The Jedi Vending Machine

Indiana University
School of Informatics and Computing
Human-Computer Interaction Design
I590 Advanced Prototyping
Final Project - Intel Perceptual Computing

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Contents

Executive Summary

This document outlines our design for the Intel Perceptual Computing Design Challenge. The design is for a Star Wars-themed vending machine where the user reaches out with their hand, the vending machine recognizes the open hand and what product it is pointed towards, and then after a period of time "fires" the product towards the user's hand using compressed air.

In the first part of this document we outline our design process. We go over the means by which we generated concepts, including brainstorming and bodystorming activities. We also describe how our concepts were revised and how we chose our final concept.

In the next part we describe the final concept in detail. We do this by providing both a quick overview description, and a deep explanation section. We also in this part of the document outline our expectations of the design, and how we hope to evaluate it by using engagement as our primary success metric.

Next, we go into considerable detail on how the prototype itself was build. This includes part and tool lists, as well as photographs and overviews from the construction of the three major components of the design: First is the code, or computerized section of the design. This is the Intel camera and Arduino code that allow the design to function. Next we outline the physical Arduino components that control the design's electronics, and the pneumatic system we use to operate the design. Finally, we describe the design's physical cabinet housing.

In the final section we provide a complete storyboard that outlines a use case for the design, and we include reflections from each team member.

Initial Seed

When we began this project, we knew right away that we wanted to create an interaction that gets away from the traditional computing setup. We didn't want a interaction paradigm that involved sitting at a computer, having a laptop in front of the user, or even holding a tablet. We wanted our interaction to move out into the environment; we wanted to capture interactions that occur naturally or ambiently, things the user wouldn't think twice about. In a way, we were interested in augmenting reality. Not in the prevalent visual sense, but by capturing and interpreting the everyday somatic actions of people who were just living their daily lives. This desire is the seed of our project; it is our starting assumption and our primary predisposition. It is this initial desire, formed in the immediate aftermath of the initial workshop, that guided our concepted and formed the primary criterion of our decision making.

Though yet vague, we had a goal. Now we knew that we needed to find out what these natural interactions might be.

Brainstorming and Exemplars

The first thing we did was brainstorm. We wanted to uncover as many examples of ambient or natural interactions as we could. We were looking for things people already did that we could capture. This brainstorming took two forms: We tried to both list as many interactions as we could come up with, and also both discover new ones and expand on the ones we had come up with by finding exemplars of them. These were then organized into design directions, of which we include several in depth examples.

Medical experiences: We considered the various motions associated with the medical profession, including the actions of a surgeon went doing surgery, and the actions a nurse might go through with a patient during a general checkup.

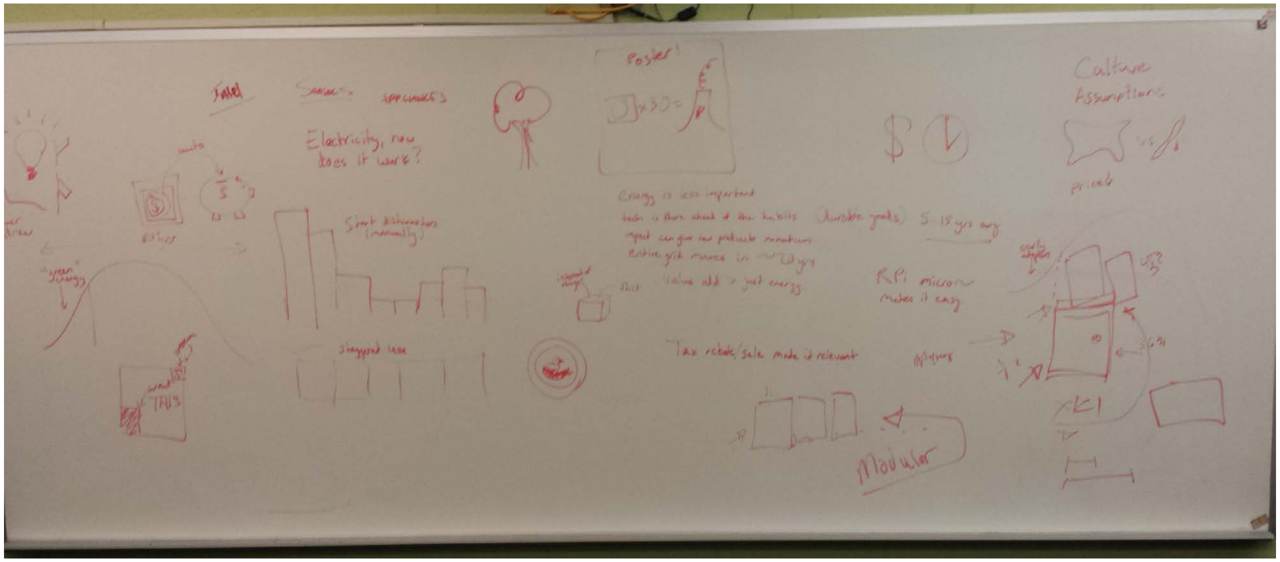
Transaction experiences: For transaction experiences, we included the casualness of automated vending transactions--principally vending machines, but we didn't want to necessarily limit ourselves to vending machines. We also looked at other kinds of transactions, including the hand motions associated with ordering a drink in a very loud bar.

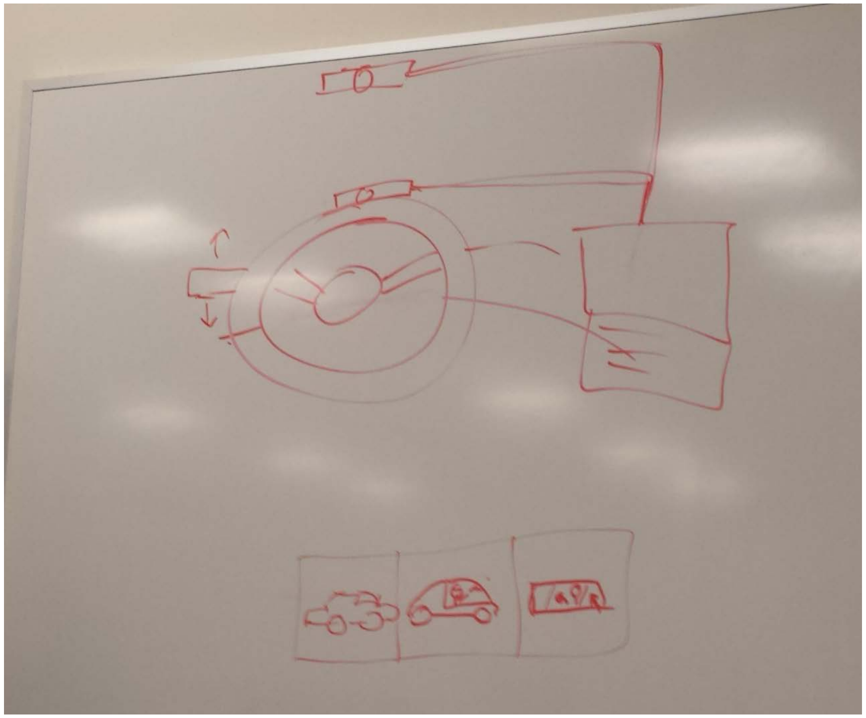
Driving experiences: We were interested in the kinds of motions associated with driving a car, mostly related to actions that are in the periphery of actually controlling the vehicle. For instance, we were interested in motions for rolling down windows (consider the traditional window crank!), or changing tracks or volume on the radio.

Musical experiences: An artist performing music on stage represents a wealth of varied body motions that are worthy of capture, and their complex interaction with the audience provides an abundance of possible outlets for that capture. But our consideration of this direction included not only the artist, but the audience: Dancing is something we could capture, perhaps dancing of an entire dance floor.

Some other directions we considered are 3D dimensional modeling, immersive video gaming, and avataring.

