PROJECT REPORT

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Introduction

This paper will reveal the basis of my proposed thesis project where I will be exploring the area of interactive design tools by the means of creating an interactive table top interface and explore how it can augment the overall user experience. The relevant findings of my literature review will provide an outline towards the general theme that is emerging from the need to re-evaluate current design ideology and how to implement these concepts into the current system. This paper will highlight the need for creating new design tools that can transcend various disciplines and skillsets to allow a broader range of people to get involved in the creative process. The literature review will also introduce the theoretical grounds for my methodological approach based on Schön's theory of reflective practice. The next section of the paper will explain how I will apply the methodology into the final project and outline the goals I have envisioned to plan for the further iteration.

Project Outline

For my thesis project, I will be exploring the area of interactive design tools by the means of creating an interactive table top interface and explore how it can augment the overall user

experience. The initial idea for this project came from a previous project I had discovered online which evolved creating a box with the inside lined with tinfoil, the foil would then be wired to an Arduino from which it can detect movement from anyone who places their hand near the foil. The Arduino can then transfer the readings into a Processing sketch to control graphics or sound. I wish to further iterate on this idea by creating smaller foil panels and attach them to the underside of a table in order to make an interactive table that could be used as a computer interface for games, design applications or music applications. The goal of the project is to bridge the void between experienced tech users and beginners.

