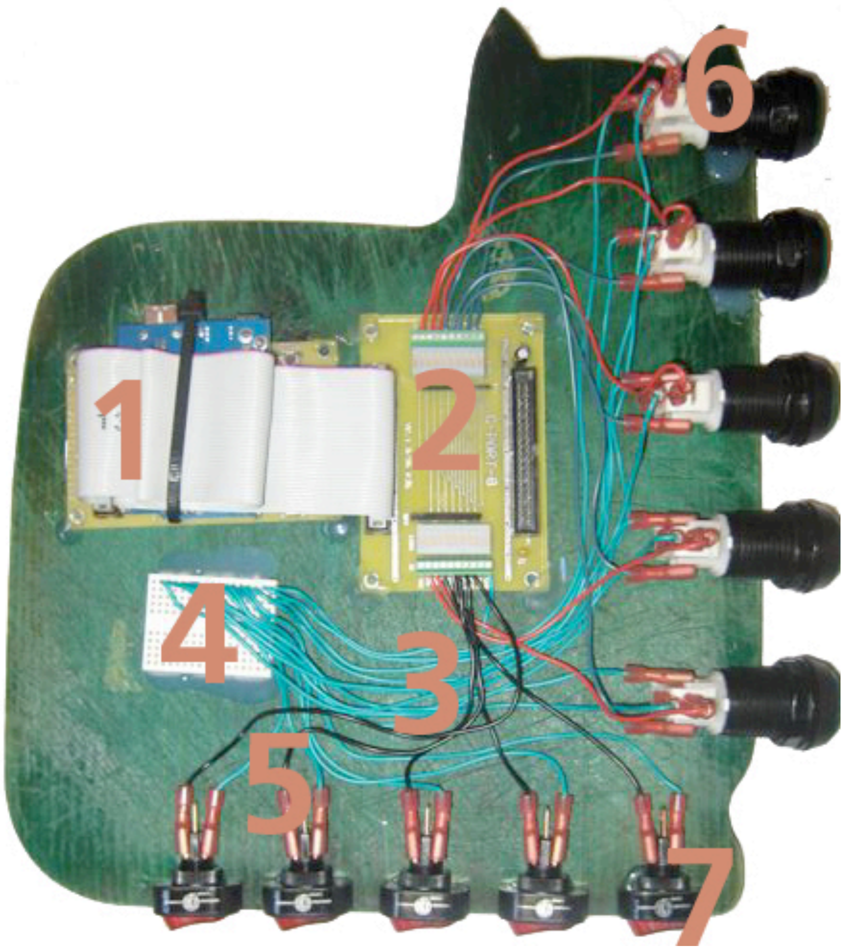
EXPLORATORIUM

INKBLOT INTERPRETATION

REDESIGN WIKI



By

MILES REED

EXPLORATORIUM INKBLOT INTERPRETATION REDESIGN WIKI

A Creative Work Report

Submitted as a Partial fulfillment of the requirements for

MASTER OF ARTS DEGREE IN EDUCATION

With concentration in Instructional Technologies

By

MILES REED

San Francisco, California
May 2009

CERTIFICATE OF APPROVAL

I certify that I have supervised the creative work, “Exploratorium Inkblot Exhibit Redesign Wiki” by Miles Reed and that in my opinion it meets the criteria for approving a culminating study submitted in partial fulfillment of requirements for the Master of Arts Degree at San Francisco State University.

Dr. Kim Foreman, Chair and Professor
Department of Instructional Technologies

Dr. Peggy Benton, Professor
Department of Instructional Technologies

Approved by COE Graduate Committee

Abstract

EXPLORATORIUM INKBLOT INTERPRETATION REDESIGN WIKI

Miles Reed
San Francisco State University

The Exploratorium Inkblot Exhibit redesign wiki guides beginning exhibit developers through planning, executing, and evaluating an exhibit redesign by following a carefully documented process that includes applied theory and hands-on activities which are actively revised and refined by both participants and subject matter experts. Current research on the impact of wikis on students in the classroom by Cavus and Ibrahim (2007) found that learning was enhanced when combined with a course-specific collaborative tool, indicating that successful use of wikis in education must be paired additional course-specific hardware and software, all of which can be obtained from this wiki for free or low-cost. Wiki development was driven by documenting the redesign of an actual exhibit, and emphasizes both the theory behind the electronics and programming as well as how the theory is applied to specific design elements in the exhibit. The wiki uses IT industry-standard terms to describe concepts so that learners will stay within a comfortable zone of proximal development and scaffold their knowledge appropriately throughout the process. The wiki was evaluated and revised by experienced exhibit developers to ensure accuracy of the instructional content.