Brainstorming and Exemplars





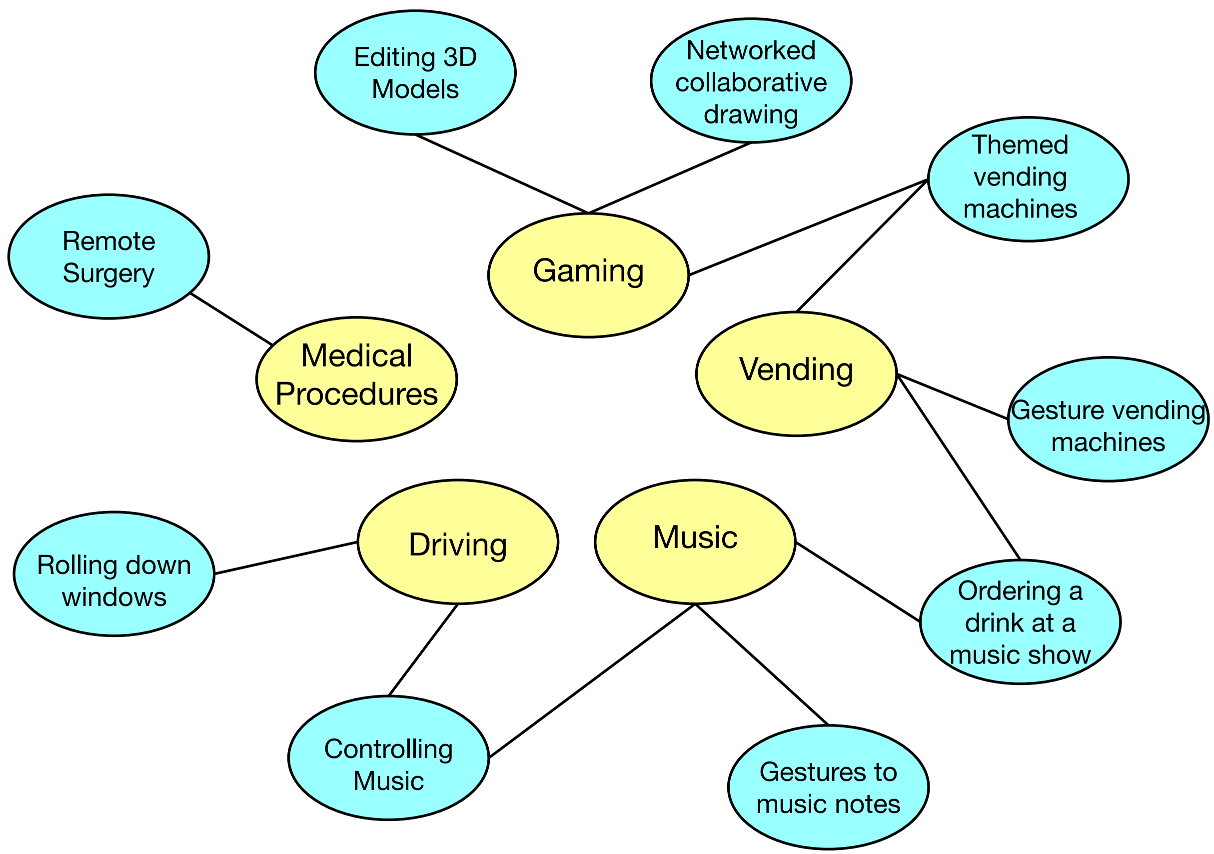
Concepts and Concept Map

Our next step was to create a number of concepts. What we created was oriented along the lines of the directions we had previously created:

From transaction experiences, we modeled a concept of a point-and-select vending machine, a Star Wars-themed vending machine, and a system for ordering drinks at a bar.

We also concepted ideas from the driving experiences; including how we might create gestures for rolling down windows, and how we might create gestures for controlling the radio.

The concept map below contains most of our concepts, with yellow representing directions and teal representing concepts:



Bodystorming

For class on the 11th of November, we bodystormed a number of our concepts to get a better understanding of the resulting gestures. This included not only the concepts we were currently considering, but some brand new ones as well.

Final Direction

During the session on November 18th we prepared a presentation of our current position to the class. For this presentation we had not yet made a solid choice of final concept, but we were leaning towards some kind of vending machine concept. We decided to present that as our concept and were encouraged by the positive response. Egged on by our colleagues, we decided to go this route and refine the direction.

Slowly, a final concept emerged of doing a Star Wars-themed vending machine. We would mean create a vending machine not only controlled by gesture, but gesture that would mimic the recognizable “force pull” action of Star Wars. We liked this because it combined our vending direction with a concrete example that allowed us to define a setting and user group. Not only this, but it even lent us a set of recognized gestures that would make contextual sense with the user. This decision allowed us to start to focus on the more pressing technical aspects of how we were going to actually build the camera code and physical components.

First, we reviewed the source material we were attempting to mimic. The uniqueness of the Star Wars gestures and the reaction from the artifact was something we knew we had to capture accurately in order for the design to function the way our users would expect. Also, capturing those very exact gestures and responses are what will make the design such a delight!

Exemplar Review (part 2)

Even though we had a solid idea for our final concept, we wanted to make sure that we had continued to explore the opportunity space such that we had a strong idea how to actually put together and make the experiment strong and memorable. With this in mind, we did a separate exemplar review focused specifically on non-standard vending experiences.

See Buzzfeed article: http://www.buzzfeed.com/arielknutson/vending-machines-you-wont-believe-exist (24 Vending Machines You Won't Believe Exist)

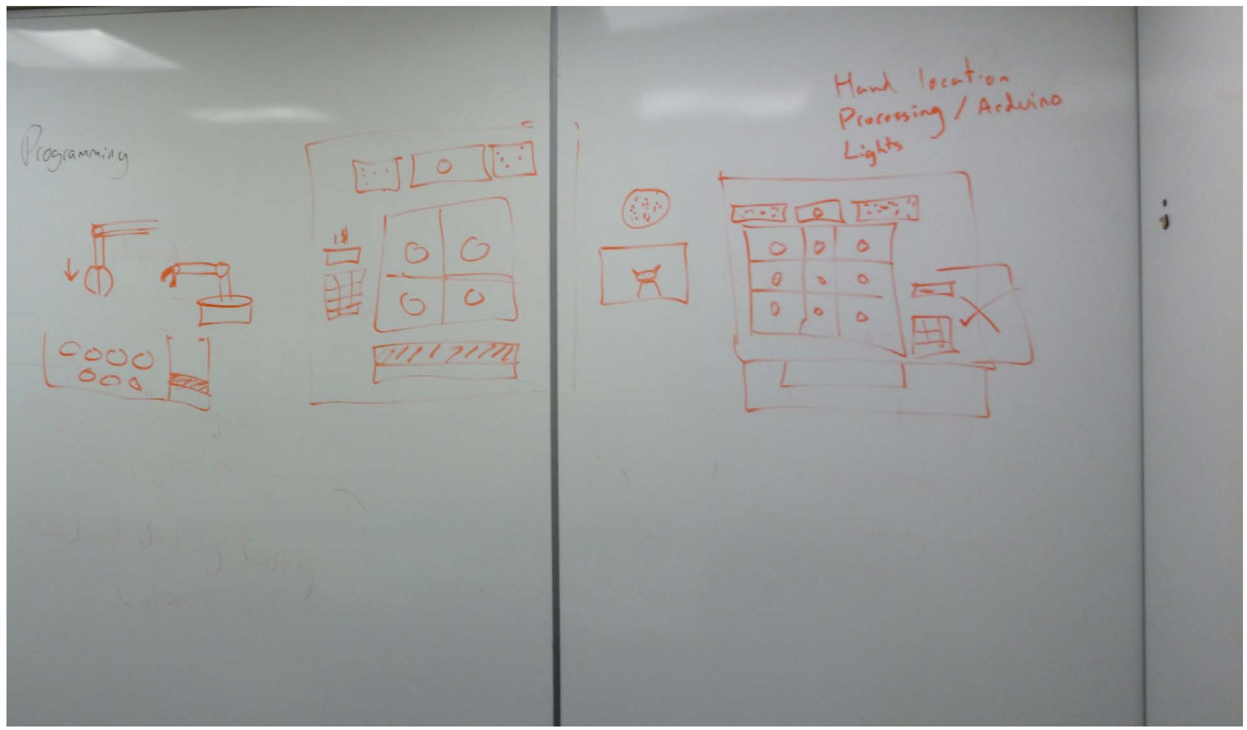
See Toxel article: http://www.toxel.com/tech/2009/06/08/14-cool-vending-machines-from-japan/ (14 Cool Vending Machines from Japan)

See The Village Voice Blogs article: http://blogs.villagevoice.com/forkintheroad/2010/10/10_wild_and_cra.php (10 Wild and Crazy Food Vending Machines)

Image from: http://blogs.villagevoice.com/forkintheroad/vending14.jpg

Moving Forward

After all these activities we felt prepared to realize a prototype of our final concept. We still knew that things would change some as we actually went forward to building, but we had a strong idea of what our design was going to entail.



Robert's Questions

Our design addresses Robert Cooksey's main questions in in this way:

Why can't I just use my hands to get things from a vending machine, instead of having to punch in numbers and letters.

Wouldn't it be cool if you could get things out of a vending machine like a Jedi?

