IDEA VALIDATION ASSIGNMENT

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Analysis / Findings

What is your project/domain? What problem are you designing for?

Goal: How can we create a dynamic garment that is driven by aesthetic design through adaptation of existing dynamic techniques?

We are creating a garment that uses e-textile materials in a way that visually enhances it aesthetically. We hope to use the dynamic properties of textiles to integrate responsiveness into the form of the garment. We hope our technology integrated in the clothing will provide small design changes to the garment that express the individuality of the wearer. We feel this is an area that has not been explored much before and we hope to combine our experiences with electronics and textile craft to create a unique garment that is dynamic and aesthetically driven.

What are the core assumptions of your project?

- Our ability to design a garment with e-textile or other responsive material integration
- We will be able to create sensors or controls with conductive thread on the body of the garment and we will be able to test and program responses from readings from these sensors
- We will be able to integrate some kind of output into the garment
- Our ability to plan elements and time management of project around desired outcomes
- Reliability of the materials and methods we use
- The need for this garment to exist

How did you test these assumptions (summarize what you did - interview, observations, surveys)

Advice from interviews:

- Find a pattern and start making it, familiarize yourself with the process so you can use the skills later. *(Melissa Feldman)*
- Create an inspiration board for your fashion direction and tech. *(Melissa Felderman)*
- Leave time and money for prototyping, order parts early. *(Melissa Felderman)*
- If you can make that more subtle or integrated with what style means to someone, it'll read more like a garment and less as a technical product. If it just changes and has a

life of its own, or changes based on something that's more fluid (sounds…) then it feels less like technology and more like a living garment. *(Laura Devendorf)*
- Keep it simple, because it can get out of scope fast! *(Laura Devendorf)*
- Do as much research and development as you can, you will run out of time at some point and will have to use what you have and move forward with the creation of the garment, even if the technical piece isn't perfect. *(Jingwen Zhu)*
- Research Arduino capabilities for detecting capacitive touch. Use a multimeter and write down your findings. Don't assume that you'll be able to do this on your own, mapping is hard and takes time to do well. There are also a lot of factors to consider with design to prevent accidental triggering with wearable garments so don't forget to test! *(Advice from Summer's dad who has a degree in electrical engineering)*

External Research into existing methods:
- Weavable capacitive touch sensors
- Weaving fiber optics
- Sewable components like lily pad and others
- Using color-changing pigments to die textiles
- Designing woven or sewn controls/interactions

What was surprising/unexpected?

The survey suggested that many people were open to the idea of wearable garments, but had very little exposure to similar garments and therefore expectations of function correlating to more mainstream wearables like the apple watch.

How will you move forward with these findings? How will this affect your Capstone?

We were positively encouraged by everyone we talked to about the excitement of designing a project like this. We concluded that our goal is both possible and has the potential to be successful given the right planning. We discovered multiple interesting methods and techniques that we could utilize but ultimately were reminded that lots of work around the concept is still needed in order for the design to be successful. Our team has begun ordering prototype materials so that we can begin developing techniques for integrating these materials into our plan for the design. Our initial step is to see how color-changing pigments, fiber optic cable, and woven or sewn circuits can be integrated into garments that we already own or buy from a thrift store. Theses altered garments will help inform overall design direction, as well as the choice of base textiles needed for our initial construction. We will also be designing and testing controls, sensors, or heating elements needed to create responsive designs. From there we will find/create a pattern and begin constructing the final garment.

What were your findings?

Laura's advice was particularly inspiring as she talked about embracing the qualities of some materials and using them to inform and support the overall style and structure of the

garment. For example, I am particularly inspired by her suggestion of using fiber optic cable in collars to provide rigid support.

Throughout our user research, we were reminded of the importance of being able to alter our design based on user feedback and modify any elements that don't make sense to a normal user. Since our project exists in a place that doesn't have many similar products, we will want to budget time to have others try the interactions and wear the prototype garments and give us their feedback in order to achieve a user-friendly end product.

Notes / Questions / Process Documentation

List the people you interviewed/observed/or sent a survey to (Name, Date, Position, etc). 6 total

1. Carson Bruns, Nov. 4, Atlas Faculty and Assistant Professor
2. Shanel Wu, Nov. 7th, Ph.D. Atlas Student
3. Melissa Felderman, Nov. 12, ENVD Professor
4. Jingwen Zhu, Nov 15th Engineer and Designer based in NYC, https://www.jingwen-zhu.com/
5. Laura Devendorf, Nov. 18, Atlas Faculty and Assistant Professor
6. Survey

Include the questions you prepared for each interview/survey and summarize the responses below.