I certify that the Abstract is a correct representation of the content of this creative work.

__________________________________ _______________

Chair, Thesis Committee Date

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The Exploratorium Inkblot Exhibit redesign wiki guides beginning exhibit developers through planning, executing, and evaluating an exhibit redesign by following a carefully documented process that includes applied theory and hands-on activities which are actively revised and refined by both participants and subject matter experts. Current research on the impact of wikis on students in the classroom by Cavus and Ibrahim (2007) found that learning was enhanced when combined with a course-specific collaborative tool, indicating that successful use of wikis in education must be paired additional course-specific hardware and software, all of which can be obtained from this wiki for free or low-cost. Wiki development was driven by documenting the redesign of an actual exhibit, and emphasizes both the theory behind the electronics and programming as well as how the theory is applied to specific design elements in the exhibit. The wiki uses IT industry-standard terms to describe concepts so that learners will stay within a comfortable zone of proximal development and scaffold their knowledge appropriately throughout the process. The wiki was evaluated and revised by experienced exhibit developers to ensure accuracy of the instructional content.

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Contents

Exploratorium Inkblot Interpretation Redesign Wiki

SECTION 1: BACKGROUND INFORMATION

Introduction

The Exploratorium Inkblot Exhibit redesign wiki is designed to guide beginning exhibit developers through the process of conceptualizing, planning, executing, and evaluating an electronic exhibit redesign. The Inkblot exhibit itself is an art installation at the Exploratorium that is an emotive, thought-provoking concept plagued by intermittent failures in the electronics that power it. The exhibit redesign has benefited the Exploratorium, as the redesign process is carefully documented and the exhibit itself is outfitted with the latest, most reliable technology on the market. The redesign also benefits individuals entering into the field of exhibit design, specifically physical computing, in that it details programming in Flash, Arduino (C++), and the creation of wiring schematics.

1.1 Background

To frame this project in the appropriate instructional context, it is important to know the purpose of the exhibit itself, however, this is the only time that the purpose of the actual exhibit will be described. In subsequent sections, "background" and "purpose" pertain to the functions of the redesign wiki and the instructional content within the wiki. The purpose of the exhibit is to have Exploratorium visitors compare their interpretations of five ambiguous inkblot drawings to other people who have looked at the same drawing, and see how their interpretations differ. The visitor is shown the inkblot drawing on a video screen and Plexiglas "book" and upon pressing any of the five buttons on the display console will hear 5 different pre-recorded people interpreting the same inkblot drawing. As these other pre-recorded people interpret the inkblot, the video display will change to highlight the specific parts of the inkblot they are describing.

The need to redesign the Inkblot exhibit arose from the problems it was experiencing: namely that the buttons on the display were unresponsive most of the time. Redesigning this exhibit has improved the reliability of the exhibit, and documenting the redesign process now gives anybody interested in exhibit design greater insight into how computer-driven exhibits are constructed. The redesign process is hosted on a wiki because the design process needs to be open-ended: it is useful for developers working with Arduino hardware and Flash software, but it conceptually extends to other types of hardware also common in physical computing, such as MAX/MSP/Jitter and Beagle Boards. As this wiki is now complete with my input into the exhibit design process, it is my hope that future exhibit developers will contribute their knowledge to the specific steps I have documented, particularly if there are any techniques that can be improved upon, so that this wiki remains accurate and up-to-date.

I started volunteering at the Exploratorium in the New Media department three months before undertaking this exhibit redesign. I have a wide background in Information Technology, but my electronics expertise was limited and this project has allowed me to "learn by doing." I have achieved a greater background in electromechanical theory and I hope the content on the wiki achieves recognition as an accurate guide to exhibit design.