Final Concept Description

Our final design is a buttonless vending machine operated by specific hand gestures. We chose a Star Wars theme to guide our design for a few reasons: It lent us a specific context and target audience, and it let us adapt to an existing mental model for our users. This last one is important because interacting with a vending machine using gestures isn't something we expect our users to be familiar with. By making the gestures the same as the "force pull" mechanic from Star Wars, and situating our design in a movie context where most of our users will be familiar with the gestures, we soften the problem of users adapting to a mental model they are not familiar with.

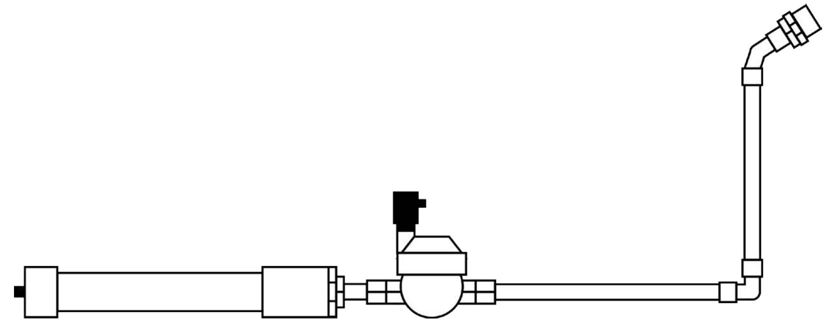


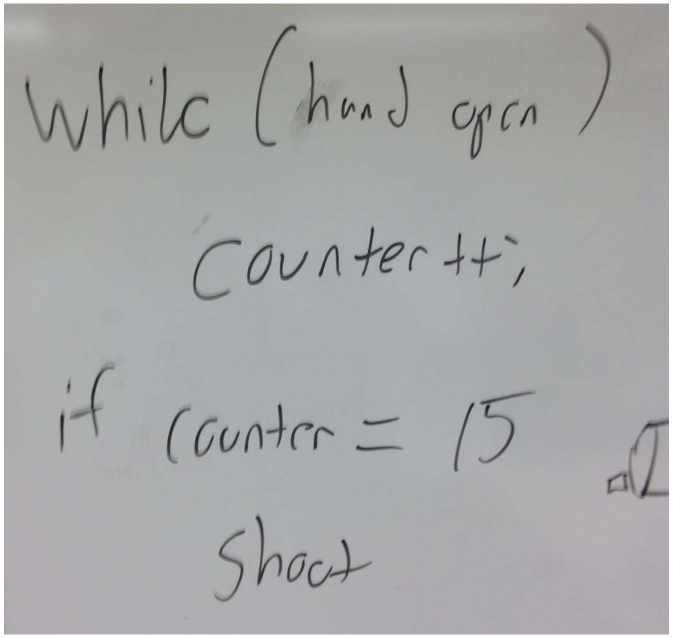
Diagram of the design's pneumatic system.

The motion camera will capture the user's hand when they extend it, and will light up boxes under products when their hand is pointed at that particular product. When the camera detects an open hand, a timer will start, when this timer is finished we will use an arduino to open a valve on a tank of compressed air and blow the candy off the vending rack and into the user's hand. The delay between them opening their hand and shooting the snack represents the effort required to do a force pull. During this delay, the machine will play sound clips of Star Wars encouraging the user the concentrate harder so they can use the force.

We envision our design as a vending machine in a movie theater; perhaps in tandem with the upcoming release of new Star Wars movies. The vending machine is more than just a way to get candy and snacks, it is a marketing gimmick, and a way to draw attention and spread buzz. It can even enhance the entire movie experience by bringing some degree of immersion and subject-appropriate novelty outside of the movie proper. Because the design is contextually situated in movie theaters probably during the premiers of new Star Wars movies, we expect our users to be primarily enthusiastic movie-goers who have knowledge of the Star Wars universe.

Final Concept Description

We predict the typical use case to be a busy theater with a lot of people around, because of this we expect the design to attract more users as spectators than



as actual operators. We expect the machine will attract attention even in a busy theater, and as some users operate it others will simply stand by to watch. We even would expect a line to use the machine forming at times. The delay between the open hand and the firing of the snack, and the encouragement from the machine during this time we expect to illicit more playfulness out of our users. Simply standing there with their hand open will eventually cause the snack to shoot, but we expect most users to “get into it”; to strain and act the part as they try to use the force! We expect the experience to be fun overall, both for participants and observers.

Evaluation

The primary intent of our design is to be delightful, therefore the primary concern of our evaluation is if the design is fun. Our design isn't about an most efficient delivery of snacks, so we didn't consider a usability metric to be particularly well suited. We think that we will be able to evaluate our design primarily though watching people interact with it, and seeing if they seem to be having fun with it or not.

For instance, in our design needs only to hold their hand in a particular position for a few seconds in order to get the machine to work. But, we expect that if the design is indeed engaging, that users will suspend belief and in a way, agree to the fantasy the design suggests. It takes no actual mental effort for the design to work, the user just holds their hand in a particular place. We expect users to behave as if the design takes effort in order to activate. We expect them to engage with it like they are one of the movie characters! If we see this happening in even half of our interactions during the show, we will consider the engagement aspect of the design a success.

Still from Star Wars: The Empire Strikes Back, used under educational fair use

Part Three: Building

In this section of the document we will show how we build our prototype, focusing on three areas:

- **Code and Camera:** This section describes the code we used with the Intel camera, what we required of the perceptual computing systems, and a link to our code hosted on Github.

- **Arduino and Pneumatics:** This section describes how we link the computerized components of our systems (the code and camera) to the physical components of our system using arduino, and also how we constructed the pneumatic system for launching snacks.

- **Cabinet:** This section is about our physical construction of the surrounding cabinet that houses the electronics of our design.

Master Parts List

Part Three - Building

Parts Used:

- Orbit 3/4" Inline Sprinkler Valve
- 16" of 2" PVC Pipe
- 10" of 3/4" PVC Pipe
- 2" to 1" PVC converter x2
- 1" to 3/4" PVC Converter x2
- 90degree 3/4" PVC Elbow
- 45degree 3/4" PVC Elbow
- 1 Valve Nipple - Closed Flow
- 3 Gallon Air Compressor
- 3 9v Batteries
- Spool of Electrical Wire
- 1 SPST Relay
- Oatey All Purpose Cement
- 12 - LED Book lights
- Arduino Uno
- Intel Perceptual Computing Camera
- Shoe Rack

Tools Used:

- Hacksaw
- Pliers
- Wire Stripper
- Soldering Iron
- Hot Glue gun

The Code

As we started work on coding, we had these functionality requirements:

- We needed the camera to recognize a closed hand from an open hand, and also to be able to report back the degree to which it is closed.

- We needed the camera to recognize what quadrant of the screen the user's hand was in. In a real model this would not be quadrants, but many zones. We chose to do quadrants and keep the number of spots at 4 in order to simplify our first prototype.