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Carson Bruns

Question 1: What do you do?
Response: I am working to develop UV sensitive tattoo ink

Question 2: Have you worked with color-changing techniques with textiles before?
Response: No, but Laura has and you should talk to her about this

Question 3: Do you have any contacts you could connect us with who might be able to help us with materials/information?
Response: Yes, “CTI...Innovation Requires Extreme Inks.” The company is based in Colorado Springs and I have the contact information of the head guy there/CEO if you guys have trouble getting in contact with them I can get you that information to help. They create the dies that respond to heat and UV that both I and Laura have been using. I have been using them in

tattoo ink, which once they found this out, they didn't like it and stopped contact. Laura was using their ink to die textiles but was having issues getting a clean coating to the textiles because the way they coat the ink makes it hard for the ink to sink into the fabric. She'll be able to explain this in more detail though.

Notes:

- He gave us a packet with samples and more information on this company.

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Shanel Wu

Question 1: What do you do?
Response: Worked on software to create weaving patterns and also including circuitry. I was not on the coding side of that, I am more craft. We communicate weaving design with pixel it is called a draft, can see the under and overlayer. The next project was called unfabricated- how to design smart textiles- bringing computing to the fabric. Knitting and weaving to me are not glued ou can unravel it and take it all apart. I designed a smart textile with this disassembly in mind. Created a woven circle that had a potentiometer to control the brightness of an LED and then disassembled. I wanted to research how taking something apart and can re-use.

Question 2: Does the conductive thread change the quality or feel?
Response: conductive thread is soft and the regular thread is fine to reuse. Using conductive thread with conventional yarn doesn't change the texture

Question 3: Have you worked with dynamic textiles before?
Response: We have, the color-changing one is based on heat and is a wire covered in yarn, so it can burn.

Question 4: What do you find most challenging when working with dynamic textiles?
Response: All the design decisions and getting a finished prototype- what interaction, yar input/out/were worn?

Question 5: Have you built a full article of clothing before?
Response: I personally have not, I get distracted and can't finish a piece

Question 6: How did you get involved in this?
Response: Previous project was in undergrad, got a bachelor's in physics and computers. Took courses that gave me hands-on experience with circuits to learn how a computer works. I picked up knitting junior year because they were stressed and kept going with it. Senior year knew about smart textiles and took a class on craft and technology. We take textiles for granted. Knitwear programs as a side gig and then switch from teaching program to looking for a lab working with this.

Question 7: How long did it take you to get used to working with textiles/how hard is it to pick up?
Response: You have time to pick up on it. There is an easy way into a full project but stick with a few techniques you won't have enough time to do it all.

Question 8: Could we use a loom here is we come in with a design
Response: Offered us some we could use, but not the big one because it is booked up

Question 9: Do you like any specific materials?
Response: I mostly use cotton because it is easier to use

Question 10: Do you have any recommendations for how to create a piece/what materials to us?
Response: Materials are above^

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Melissa Felderman

Question 1: What do you do?
Response: Mostly accessories, accessories have been a bigger focus because they are a bit more versatile. Clothes have a tacky feel, I feel like accessories have more of a funky and you just pop it on. Wearables for me have been more fun and not to get data from.

Question 2: Have you worked with dynamic textiles before or seen you found successful?
Response: I know someone from New York, but I haven't seen it commercially successful other than the levis jacket. I feel like we are not there yet. Jingwen used thermochromic paint, heating changed based on her mood from her journal entries. It was meaningful and not just a twinkly piece. Something you wear should be interactive. I have not worked with dynamic textiles. I recommend doubling up the thread for more conductivity.

Question 3: What do you find most challenging when working with dynamic textiles?
Response: N/A

Question 4: How do you see the potential and possibility for our project to work in the allotted time? I.e. do you have recommendations for what materials to use/how to go about this in a feasible and realistic way?
Response: Always plan to build your project 3-5 times especially with wearables it is a slower process. I am not just talking about time but also money, account for buying things multiple times and the wrong piece, check with me or Arielle. I never start out to start with everything I am constantly buying things. Test what you are making in smaller versions, build in a lot of time

with that, so you learn how everything interacts with each other. Planning how to present it to people judging it academically. Along the way define the user because wearables need to speak to the identity of the user. What is that event, who is that person, what is their personality to define why you used what you used. I'd rather you guys do a basic interaction and a very beautiful piece. I think you all should practice making garments over break as part of your research. Vogues has cool pattern online. Make an inspiration board to help find what you want to do.
Get supplies from Sparkfun and Adafruit they have similar product lines. The biggest benefit from Sparkfun is you can pick it up. Use conductive thread only on the bottom in the sewing machine. Use Kobakant as a resource because you can get more DIY. Make anything soft if you can avoid hardware.

Question 5: Do you have any further contacts you could connect us with that can help us get materials for this?
Response: I'll reach out to some people and get back to you.