1.2 Purpose

The goal of this project was to create a wiki that documented each stage of the exhibit redesign process. The information is organized into logical sections and subsections, and includes code, photographs, and annotated diagrams to clarify the purpose of each step taken. This project was justified because the exhibit itself is part of the permanent floor collection and needs to work properly. This project was also justified because the redesign is of beginning to intermediate complexity, appropriate for an audience of beginning exhibit developers with a background in Information Technology.

1.3 Significance

The impact of this project on the Exploratorium is threefold: the exhibit itself works properly now that it has been redesigned, the redesign process is now well-documented for any future exhibit developer at the Exploratorium to examine and improve upon, and lastly, the entire document is publicly viewable so that exhibit designers from other institutions, or those aspiring to become ones, can view and critique the design process itself. Insofar as my personal development, by having to clearly document my redesign steps on the wiki and collaborate with other people at the Exploratorium, I have gained a through understanding of exhibit redesign and principles underlying it. The instructional aim of this wiki targets learners similar to myself: beginning exhibit developers that are comfortable around electronics and computers but are looking for instructional material that has applied theory to specific problems at hand.

Current research on the impact of wikis on students in the classroom by Cavus and Ibrahim (2007) found that learning was enhanced when combined with a course-specific collaborative tool, indicating that successful use of wikis in education must be paired with additional course-specific hardware and software. The implications for this project stemming from their research suggest that anybody attempting to learn from this wiki should have the same hardware and software to experiment with that the wiki is referencing. Adobe Flash is available at a significant discount for students, while the Arduino microcontroller and pushbutton switches can be obtained for under $50. The programming environment for the Arduino is free and open-source. The bottom line: in order to get the most out of this redesign wiki, the target audience needs to invest in a small amount of hardware and software. By doing this, research suggests they will benefit in a tremendous amount of learning by experience. Additionally, the wiki uses IT industry-standard terms to describe concepts so that learners will stay within a comfortable zone of proximal development and scaffold their knowledge appropriately throughout the process.

SECTION 2: FRONT-END ANALYSIS

2.1 Introduction and Literature Review

Several qualitative studies have already been conducted to better understand the experience of instructors adopting a wiki. West, Waddoups, and Graham (2007) discussed instructor experience both in terms of how the wiki was adopted to fulfill specific instructional objectives, and whether the technology was embraced fully, partially, or eventually discarded. The progression of adopting a course to be taught fully within the wiki relied heavily upon an instructor's past experience with instructional technology. Most instructors did not have a vast amount of experience in developing and administering a course using this technology, and so they chose to slowly incorporate features of the system into their teaching repertoire over time. For example, an instructor would choose to upload his PowerPoint presentations to the class website during the first semester. During the second semester, he would then use the management system to keep track of student grades. Teachers with more technological expertise would choose to do both simultaneously, and would also serve to lead by example for other teachers who were considering what next adopting step to take. A study by Samarawickrema and Stacey (2007) came to similar conclusions.

Though previous technological experience also played a role in the speed at which a wiki was implemented, socially supportive environments, where instructors were comfortable conversing with fellow faculty about their experiences with adapting their course to a wiki, also influenced the speed of adoption. This study also highlighted the changing roles that instructors played when developing material for an online course. As one interviewee stated “You become an administrator and a teacher and a multimedia developer and you are a researcher and whatever else that I’ve left out” (Samarawickrema & Stacey, 2007, p. 10). Several studies have looked at the challenges of adopting a wiki from a viewpoint of technical problems an instructor might encounter. Bongalos et al. (2006) detailed specific inhibiting factors an instructor might encounter while developing and administering a course, such as forgotten passwords for students and teachers, availability of the system during class hours, and overall difficulty of navigation. Prior technical experience was generally helpful in figuring out password issues and navigational concepts, just as West et al. (2007) has found about the speed and ease of transition. Another interesting subject of discussion that merits interest is the students’ effect on teachers adopting a wiki. In an actor-network perspective, both Samarawickrema and Stacey (2007) and West et al. (2007) found that student demand for lecture materials to be accessible online drove instructor adoption of a wiki. In both studies it was the most frequently cited reason for adoption after pressure by the administration to adapt traditional paper-based courses to an online system.