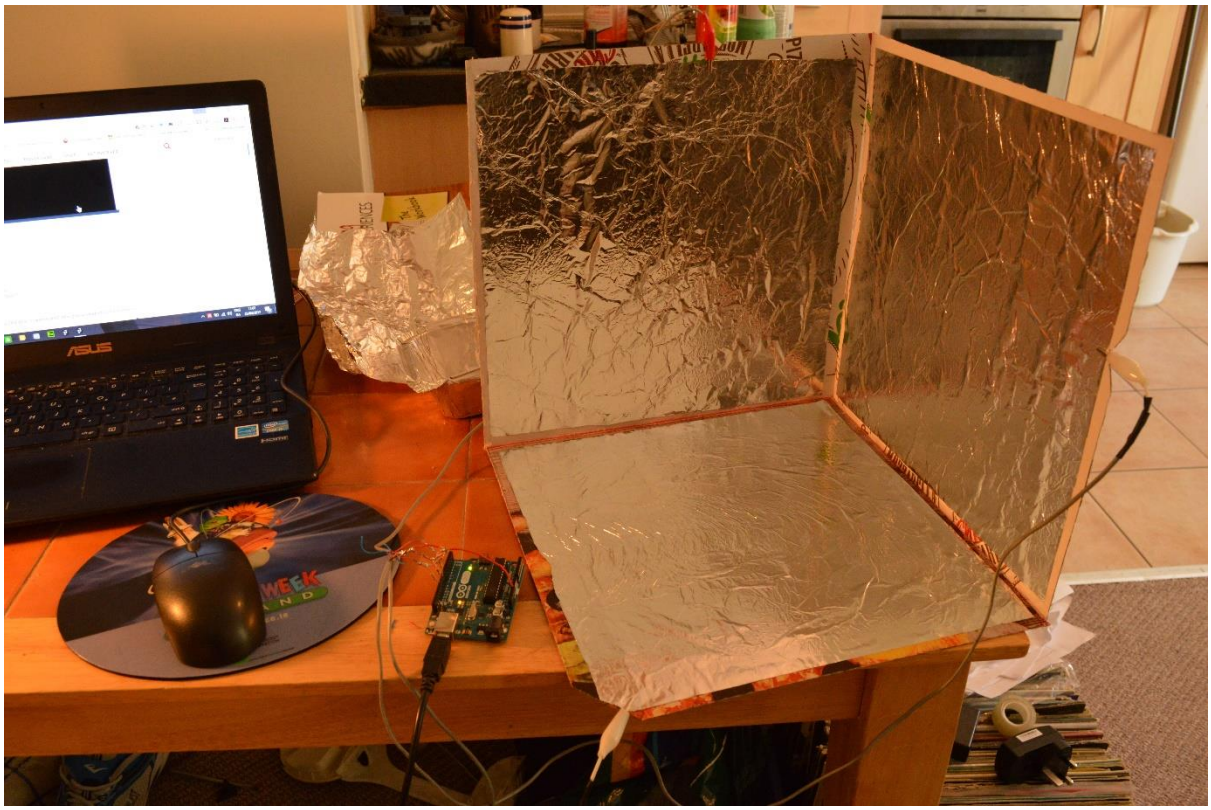

Figure 1 : Homemade motion detecting foil cube prototype

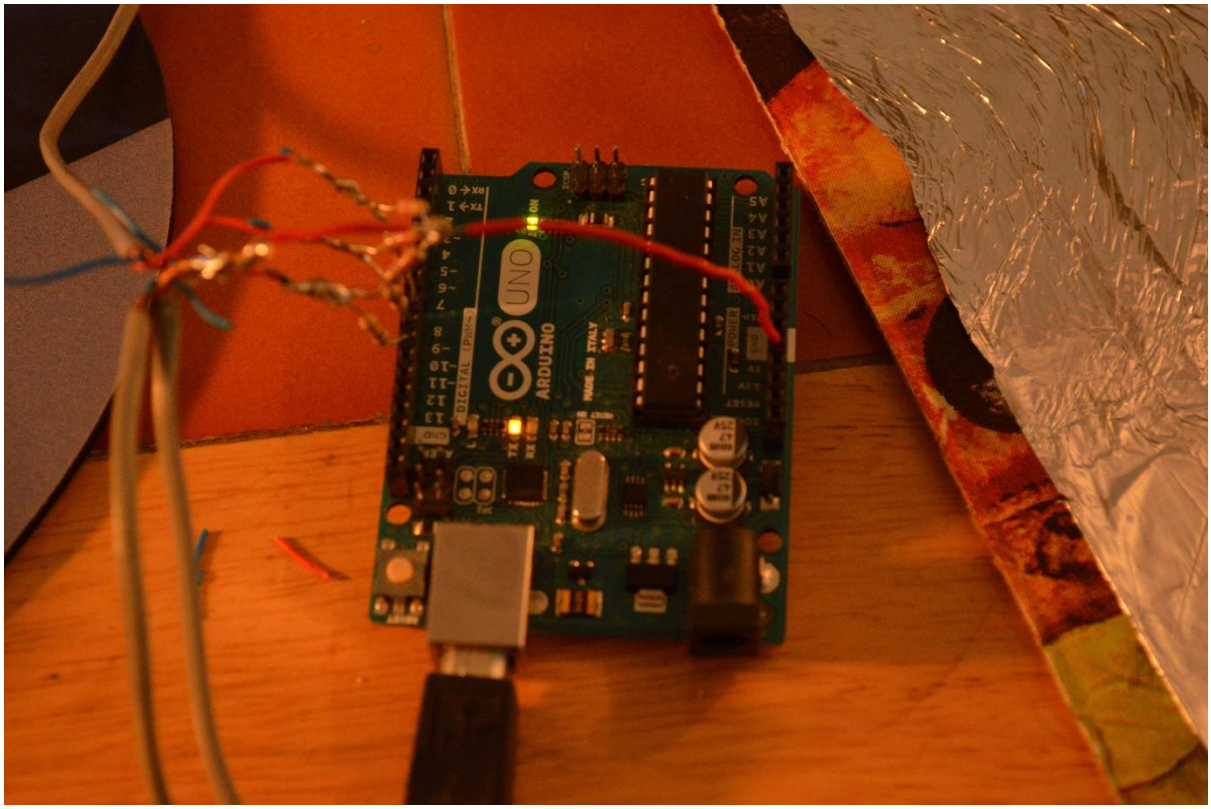

Figure 2 : Arduino wired to Foil cube

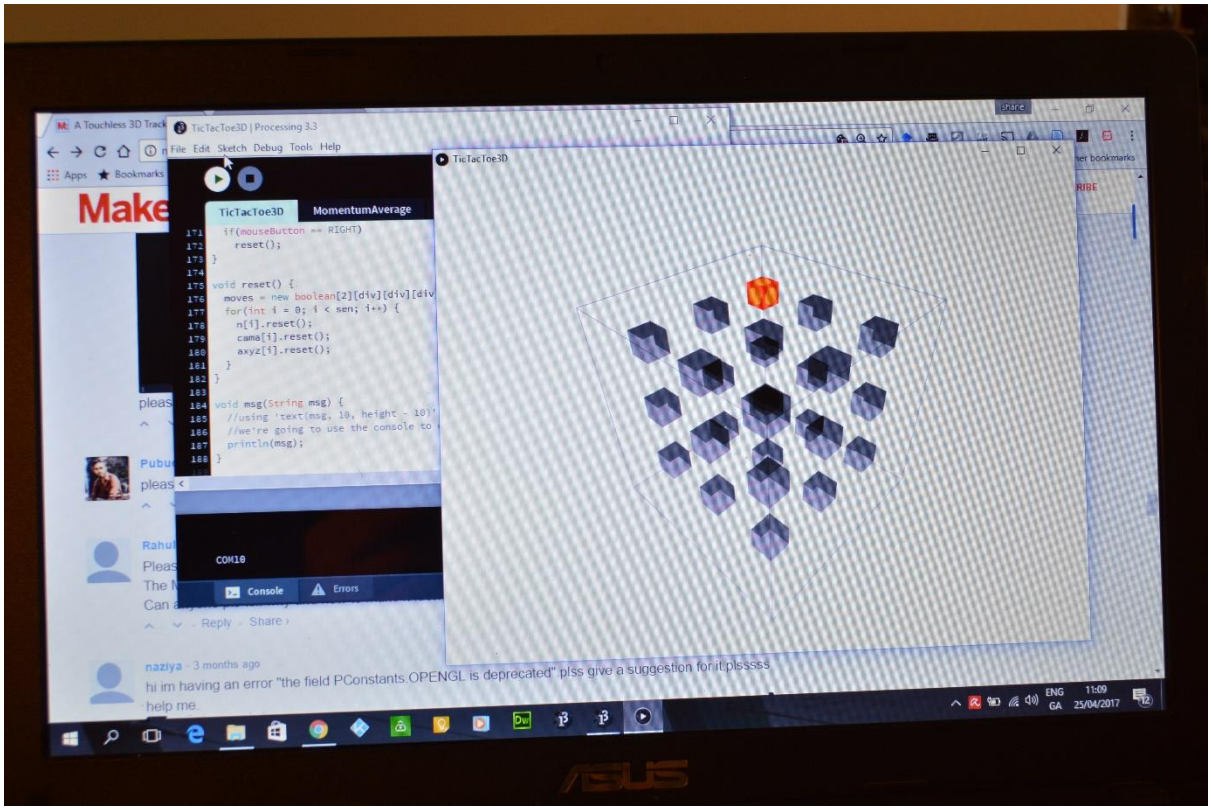

Figure 3 : Processing Sketch for reading data from the tin foil cube

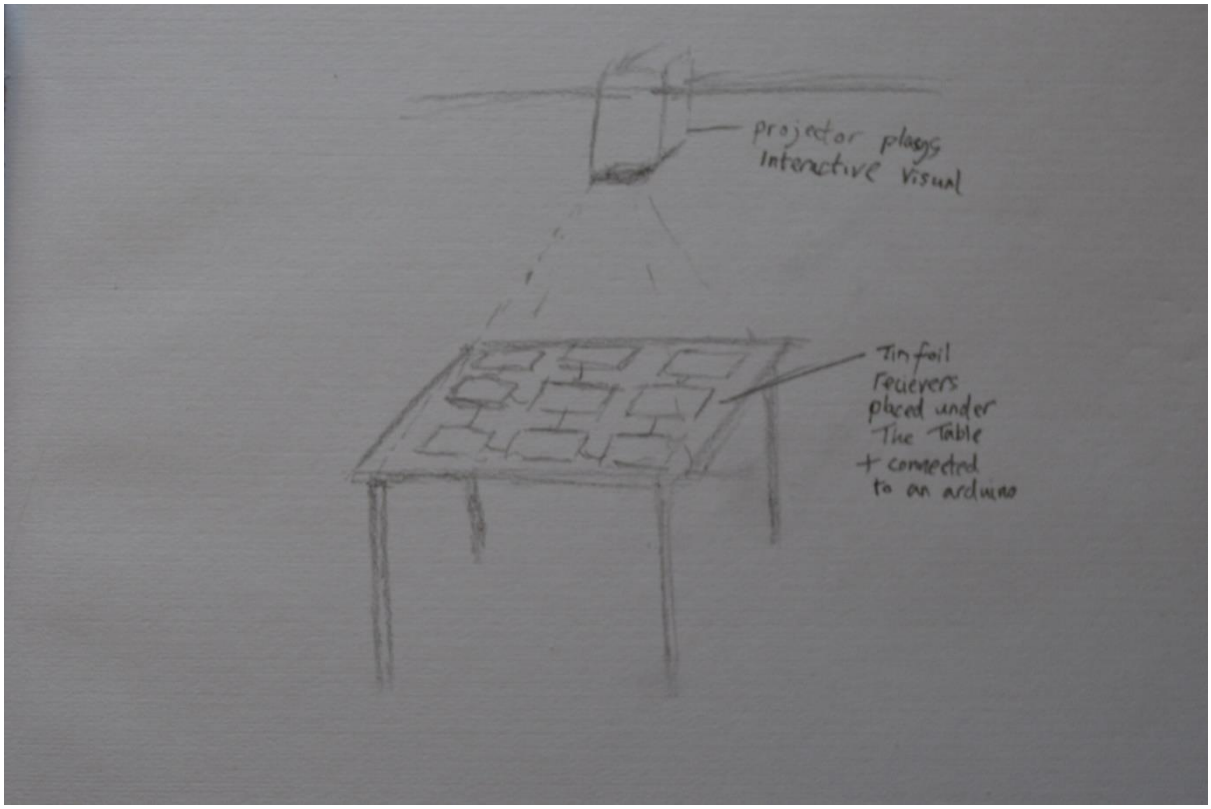

Figure 4 : Sketch of Interactive Table

Literature Review

Joerg Beringer states in his article *Reducing Expertice Tension* that End User Development (EUD) is the design issue that permits experts of their own areas to personal software components for their own specific field of expertise. (Beringer, 2004) emphasises that that this design issue is not only a problem for the experts the software is designed for but also for those who lack the skills and expertise needed to operate the software artefact. In the (Sanders and Stappers, 2008a) paper entitled *Co-creation and the new landscapes of design*, the focus is towards how the user-centred method in reference to co-designing is transforming the landscape in regards to the roles of designers, researchers and users. (Sanders and Stappers, 2008a) emphasize that the practice of design is evolving from a user-

centred approach to a more co-designing approach to which more so embraces the users creativity. The focus of manufacturing companies has always been open to design methods to make products initially based on a deterministic idea of what people need. Therefore (Sanders and Stappers, 2008a) state that the first advances in user- centred approach originated from industrial practices from which it was used from the experts viewpoint where researchers would be appointed to interview the users, who were mainly passive in the