EMPOWERING PEOPLE WITH DISABILITIES
Participatory Design Using Micro-Controllers

Elaine Yuen, PhD
Naropa University, Boulder, CO

Michael MacAllister, MID,
University of the Arts, Philadelphia, PA

Presentation at APHA 140th Annual Meeting
San Francisco, October 30, 2012

Presenter Disclosures

Elaine Yuen

Had the following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

"No relationships to disclose"

Background

- Estimated 12% of U.S. population has a disability*
- Often have unique needs that are not readily met by off-the-shelf products.
- Specialized products are often the only option
  - can be expensive and unaffordable
  - especially for someone who may have difficulty even entering the workforce.

- This project evaluates a low cost approach to empowering people with disabilities to address these unmet needs.

* US Census, 2009

Arduino for Disabilities Project

- Faculty-led design research sponsored by the Corzo Center for the Creative Economy at the University of the Arts (UArts) in Philadelphia, Pennsylvania.
- Persons with disabilities were partnered with design students in a collaborative environment to explore the use of a powerful low-cost, open-source micro-controller called the Arduino.
- Each team was challenged to apply their new Arduino design skills toward solving a real life problem for the team member with the disability.
- This was not a case of "teaching the disabled" but rather a case of building a collaborative community of practice.

What's an Arduino?

- Easily used, low cost micro-processor
- Uses input from sensors
  - to switch on and off motors, lights or various output devices.
- Has been taught in colleges and high schools

The Arduino (left) is a programmable switch

Project Objectives

- To empower persons with disabilities to co-design and produce solutions to their own problems.
- To understand the obstacles that present themselves in this process.
- To determine what tools, structures, methods, technologies, learning systems… might improve this learning and making environment.
- To document the dynamics and benefits of this community of practice.
- To evaluate this project as an educational model for encouraging design citizenship in young designers.

Methods

- Five design students were partnered with five people with disabilities.
- Together they were challenged to learn the basic skills of using the Arduino.
- Participatory design process was engaged to apply these skills to address a real problem in the life of the person with disabilities.
- Video interviews and surveys were conducted before and after the project to capture learning outcomes.

- Some college education, and two had completed high school / GED.
- Four rated their health as "good" or "excellent"
- All lived independently
- All used a motorized wheelchair
- All reported using the Internet and owned an electronic device such as a Blackberry or IPhone
- Either "comfortable" or "very comfortable with math and science
- Medical conditions: lymphedema, cerebral palsy, scoliosis, multiple sclerosis, severe arthritis, paraplegia, congestive heart failure, hemiplegia, constant pain, memory and vision issues.

- Multimedia and Industrial Design majors
- Experience with the Arduino ranged from "None" to "Expert"
- All had taught other topics than the Arduino
- Patience as ranging from "Extremely patient" to "Patient"

- Three knew someone (family member, friend) who was a person with disabilities
- One had worked with persons with disabilities of all kinds: developmental as well as physical
- Another student had a family member with disabilities caused by a stroke

- Student comments:
- "… wanted to experience the dual challenge of teaching the Arduino and learning what it is like to live with disabilities"
- "… excited to see how creative technology can positively influence the lives of individuals with disabilities"

Data Collection and Artifacts

- Surveys. Structured surveys at the start of the project.
- Audio recordings. Informal debriefings were recorded after each class and work-session.
- Photographs. 1,513 photos were taken throughout the course of the project.
- Video Interviews. Conducted half way through to Liberty and UArts participants. Exit interviews of the Liberty participants were filmed.
- Home Visits. Three participants from Liberty invited their partners into their homes.
- Blog Entries. All were invited to share impressions through voluntary entries on a public blog. http://arduinofordisabilities.wordpress.com
- Written Exit Interviews from UArts participants

Working Together
Changing Boundaries of Personal Space

Learning about electronics

UArts Students: Toward Citizenship

- Increased skill in teaching
- Increased knowledge of / advocacy for / empathy with persons with disabilities.
- Personal, close connections were formed
  - sharing of technical skills and information
  - included empowerment of both the Liberty and UArts participants:

As they partnered with the Liberty students, UArts students were impressed and somewhat surprised with the enthusiasm that they showed:

- *"so far I'm really happy to see how well the people are grabbing the ideas, I would say it's not the exact same pace as everyone in college, it's a lot faster …. how people are really getting into it, and the fact that people are showing interest is really amazing, because it's something that usually if you bring it up to your relatives or parents, they go "oh I don't know what that is…" just let it go, let it slide…"*

An aspect of the UArts students' learning was an increased understanding and empathy with the Liberty students, not only of their physical difficulties but also within the learning process itself:

- *"Being a part of this experience allowed me to better understand the types of struggles that individuals with disabilities endure on a daily basis."*

- *"it's material for them to think about - for example how their wheelchair works. And maybe it's not very practical for them to .. create their own tools, but maybe I think they can come up with ideas - because they are the people who encounter those problems.   So I think for them to come up with ideas, that can help some other designers to improve those tools for them."*

Kevin and Brandon with their prototype showing wheelchair actuated switches that would turn on and off Brandon's lamp in his room.