Several studies were seeking to answer one of the bigger-picture questions regarding the adoption of wikis: can a wiki ultimately save instructors time in the development and administration of instructional material? The most common conclusion was that, in the short-term, wikis required a significant investment of time to learn skills and then develop course material. In the long-term, wikis could save significant amounts of time because of the ability to reuse previous online material for the following semester without having to physically prepare and reproduce new material. West et al. (2007) heard a common refrain from instructors they interviewed: not only was the previous semester’s course material available again for the next semester, but additional material that was still paper based could be slowly filtered in over time to supplement the older material.

Baudry et al. (2005) suggested both a standardized format for creating lessons, and clearly defined roles for both producers and administrators of instructional material so that not only could an online course be reused by the same instructor, but could be built upon by a colleague. This is a critically important feature in a wiki: the format must be standardized so that the document can be edited by multiple individuals. Baudry et al. (2005) proposed that the original creator of the content be called the composer, and the person actually teaching the material be called the publisher. Using a construction metaphor, individual lessons would be considered bricks, and a model would be presented to demonstrate what these bricks would eventually build. The lessons, however, would have meta-data attached to them describing what the individual lesson sought to accomplish so that they could be used as separate modules. Similar to the SCORM system adaptations to wikis proposed by Barker (2004), these suggestions to develop content in a unified manner could ultimately save the instructor time in teaching online material without having to develop it from scratch or convert all of it from a paper-based course.

2.2 Needs Assessment

Upon completion of reading the exhibit redesign wiki, and ideally working with the same hardware and software as mentioned above to make the exhibit work as specified in the wiki, the learner should be able to apply the skills of planning, writing, and testing hardware and software in a museum environment in support of a computer-driven exhibit. The learner should also be able to demonstrate how to take input from and direct output to specific sensors on the Arduino microcontroller, read and write schematic diagrams, program in Flash, and clearly document the development and design processes involved in creating a floor-quality exhibit. The current skill set that the target audience has will be a mixture of hardware and software knowledge stemming from a general background in IT. The knowledge gap between what the target audience currently knows and what they should know after reading the wiki is how to apply their new skills in physical computing to exhibit design.

In order to accomplish the instructional goal of teaching new media developers how to design exhibits, our delivery format has several characteristics of Web 2.0 technologies that are grounded in sound learning theory. In choosing a wiki format as the method of delivering instruction, the entire body of knowledge in the wiki has the following characteristics:

- Easily accessible information: The learner is able to access the content anytime, from any location.
- Translatable: The learner is able to translate the instruction into his or her native language.
- Participatory: the learner is able to comment upon and annotate the wiki instruction as they follow the lessons in the wiki. If a set of instructions are unclear, the learner can modify the instructions to add clarification, add a note flagging the unclear instruction, or add a comment to the page seeking clarification.
- Contributions from multiple subject matter experts (SMEs): Though the wiki has one primary author, additional experts have contributed material where appropriate, both during the development of the wiki, and in the months and years after the bulk of instruction has been written..
- Media-rich: The wiki contains text, graphics, and movies.

The above criteria could only be met in their entirety by the hosting the instructional material in a wiki format. Materials published via CD-ROM or tree-derived material would not be easily updatable or readily available. A traditional website would be readily available but annotating it with comments and revisions by users and subject matter experts would have to go through whomever maintained the website and the site would grow slowly, if at all. Therefore, a wiki format provides the greatest amount of user contribution, accuracy, and expansion possibilities.

To determine whether or not there was a need for instructional content aimed at beginning new media developers, I spent three months at the Exploratorium observing the processes that went into exhibit design, and saw that there was both a huge amount of creativity and skill that went into the planning and construction of exhibits. Exhibit developers collaborated often to draw upon each other's expertise. Because this instructional material is collaborative and constantly evolving, it will hopefully stimulate creative inquiry and expertise in the learners so that others may draw upon their knowledge in the future. As beginning exhibit developers digest the information in this wiki, they will hopefully feel compelled to add to the original content.