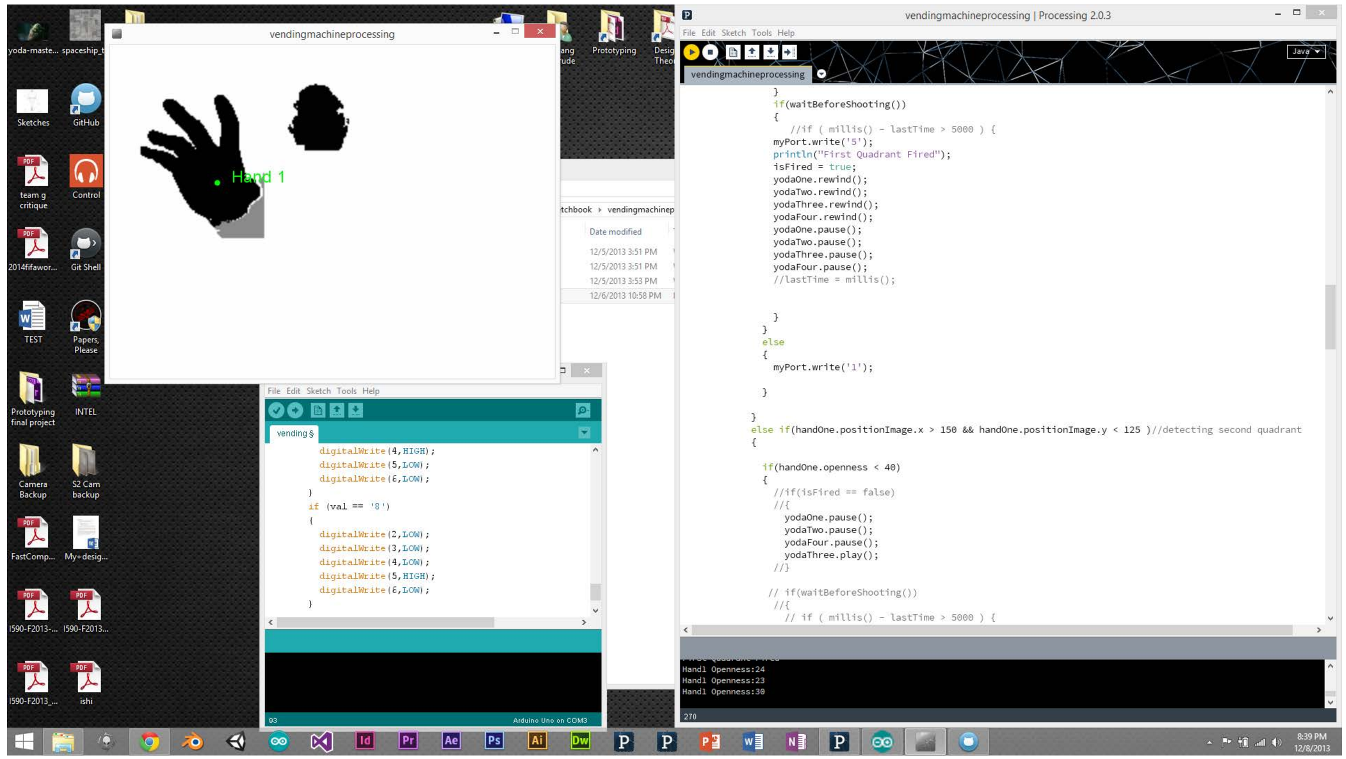
- The code had to tick a timer as long as the user's hand was held in the same position and quadrant. When the timer reached a certain point, the code has to somehow cause the candy to fire out (more on this later).

- An optional feature: We wanted the code to trigger the playing of sounds.

See our code on Github:

https://github.com/sarangborude/JediVendingMachinePrototype

The Code



Screenshot of interacting Arduino and Perceptual Computing code.

Arduino and Pneumatics

We used Arduino as the interface between the computer running the perceptual camera, and the physical components needed to actually shoot snacks. Exactly how we were going to physically move snacks was one of the last parts of our design to be decided, and before finalizing that we went through an entire stage of concepting and iteration where we considered using everything from catapults to robotic arms. In the end we decided on a pneumatic system that would literally blow the snacks off the rack towards the user.

An absolutely central part of the mechanical system our design was this valve. Technically built to control sprinkler systems, this valve is rated for a high psi, and is one way (once opened it can't be closed until pressure is equal). The valve could be opened via an electrical signal, meaning we could operate it with an Arduino board.

Photo: Home Depot

Arduino and Pneumatics

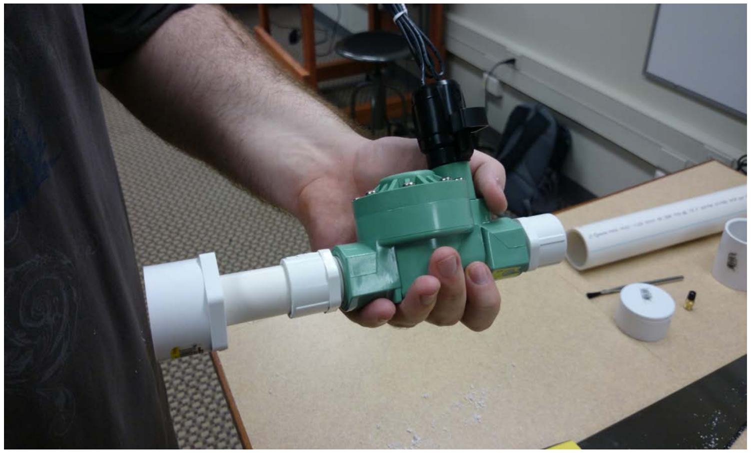
The launcher system was build from adapted plans from the Internet. We used a large PVC pipe to create an air tank (rated at 250 psi, we knew this could hold just about as much air as we could pump into it). The tank is connected at one end to the main valve, and is capped at the other end with an input valve that allows us to fill the tank with an air compressor. The other side of the main valve contains a few directional pipes to get the compressed air to go where we need it.

Attaching pipes to the main valve.

Sawing pipes to make the reserve air tank.

Arduino and Pneumatics

More fitting on the main valve.

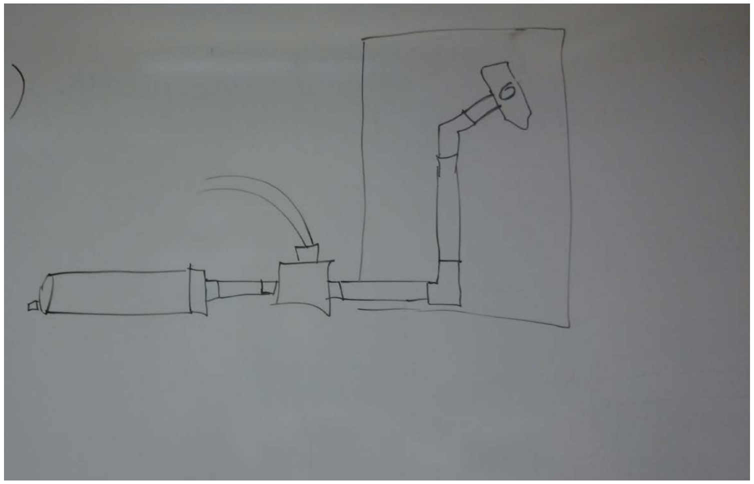


The input valve installed on the tank.

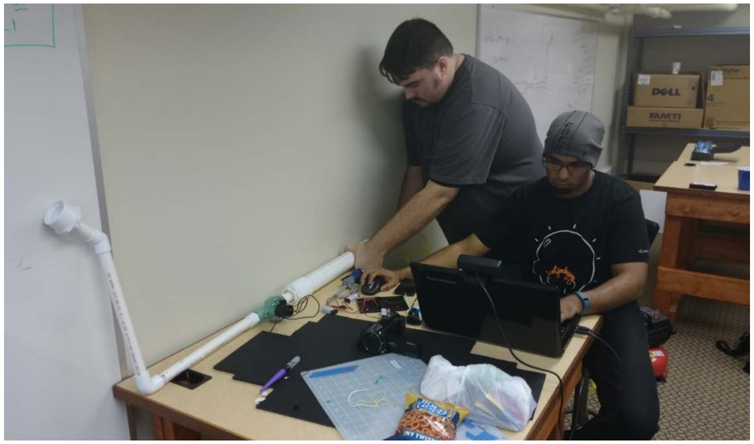
Hand testing the main valve.

Arduino and Pneumatics

Whiteboard sketch of the pneumatic system used during construction.



With additional piping added.

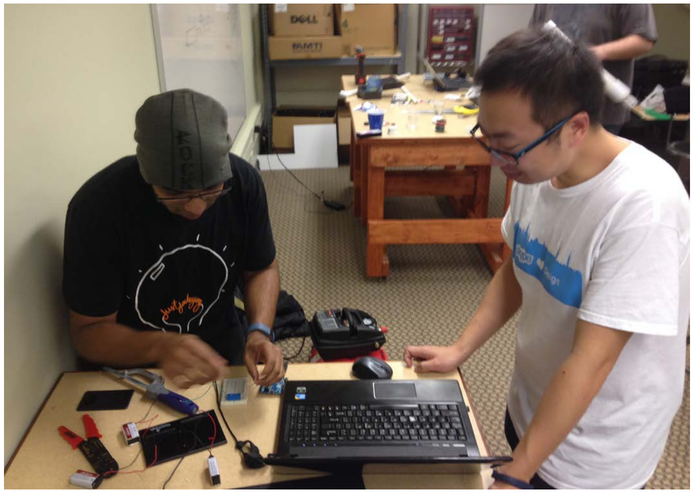


First test-fire of the pneumatic system (done outside in the Informatics courtyard, we were concerned about the possibility of it blowing up!)