process. This was the American approach whereas the Northern European approach was exploring a more participatory method where by the users role was more of a partner in the design process. (Sanders and Stappers, 2008a) believe that from the conjunction of these two methods the concept of co-creation/co-design has emerged within the field of participatory design. In the broader sense of the term co-design in participatory design even when the user has been promoted to co-designer the authorship remains with the designer, as it is the designer's role to create the scenario for the user. The roots of co-design are very much steeped in business and marketing practices and are somewhat lacking in a truly creative ethos. Fischer's paper entitled *Beyond 'Couch Potatoes': From Consumers to Designers and Active Contributors*, further analyses the issue by declaring that a culture is defined by their media and tools in order for them to think, work, learn and collaborate. Fischer believes that through the arrival of new media artefacts, that the culture has shifted to one where the artefacts are designed from the viewpoint that the human is a consumer (Fischer, 2002a). To counter act this issue Fischer explores the concept of the 'designer' as " a person who wants to act as an active participant and contributor in personally meaningful activities " (Fischer, 2002, p. 2), from which he believes that humans should take on the role of designers should they desire to do so. (Sanders and Stappers, 2008a) Highlight as what they believe to the reasons why the principles and practices of co-design have had so many setbacks, they begin with the point that co-creativity involves the belief that everyone has creativity, which would

