifically to fit their interests.

4.1 Participatory Design Workshop

We recruited older adult crafters from a rural midwestern town and the surrounding area by reaching out to recreational centers, senior centers and assisted living communities to participate in a series of workshops to occur outside of their current crafting group times. The workshops consist of three two-hour sessions focused on 1) understanding their crafting habits and practices, 2) building their knowledge of small electronics and 3) prototyping ideas of how they would electronically enhance their craft.

In the first session, participants teach the researchers about their crafts in a show-and-tell manner followed by a focus group discussion about their crafting. Additionally, participants fill out a survey on demographics, crafting habits, and familiarity with technology.

The second session is focused on the research team teaching the participants skills relevant to small electronics. We demonstrate how to build paper circuits and teach some basics of electronic circuitry before participants create their own light-up birthday card. Next, we introduce some basic Arduino components and have the participants go through an activity using a pre-programmed Grove Kit from Seeed Studios. Participants were asked to fill out a pre- and post-test to evaluate their confidence working with electronics.

Finally, in the third session we created low-fidelity paper prototypes based on their ideas. To facilitate idea generation, participants were encouraged between session to take pictures or videos of ideas in their own homes to share. Participants are also encouraged to bring in items that they would want to enhance with electronics. These ideas will be shared in a brainstorming session to help inspire participants, after which they will create low-fidelity prototypes using office supplies, pre-cut shapes (e.g. an Arduino), and sample physical components like LEDs. We will conclude with a questionnaire asking for feedback on the workshop as well as specific questions about their health interests.

The workshop was analyzed using an affinity diagram to analyze themes. Survey data was analyzed with descriptive statistics and the pre-post test for the second session was analyzed using a paired t-test to validate whether or not the participants improved their understanding of electronics.

4.2 Toolkit Design

Using information gathered from the participatory design workshops, we manufactured a toolkit to allow older adults to create personal electronic devices independently. Our toolkit is designed to be accessible and customizable, allowing adults with little electronic or programming knowledge to benefit while more experienced individuals are not limited. We tested a series of electronics from the LilyPad set and Flora set to decide if they should be included in our toolkit.

5. FINDINGS

5.1 Participatory Design

- Several major themes emerged from the participatory design workshop such as adding lights to improve the aesthetics of crafts, enhancing the interactivity of crafted objects by adding lights along with other sensors, and using electronics to create customized household objects relating to health, security, and recreation.

- Many participants were interested in using electronics to enhance the aesthetics of their existing creations, such as adding lights to shirts or quilts.

- Participants were also interested in using electronics to make their crafts more interactive and in addition to adding lights, would add other sensors or outputs. For example, one participant was interested in adding lights to her dog quilt as well as a motion activated voice box so it would bark when someone walked by. Another participant was interested in making a painting that would have motion activated lights. Several participants were interested in making lit creations that would only come on when it was dark.

- In addition to enhancing the appearance of crafts they were currently creating, participants were interested in enhancing the functionality of everyday objects relating to health, security, and recreation. One participant thought of adding a heat sensor to a heating pad that would buzz if the temperature became too high for older people's sensitive skin. Several participants mentioned ideas about sensors that would detect motion and notify family members that their loved ones were up and about. Other kinds of sensors could indicate through lights or sound that one's blood sugar or oxygen levels had dropped.Another idea was putting a visual display on a box that would require the user to practice multiplication tables or play a game of X's and O's before the box would open.

5.2 Soft Textile Toolkit

- We made two exemplar objects to show how the toolkit could be used to enhance the functionality of everyday objects.

- The first object is a medication box with light sensitive LEDs. The LEDs will turn on when the box is open or if the box has not been opened in twelve hours.

- The first prototype of the medication box was made from laser-cut cardboard, LEDs, a light sensor and the LilyPad Arduino. We sewed all of the components by hand and the circuit was sealed by a cotton fabric panel so only the power switch was accessible.

- For the second prototype we wanted to make it easier for a beginner to make the box. We decided to make the LilyPad components snap into a fabric underlay and color code the top of each piece to indicate power, ground, digital, and analog. Additionally, we decided to add strips of conductive fabric to make it easier to use the LilyPad in a sewing machine.

- The second object is a pair of "see-in-the-dark" 3-D printed glasses. An LED in the front of the glasses lights up when a light sensor attached to the glasses senses darkness.