Arduino and Pneumatics

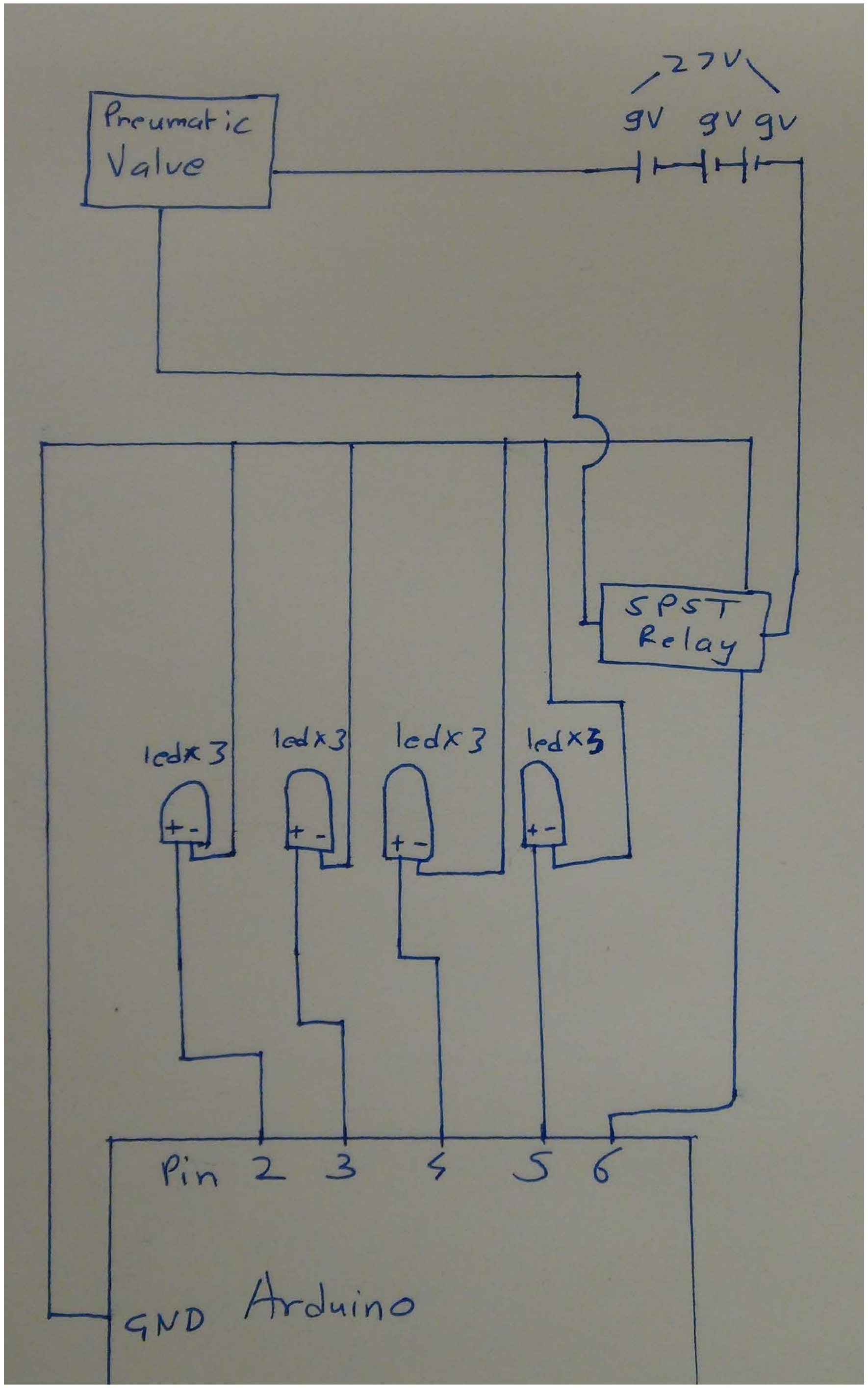
We used Arduino to both power and send the signal to the main valve to open. The power was provided by three chained 9-volt batteries. The perceptual computing code tells the Arduino code when to send the open signal. In addition, the Arduino controls LEDs we attached under each snack quadrant so the user knows what they force gripping.

Working on Arduino wiring for the main valve.



Arduino and Pneumatics

Arduino wiring diagram

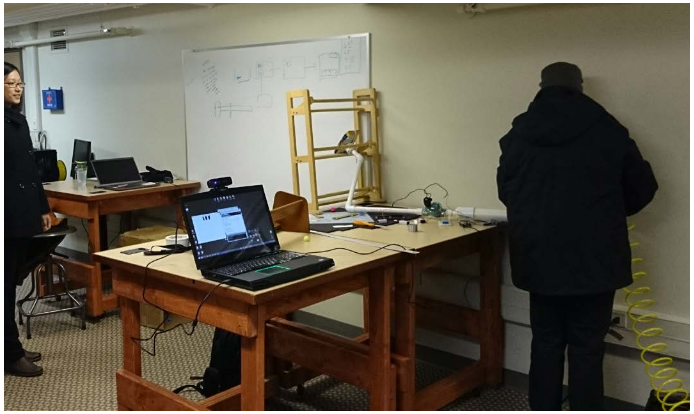


Part Three - Building

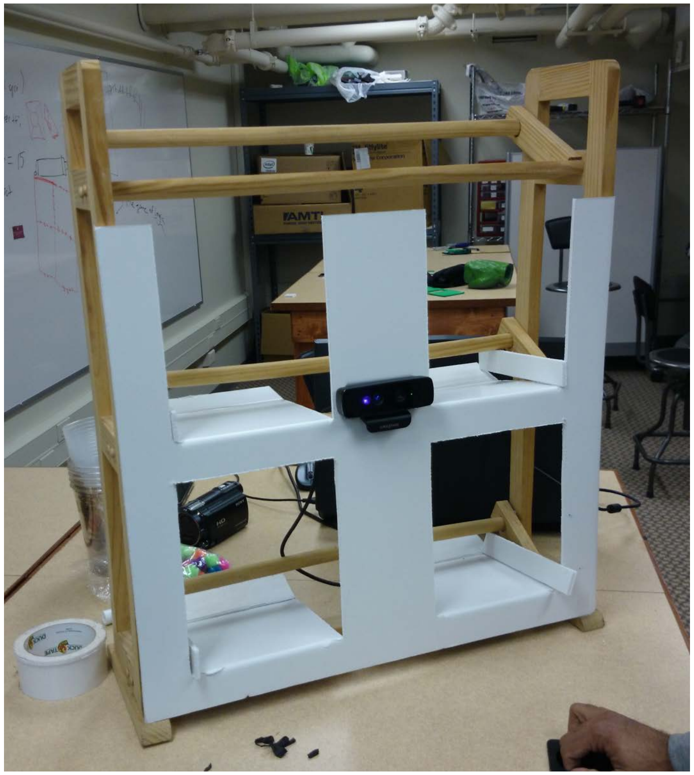
The Cabinet and Aesthetics

The cabinet is the physical component of our design that holds the snacks before they are fired, and also serves as the support structure to hold the camera and LEDs. Besides functional concerns, the aesthetics of the cabinet help communicate the themed nature of the design.

The base of the cabinet was an old shoe rack.

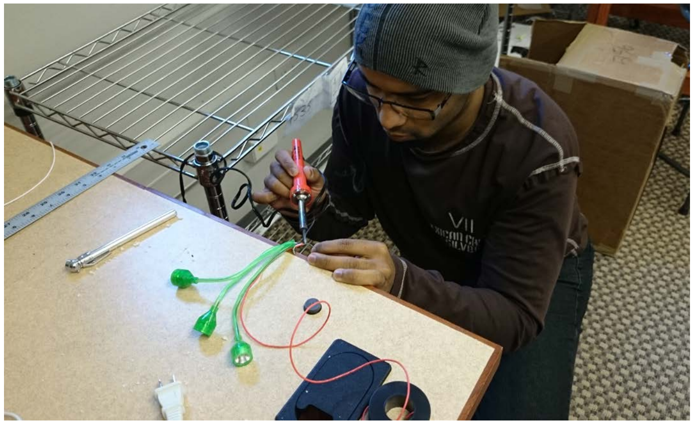


The perceptual computing camera mounted on the rack, and the rack starting to get plated with paper to create the Star Wars aesthetics.



The Cabinet and Aesthetics

Working on soldering connections for the LEDs to mount in the cabinet



The front part of the cabinet cut and marked out prior to fitting.