not be a generally accepted standpoint, particularly from those involved in the world of business. For Sanders and Stappers co-designing in business terms can be seen as a threat to the existing hegemonic structures of companies who they believe prefer to adopt the model the leading people, the so-called experts are the only one's capable of taking on the role of the co-designer. (Fischer, 2002b) calls for a paradigm shift in regard to the production of next generation of technological artefacts believing that knowledge must not be restricted to who he labels as 'high - tech scribes', those whose roles are distinguished by the division of the computing world from the greater population who are marginalized by their lack of knowledge into the role of the consumer, further emphasising the need for social discussions and a collaborative design approach. (Fischer, 2010a) advocates that the Web 1.0 model primarily supported web page publishing and e-commerce but with the emergence of Web 2.0 there was fundamental cultural shift from a consumerist culture to a culture of sharing and participation with collaborative design environments, social media and social networks. (Sanders and Stappers, 2008a) agree with this point of view stating that the internet has given a voice to those who were previously disenfranchised, they believe that the next generation will have more choice in the distribution and control of ownership. (Sanders and Stappers, 2008a) also agree with (Fischer, 2002b) on his stance on that participatory thinking is in opposition to consumerism and maintain that consumerism is associated with the notion of happiness. (Sanders and Stappers, 2008a) have encountered in their studies that people are slowly seeking the middle ground regarding to consumerism as the option to partake in different creative experiences are emerging, but Sanders and Stappers believe it will take some years before consumerist culture moves towards an equilibrium with creative practices. Participatory design has also been seen by the competitive marketplace as nothing but academic endeavour but in recent years perceptions have changed as product development has become predominantly more knowledge based, as the focus shifts from just designing

products “for user’s to designing products for the future experiences of people, communities and cultures”(Sanders and Stappers, 2008a, p. 6),

(De Haan, 2013)states that the decrease in fixed design costs in relation to the production of computing hardware, enables a more flexible approach to the human centred design process. This affords to the designer a greater opportunity to enhance their focus on the user’s experience of the product. (Gross and Do, 2007) support the Leonardo model, in where an individual will traverse between different disciplines, acquiring what skills and knowledge they need to reach there end goal. (De Haan, 2013)highlights that Interactive computing started out as hard core electronics and the emergence of tangible interaction has given the user a more human like sense of operation as opposed to pressing buttons and flicking switches. (Gross and Do, 2007) explore the concept of tangible interaction and the desire to ‘make things’. “ We build computationally enhanced artefacts that are objects to think with, to play with, to contemplate ideas about design.” (Gross and Do, 2007, p. 10). Gross and Yi-Luen Do further emphasize this concept by listing three key points (1) Owning the Problem – to identify a problem and to find the solution. (2) Design and the play Instinct – In opposition to the tedious production techniques, here the element of play is utilised in the way a Crafts person would explore their medium and processes, to which may pave the way for a more innovative interactive experience. (3) Building Tools to Make Things – to abandon the idea of making a specific design for a specific user, rather to explore the possibilities of affording the user more of a physical interaction in opposition to mundane point and click interaction with a piece of computer software. This may personalise the usage of the application for the user (Gross and Do, 2007).

(Gaver, 2012) advocates exploring the broader landscape of design through sketching, scenarios, design proposals and design games is a vital to the design process but also is a

strong believer in that through the practice of making leads to discovery and how this more hands-on approach allows for a deeper understanding than that of analytical methods.

(Löwgren, 2016) agrees with this statement and believes it to be one of the reasons attributed to the rising appreciation that the process of making is an important area in the further studies of interaction design. Through Löwgren's own design practice, from which he was exploring the idea of combing physical computing with bookbinding, to make a book that could count its pages, he highlights an important point. On a project to which he felt was problematic and beginning to become a dead end due to fact that the book was not giving accurate readings, it was trough his mistakes that Löwgren discovered a new design concept of a pressure sensitive book that had the potential of creating new augmented book experiences (Löwgren, 2016). Donald A. Schön's paper *The reflective practitioner – how professionals think in action*, (Schön, 1983) asserts from his findings that the reflective practitioner through trial and error " the situation talks back"(Schön, 1983, p. 3) to the practitioner who then discovers new possibilities and outcomes from the task at hand.

(Fischer, 2010b) explores reflective practice involved in the Envisionment and Discovery Collaboratory (EDC), a research platform that brings participants of various backgrounds to collaborate to resolve complex urban planning issues. The EDC incorporates the use of HCI technologies such as table top computing and integration of tangible computing components. (Ishii, 2008) emphasises that the use of tangible computing under these circumstances allows the users to take advantage of their dexterity and to get hands on with physical forms, the purpose of tangible user interfaces in this setting is to make the design process trans-disciplinary, participants of various backgrounds when brought together can inform one another and reflect through the collusion of ideas without requiring a great deal of skill to perform the tasks.

The work of Jay Silver embraces the concepts of the maker methodology and DIY nature to which he refers to as his ‘awakening’. (J. Silver, 2009a) began his journey began with exploring the idea of using a basic 555 timer circuit to make anything from everyday objects to living things into a Theremin style electronic musical instrument. How the device works is that whenever it makes contact with anything conductive it will make noise through a speaker built into the circuit. Silver experimented with different conductive materials and could even use the device to play musical notes on a puddle of water. It was not until Silver discovered that graphite from a pencil could be used as a conductive circuit that the idea of the Drawdio came around. The Drawdio is an electronic musical instrument that allows the user to draw their own circuits to control audio. (J. Silver, 2009a) insists that the ideation of the device was acquired partly through his own reflective practice and from sharing ideas with other people, many other artists and crafters have used the circuit design. The success of the idea is due to the simplicity of the circuit, many from the field of design are of the belief that prototyping with electronics is mainly about experimenting with Arduino and Raspberry Pi microcontrollers, (Evans, 2012) believes that the arrival of opensource microcontrollers have introduced people to the world of hacking electronics but still considers them to be artefacts that interlinked with consumerist values, (Evans, 2012) believes that society should promote the re-using and re-cycling of discarded obsolete technological artefacts and therefore the maker/hacker or potential designer can use the discarded raw material as a source of motivation to re-design and be creative. (De Roeck et al., 2014a) emphasizes that using current interactive prototyping tools (Arduino, Processing, Raspberry Pi) have pitfalls in that they may have too much of an influence on how an artefact is designed. De Roeck paper is mainly focused on early ideation processes and promotes the concept of low fidelity prototyping while initially stating that there is a need for more explorative digital tools for the ideation process to which tools such as Scratch and MakeyMakey are mentioned at the

beginning of the paper. (J. Silver, 2009a) describes the Drawdio as a toolkit that would allow users to explore and improvise on a broad spectrum of possible activities through the appropriation of the original design, the Drawdio is also the predecessor to the MakeyMakey.