- The first prototype of the glasses consisted of a fabric patch on which the Lilypad Arduino and the light sensor were sewn together using conductive thread. This patch was attached to the side of the glasses using non-conductive thread. The Lilypad communicated with the LED, which was connected to the front of the glasses using non-conductive thread, through long strands of conductive thread that hung below the temples of the glasses.

- Problems that arose with the first iteration of the glasses were loose conductive thread connections between the fabric and the electronics. Also, we encountered difficulty securing the fabric patch and electronics to the hard plastic of the glasses.

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Figure 1: Color Coded LilyPad with Snaps and Conductive Fabric

5.3 Toolkit

- Our toolkit contains a modified LilyPad Arduino , sensors, LEDs,

- We modified the LilyPad Arduino platform by laser cutting strips of conductive fabric and ironing them on to a fabric underlay labeled with the corresponding part. We soldered snaps to the underside of the LilyPad and sewed the corresponding male snap into the conductive fabric underlay with conductive thread. This allows the LilyPad modules to be easily removed from exisiting projects and reused for future projects.

- The top of the LilyPad was color-coded so it would be easier for older adults to build circuits - pink indicated power, black indicated ground, and yellow indicated analog.

Component	Included or Excluded	Reason
Light Sensor	....	....
Motion Sensor	....	....

6. DISCUSSION

6.1 Participatory Design

- Insert the significance of major themes that emerged from the workshop

- Theme: Aesthetics

- Theme: Interaction - indirect vs. direct

- Theme: Functionality - practical vs. health related

6.2 Exemplar Objects

- We realized that placing a strong emphasis on modular design simplified the construction of our example objects. Adding snaps to the components allowed the parts to be reused in future projects while also eliminating the need the sew the difficult tabs into fabric. The conductive fabric allowed for the use of the sewing machine, making the process much faster.

- We extended this modularity to our toolkit to ensure that users can create a basic craft within a relatively short period of time.

6.3 Toolkit

- Our toolkit is designed specifically for older adults because it is highly customizable, while still allowing those with little electronic knowledge to participate. We have modified the LilyPad Arduino [4] platform to make it easier to sew with conductive fabric strips and the connections are more obvious with a color coded system. Additionally, the toolkit has more guidance as it is accompanied by a written user manual catered for older adults as opposed to LilyPad's online guide pages.

- Components are can be connected with either copper tape or conductive thread. This allows for greater flexibility as the components do not require a specific platform or medium to be used, such as cloth or a hard surface. Previous maker kits were more abstracted and required a specific platform, such as MakerWear [11], which had magnetic connections to a specific platform, or LittleBits [2], which had magnetic connections. Additionally, the toolkit can be used to create two-dimensional or three-dimensional products, and can be used to integrate electronics into pre-existing household objects.

7. CONCLUSION

The conclusion will go here.

8. ACKNOWLEDGEMENTS

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9. REFERENCES

[1] S. Ananthanarayan, K. Siek, and M. Eisenberg. A Craft Approach to Health Awareness in Children. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, pages 724–735, Brisbane, QLD, Australia, 2016. ACM.

[2] A. Bdeir and T. Ullrich. Electronics as material: littlebits. In *Proceedings of the 5th International Conference on Tangible, Embedded, and Embodied Interaction*, pages 341–344. ACM, 2011.

[3] M. Brereton and B. McGarry. An observational study of how objects support engineering design thinking and communication. In *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '00*, pages 217–224. ACM Press, 2000.

[4] L. Buechley and M. Eisenberg. The LilyPad Arduino: Toward Wearable Engineering for Everyone. *IEEE Pervasive Computing*, 7(2):12–15, April 2008.

[5] L. Buechley and M. Eisenberg. Fabric PCBs, electronic sequins, and socket buttons: techniques for e-textile craft. *Personal and Ubiquitous Computing*, 13(2):133–150, 2 2009.

[6] L. Buechley, N. Elumeze, C. Dodson, and M. Eisenberg. Quilt snaps: A fabric based computational construction kit. In *Proceedings - IEEE International Workshop on Wireless and Mobile Technologies in Education, WMTE 2005*, volume 2005, pages 219–221, 2005.

[7] G. D. Cohen, S. Perlstein, J. Chapline, J. Kelly, K. M. Firth, and S. Simmens. The Impact of Professionally Conducted Cultural Programs on the Physical Health, Mental Health, and Social Functioning of Older Adults. *The Gerontologist*, 46(6):726–734, 2006.