Part Three - Building

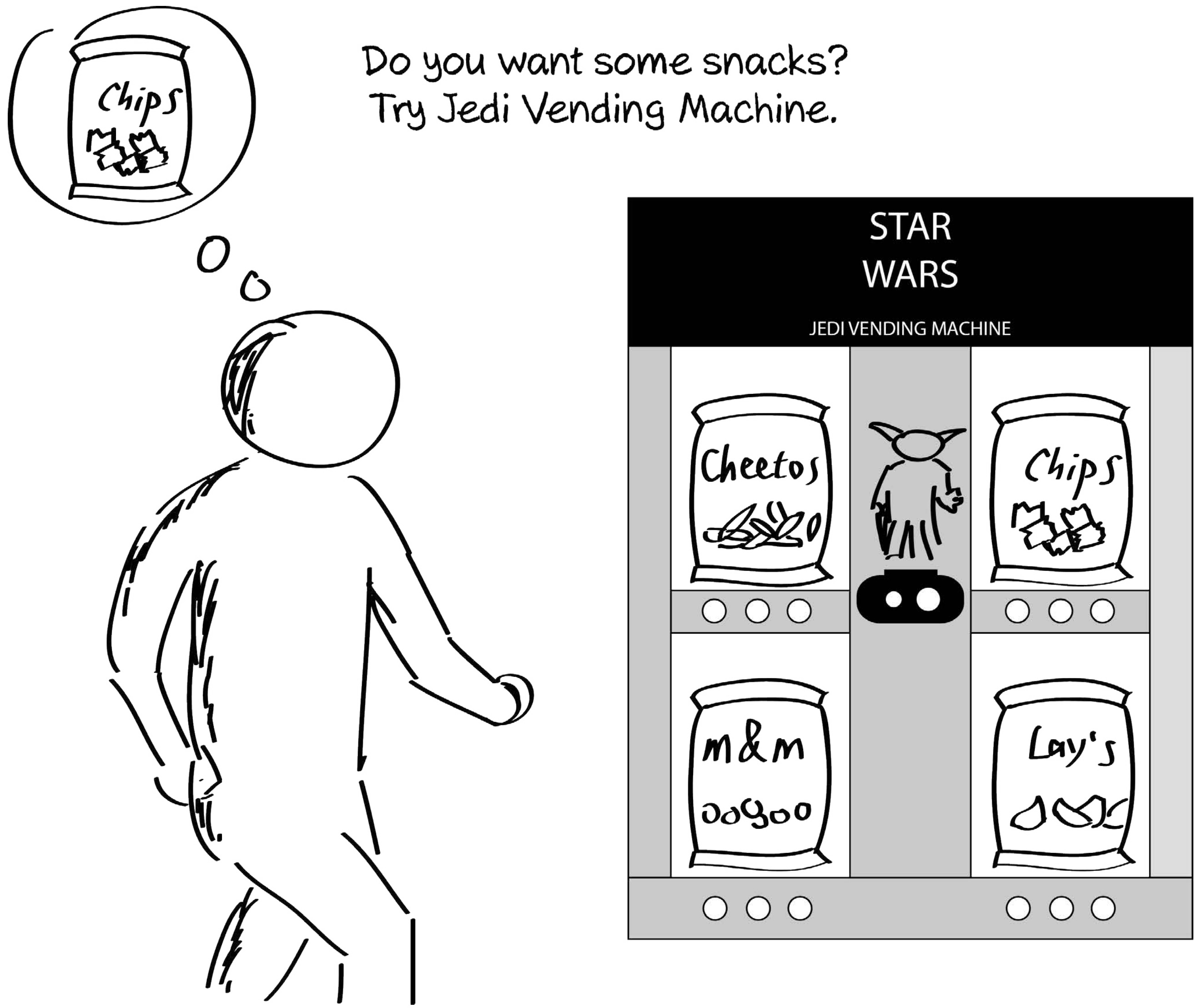
The Cabinet and Aesthetics

The finished cabinet.

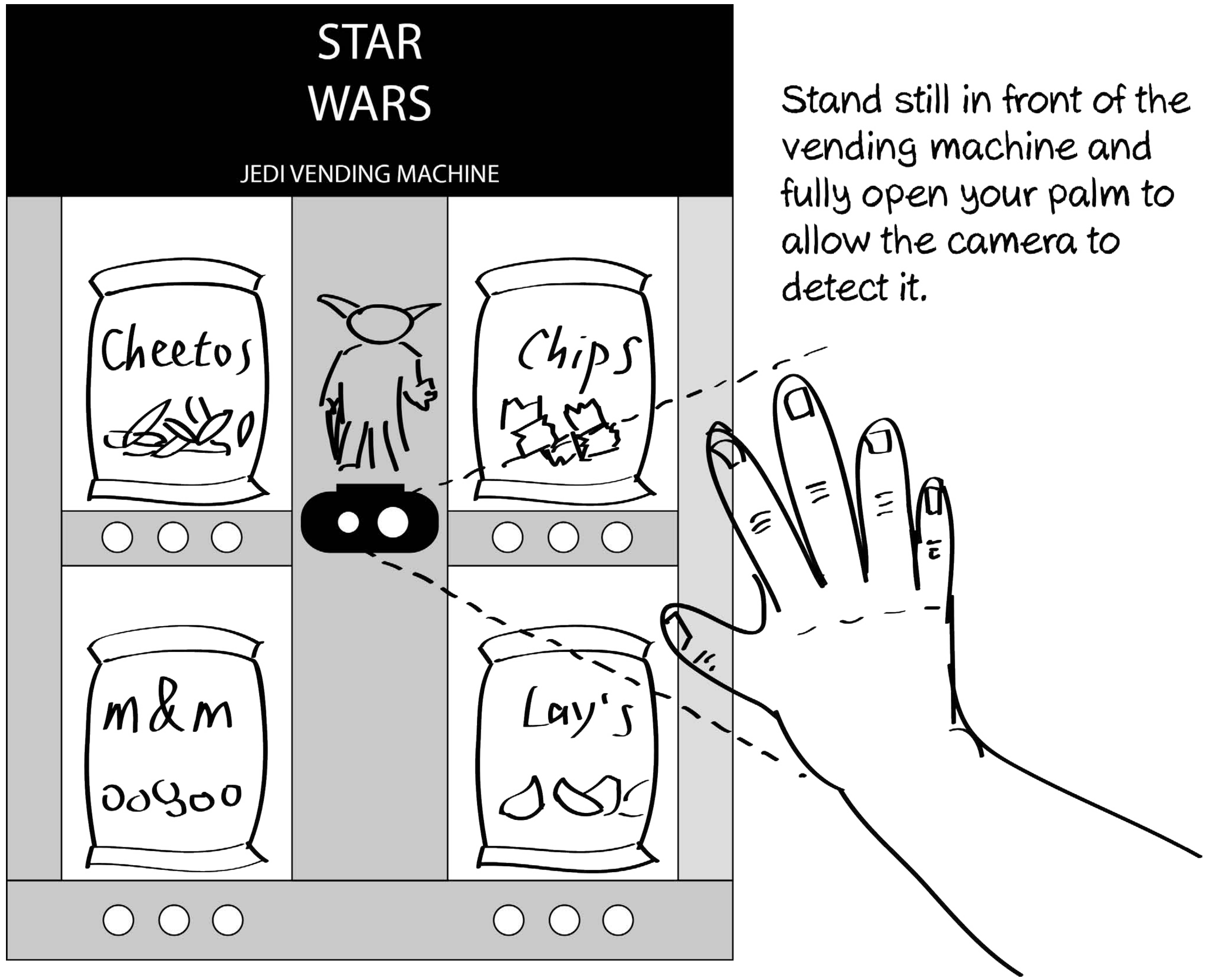
Part Three - Building

Storyboards

The following storyboards outline how the entire design will work.