(Silver et al., 2012) asserts that the Drawdio makes designing interfaces simple for people but they are constrained to generating music, the MakeyMakey enables users to explore tangible interfaces that can control any software on a computer. The MakeyMakey helps experts to ideate and explore the gap in the landscape for tangible user interfaces while also being inclusive to beginners.

Methodology

For my methodological approach, I will be adopting Schön's theory of reflective practice as the basis of my theoretical framework. Through my research I have explored the concept of meta-design and what I found particularly interesting were the user centred methods involving the users as designers and the call for cultural shift towards how we collaborate and co-design (Beringer, 2004; Fischer, 2010a, 2002a; Sanders and Stappers, 2008b). A paradigm shift liberating the marginalised, those who were relegated to positions that deemed them unfit to the expert mindset (Fischer, 2002a; Sanders and Stappers, 2008b). The general

theme that emerged from my findings is the idea of creating new design tools that can transcend various disciplines and skillsets to involve a broader range of people in the creative process. (Fischer, 2010b; Ishii, 2008) emphasize the importance of transdisciplinary collaboration through their research on desktop based tangible user interfaces and how by collaborative means and reflective practice the users/ designers can reflect and inform each other of different possibilities and potential outcomes, all the users have equal roles in the creative process. For my thesis project, I will be exploring the area of interactive design tools by the means of an interactive table top interface and how it can augment the overall user experience. The project is still in its early stages and I am currently exploring what materials and technologies I am going to require. I propose to run experiments pertaining to Schön's theory to reflect on my own practice of making and explore how to create a motion based desktop interface similar to the Leap motion and to explore how this technology can be used as an interactive interface that can be integrated into other forms of digital media and prototyping software such as Processing and Pure Data. Discovering through my own reflective practice by experimenting with materials is important to me and as Schön's theory upholds it is important in a creative process that the material communicates or 'talks back' to the practitioner, in turn the practitioner discovers previously unseen outcomes and creates new possibilities (Schön, 1983). My research methods for this project will be predominantly qualitative as I will have to test and observe users through adopting low and high fidelity prototyping techniques in order to explore the different possible outcomes for the interactive interface. I envision the project to be an interactive tool that has the potential to be used as an interface for numerous different types of computer applications that will be applicable to a broad range of users.

Technologies Involved

- Arduino Microcontroller
- Pure Data or Max/Msp
- Processing
- Electronics
- Arduino Ide

Plans for the Summer

Reference List

Barricelli, B.R., Fischer, G., Fogli, D., Mørch, A., Piccinno, A., Valtolina, S., 2016. Cultures of Participation in the Digital Age: From “Have to” to “Want to” Participate. ACM Press, pp. 1–3. doi:10.1145/2971485.2987668

Beringer, J., 2004. Reducing Expertise Tension. Commun ACM 47, 39–40. doi:10.1145/1015864.1015885

Beringer, J., Fischer, G., Mussio, P., Myers, B., Paternò, F., de Ruyter, B., 2008a. The Next Challenge: From Easy-to-use to Easy-to-develop. Are You Ready?, in: CHI ’08 Extended Abstracts on Human Factors in Computing Systems, CHI EA ’08. ACM, New York, NY, USA, pp. 2257–2260. doi:10.1145/1358628.1358663

Beringer, J., Fischer, G., Mussio, P., Myers, B., Paternò, F., de Ruyter, B., 2008b. The next challenge: from easy-to-use to easy-to-develop. are you ready?, in: CHI’08 Extended Abstracts on Human Factors in Computing Systems. ACM, pp. 2257–2260.

Buchanan, R., 1992. Wicked Problems in Design Thinking. Des. Issues 8, 5–21. doi:10.2307/1511637

Busch, O. von, Palmås, K., 2006. Abstract hacktivism: the making of a hacker culture. Open Mute, London; Istanbul.

Collins, N., 2006. Handmade electronic music: the art of hardware hacking. Routledge, New York.

De Haan, G., 2013. A Vision of the Future of Media Technology Design Education - Design and Education from HCI to UbiComp, in: Proceedings of the 3rd Computer Science Education Research Conference on Computer Science Education Research, CSERC ’13. Open Universiteit, Heerlen, Open Univ., Heerlen, The Netherlands, The Netherlands, p. 6:67–6:72.

De Roeck, D., Stappers, P.J., Standaert, A., 2014a. Gearing up!: a designer-focused evaluation of ideation tools for connected products. ACM Press, pp. 521–530. doi:10.1145/2639189.2639204

De Roeck, D., Stappers, P.J., Standaert, A., 2014b. Gearing up!: a designer-focused evaluation of ideation tools for connected products. ACM Press, pp. 521–530. doi:10.1145/2639189.2639204

Dena, C., 2007. Capturing Polymorphic Creations: Towards Ontological Heterogeneity and Transmodiology, in: Proceedings of the 4th Australasian Conference on Interactive Entertainment, IE ’07. RMIT University, Melbourne, Australia, Australia, p. 8:1–8:8.