Notes:

- Check
    - Kobakant
    - Despina
    - Zach Posin dress
    - some shoes in high fashion
    - see who avant-garde fashion serves.
- Artists to check
    - Kate Hartman: Social Body Lab
- Said she would be an advisor

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Jingwen Zhu

Introductions:

- Study design in design in NYC
- Focus on wearable tech
- Working as a co-founder at a startup called wearable media
- And research resident at ITP teaching wearables
- Left wearable media and joined a design company called ???
- Work as an electrical design engineer
- Products focused on electronics for consumer projects
- They have clients so products change for what the consumer needs
- Started from expressing herself before collecting data

- Work with electronics that collect data and they have a lot of conversations about data security and about whether it's necessary. It’s very easy to add a sensor, but what's the point and how can we be more responsible and mindful of those technology pieces

Question 1: What was your experience with thermochromic pigments?
Response: This was my basic idea for the design of my color-changing dress. Seen a lot of work using LEDs but didn't want to use LEDs because that’s not in everyday life and we use it to express ourselves. Color is in everyday life. I found thermochromic pigments as the answer and found a way to control the color change with a circuit (heating pad). Challenge was how to power it and bring the paint to something you can wear. It is very power consuming, had to work on the circuit to eliminate the consumption of electricity. Ways to do that with hard/software. battery size is similar to an iphone for the dress. Screen printing the pigments onto the clothes was tricky because the pigments react differently on different materials, most of the screen printing you are not supposed to high heat wash them, but you need to use heat in the design of the dress so it involved a lot of tests with the pigments, fabric and heat usage. Testing is very inefficient for power consumption, I used an iron to test the color change and see it immediately and easier. I spent about 6 months working on the project. After that, I’m still working on improvements. This project was the beginning of my working more with dynamic textiles. How can I integrate circuits and interactive components into the textiles? Learning weaving and machine knitting.

Question 2: What do you find most challenging when working with dynamic textiles?
Response: I used hydrochromic pigments before which changes color when it gets wet. Color changing under sunlight. These are harder to control because they’re harder to test. Kinetic textiles, muscle wire that memorizes the shape between power cycles. It’s kind of wear so you have to work with really light fabric for this to actually move the fabric. You can use motors to drive the pieces to move. You can move the fabric in any way you want but designing with a motor is really challenging to mount. Use electromagnetic circuitry, basically using magnets in textiles and power them with an AC circuit.

Question 3: How do you see the potential and possibility for our project to work in the allotted time? I.e. do you have recommendations for what materials to use/how to go about this in a feasible and realistic way?
Response: 2 and a half months is the time I spent on actually making the dress. The actual production takes less than 2 months. for you, you could give yourself a specific timeline for testing and after that work with whatever you have. Even if it works but isn’t ideal, just work with it to make the final product so you have the final products. This is common when working with tech and also deadlines. You need to use your design to overcome the technology not being super ideal. Making a garment involves pattern making and designing on top of the technology, so there are multiple parts and need plenty of time to design the piece. Another take away was a lead time, make sure you account for shipping times and getting the parts. Working with the hardware you’re working with physical parts so everything needs to be present. Project planning is really important. Working on a team will help when dividing tasks.

Understand what the main challenge and core of the project. Having the garment being powered by battery was very important for me, instead of being connected to a wire and a wall. No one else cares if it's battery-powered because its a showpiece, so I would've spent less time on the battery and more time on the work...so know what's important when designing. If you like the challenge, give yourself a challenge to overcome.

Question 4: What is your experience working with fiber optics?
Response: I haven't but I worked with someone who weaved fiberoptics into textiles. I think it's a bit stiff to work with. It's a design challenge. You have to layout your piece and cut the fiber optics according or using a knitting pattern that makes it possible to knit in. Good cause its thin

Question 5: Do you see a lot of the wearable fashion coming out in NYC?
Response: Mainstream fashion is pretty conservative. Fashion companies still aren't sure about having wearable clothes. It's very hard to design with, the fashion designers aren't familiar with these ways of making clothes so they shy away from it. The technologies aren't quite there yet. They think it's a lot of work and effort with wiring and battery. Small group with a 3D print fashion and they have an online store. Thin layer onto textiles. More brands like indie designers are doing this but it's a small community. Lumia is developing textiles and working with fashion brands to implement this fabric to brands clothes. Heating jacket. They're textile can heat up with a small sized battery. It can also illuminate and act as a capacitive touch interface. Fashion companies and furniture and interior design companies. Able to embed textiles into other products. A lot of startups in NY that are focusing on this.