2.3 Content / Task Analysis

Content selection for the wiki was fairly straightforward. After observing the exhibit design process, I wrote down all of the functional skills required to build an exhibit from scratch, and assigned them to broad conceptual categories that are the chapters in the wiki. Each of these skills is then found in a section. Content in each chapter is not prioritized; each chapter teaches an independent set of skills, however, each section of a given chapter builds upon the previous section, moving from theory to how that theory is applied.

Because the content section process required assigning specific skills to broader categories, I found myself assigning and then re-assigning skills to different chapters. For example, programming in C++ for the Arduino board could fall into a chapter about programming techniques, or it could fall into a chapter about human interaction, or into a chapter about Flash-Arduino interfacing. By the end of the content selection process, I decided to place skills into chapters according to an input-output systems model: interaction->interpretation->event->output. Therefore, all skills related to programming the Arduino went into the chapter about interaction.

2.4 Learner Analysis

Understanding my target-audience was a both a self-exploratory and social endeavor. My professional goal is to transition from general information technology work to a career in designing multimedia exhibits in museums that are powered by computers and microcontrollers. Given that teaching a subject is the best way to thoroughly learn it, I aimed to achieve a high level of proficiency in the realm of physical computing while building this instructional wiki. Understanding my audience was not entirely self-exploratory, however. I also discussed the topics and depth of knowledge that would need to be taught on the wiki with exhibit development experts at the Exploratorium and with fellow information technology peers to determine what reasonable entry skills would be assumed and how much detail should be covered in each chapter of the wiki. Users of this wiki will be motivated by how much they can use their existing knowledge of computers to apply their skills to a whole new set of devices and controls in the physical world. As one exhibit designer here stated “our world as exhibit developers is about making things happen when we press buttons and flick switches.” The results of becoming a proficient physical computing engineer are evident in how well we can take results in the physical world and translate them into electronic events, or conversely, how we can make electronic events trigger physical objects. Users that come from a traditional IT background will become enamored with how tangible this field of physical computing is, and be able to take pride in results that impact our physical world and not simply our virtual one.

The instructional material is hosted on a wiki. The specific wiki technology that is used is DokuWiki.

DokuWiki was selected as the wiki of choice because it has been built specifically for documentation and instruction. For example, emphasis is placed on linking related terms and concepts, and documentation contained within has levels of depth so that subjects can be nested within subjects. I evaluated MediaWiki as an alternative instructional method but found that it was too much geared towards the aims of Wikipedia; that is to say it has been build as an encyclopedia to connect information of any type, rather then to organize a collection of related concepts.

Within DokuWiki, my instructional material consists of text, photographs, video, and ZIP files of code examples that can be downloaded and run from a user's computer. Because the content is on a wiki, all of the instructional material can be annotated by users and other subject matter experts with any additional ZIP files, photographs, video, and explanatory text.

SECTION 3: DESIGN AND DEVELOPMENT

3.1 Instructional Goals and Objectives

After completing the instructional content on the Exhibit Redesign Wiki, learners should feel competent in several areas of physical computing:

- Goal: Understand the fundamentals of electronic circuitry
    - Subtask: Build a simple circuit with a pushbutton switch
    - Subtask: Build a voltage divider to test voltage input
    - Subtask: Use an oscilloscope to measure voltage output over time
    - Subtask: Use a voltage meter to test momentary voltage
- Goal: Understand the fundamentals of microcontroller programming

    - Subtask: Write a simple program to respond to a button press
    - Subtask: Write a debouncing routine to correctly detect a button press
    - Subtask: Write a program to detect a closed position in a Reed switch
- Goal: Understand the fundamentals of Flash programming
    - Subtask: build a simple scene and timeline
    - Subtask: build a complex flash animation with multiple scenes
    - Subtask: build programmatic “bookmarks” to cue the complex animation at specific points
- Goal: Understand the fundamentals of Flash-Arduino interfacing
    - Subtask: Connect Arduino and Flash with network socket layering
    - Subtask: Simulate simple programmatic events in Arduino code to trigger Flash cues.
    - Subtask: Make physical event on Arduino trigger programmatic event in Flash