Drew, D., Newcomb, J.L., McGrath, W., Maksimovic, F., Mellis, D., Hartmann, B., 2016. The Toastboard: Ubiquitous Instrumentation and Automated Checking of Breadboarded Circuits, in: Proceedings of the 29th Annual Symposium on User Interface Software and Technology, UIST ’16. ACM, New York, NY, USA, pp. 677–686. doi:10.1145/2984511.2984566

Eglash, R., 2004. Appropriating Technology: Vernacular Science and Social Power. U of Minnesota Press.

Evans, M., 2012. Hack everything: re-purposing everyday devices - Matt Evans, Linux.conf.au 2012 -- Ballarat, Australia. Ballarat, Australia.

Fischer, n.d. End User Development and Meta-Design: Foundations for Cultures of Participation [WWW Document]. URL http://l3d.cs.colorado.edu/~gerhard/papers/EUD-siegen-2009.pdf (accessed 4.27.17).

Fischer, G., 2010a. End User Development and Meta-Design: Foundations for Cultures of Participation. J Organ End User Comput 22, 52–82. doi:10.4018/joeuc.2010101901

Fischer, G., 2010b. Extending Boundaries with Meta-design and Cultures of Participation, in: Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries, NordiCHI ’10. ACM, New York, NY, USA, pp. 168–177. doi:10.1145/1868914.1868937

Fischer, G., 2010c. End User Development and Meta-Design: Foundations for Cultures of Participation. J Organ End User Comput 22, 52–82. doi:10.4018/joeuc.2010101901
Fischer, G., 2002a. Beyond “Couch Potatoes”: From Consumers to Designers and Active Contributors. First Monday 7.
Fischer, G., 2002b. Beyond“ Couch Potatoes”: From Consumers to Designers and Active Contributors, in: Computer Human Interaction, 1998. Proceedings. 3rd Asia Pacific. IEEE, pp. 2–9.
Gaver, W., 2012. What should we expect from research through design?, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, pp. 937–946.
Gestural Interaction [WWW Document], 2009. URL http://tangible.media.mit.edu/project/gestural-interaction (accessed 2.19.17).
Gross, M.D., Do, E.Y.-L., 2007. Design, Art, Craft, Science: Making and Creativity, in: Proceedings of the 2007 Symposium on Science of Design, SoD ’07. ACM, New York, NY, USA, pp. 9–11. doi:10.1145/1496630.1496636
Hallnäs, L., Redström, J., 2002. From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things. ACM Trans Comput-Hum Interact 9, 106–124. doi:10.1145/513665.513668
Harrop, P., 2007. Open Sourcery: When Hacker Culture Informs the Design Studio. J. Archit. Educ. 1984- 61, 69–72.
Holler, J., Tsiatsis, V., Mulligan, C., Avesand, S., Karnouskos, S., Boyle, D., 2014. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Academic Press.
Hvannberg, E.P., 2010. Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries. Association for Computing Machinery, New York.
Ishii, H., 2008. Tangible bits: beyond pixels, in: Proceedings of the 2nd International Conference on Tangible and Embedded Interaction. ACM, pp. xv–xxv.
Klemmer, S.R., Newman, M.W., Farrell, R., Bilezikjian, M., Landay, J.A., 2001. The Designers’ Outpost: A Tangible Interface for Collaborative Web Site, in: Proceedings of the 14th Annual ACM Symposium on User Interface Software and Technology, UIST ’01. ACM, New York, NY, USA, pp. 1–10. doi:10.1145/502348.502350
Löwgren, J., 2016. On the significance of making in interaction design research. interactions 23, 26–33.
Martin, L., 2015. The Promise of the Maker Movement for Education. J. Pre-Coll. Eng. Educ. Res. J-PEER 5. doi:10.7771/2157-9288.1099
Material Anxieties - Research [WWW Document], n.d. . Inst. Mak. URL http://www.instituteofmaking.org.uk/research/material-anxieties (accessed 4.2.17).
Moussette, C., Banks, R., 2011. Designing Through Making: Exploring the Simple Haptic Design Space, in: Proceedings of the Fifth International Conference on Tangible, Embedded, and Embodied Interaction, TEI ’11. ACM, New York, NY, USA, pp. 279–282. doi:10.1145/1935701.1935763
Nicolas Collins: Hacking Workshops [WWW Document], n.d. URL http://www.nicolascollins.com/hackingworkshops.htm (accessed 4.3.17).
O’Murchu,Nora.pdf, n.d.
Peppler, K., Bender, S., 2013. Maker movement spreads innovation one project at a time. Phi Delta Kappan 95, 22–27.
Robo Ulbricht, n.d. NE555 with Arduino frequency counter.
Sanders, D., 2003. Tools and Techniques for Teaching Object-oriented Concepts. J Comput Sci Coll 19, 133–134.
Sanders, E.B.-N., Stappers, P.J., 2008a. Co-creation and the new landscapes of design. Co-Des. 4, 5–18.