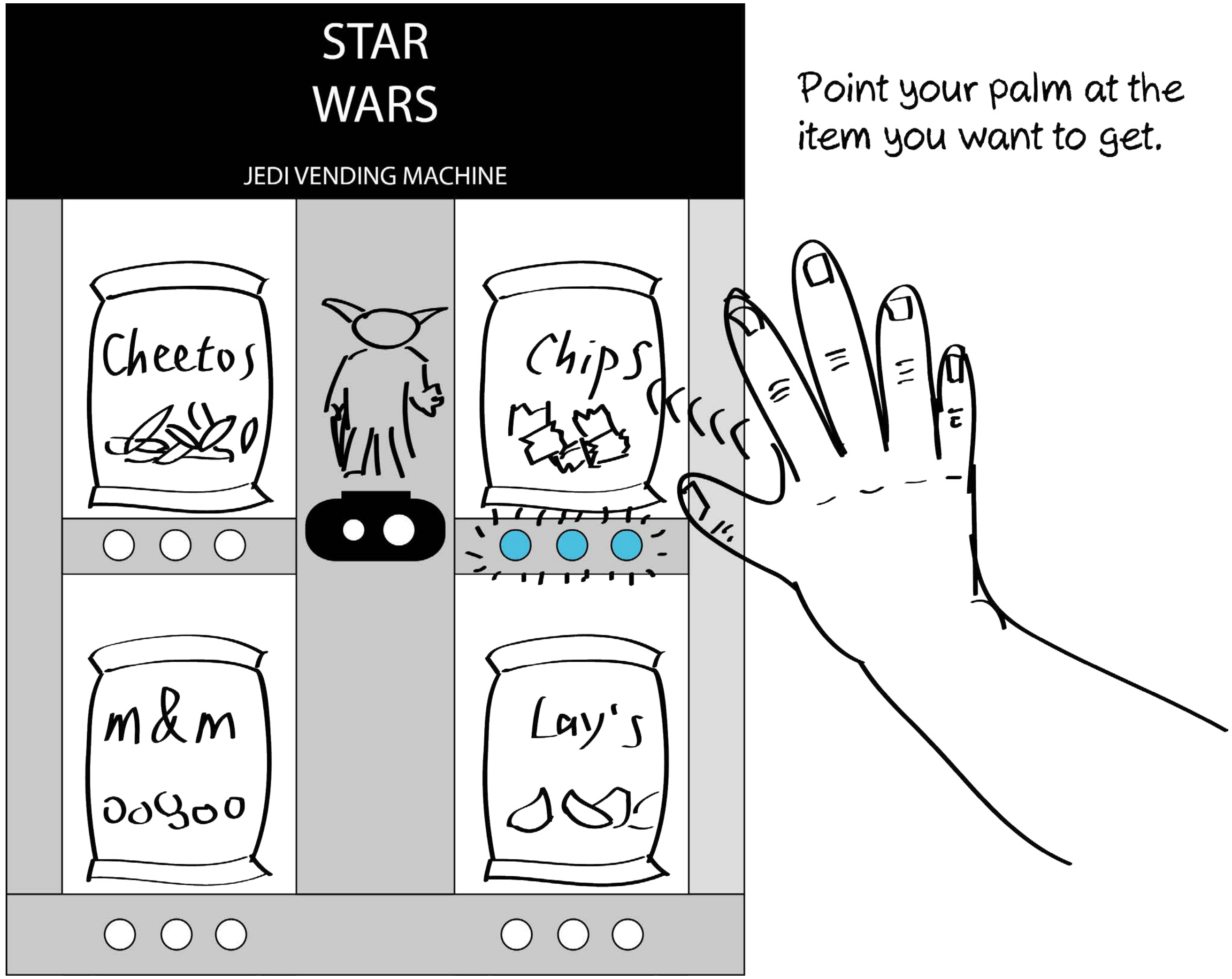


Storyboards



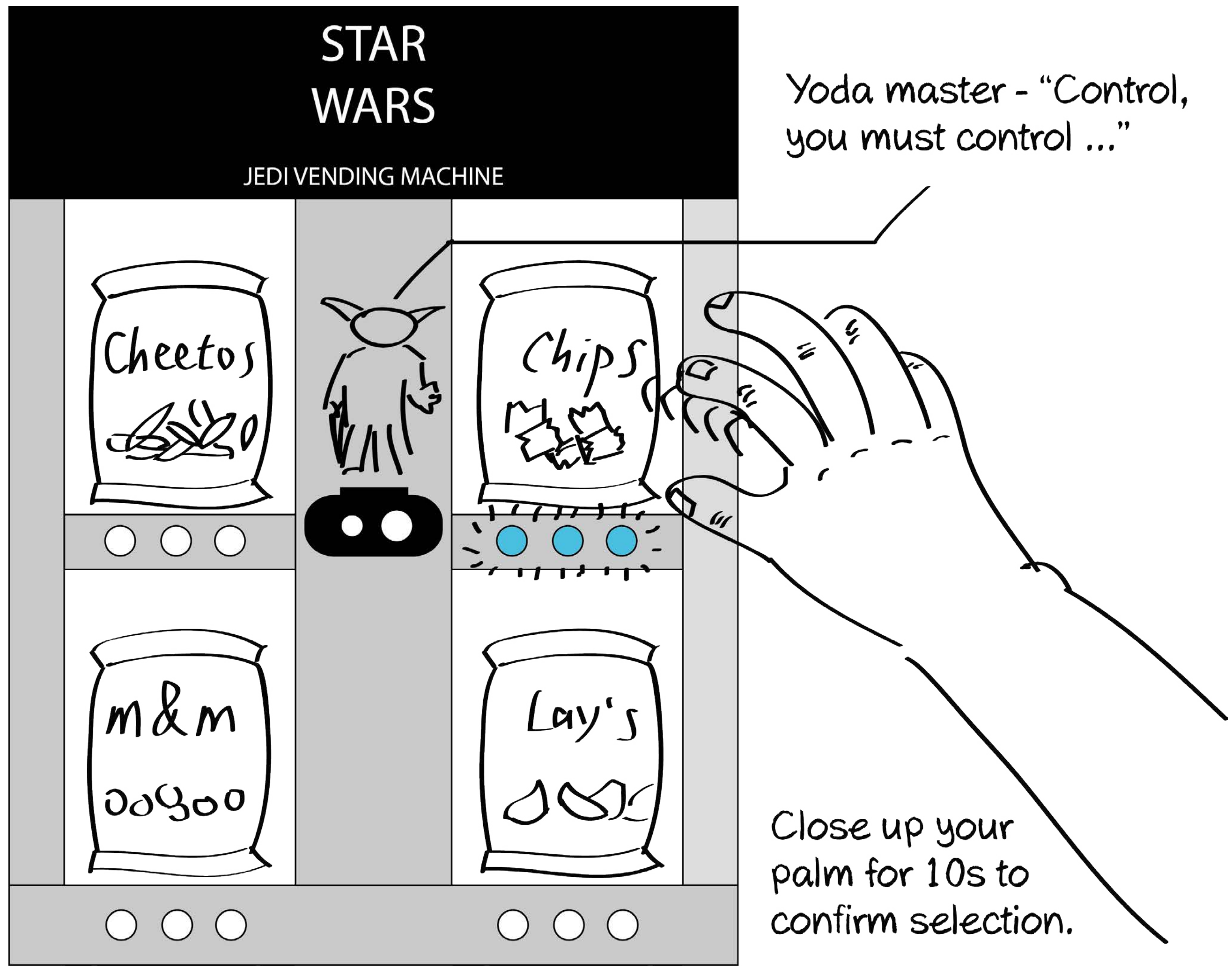
Stand still in front of the vending machine and fully open your palm to allow the camera to detect it.