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Ben and Glenda's project was a wheelchair accessory for signaling in traffic when her wheelchair is turning.
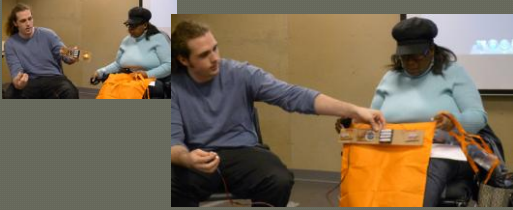
Liberty participants also noted that their experiences of learning electronics and programming changed over the course of the sessions:

"I'm having a ball. When I first started I thought ok, this is going to be tedious, I'm not going to like it - I originally thought should I stick with it, or abandon it? And I love it, because the more I come, the more I get exposed to it… And it's more than just learning, you grab so much from here - like Kevin and I we formed a friendship that goes beyond here. So even the amount of friendships that are formed based on something like this. You know is incredible."

"Yes, it's been really really - better than I expected. Because I'm not a hand-on mechanical person - I know how to sew, I can sew really good - but as far as equipment - that kind of stuff - no, I have no (shaking her head) I was like, where does this go? What is this? But I'm getting it together now, and in the beginning I had a lot of difficulties seeing because the stuff was so small - but I can see the stuff a lot better now, and I thought to bring a magnifying glass to class but I didn't have to…"

For some of the Liberty students, the Arduino workshop also supported improved cognitive and social skills, and an increased feeling of confidence and independence.

"I'm a little bit more aware about how things work now. when things break around me now I tend to take them apart (laughs) - small things, not big things like (a toaster) - when small things come apart I try to see if I can put it back together - before would just throw them out but now, now I'll say "well maybe I could fix this." You know. Sometimes I actually do fix it".

"…basically a small amount of knowledge was opening up where I was starting remembering things - my past, what I did - what I've noticed lately is that seems like some things come to me a little quicker - yeah - I wouldn't say a great improvement but like maybe like having a conversation, talk about a topic, I might forget exact topic, but a day later I'm clear again. And I thought that was interesting because it seems like more fruitful…"
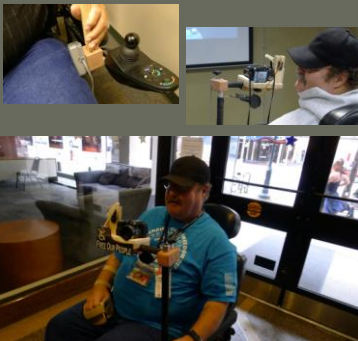
Lastly, participants commented on an increased feeling of independence and confidence, as well as an appreciation of increased knowledge:

"… that I'm not as slow as my kids think I am. My kids think they have to do everything for me. And they don't. I keep trying to tell them that. I'd rather do stuff for myself. But they still think they have to do everything for me. But they don't know I'm looking for an apartment. Trying to find me an apartment so I can leave my house (interviewer: and you feel you could do that)… I am going to do that".

"It is all about seeing the simple and realizing the possibilities you have to do bigger things. I now realize that by learning how to do these simple things, I can increase my independence. I never feel like you should ever stop learning because without knowledge you become complacent. The knowledge that everyone from UArts brought to the class is something that I really appreciate"

Chiaying worked with Marsha to develop switches that helped Marsha turn off her lights from her bed. Marsha got out her acrylics and had customized her switches as well as helped with the overall concept development. The Arduino and a solid state relay were packaged in a plywood box with a plexi cover so Marsha could see the electronics.

Exhibit at the Philadelphia Center for Architecture: "Green, Urban and Glocal" Winter, 2012

"This project is not about designing particular solutions to individual problems, but rather is about developing a system that empowers individuals with disabilities to solve their own issues."

Concerns and Next Steps

- Scale. Components were difficult to handle and hard to see as well.

- Workspace.
  - Laptop workspace could be designed to enable work from the wheelchair.
  - Clamps and clips would make it much easier for people working with only one hand.

- Additional work on curriculum and evaluation

- Project is continuing Fall, 2012

Thank you!

Elaine Yuen PhD
Associate Professor, Naropa University
eyuen@naropa.edu

Michael McAllister MID
Associate Professor, University of the Arts
mmcallister@uarts.edu