Sanders, E.B.-N., Stappers, P.J., 2008b. Co-creation and the new landscapes of design. Co-Des. 4, 5–18.
Schön, D.A., 1983. The reflective practitioner: how professionals think in action. Basic Books, New York.
Sengers, P., Gaver, B., 2006. Staying Open to Interpretation: Engaging Multiple Meanings in Design and Evaluation, in: Proceedings of the 6th Conference on Designing Interactive Systems, DIS '06. ACM, New York, NY, USA, pp. 99–108. doi:10.1145/1142405.1142422
Silver, J., 2009a. Awakening to Maker Methodology: The Metamorphosis of a Curious Caterpillar, in: Proceedings of the 8th International Conference on Interaction Design and Children, IDC '09. ACM, New York, NY, USA, pp. 242–245. doi:10.1145/1551788.1551841
Silver, J., 2009b. Awakening to maker methodology: the metamorphosis of a curious caterpillar, in: Proceedings of the 8th International Conference on Interaction Design and Children. ACM, pp. 242–245.
Silver, J., Rosenbaum, E., 2010. Gifts for Intertwining with Modern Nature, in: Proceedings of the 9th International Conference on Interaction Design and Children, IDC '10. ACM, New York, NY, USA, pp. 340–343. doi:10.1145/1810543.1810608
Silver, J., Shaw, D., Rosenbaum, E., 2012. Makey Makey: Improvising Tangible and Nature-based User Interfaces, in: Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction, TEI '12. ACM, New York, NY, USA, pp. 367–370. doi:10.1145/2148131.2148219
Silver, J.S., 2009a. Nature As Interface: MacGyver'Ing and Martha-Stewart'Ing Interactivity with Trees, Pencils, Grandpa, Even the Kitchen Sink, in: Proceedings of the Seventh ACM Conference on Creativity and Cognition, C&C '09. ACM, New York, NY, USA, pp. 483–484. doi:10.1145/1640233.1640367
Silver, J.S., 2009b. Nature as interface: MacGyver'ing and Martha-Stewart'ing interactivity with trees, pencils, grandpa, even the kitchen sink, in: Proceedings of the Seventh ACM Conference on Creativity and Cognition. ACM, pp. 483–484.

Barricelli, B.R., Fischer, G., Fogli, D., Mørch, A., Piccinno, A., Valtolina, S., 2016. Cultures of Participation in the Digital Age: From "Have to" to "Want to" Participate. ACM Press, pp. 1–3. doi:10.1145/2971485.2987668
Beringer, J., 2004. Reducing Expertise Tension. Commun ACM 47, 39–40. doi:10.1145/1015864.1015885
Beringer, J., Fischer, G., Mussio, P., Myers, B., Paternò, F., de Ruyter, B., 2008a. The Next Challenge: From Easy-to-use to Easy-to-develop. Are You Ready?, in: CHI '08 Extended Abstracts on Human Factors in Computing Systems, CHI EA '08. ACM, New York, NY, USA, pp. 2257–2260. doi:10.1145/1358628.1358663
Beringer, J., Fischer, G., Mussio, P., Myers, B., Paternò, F., de Ruyter, B., 2008b. The next challenge: from easy-to-use to easy-to-develop. are you ready?, in: CHI'08 Extended Abstracts on Human Factors in Computing Systems. ACM, pp. 2257–2260.
Buchanan, R., 1992. Wicked Problems in Design Thinking. Des. Issues 8, 5–21. doi:10.2307/1511637
Busch, O. von, Palmås, K., 2006. Abstract hacktivism: the making of a hacker culture. Open Mute, London; Istanbul.
Collins, N., 2006. Handmade electronic music: the art of hardware hacking. Routledge, New York.
De Haan, G., 2013. A Vision of the Future of Media Technology Design Education - Design and Education from HCI to UbiComp, in: Proceedings of the 3rd Computer Science Education Research Conference on Computer Science Education Research, CSERC

’13. Open Universiteit, Heerlen, Open Univ., Heerlen, The Netherlands, The Netherlands, p. 6:67–6:72.
De Roeck, D., Stappers, P.J., Standaert, A., 2014a. Gearing up!: a designer-focused evaluation of ideation tools for connected products. ACM Press, pp. 521–530. doi:10.1145/2639189.2639204
De Roeck, D., Stappers, P.J., Standaert, A., 2014b. Gearing up!: a designer-focused evaluation of ideation tools for connected products. ACM Press, pp. 521–530. doi:10.1145/2639189.2639204
Dena, C., 2007. Capturing Polymorphic Creations: Towards Ontological Heterogeneity and Transmodiology, in: Proceedings of the 4th Australasian Conference on Interactive Entertainment, IE ’07. RMIT University, Melbourne, Australia, Australia, p. 8:1–8:8.
Drew, D., Newcomb, J.L., McGrath, W., Maksimovic, F., Mellis, D., Hartmann, B., 2016. The Toastboard: Ubiquitous Instrumentation and Automated Checking of Breadboarded Circuits, in: Proceedings of the 29th Annual Symposium on User Interface Software and Technology, UIST ’16. ACM, New York, NY, USA, pp. 677–686. doi:10.1145/2984511.2984566
Eglash, R., 2004. Appropriating Technology: Vernacular Science and Social Power. U of Minnesota Press.
Evans, M., 2012. Hack everything: re-purposing everyday devices - Matt Evans, Linux.conf.au 2012 -- Ballarat, Australia. Ballarat, Australia.
Fischer, n.d. End User Development and Meta-Design: Foundations for Cultures of Participation [WWW Document]. URL http://l3d.cs.colorado.edu/~gerhard/papers/EUD-siegen-2009.pdf (accessed 4.27.17).
Fischer, G., 2010a. End User Development and Meta-Design: Foundations for Cultures of Participation. J Organ End User Comput 22, 52–82. doi:10.4018/joeuc.2010101901
Fischer, G., 2010b. Extending Boundaries with Meta-design and Cultures of Participation, in: Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries, NordiCHI ’10. ACM, New York, NY, USA, pp. 168–177. doi:10.1145/1868914.1868937
Fischer, G., 2010c. End User Development and Meta-Design: Foundations for Cultures of Participation. J Organ End User Comput 22, 52–82. doi:10.4018/joeuc.2010101901
Fischer, G., 2002a. Beyond “Couch Potatoes”: From Consumers to Designers and Active Contributors. First Monday 7.
Fischer, G., 2002b. Beyond“ Couch Potatoes”: From Consumers to Designers and Active Contributors, in: Computer Human Interaction, 1998. Proceedings. 3rd Asia Pacific. IEEE, pp. 2–9.
Gaver, W., 2012. What should we expect from research through design?, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, pp. 937–946.
Gestural Interaction [WWW Document], 2009. URL http://tangible.media.mit.edu/project/gestural-interaction (accessed 2.19.17).
Gross, M.D., Do, E.Y.-L., 2007. Design, Art, Craft, Science: Making and Creativity, in: Proceedings of the 2007 Symposium on Science of Design, SoD ’07. ACM, New York, NY, USA, pp. 9–11. doi:10.1145/1496630.1496636
Hallnäs, L., Redström, J., 2002. From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things. ACM Trans Comput-Hum Interact 9, 106–124. doi:10.1145/513665.513668
Harrop, P., 2007. Open Sourcery: When Hacker Culture Informs the Design Studio. J. Archit. Educ. 1984- 61, 69–72.