3.2 Instructional Sequencing Strategy

The content of the wiki places a high priority on the functional application of skills in electronics and programming in exhibit design. The content on the wiki is presented in the following format:

- Chapter
    - Section
        - Theory
            - Application of theory

For example, the section of the wiki detailing the programming of the Arduino input board has the following format:

- 🎬 Chapter: Arduino Programming
    - Section: Arduino Events programming
        - Theory: Arduino inputs and event triggering
            - 🎬 Application of theory: make an input on the Arduino trigger an event within the Flash program

With this delivery format, the learner will not only develop a strong understanding of microcontroller programming, but will also see the application of this theory to the exhibit and be able to test out the code on her or his own Arduino device.

3.3 Development Process

The instructional development process has mirrored the redesign process of the Inkblot Interpretation exhibit. As I completed each step of redevelopment with the exhibit, I documented my steps and uploaded them to the wiki. I built out the “Application of theory” sections first, as I had to figure out how to make specific part of the exhibit function according to the original design. Once I knew how to make a certain part function, like a button trigger, I would then go back and take photographs and write the theory behind the code I had written. I then also wrote a simpler, conceptual explanation of what goal needed to be accomplished. I essentially worked backwards to design this wiki because of two fundamental facts about my learning style: first, I had no idea how to accomplish any of the design goals set fourth in the wiki before I started experimenting with the redesign, and second, my style of learning is to “mess around until it works” and then go back and figure out why it works. The wiki, in contrast, tells you exactly why it should work and exactly how to go about doing various tasks. In summary, the wiki development process is just a very detailed and well documented wiki on how I taught myself how to work in the realm of physical computing. This is why it is absolutely critical that the document is in the form of a wiki. I depended on the expertise held by experienced exhibit developers to fact-check the theory that I had deduced from making design decisions and correct the document where it is warranted.

SECTION 4: FORMATIVE EVALUATION

4.1 Expert Review

I drew upon the mental resources of three exhibit developers at the Exploratorium to serve as subject matter experts in the review process. To better illustrate their role in shaping the development process, I will briefly review their skills, my skills, and the skills of the target audience that might benefit from this wiki. The subject matter experts at the Exploratorium represent individuals with a mastery of the subject matter. They have been working at the Exploratorium in the area of exhibit design for several years, and have had formal education before that in the field of exhibit design and interactive media. My skills in exhibit design have improved immensely during the process of creating this educational wiki. I do not have mastery of this field, yet I am no longer a beginning exhibit developer. The target audience of this wiki are people who have some skills in IT and electrical engineering but lack a functional knowledge of how to put these skills to use in the area of exhibit design. My subject matter experts were versatile enough to both suggest technical improvements in the C++ and Flash coding areas of the wiki, and also helped rewrite some of the language in the introductory chapters that set the stage conceptually for the rest of the project documentation. Essentially, they were able to think back to their days in school and recall ways in which similar information was presented to them in meaningful ways.

4.2 One-on-One Review

I used pre and post-instruction surveys (see appendices) when initially prototyping my wiki with Exploratorium exhibit design volunteers. I was able to find an ideal group of individuals serving as volunteers at the Exploratorium. These people came from educational, information systems management, and engineering backgrounds, and all had a similar desire to learn about the process of exhibit development. The abstract image exhibit that this wiki is based around served as a good example of how exhibits are redeveloped on the Arduino platform. One volunteer had experience writing code for the Arduino but had no experience in developing a Flash program that tied into the Arduino. Another volunteer had extensive Flash programming experience but had not developed code for the Arduino. Suggestions from the volunteers resulted in revisions to the animated graphics and a clearer technical schematic to explain how the exhibit was physically wired together. Taken together, comments from the volunteers resulted in a clearer "big picture" description of the exhibit itself. As the primary developer of the wiki, I had been concentrating on the small details of instruction, and their viewpoints allowed me to go back and develop a more streamlined and consistent set of documentation.