[8] R. Cornejo, R. N. Brewer, C. Edasis, and A. M. Piper. Vulnerability, Sharing, and Privacy: Analyzing Art Therapy for Older Adults with Dementia. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing - CSCW '16*, pages 1570–1581, 2016.

[9] S. Hodges, N. Villar, N. Chen, T. Chugh, J. Qi, D. Nowacka, and Y. Kawahara. Circuit Stickers: Peel-and-Stick Construction of Interactive Electronic Prototypes. In *ACM CHI Conference on Human Factors in Computing Systems*, pages 1743–1746. ACM, 2014.

[10] E.-S. Katterfeldt, N. Dittert, and H. Schelhowe. EduWear: Smart Textiles as Ways of Relating Computing Technology to Everyday Life. In *Proceedings of the 8th International Conference on Interaction Design and Children*, pages 9–17, Como, Italy, 2009. ACM.

[11] M. Kazemitabaar, J. McPeak, A. Jiao, L. He, T. Outing, and J. E. Froehlich. Makerwear: A tangible approach to interactive wearable creation for children. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pages 133–145. ACM, 2017.

[12] M. Kazemitabaar, L. Norooz, M. L. Guha, and J. E. Froehlich. Makershoe: Towards a wearable e-textile construction kit to support creativity, playful making, and self-expression. In *Proceedings of the 14th International Conference on Interaction Design and Children*, pages 449–452. ACM, 2015.

[13] A. Lazar. Successful Leisure in Independent Living Communities: Understanding Older Adults' Motivations to Engage in Leisure Activities. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pages 7042–7056, Denver, CO, USA, 2017. ACM.

[14] A. Lazar, R. Cornejo, C. Edasis, and A. M. Piper. Designing for the third hand: Empowering older adults with cognitive impairment through creating and sharing. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, pages 1047–1058. ACM, 2016.

[15] A. Lazar, C. Edasis, and A. M. Piper. Supporting People with Dementia in Digital Social Sharing. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, pages 2149–2162, New York, New York, USA, 2017. ACM Press.

[16] S. Lindsay, D. Jackson, C. Ladha, K. Ladha, K. Brittain, and P. Olivier. Empathy, Participatory Design and People with Dementia. In *ACM CHI*, pages 521–530, Austin, Texas, USA, 2012. ACM.

[17] D. A. Mellis, S. Jacoby, L. Buechley, H. Perner-wilson, and J. Qi. Microcontrollers as material: crafting circuits with paper, conductive ink, electronic components, and an "untoolkit". In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction*, pages 83–90, 2013.

[18] A. Mihailidis, S. Blunsden, J. Boger, B. Richards, K. Zutis, L. Young, and J. Hoey. Towards the development of a technology for art therapy and dementia: Definition of needs and design constraints. *The Arts in Psychotherapy*, 37(4):293–300, 2010.

[19] H. Noice, T. Noice, and G. Staines. A Short-Term Intervention to Enhance Cognitive and Affective Functioning in Older Adults. *Journal of Aging and Health*, 16(4):562–585, 2004.

[20] H. Perner-Wilson, L. Buechley, and M. Satomi. Handcrafting textile interfaces from a kit-of-no-parts. In *ACM TEI*, pages 61–68, Funchal, Portugal, 2011. ACM.

[21] Y. Rogers, J. Paay, M. Brereton, K. Vaisutis, G. Marsden, and F. Vetere. Never too old: engaging retired people inventing the future with makey makey. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 3913–3922. ACM, 2014.

[22] S. Stusak, A. Tabard, F. Sauka, R. A. Khot, and A. Butz. Activity Sculptures: Exploring the Impact of Physical Visualizations on Running Activity. *IEEE Transactions on Visualization and Computer Graphics*, 12(20):2201–2210, 2014.

[23] J. Verghese, A. LeValley, C. Derby, G. Kuslansky, M. Katz, C. Hall, H. Buschke, and R. B. Lipton. Leisure Activities And The Risk of Amnestic Mild Cognitive Impairment In The Elderly. *Neurology*, 66(6):821–827, 2006.

[24] R. J. S. L. Waller, Diane. A Multi-centre Randomized Control Group Trial on the Use of Art Therapy for Older People with Dementia. *Group Analysis*, 39(4):517–536, 2006.

[25] R. S. Wilson, C. F. M. de Leon, L. L. Barnes, J. A. Schneider, J. L. Bienias, D. A. Evans, and D. A. Bennett. Participation in Cognitively Stimulating Activities and Risk of Incident Alzheimer Disease. *JAMA*, 287(6):742, feb 2002.