Holler, J., Tsiatsis, V., Mulligan, C., Avesand, S., Karnouskos, S., Boyle, D., 2014. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Academic Press.

Hvannberg, E.P., 2010. Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries. Association for Computing Machinery, New York.

Ishii, H., 2008. Tangible bits: beyond pixels, in: Proceedings of the 2nd International Conference on Tangible and Embedded Interaction. ACM, pp. xv–xxv.

Klemmer, S.R., Newman, M.W., Farrell, R., Bilezikjian, M., Landay, J.A., 2001. The Designers' Outpost: A Tangible Interface for Collaborative Web Site, in: Proceedings of the 14th Annual ACM Symposium on User Interface Software and Technology, UIST '01. ACM, New York, NY, USA, pp. 1–10. doi:10.1145/502348.502350

Löwgren, J., 2016. On the significance of making in interaction design research. interactions 23, 26–33.

Martin, L., 2015. The Promise of the Maker Movement for Education. J. Pre-Coll. Eng. Educ. Res. J-PEER 5. doi:10.7771/2157-9288.1099

Material Anxieties - Research [WWW Document], n.d. . Inst. Mak. URL http://www.instituteofmaking.org.uk/research/material-anxieties (accessed 4.2.17).

Moussette, C., Banks, R., 2011. Designing Through Making: Exploring the Simple Haptic Design Space, in: Proceedings of the Fifth International Conference on Tangible, Embedded, and Embodied Interaction, TEI '11. ACM, New York, NY, USA, pp. 279–282. doi:10.1145/1935701.1935763

Nicolas Collins: Hacking Workshops [WWW Document], n.d. URL http://www.nicolascollins.com/hackingworkshops.htm (accessed 4.3.17).

O'Murchu,Nora.pdf, n.d.

Peppler, K., Bender, S., 2013. Maker movement spreads innovation one project at a time. Phi Delta Kappan 95, 22–27.

Robo Ulbricht, n.d. NE555 with Arduino frequency counter.

Sanders, D., 2003. Tools and Techniques for Teaching Object-oriented Concepts. J Comput Sci Coll 19, 133–134.

Sanders, E.B.-N., Stappers, P.J., 2008a. Co-creation and the new landscapes of design. Co-Des. 4, 5–18.

Sanders, E.B.-N., Stappers, P.J., 2008b. Co-creation and the new landscapes of design. Co-Des. 4, 5–18.

Schön, D.A., 1983. The reflective practitioner: how professionals think in action. Basic Books, New York.

Sengers, P., Gaver, B., 2006. Staying Open to Interpretation: Engaging Multiple Meanings in Design and Evaluation, in: Proceedings of the 6th Conference on Designing Interactive Systems, DIS '06. ACM, New York, NY, USA, pp. 99–108. doi:10.1145/1142405.1142422

Silver, J., 2009a. Awakening to Maker Methodology: The Metamorphosis of a Curious Caterpillar, in: Proceedings of the 8th International Conference on Interaction Design and Children, IDC '09. ACM, New York, NY, USA, pp. 242–245. doi:10.1145/1551788.1551841

Silver, J., 2009b. Awakening to maker methodology: the metamorphosis of a curious caterpillar, in: Proceedings of the 8th International Conference on Interaction Design and Children. ACM, pp. 242–245.

Silver, J., Rosenbaum, E., 2010. Gifts for Intertwining with Modern Nature, in: Proceedings of the 9th International Conference on Interaction Design and Children, IDC '10. ACM, New York, NY, USA, pp. 340–343. doi:10.1145/1810543.1810608

Silver, J., Shaw, D., Rosenbaum, E., 2012. Makey Makey: Improvising Tangible and Nature-based User Interfaces, in: Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction, TEI '12. ACM, New York, NY, USA, pp. 367–370. doi:10.1145/2148131.2148219

Silver, J.S., 2009a. Nature As Interface: MacGyver'Ing and Martha-Stewart'Ing Interactivity with Trees, Pencils, Grandpa, Even the Kitchen Sink, in: Proceedings of the Seventh ACM Conference on Creativity and Cognition, C&C '09. ACM, New York, NY, USA, pp. 483–484. doi:10.1145/1640233.1640367

Silver, J.S., 2009b. Nature as interface: MacGyver'ing and Martha-Stewart'ing interactivity with trees, pencils, grandpa, even the kitchen sink, in: Proceedings of the Seventh ACM Conference on Creativity and Cognition. ACM, pp. 483–484.