Question 6: Why do you think the wearable hasn't gotten to everyday fashion yet?
Response: Technology is not there yet. Levis and google collab jacket, it was disappointing because they were still embedding chunky electronics in the cuff. hard/soft integration is challenging. Engineers are working on that but we haven't seen a good solution yet. Mindset: a lot of people when they think of wearables think of apple watch or Fitbit. We don't think of it as garments, the need is questionable. What's the ned and whats the market there? It's hard to define what's the market when it doesn't exist yet. Use case, garments are limited when for a specific use. Need it to go with anything and also have the functionality for different lifestyles and also different uses in one to justify having a smart garment.

Question 7: Can focusing on aesthetics over utility help the problem of finding a need for the garment?
Response: Yes, aesthetic can help the use case and give more of a reason and need for the garment. You know what you are expecting. Utility, users are more needy vs aesthetic. Use case, even more, regular garments, they can be used for different occasions, so to focus our design on either a specific occasion or everyday use. You narrow down your challenges when making clothing for a specific time to wear it.

Notes:

- Knitting yarn to create a stretch sensor. Stretch knitted patch to change the tune of the sound.
- Having a clear direction is very important. Glad you're clear right now.
- Would love to see our project when it's done and knows more about the story. A lot of wearables are (ugly?) a lot of story behind it is very meaningful. If we have any questions throughout the project we can reach out.

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Laura Devendorf

Question 1: What do you find most challenging when working with dynamic textiles?
Response: Yes. A lot of the research in the lab started from the color-changing work (started 4 years ago). No prototyping support. Hand-painted all the yarns and then sent them to Washington to get them weaved. Powering was another challenge. The more tightly you pack the yarns the less power you need because the power will move across, but a log pattern you need a lot of heat and power. Running an amp of current which is slightly dangerous to wear. Working steadily to get that number down but it takes a lot of tricks. They're gonna take more power on a cold day, vice versa on a hot day, variability on a person's body temp changes (some people see it as a limitation but I design with it and see it as poetic).

Question 2: How do you see the potential and possibility for our project to work in the allotted time? I.e. do you have recommendations for what materials to use/how to go about this in a feasible and realistic way?
Response: Yes but there are different levels of achievability. Handweaving would take much longer. Suggestion: think about a really subtle design feature that you can change that would radically change the garment. Different design tricks you can do to enhance the effect. The bigger it gets the more problematic. Silkscreen with thermochromatic pigment, and with heating pads and use that as the control to make this appear and disappear. The eye will pick up small design changes in the garment, so go smaller than bigger and it'll still have the same effect. The key is finding the right mapping. What causes the color to change? If you can make that more subtle or integrated with what style means to someone, it'll read more like a garment and less as a technical product. If it just changes and has a life of its own, or changes based on something that's more fluid (sounds…) then it feels less like technology and more like a living garment. Everyone's going to call it a mood ring because it is the only thing people already know that they can relate to this kind of work.

Question 3: Do you have any further contacts you could connect us with that can help us get materials for this?

Response: Website to look at solarcolordust.com/Glitterhippo (partner company). They sell a lot of thermochromic materials. A lot of Instructables posts on how to mix them with acrylic paint and paint them on to them. It's easiest to use pelta heating element. You would win a thermochromic yarn with copper wire and then it's a lot of experimenting with trying to heat the copper and it'll drastically increase the time the project will take. The heating elements though bulky will be easy. Laura grant...based in SF does wearable tech stuff. It will be more helpful to narrow down on how we're going to do this and ask specific questions to wearable people ...will be more helpful. Changing the collar with drastically change the style of the shirt.

Question 4: What is your advice on working with circuits in woven fabrics?
Response: A lot of circuits a lot simpler than we might think. A force sensor just changes in response to pressure. Cobacant website, earlier textile references. Waffle weave 3D structure helps better with pressure sensors. The process seems to work better when you play with the materials and see what you get rather than wanting something specific and trying to make it. The yarn changes when can work. Force sensors, strain sensors, and temp sensing works (but you have to buy much higher quality materials for temp sensors). Electrode structure that can sense muscle activity. Resistors, voltage dividers. Don't know how to weave a capacitor or a transistor (though other people have). My dream is to weave a whole Arduino. Touch sensing. Posture sensing. Color changing thread (not a circuit, just a wire).

Question 5: What do you think the practicality of this work being applied to worn clothes is?
Response: Production infrastructure is a barrier. Can wash/dry but most of the time clothes have a piece you need to take out. There's nothing stopping it from being commercial except with textile industry have never worked with circuits before so they don't know how to test them and the industrial machines cant handle making them. Find on handmade scale but barrier when dealing with large scale production. Have to test if the circuits with withstand . it's all there, just need some time.

Notes:

- Keep me updated!
- Focus on solving a simple design change
- It can get out of scope very quickly if you don't keep it simple
- Website to look at solarcolordust.com/Glitterhippo (partner company)