Storyboards

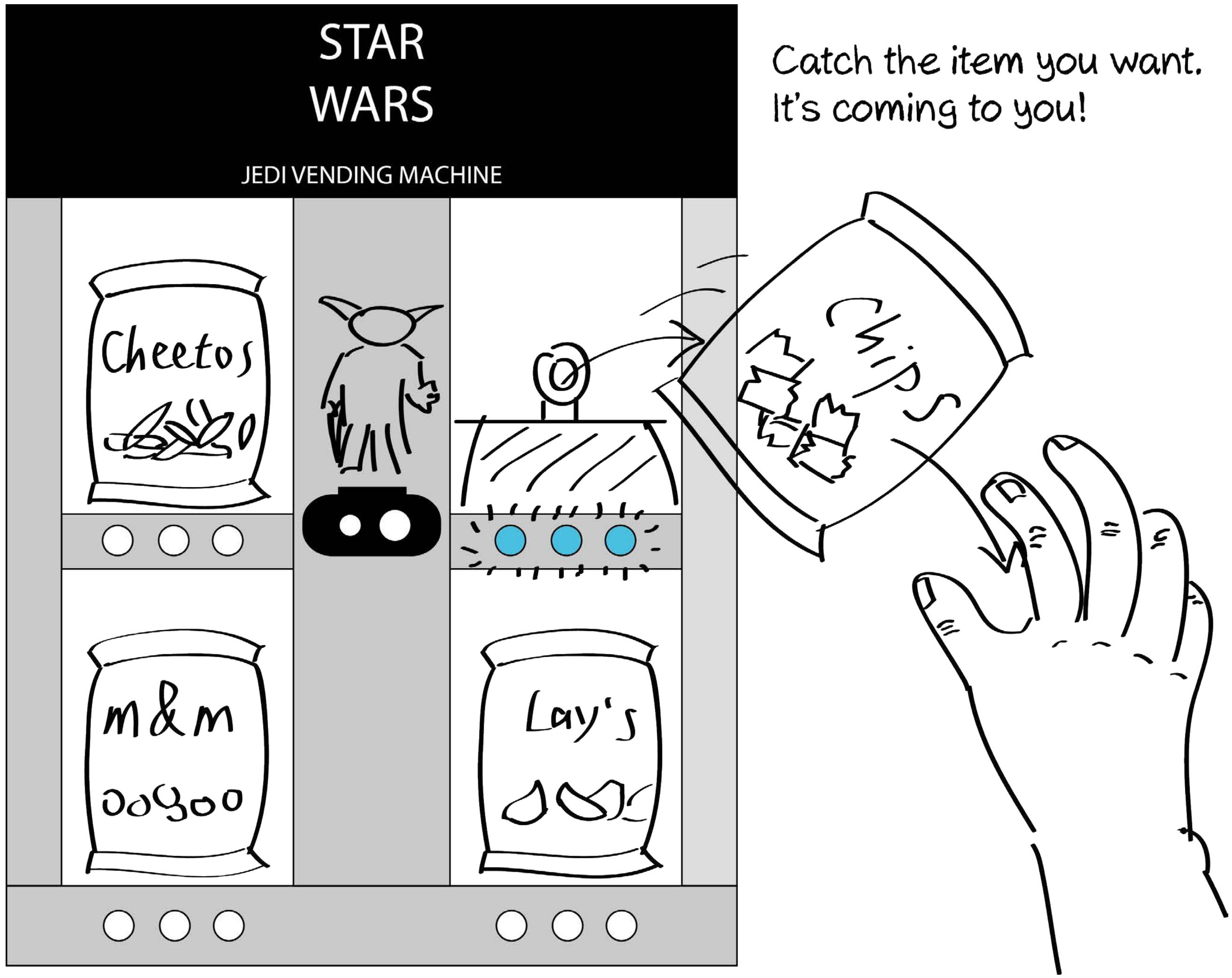


Point your palm at the item you want to get.

Storyboards



Storyboards



Catch the item you want.
It's coming to you!

Reflections

This final section contains our teams reflections on the project.

Sarang

How does this project change the way you think about designing and prototyping for tangible and embodied interactions?

We've using computers for around 40 years. A lot of things have changed so far, but still the way we are interacting with computers has not changed a lot. We still using keyboard and mouse which makes interaction with computers very machine like. In this project, we used gestures as a way of interacting with a very common device. We elevated the experience of using a traditional vending machine and took it to the next level. I feel like such change of experiences creates an excitement in the user. In a way we've also pushed our boundaries while doing this project. We never thought that we would be able to create a pneumatic air cannon controlled by arduino and perceptual computing sdk as this was something none of us were familiar to. We were experiencing extreme joys when things worked and extreme tension when they didn't. Having a belief and courage that we can do it forced us to experience everything we learned in the class. Hacking, repurposing, material, Look and feel and many such thing. I personally feel that I've used everything I learned in this class and implemented it in this project. Doing everything, right from programming, soldering, pipe fitting, decorating, using saw blades, air compressors, circuits and simple materials as foam boards was very energetic and fun.

What was your own process of moving away from problem solving and targeting program framing and setting for perceptual computing in this particular assignment? What were the challenges and accomplishments?

Our goal was to have fun with this project. We were having a thinking to make something cool. Not to worry about what problem we're solving. We thought of giving an exciting experience to our users. We focused on what novel interactions can be possible with this new way of interaction and what can we do with it. I feel like this interaction is still not upto the mark, but it is getting there. As far as challenges are concerned, there were many and at every phase of the project. By the end of the project I had a realization that I am using every single thing I learned in this class. For example, we didn't have any led lights, so we went to dollar tree got 20 book reading lights and took the LEDs from it and used it for the vending machine. So finding things, repurposing things and reutilizing things with a short amount of time was a great challenge we did a nice job facing it.

Matt

How does this project change the way you think about designing and prototyping for tangible and embodied interactions?

It gave me an opportunity to focus a bit more on the bodily interactions per se rather than what would have probably been my personal approach on a problem like this: That is, to look at what kinds of actions people are actually willing to do and not willing to do. Instead, the project taught me to look at the things people were already doing, which I think is a better way to go about that. In terms of prototyping, the project gave me a broader sense of the available tools for doing this kind of work, as well as what current technology is and isn't capable of.

What was your own process of moving away from problem solving and targeting program framing and setting for perceptual computing in this particular assignment? What were the challenges and accomplishments?

The process in question did not occur in this project, as designing for opportunity rather than problem solving is something I was already familiar with. I had done just that for the CHI 2013 Student Design Prompt, and already faced the complexities of differences in methodology, procedure, and argumentation. Over the course of doing that project I did learn a great deal about the differences in approach between problem solving and opportunity seizing design. If I'm to be honest, this project actually muddled considerably what I already knew, and it was quite difficult at times to tell that opportunistic design was the focus, because words like "practicality" kept being used. For instance I remember hearing that a design not made to solve a problem is also not aimed to be practical, but may end up being practical. Things like that just don't make sense to me. I think I have a solid hold on what it means to design for an opportunity rather than problem space, but even such designs--to me--still demand practical application and address human need; the need just may be very subtle.

Travis

How does this project change the way you think about designing and prototyping for tangible and embodied interactions?

For this assignment I feel like we did not actually target for a tangible / embodied interaction. The knowledge of our interaction came from a movie of fiction. Holding your hand in a grasping action and aiming it at an object will not actually pull the object towards you, but in the movie, the “force” is possible. We wanted to try and give the user the experience of being able to control an object with the “force”. We decided to utilize the features of the camera to know when a person is holding their hand in the manner of a jedi.

What was your own process of moving away from problem-solving and targeting program framing and setting for perceptual computing in this particular assignment? What were the challenges and accomplishments?

It actually took our team a while to decide what we actually wanted to do with the camera, and what applications it would be helpful in. We through around the idea of vending machine, in-car-experience, and 3D modeling for about a week. Once we decided to go with the vending machine, I do not remember why Star Wars, or even an air canon came up, but it did, and we ending up loving the idea once we started ideating around the concept. Though this might not be the most practical application, we felt that creating a unique experience of fright / enjoyment would be good enough!

CJ

How does this project change the way you think about designing and prototyping for tangible and embodied interactions?

Initially, we were given with Intel Perceptual Computing camera which was demonstrated as a new way of interacting with personal computer, but this project encouraged us to think out of the box and discover its potential usage through wide range of prototyping. Instead of limiting ourselves to only focus on the virtual environment and computer screen, we turned to look for ambient purposes and tangible interaction. That means our creativity does not belong to exploration in programming exclusively any longer, and the scope of making things happen has been extend by any possible embodiment. With such a great opportunity, our team started thinking about taking advantage of the features of the camera as well as its constraints. By discussing and sketching different ideas, a new way of interacting with vending machines became our promising direction.
While we were planning and executing our idea, it turned out to be that plan doesn't away promise the expected results. We tried to fine the right components and materials, but sometime solutions didn't show up. However, taking situated actions is the key that kept things going on the right way. In other words, in order to combine physical and virtual interactivity, making a plan and changing it accordingly all the time is how it works. Tangible and embodied interactions come into beings because of the ultimate combination of technology and design, whereas the catastrophe of this occurrence is the group of people who are able to think and do on the go.

What was your own process of moving away from problem solving and targeting program framing and setting for perceptual computing in this particular assignment? What were the challenges and accomplishments?

In my own process, the very first step of achieving moving away from problem solving and targeting program framing and setting for perceptual computing is being aware of the fact that there is not always a problem. Thinking about making something new and different encouraged me to overcome the negative attitudes towards typical problem solving. Usually when I realized an emergence of a problem, reasoning of tensions and conditions of existing situations would arise. However, in this particular project, we not only need to define our own design

CJ (continued)

space, but also have to take the given technology and its constraints into account, so there are all kinds of unknown possibilities as opposed to obvious problems to tackle with. Framing and setting a program which serves our goal of designing a new way of interacting with vending machines is the appropriate means to take. What I did in this project was figuring out what we really want in the end, then break this vision into pieces to see what we need to do to get them. When it came to taking actions, I went with the flow and responded to subsequent outcome for the sake of making it come true. Compromising and redirecting myself sometimes even generated surprising opportunities which helped me to push the progress even further. This was hard at the moment you encountered a barrier, but as long as you stay focus and go with the flow and everything will become right eventually. The most fruitful accomplishment of this project is having the chance of applying almost all the skills and methods we learned in prototyping class. Such experience once again enhanced our in a comprehensive way. Besides, teamwork was very impressive due to the fact that everyone’s capabilities have been used so wisely that the outcome is amazing.

Thank You!

Thanks for reading! And a special thanks to Shaowen Bardzell, Yue Pan, Gopinaath Kannabiran, Rajiv Mongia, Robert Cooksey, and the 2014 HCI/d Cohort for their constant inspiration and encouragement.