4.3 Field Test

I used the same pre and post-instructional surveys for the field test as I did for the one-on-one review. These surveys were useful in aggregate to ensure that the content in the wiki targeted the correct group of learners. Most of the learners surveyed had fair to moderate expertise in 2 or 3 of the hardware or software skill subsets surveyed. No participants surveyed had moderate or journey-level expertise in all skill subsets. All respondents indicated that the instructional material in all areas was "good" or "great" leading me to the conclusion that the material is appropriate for learners approaching exhibit design with varying skill sets. This is an important goal that has been met, as there is not a great deal of formal instruction available detailing how to apply hardware and software skills to exhibit development. Exhibit developers usually come from an IT, hardware, or software programming background, and therefore this material needs to be suited for a diverse audience of beginning exhibit developers.

SECTION 5: SUMMARY AND CONCLUSIONS

5.1 Summary

Based on the differences between pre and post-instruction surveys and user comments, it seems clear that the instructional wiki I have created is an effective tool for developing skills in exhibit design and development. Admittedly, the target audience is a niche market. There is only one school in the U.S. that offers anything remotely similar in terms of blending technical know-how with interactive media development, and two of the three individuals in exhibit design at the Exploratorium have gone there. The wiki stands alone in terms of the subject matter it covers, but will only be relevant to a small number of people. As far as improving the instructional content in the future, the wiki is an open document that can be edited by anybody. If it gains even a small amount of recognition in the exhibit development community, it will hopefully be expanded to include prototyping with other types of hardware and software. The abstract image exhibit was chosen because it represents general design principles used at the Exploratorium, but the wiki could greatly benefit from expanded subject matter.

5.2 Conclusions

I feel quite fortunate that in 17 weeks I was able to accomplish all of the goals I set for myself: I created an instructional wiki which not only served as my final project but during its creation gave me a through understanding of hardware and software interaction and significantly raised my level of expertise. The Exploratorium received approximately 400 hours of volunteer time and a newly refurbished exhibit out of this process, and I will continue to volunteer there. After completing the field study I learned that it is important to have both experts and novices at every stage in the design process to lend input and clarify the instruction itself. At the end of this process, the only improvement I feel could be made to the overall design process would be to split the final project into two semesters: the first for creating the instructional material itself, and the second for field testing and dramatically revising the original material.

SECTION 6: BIBLIOGRAPHY

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SECTION 7: INSTRUCTIONAL MATERIALS

This project is online at http://www.openbookconsulting.org/dokuwiki/

Appendices

A. User pre field test survey

B. User post field test survey

Appendix A

User pre field test survey

Thank you for taking the time to fill out these surveys! The first survey should be taken before you read the Abstract Image Redesign wiki. This survey will give us information about your pre-existing knowledge and skills. The second survey will ask for your opinions on the quality of the instructional material, and what, if any, impacts it had on your knowledge and skills.

Appendix A: Pre-Field Test Evaluation Sheet

Name: ____________________

Level of *overall* hardware expertise:

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Level of expertise with component assembly (resistors, capacitors, diodes, soldering):

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Level of expertise with embedded devices and microcontrollers:

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Level of *overall* programming expertise:

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

C++

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Java

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

MAX/MSP/JITTER

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Flash (animation)

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Flash (actionscript)

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Level of *overall* desktop computer knowledge (Mac, Windows OSs)

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Level of networking stack expertise (TCP/IP, 7 layer OSI model interactivity):

1 (poor) 2 (fair) 3 (moderate/working knowledge) 4 (journey/trade-skilled) 5 (mastery)

Appendix B

User post field test survey

Name: ____________________

How would you rate the quality of instructional graphics (still photos, animations, figures)

1 (poor) 2 (fair) 3 (good) 4 (great) 5 (outstanding)

Specific comments:

How would you rate the quality of C++/Arduino Programming module?

1 (poor) 2 (fair) 3 (good) 4 (great) 5 (outstanding)

Specific comments:

How would you rate the quality of the Flash programming module?

1 (poor) 2 (fair) 3 (good) 4 (great) 5 (outstanding)

Specific comments:

How would you rate the quality of the hardware / taskflow module?

Specific comments: