

# Hercubit

## **Hercubit: Smart Fitness Tracker and Social Platform**

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## Table of Contents

<b>1. Introduction</b>	3
<b>2. Executive Summary</b>	4
<b>3. Background Research</b>	4
3.1. Competitive Analysis	4
3.2. Gym User Study	7
3.3. Customer Needs Interviews	8
<b>4. Design Approach</b>	10
4.1. Affinity Diagram	10
4.2. Personas	11
4.3. Storyboarding	15
4.4. Paper Prototyping	15
4.5. Wireframing	16
4.6. Usability Testing and Iterations	16
4.7. Diary Study and Insights	22
4.8. Final Design and Decisions	26
<b>5. Hardware Development</b>	28
5.1. Arduino Module	28
5.2. Hercubit Device	30
<b>6. Software Development</b>	31
6.1. Front-End (UI/UX)	31
6.2. Back-End (Data Storage/Device Communication)	33
6.3. Data Science (Real-Time Feedback/Machine Learning)	34
<b>7. Final Product</b>	37
7.1. Components Break-down	37
7.2. Putting things together	38
7.3. Potential Use Cases	38
7.4. Branding (Product Name/Logo)	39
<b>8. Challenges</b>	39
<b>9. Future Considerations</b>	40
<b>10. Conclusion</b>	41
<b>11. Acknowledgements</b>	41
<b>12. Appendices</b>	41

## **Abstract**

Hercubit is our capstone MIMS final project at the UC Berkeley School of Information (I School). We are building a wearable device on top of the Arduino architecture with motion and wireless sensors that accurately track user's body movement while they exercise. Besides the Smart Fitness Tracker (Hercubit), we will also deliver a social platform which potentially allows multi-player game setting that we hope can engage users more into exercising and thus benefit their health. This project aligns with popular interests such as Internet of Things (IoT) and quantified-self wearable devices. It also integrates the skills we acquired from the I School, including usability assessment, tangible user interface, machine learning, and web development.

## **1. Introduction**

Advances in wearable technologies have opened up body sensor research and application development at an unprecedented level in recent years. Wearable computers, or wearables, are miniature electronic devices that are worn under, with, or on top of clothing. Wearables can be an extension of the user's mind and body. In many applications, user's skin, hands, voice, eyes, arms as well as motion or attention are actively engaged as the physical environment. This opens up immense possibilities for using wearable computers in different application domains. In particular, the health and fitness consumer market is growing in recent months. Products such as the Fitbit Flex and the Misfit Shine are marketed as personal activity trackers. These state-of-the-art products work together to play a vital role in helping the users reach and maintain fitness goals, fusing advanced activity tracking, biometric data, and Bluetooth connectivity.

Given the growing commercial popularity of the wearable and fitness technologies, an interesting research topic is to develop and evaluate different practical methods for regular users to wear body sensors while exercising to sustain their health at the same time enjoying the benefits wearable devices may provide. In this work, we explore the feasibility of building a smart fitness tracking and monitoring system for exercises. We make a significant departure from previous wearable fitness tracker by implementing two important features. One of the main features is passive tracking of 3 weight-lifting exercises, allowing active users to track and set daily goals with various combination of weight and repetitions of free weights. Our application also encourages social interaction and peer competition, making exercise both more engaging and enjoyable than other fitness trackers on the market.

Taken together, these features suggest that building a smart fitness tracking and social platform is achievable. In the remaining sections, we describe our idea generation, experimental design, user research, as well as the actual hardware and software implementation, of the "Hercubit" product.

## **2. Executive Summary**

### 2.1 Problem and Scope

Commercial, over-the-counter fitness tracking sensors, such as the Fitbit Flex Wireless Activity Wristband, often have limitations of: 1) Being suitable for walking or jogging but not really applicable to gym-based exercises (Free Weights + Machines), and 2) Lacking interesting and fun social interactions from peer competition. In this project, we attempt to build a wearable device platform that tackles this problem.

### 2.2 Proposed Solution

Our solution consists of three components that combine together as a *Smart Fitness Tracker and Social Platform*: 1) Arduino architecture with motion and wireless sensors that accurately tracks user's body movement while they are doing fitness exercise, 2) A social platform which allows multi-player game setting that we hope can engage the users more into exercising and thus benefit their health, and 3) A visualization of user progress that facilitates users' review and track of their daily workout activity.

### 2.3 Team Members

We are second year graduate students from the UC Berkeley School of Information. We have diverse backgrounds in computer science, user interface design, user experience research, economics, and statistical programming.

### 2.4 Original Idea

The original idea was a continuation of projects started by Morgan Wallace in Tangible User Interfaces (School of Information Fall 2013) and New Product Development (Haas Fall 2013).

## **3. Background Research**

### 3.1 Competitive Analysis

2013 was often called the year of wearables and in the last two years there have been a handful of wearable fitness devices that have successfully made it to market --- a few of them even aim to track weight lifting like we do. It is also worth noting that crowd-funding has allowed even more of these competitors to achieve success since personal exercise gadgets are highly demanded by the young, tech-savvy users of Kickstarter and IndieGoGo.

#### 3.1.1 Products

##### 3.1.1.1 *Fitbit*

For brevity, we shall consider the Nike Fuelband, the Jawbone Up, the Misfit Shine and other popular 2013 activity trackers all as ‘Fitbits’ since they essentially do the same thing (count steps or similar activity and save to a database). Fitbits are fancy pedometers that save your activity data (steps and stairs climbed). Users enjoy being rewarded for achieving their default goal of 10,000 steps per day. However, most users also complain that the novelty wears off. Users quickly understand their walking patterns but Fitbits do not then push users into making lasting, healthy changes.

#### *3.1.1.2 GymWatch*

<https://www.gymwatch.com/>

There are several Indiegogo companies taking pre-orders for their watch-like gym exercise trackers. Gymwatch is one of those. It is an upper-arm-worn device that uses sensors and bluetooth to capture and send exercise data to phones and eventually the cloud. GymWatch uses machine learning algorithms to determine type of activity. It focuses on providing the optimal gym-based workout by encouraging your goals while also suggesting modifications based on intensity. Gymwatch also has a SMART-TRAINER feature which gives live feedback on a device for your reps, cadence, intensity, and even motion correction.

Unique to the other competition, GymWatch is also selling directly to gyms and workout studios. They not only offer additional hardware like NFC chips for gym equipment that can talk to users’ GymWatches, but also they offer studio management software (e.g. employee management) as an extension of their web platform.

#### *3.1.1.3 Push*

<http://www.pushstrength.com/>

Push is another new, crowd-funded company offering its Push device for pre-order. Push is for athletes in-training who need to measure all their activity and share it with coaches. Similar to GymWatch, the value proposition of Push is optimizing your strength training. Push uses speed and shakiness to give feedback to either change the weight or to change their pace/stop. It also syncs with smart phones and helps users plan a training program. Essentially, Push is for athletes.

#### *3.1.1.4 Atlas*

<http://atlaswearables.com/>

Atlas, like GymWatch is a crowd-funded, wrist-worn exercise tracker in pre-order. Atlas will track a wide variety of gym-based exercises, running, several sports-based activities, swimming, and will be able

to learn new exercises. Unlike the previously mentioned fitness trackers, it also has a heart-rate sensor for measuring cardiovascular intensity.

#### *3.1.1.5 Amiigo*

<https://amiigo.com/>

Although Amiigo is another recent crowd-funded fitness tracker in pre-order, it differs by using an optional shoe clip which provides additional data on movement of the legs to enhance tracking for activities like biking where the arms are stationary. It tracks similar activities to Atlas.

#### *3.1.1.6 Basis*

<http://www.mybasis.com/>

Basis is a watch that uses sensors such as accelerometer, skin temperature, optical blood flow, and perspiration sensor. It focuses on walking and running style activity while also being useful in non-exercise scenarios whereby monitoring sensor readings could help users understand their physical or emotional states like stress levels.

#### *3.1.1.7 Game consoles - Xbox Kinect and Wii - Motion games*

<http://www.xbox.com/en-US/kinect> <https://www.nintendo.com/wii>

Xbox Kinect advertises ‘full body gaming’ allowing users to move and gesture to control games or exercise alongside a virtual personal trainer. Similarly, Wii offers a handheld controller that uses accelerometers to give players control of games using a wide variety of gestures. Popular fitness games exist for both Xbox and Wii and they offer live feedback and game-like features. However, they are expensive and typically limited to livingrooms.

### *3.1.2 Features*

#### *3.1.2.1 Portability*

From both competitive analysis and user research, portability was a must-have feature; the only exception being video game consoles (3.1.1.7). Any wearable device must be able to follow the user and enhance their experience even many environments.

#### *3.1.2.2 Tracking*

Whether casual game or device for training professional athletes, tracking the user’s activity accurately and saving for further analysis is essential. Users want to quantitatively compare their activity against their past and against others.

### *3.1.2.3 Calculation*

Many of the devices in the competitive analysis use raw sensor data to calculate many other metrics or detect other patterns that the user find valuable. Some even allow the users to train custom machine learning classifiers so that new exercises can be tracked with accuracy.

### *3.1.2.4 Visualization*

The enormous amount of data collected from wearable devices necessitates visualization and simplification for the user to gain proper insights. Nearly all competitors provide ample visualization tools.

### *3.1.2.5 Social Features*

Users want feedback and they demand it not only from the device but also from the people they know and trust. Bragging, asking, comparing, competing, collaborating and many more social features can significantly enhance the experience and prolong the use of the device.

### *3.1.2.6 Real-Time Feedback*

Live feedback allows users to see their activity, make corrections to their form, and get instant gratification. Like looking in a mirror, users immediately view and interpret what they see to enhance the experience.

### *3.1.2.7 Web & Mobile App*

Portability not only applies to the device but also the data. The ability to interact with the platform and its data is a valuable feature. Users in our research consistently wanted to access their data on their mobile devices as well as the desktop/web platform.

## **3.2 Gym User Study**

### **3.2.1 RSF Trainer Interview**

On December 6th, 2013, we interviewed Dini Wong, a Circuit Training Instructor at the Recreation Sports Facility (RSF). We asked him several questions in order to understand how fitness trainers tailor the needs from customers with different backgrounds. Dini taught circuit training course every Tuesday/Thursday. He walked us through the process of working with new students in circuit weight training. He would first learn about their fitness goals and then determined which exercise plan was more suitable for each student. We learned from our talk with Dini that we shall accommodate difference (genders, body mass, experience) in our customers. We also learn that ultimately, we would want to recommend different exercises to different people.

### 3.2.2 RSF Subjects Observation/Interview

We observed gym users at the RSF on November 2<sup>nd</sup>, 2013. We found that most users did their exercise solitarily; some wore MP3 players and listen to music while exercising. We also noticed that about half the users did not have a regular sequence of machine usage (i.e. they randomly choose a vacant machine to use). In addition, most of the gym users did not have the habit of tracking their exercise data (e.g. number of repetitions, weight...). We embedded these findings into our first prototyping design.

### 3.3 Customer Needs Interviews

The main goal of these interviews was to find out how people plan, execute, and track daily exercises, and to learn if there is any motivation and/or incentive behind it. Additionally, through these interviews, we would also like to know if people would be interested in doing exercise at home through gamification devices. In total, we interviewed 7 participants.

#### 3.3.1 Interview Approach

Most of these interviews were conducted by the team, with one main interviewer, one audio recorder and two note-takers. There were also a few interviews conducted by individual members. After each interview, we created a summary sheet with questions/prompts and customer statements, then interpreted these information into customer needs. Each interview lasted about 25-30 minutes. Some interview questions include:

- Describe your most recent exercise experience.
- Do you have a goal or incentives for doing exercise?
- Do you have a plan for exercise?
- Do you exercise with other people? Why or why not?
- Do you track your workout? Why or why not?
- Are you currently using any tracking devices?
- How do you like to exercise?
- Do you play fitness games?

#### 3.3.2 Participants Selection

Since we would like to understand how people plan and track exercises in different ways, we approached students and friends around with different lifestyles and exercise habits.

#### 3.3.3 Interview Findings

Below are the key findings we learned from the interviewees:

- I. **People track their exercise activities:** Most interviewees use some kind of methods to track and record their exercise. Some people use digital forms such as mobile apps or Google Calendar; others use planners or simply pen and paper.
- II. **“Being social” is one of the key incentives for people to do exercise:** A great number of interviewees mentioned that the reason for them to do exercise is to be social. Activities such as all kinds of ball games, yoga and jogging are the most common activities these interviewees do with friends.
- III. **Most common reasons people don’t work out at gym are “Personal Schedule”, “Unnatural Environment” and “Commute Distance”:** During the interviews, many participants mentioned that they rarely work out at gym. Some interviewees felt that working out at gym needs time to commute that sometimes their schedules don’t allow. Other people also mentioned that they preferred doing exercise outside or at home rather than cramming inside the gym with lots of strangers.
- IV. **People get motivated when seeing their own exercise records, and too much manual input decreases users’ motivation to track:** Most people felt that reviewing their achievements really motivates them to keep exercising, and too much manual input decreases their motivation to keep tracking their activities. This is especially true when using some mobile apps to track and record.
- V. **People seek / try to seek advice and guideline when doing exercise:** Many interviewees sought or tried to seek advice when doing exercises. Some interviewees use online forums to find information, and others compare and copy what others do in the gym.
- VI. **Most people agree that strength training is important, but at the same time, are afraid to hurt themselves if doing improperly:** During the interview, most people think that strength training is good for health, but some people also mentioned that they rarely do strength training because they are afraid hurting themselves without guidance.

#### 3.3.4 Reflections

We realized that there are still lots of limitations of the existing products/apps, which affect people’s motivation to keep exercising. Also many people are usually busy and have to be flexible with allotting time for exercise. Location like timing needs to be flexible for good user engagement.

## 4. Design Approach

### 4.1 Affinity Diagram

We conducted interviews with students and working professionals. During the interviews we inquired about their current exercise routine and had interviewees walk us through a recent exercise experience. Additionally, we had them use the early version of the Hercubit device in front of a monitor visualizing the motion sensor output. We asked for their thoughts on using exercise devices in front of computer screens.

After conducting all interviews, we conducted a user needs assessment. The assessment consisted of writing transcripts for all interviews, parsing them by discreet user needs, and lastly, translating needs into potential product features. All product features were put on sticky notes and organized into categories in a process called affinity diagramming. The results of affinity diagramming were saved here in image form and in a spreadsheet.



Product features that resulted from many interviews gave us key insights when moving forward into development of our wearable fitness device. In addition to user needs assessment/affinity diagramming we used our user research findings to make personas.

## 4.2 Personas

### 4.2.1 Male Student



**Name:** Lee Woods

**Location:** Berkeley, CA

**Age:** 24

**Profession:** Graduate Student at UC Berkeley

**Description:**

Lee is a master student at UC Berkeley specializing in data analysis and statistics. Besides being a data enthusiast, Lee is also a big fan of all kinds of new technology. Lee used to work out in a gym almost everyday when he was an undergraduate student. However, due to heavy GSR and GSI work loading in graduate school, Lee hasn't been to gym and work out for more than two years.

On weekdays, Lee usually wakes up at 7am and takes a quick shower before heading off to school by 9am. At school, he usually sits in front of the desk for all day dealing with data and statistics, and walking back and forth between labs and classrooms seems to be the only exercise he does at school nowadays. Lee usually leaves his lab around 8pm. After commuting home, he cooks light dinner and then relaxes in front of his desktop browsing Facebook and checking online news. Lee then starts doing schoolwork again from 9pm and then gets ready for bed before 12am. On weekend, Lee usually stays at home and does all kind of housework, or stick in front of PC and watch Netflix.

**Motivation and/or frustration:**

The biggest motivation for Lee to use Hercubit is to get effective strength training without going to a gym. Since it takes time to commute from his place to gym, Lee is happy to use Hercubit as his strength training tool at home or in the lab when he has spare time. The portability and data tracking features of Hercubit also motivates Lee to exercise more frequently since he can do exercise without location limitations and see the progress of his workout anytime, anywhere.

#### 4.2.2 Female Student



**Name:** Joann Ryan

**Location:** Oakland , CA

**Age:** 19

**Profession:** College Student

**Description:**

Joann is a 2<sup>nd</sup> year college student majoring in graphic design at Academy of Art University. Due to her busy school schedule, Joann usually stays up late working on her design projects during the week. Joann feels that she needs to work out more frequently in order to be energetic, but at the same time, cannot afford an expensive gym membership fee or a personal trainer. Also she can't spend time commuting to the gym.

On weekdays, Joann usually wakes up at 9am and has a quick breakfast before going out. At school, Joann sometimes plays volleyball with her friends on Friday then has lunch together with the team. Joann usually arrives home around 6pm and takes a nap right after. She then wakes up again at 9pm, has a quick dinner, and start working on her school works till mid-night. On weekend, Joann enjoys grocery shopping and watching movies with her friends.

**Motivation and/or frustration:**

The biggest motivation for Joann to use Hercubit is to get well-structured and efficient strength training sessions without hurting herself. For Joann, Hercubit is like a personal trainer that she can trust and follow to set up her daily goals. She can easily start a training session anytime when she has free time at home even in the mid night. Besides, Joann also uses Hercubit to relax and refresh her mind after sitting in front of desk designing things for hours. As a beginner of strength training, Joann feels that the achievement system really encourages her to keep exercising, and the visual components increase her interests to follow and do more exercises with Hercubit.

### 4.2.3 Male Professional



**Name:** Richard Clark

**Location:** Portland, OR

**Age:** 34

**Profession:** Graphic Designer for Video Game company

**Description:**

Richard has loved video games his whole life. He is frequently passionate about new technology. Recently he got a physical from his doctor and was strongly encouraged to do more exercise. After trying 2 different gyms, he gave up and started working out from home where he could have the privacy he demanded.

On weekends he travels to Seattle to see his girlfriend who is in a punk rock band. He reads a lot of comics on his iPad when he travels. He even has a blog where he discusses the artwork in “The Walking Dead” comics.

On weekdays, he wakes up at 9am and drinks 2 cups of coffee before he gets out of the house because he suffers from sleep apnea. At work he reads emails and works on projects for a few hours at a time, taking only occasional breaks for more coffee, lunch with friends and coworkers, and also for the daily meetings with his boss.

**Motivation and/or frustration:**

The biggest motivation for Richard to use Hercubit is to stay healthy and get rid of tiredness after sitting in front of the desk after long hours. Hercubit provides him a private, casual and time efficient way to relax and keep fit. Besides, the social and gamification features also motivates Richard to do exercise more often since he can always see the progress of exercise activities and compares with other friends.

#### 4.2.4 Female Professional



**Name: Kim Wood**

**Location: San Francisco, CA**

**Age: 45**

**Profession: Business Consultant**

**Description:**

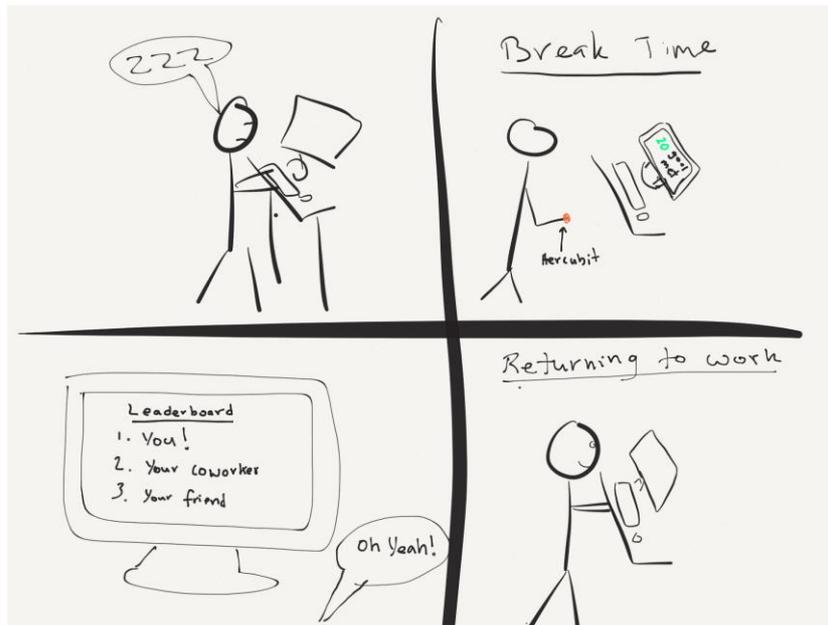
Kim is a business consultant based in San Francisco. She usually has a very busy schedule and sometimes also need to travel a lot depends on projects she works on. Kim suffers from insomnia, and her doctor suggested her to do more exercise in a daily basis. Since she has a very tight schedule, she doesn't want to spend extra time commuting to the gym to work out. She usually work out at home by using DVD with instruction.

On weekdays, she wakes up around 7:30, has light breakfast at home then go to work. She usually works from 9:30 to 18:30, and takes one hour lunch break. She usually arrives home around 19:30, and spends most of the time checking/replying emails as well as preparing materials for tomorrow's work after dinner. On weekends, Kim sometimes attends yoga classes with her friends. She also enjoys surfing the Internet to learn about new technology which is also related to her work.

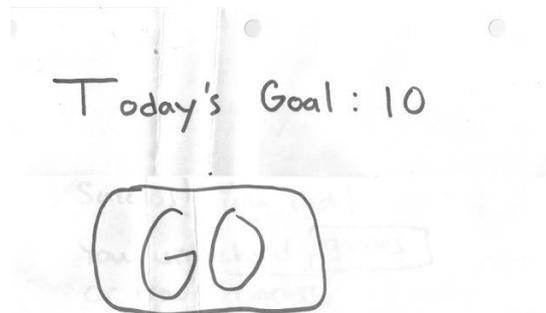
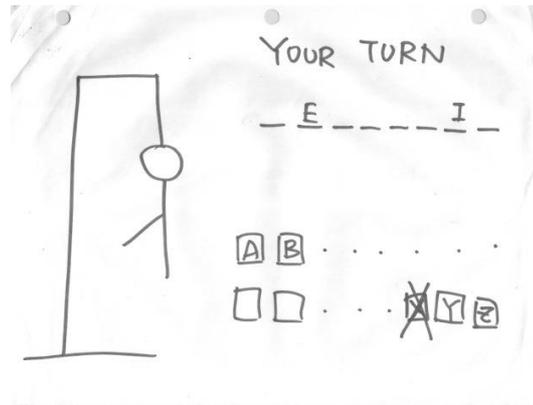
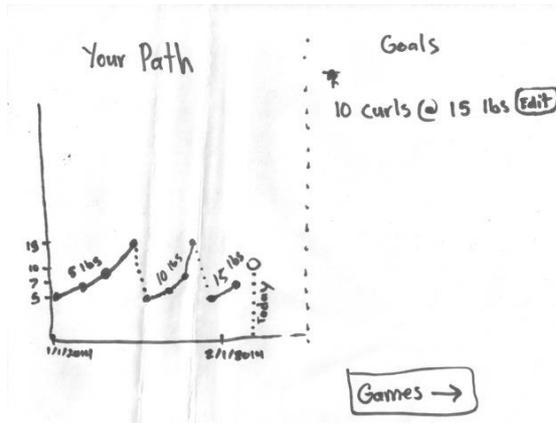
**Motivation and/or frustration:**

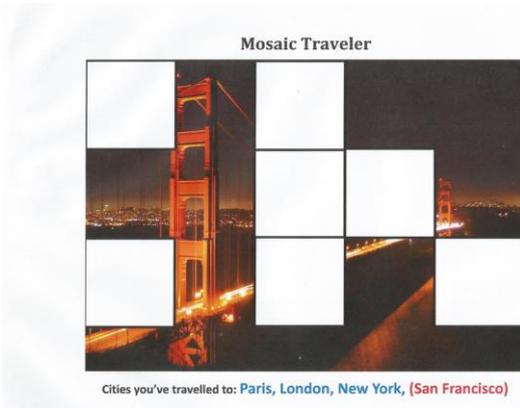
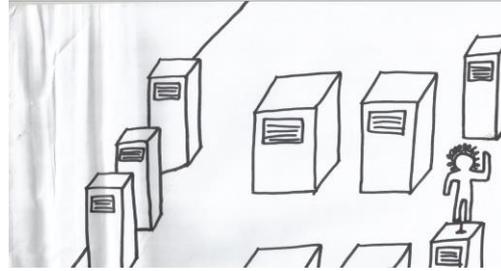
The biggest motivation for Kim to do exercise using Hercubit is to eliminate insomnia, and she can have a more flexible schedule when doing exercise at home. The biggest frustration for Kim to do exercise without Hercubit at home is that it's hard to set goals based on her needs and to track her exercise accurately.

### 4.3 Storyboarding

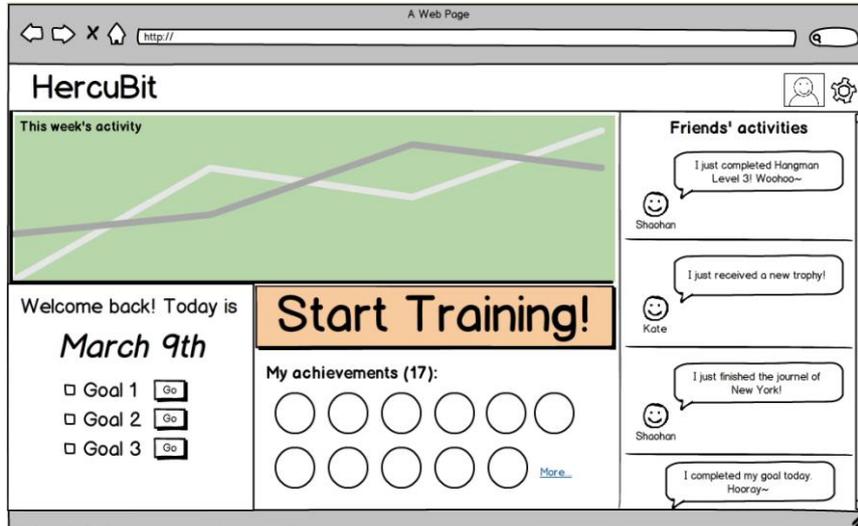


### 4.4 Paper Prototyping





## 4.5 Wireframing



## 4.6 Usability Testing and Iterations

### 4.6.1 Goal

Right after completing our first prototype, completion, we conducted the usability testing to determine whether the interface design and features meets their intended purpose. The particular goals of this usability testing are 1) To understand the learnability of our prototype to the new user experience, 2) To

understand what functionalities users like or dislike, and any incentives or frustrations behind, 3) Discover usability issues in our prototype.

We designed the test to be a 20-30 minutes length test, which includes a 5 minutes initial interview for user background info gathering and a 5 minutes follow up questions after the test in order to understand their experience of using other tracking methods.

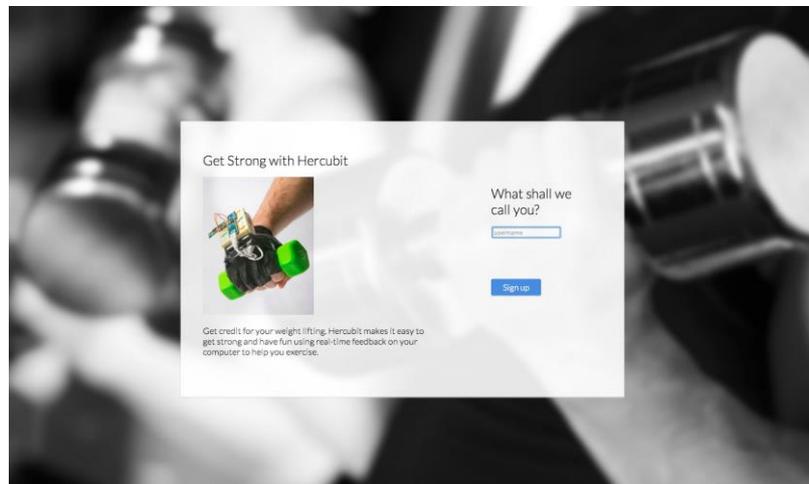
#### 4.6.2 Recruiting

Since Hercubit is designed for everyone who is interested in going exercise at home, we recruited people who “liked” Hercubit on Facebook page. In the end, we conducted the usability testing on 5 participants, 3 male and 2 female, aged 26~33.

#### 4.6.3 Process

Before the usability testing started, we asked each participant about their daily exercise habits and plans [See 12.1 Usability Testing Scripts]. After the initial interview, we assigned the following four tasks for each participant to complete:

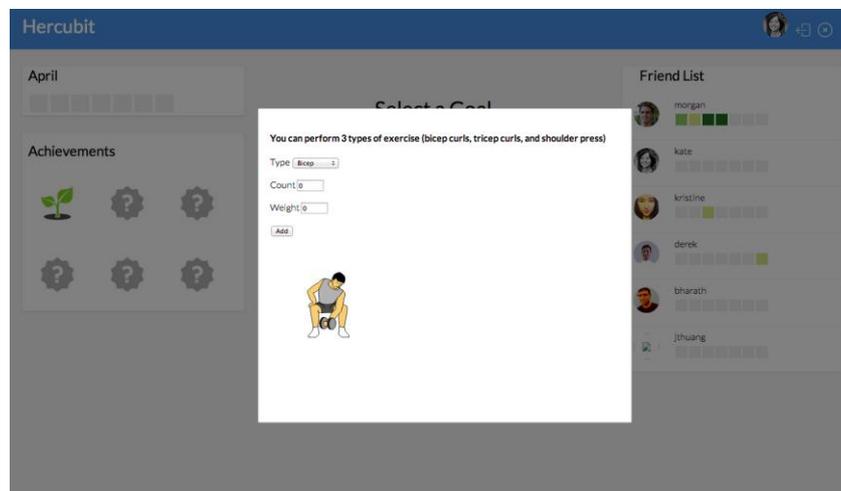
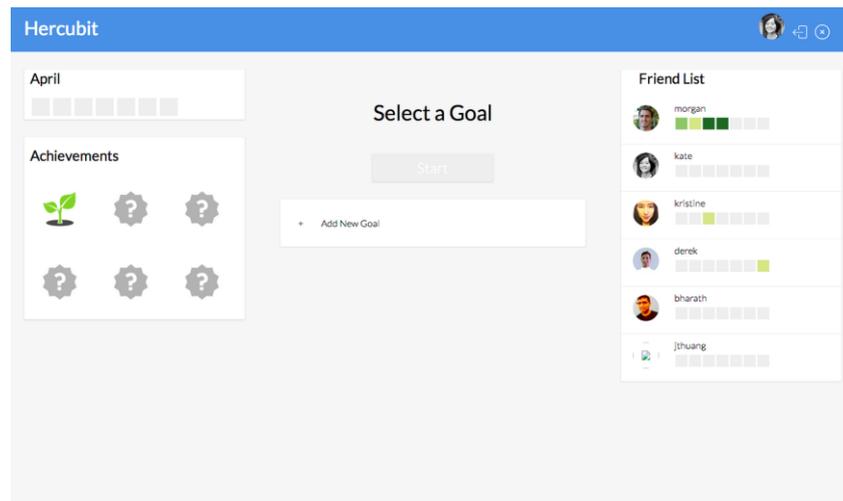
- **Task 1: Login to Hercubit with userid=”test” and connect your device to the system**



We designed this task in order to understand: 1) how people start the service and to see if the designed user flow is intuitive enough and easy to operate, 2) if the designed signal is obvious enough that user knows when the device is connected or disconnected.

- ❖ **Success Criteria:** Participant finds the box to login within 30 seconds, and have the whole system ready within 1 minute.

- **Task 2: Set up your goal of the day: 10 reps for bicep curl for 3 pounds**



We designed this task in order to understand if the flow for setting up goals is intuitive enough and easy to operate.

- ❖ **Success Criteria:** Participant finds the correct block to fill in the assigned goal within 1 minute.

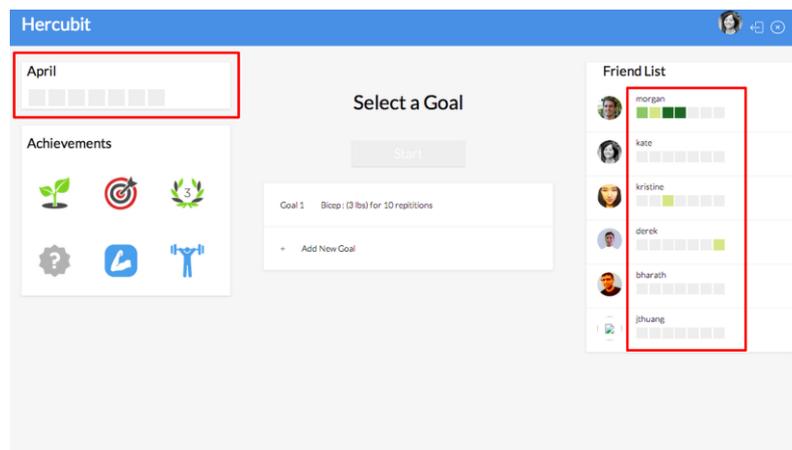
- **Task 3: Start exercising with the goal you just set up**



We designed this task in order to 1) understand if the call for action is clear enough on our dashboard, 2) observer user’s reaction on the real-time visualization, 3) understand if the information given on the screen does make sense to the user

- ❖ Success Criteria: Participant completed the exercise without any prompt

- **Task 4: Please explain what heat map (squared in red) is**



We designed this task in order to understand if the information and symbols given on the dashboard do make sense to the user.

- ❖ Success Criteria: Participant gives correct definition – the calendar heat map view represents the last 7 days, the darker the color is, the more exercises are accomplished.

#### 4.6.4 Findings

	P1	P2	P3	P4	P5
Task 1 (Login)	Success	<b>Use other name to login</b>	Success	Success	Success
Task 2 (Add goal)	Success	Success	Success	Success	Success
Task 3 (Exercise)	Success	<b>Didn't click on start</b>	<b>Didn't click on start</b>	<b>Didn't click on start</b>	<b>Didn't click on start</b>
Task 4 (Blocks)	<b>Not sure</b>	<b>Not sure</b>	<b>Not sure</b>	<b>Not sure</b>	<b>Not sure</b>

The chart above shows the result of our usability testing. Key findings from each task:

#### I. Task 1 – Login page

- Most users (4 out of 5) successfully logged in with the username “test”

## II. Task 2 – Set up goal

- 3 out of 5 users don't like to use up and down buttons to adjust numbers
  - (P1) "These buttons are too small and hard to click"
  - (P2) "I will just type in numbers because clicking up and down is annoying"
- 4 out of 5 users were confused while setting a new goal
  - Some users wanted to know more context of a goal
    - (P2) "I am confused because I will have to skip the "Start" button on the top to set my goal, then skip the button again to choose the goal, read the goal I selected, then finally click on the "Start" button."
  - 3 out of 5 users found that animation for exercise type is useful and entertaining
    - (P2) "There is a cute man. Oh that's so cute!"
    - (P2) "That's very helpful because I don't know what is what"

## III. Task 3 – Exercising with Hercubit device

- 4 out of 5 users thought the device was connected to the computer once he or she put the device on, without clicking on the "Start" button
- 4 out of 5 users didn't know they need to choose a goal first in order to start the exercise
- 3 out of 5 users had positive reactions toward the real-time counting visualization
  - (P3) "It's cool when I see the count is increasing"
  - (P4) "I like the real-time feedback with BIG number"
- 4 out of 5 users didn't see the prompt of reaching the goal
- 3 out of 5 users got confused after the count exceeded the goal
  - (P2) "If I exceed the goal, I hope it jumps to another screen"

## IV. Task 4 – Heat Map grid

- All users (5 out of 5) said they were not sure what 7 blocks inside the heat map represent
  - (P1) "I guess 7 blocks represent one week, from Sunday to Saturday"
  - (P2) "I think 7 blocks means seven days of a week"
  - (P3) "I think the blocks either mean the goal the user have done"
  - (P4) "I am not sure if the block on the right side means today, or the middle block means today"
  - (P5) "I guess these 7 blocks indicate 7 goals the user set"
- All users (5 out of 5) said they were not sure what the opacity of the block color means
  - (P1) "I am not sure, but I guess opacity of colors indicates something related to exercise frequency or goal achievement"

- (P2) “I think color means people’s score on that day”
- (P3) “I guess color means level”
- (P4) “I guess color indicates how many activities have been done for that day”

**V. Other Findings:**

Achievement system (earning badges)

- 4 out of 5 users were surprised when they got a badge

**VI. Nice to have**

- 4 out of 5 users said it would be nice to have instruction especially for first time user
- 3 out of 5 users mentioned that they would like to see if there is any indicator showing they have complete current level and can go to the next level
- 3 out of 5 users would like to see exercise summary, record and/or history
- 4 out of 5 users would like to have more interaction with friends:
  - For collaboration:
    - (P2) “I would like to workout with friends when clicking on friend, and the friend can also teach me how to exercise too!”
    - (P3) “It would be great if I can send gifts or points to friends to motivate them”
  - For competition:
    - (P4) “I would like to create challenges and let friends taking those challenges”
    - (P5) “I love to compete with friends”
  - 3 out of 5 users said it would be nice if they can know how much more they should workout to get them onto the top of the list

4.6.5 Recommendations

- Change the layout to better illustrate the workflow of adding a new goal, select a goal, and start exercise
- Enlarge the status message
- Add progress summary to indicate personal progress
- Add more interactions with friends such as messaging and sending challenges
- Add more information of the heat map block when hover or clicking
- Add more instruction when doing the exercise
- Add first-time-use instruction
- Emphasize the importance of .gif
- Highlight the selected goal

- Highlight oneself in the friend list

## 4.7 Diary Study and Insights

### 4.7.1 Goal

By conducting a diary study, we hope to learn how users will react to the prototype and how they integrate it with their daily basis. Whether they will feel positive, annoyed, or will be more consistent with the exercise activity. We gave out the prototype to users and let them self-report the usage of prototype for a week.

### 4.7.2 Process

The process of the diary study included the following steps. Each step will be described in detail in the following sections.

- Recruiting
- Setup
- Review the entries
- Follow-up Interview
- Affinity Diagram & Findings
- Recommendations

### 4.7.3 Recruiting

In the initial phase of this project, we conducted 7 customer needs interviews. We therefore had a brief understanding about their exercising habit and basic information. Most of them showed high interest of trying out our prototype if possible. We contacted all the interviewees via email and 4 of them responded, including 3 Mac users and 1 Windows user. However, due to technical difficulties and time constraints, we had to turn down the Windows user and focused on the Mac users. In the end, we had 3 participants, 2 male and 1 female, aged 24~33.

### 4.7.4 Setup

- Google Blogger
  - In order to let the users keep the diary in their most convenient way, we set up a Google Blogger (<https://www.blogger.com/>) for each participants, which is only accessible and visible to the participant and us. We specifically told the participant about this privacy setting so he/she can be more comfortable writing the diary.
  - We set up the Blogger in the way that the participant can choose to either log in to the web page, or simply send email to a particular email address to make blog post.

- In addition, we also gave them a physical notebook and a 3-color retractable ballpoint pen if they'd prefer hand-written than typing.
- Guide
  - In the setup stage, we created a diary study guide [see appendix 12.2] to give the participants more context of what they should be doing, and to act as a guidance when they are writing the diaries. We also provided our contact information in case the participants encounter any problem. The guide is provided in both soft (as the first post in the Blogger) and hard copy.
- Device (Hardware)
  - We gave each participant 1 Hercubit device with a backup battery, and a 3-pound dumbbell.
- Website (Software)
  - We install the Hercubit website in each participant's local machine, and provided a Dock icon so they can run the Hercubit website simply by clicking on that icon.

#### 4.7.5 Review the entries

During the 7-day diary study, we paid close attention to each participant's Blogger and reminded them to make some post if they've not been making any post for more than 2 days. We also dealt with some unexpected software and hardware issues such as the connection between the Hercubit device and the computer failed, and the chips accidentally burned out so we have to replaced the hardware with a backup one.

#### 4.7.6 Follow-up Interview

The goal of the follow-up interview is to encourage participants to talk about their thoughts and feeling of using Hercubit, if missing in the diary, as well as letting us to understand any questions occur in the diary.

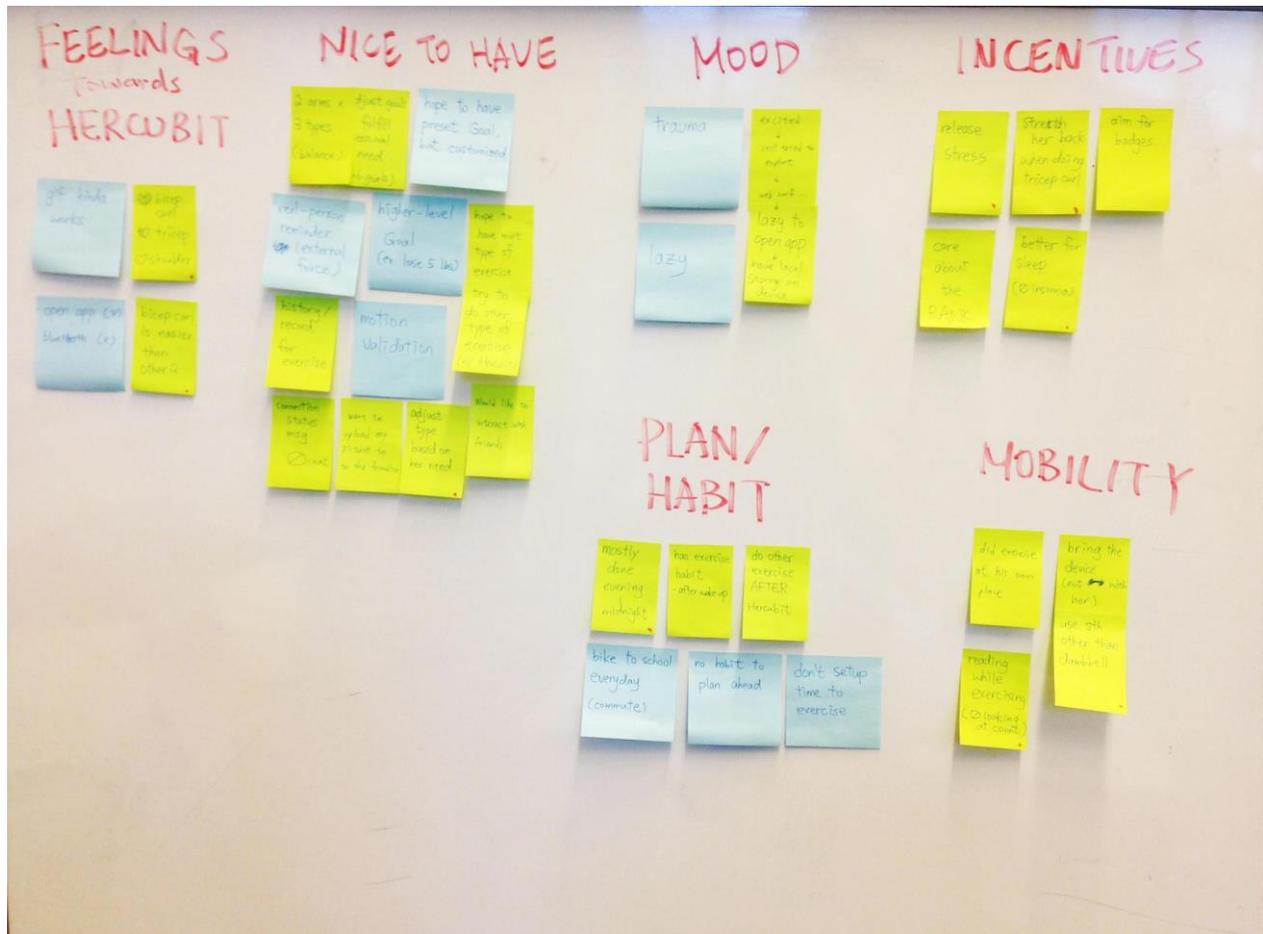
On the last day of the study, we set up an interview with each participant in order to get an overview thoughts of their experience for the past week, and also for them to return the hardware. The interview was semi-constructed, mostly opened to the participants to talk about their feelings and anything that they thought was related. We also prepared several guiding questions to start the conversation as following:

- What's your overall feeling towards Hercubit?
- What's your incentive of using Hercubit?
- Why did you (not) exercise using Hercubit?

- Can you describe more detail about \_\_\_\_\_ in your diary?

#### 4.7.7 Affinity Diagram & Findings

Based on the diary and the follow-up interview, we coded the findings into an affinity diagram with different categories.



The findings are categorized into 6 categories:

#### I. Incentives

- Get the badges and beat friends on the rank (P3)
  - (P3) “Next goal: try to get the ‘3-day strike’ badge!”
  - (P3) “Why am I still the last one in the rank list?! XD”
  - (P3) “One more day for the ‘3-day strike’ badge”
- Release stress and stretch the body, easier to fall asleep (P1)
  - (P1) “I do it before I go to sleep, and it helps me to sleep better”
  - (P1) “The tricep exercises were really great. My back had gotten a little cramped from sitting with bad posture and for whatever reason, doing the tricep curls stretched me out and made me feel better.”

- (P1) “Some light physical activity before I go to sleep helps a lot with clearing my mind if I have been studying or programming before sleeping.”

## **II. Nice to have**

- Hope to have higher level goal with customizable tasks (P1, P2, P3)
  - (P2) “‘Goal’ might be something at a higher level, like ‘losing or gaining 5 pounds’”
  - (P3) Hope to have a more general goal, like endurance or power
- Like to have more interaction with friends (P3)
  - (P3) “Can have async competition with friends, and sort the friend list rank by different criteria”

## **III. Plan/Habit**

- Participants stick to their existing habit (P2, P3)
  - (P2) “The most exercise I do is bike to school”
  - (P3) Integrate Hercubit into his every morning exercise

## **IV. Mobility**

- The device can be placed at a static place (P1, P2, P3) or being traveled with the participant (P1)
  - (P1) “A quick 5 min session to try out Hercubit. I was at my boyfriend's house and could not find his weights, so I used a piece that came from ikea furniture that had not yet been put together. I did some bicep curls.”
- The participant was able to do other task while exercising (P1)

## **V. Feelings towards Hercubit**

- The instruction works pretty well (P1, P2, P3)
- Open the app is easy, but were not familiar with the device (P2, P3)
  - (P2) “Open the app is easy, but pairing the device with the computer is terrifying”
  - (P3) “I’m afraid that I’ll break it”
- Participants have their own preference towards different type of exercise (P1, P2, P3)
  - (P1) “For the bicep curls, I switched from holding the weights vertically to horizontally around the middle, since it felt better to change things up.”
  - (P2) “I’ll test out the maximum weight at the first time, then you can recommend me lessons but I still want to have control over it, like how most treadmills do”
  - (P3) “First I play the 3 Hercubit types of exercise, and then 20 push-ups and 20 ab roller workouts, and then some stretching exercises”

- (P3) “I really hope that Hercubit can record more types of exercise, at least push-ups and ab rollers.”

## VI. Mood

- Excited -> Trying to explore -> Losing incentives -> Getting lazy (P2, P3)
  - (P3): “Day 1: This is my first day with Hercubit, feel quite excited to play with it. It's the first thing I do after I get up. (Even before using Facebook!)”
  - (P3): “Day 2: Try Hercubit for other types of exercise, ex: hold the dumbbell from the leg to the height of shoulder, seems still work”
  - (P3): “Day 4: Sort of become quite natural to just use the Hercubit and think nothing. XD”
  - (P3): “Day 6: Somehow felt kind of lazy to open the laptop to run the Hercubit app.”

### 4.7.8 Recommendations

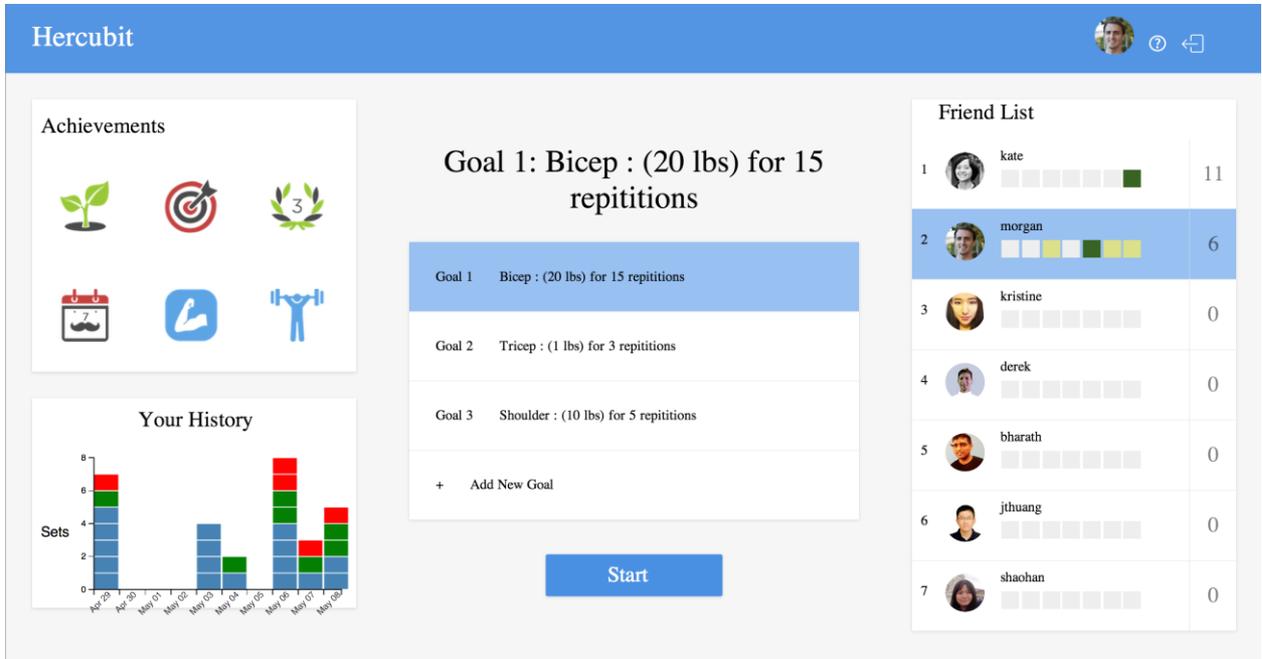
- Have pre-defined higher-level goals (e.g. lose weight, build muscle) with sub-goals, and preserve the functionalities of letting users to modify the detail of the goal
- Have instructions (e.g. gif) on the exercise screen as well as the goal-setting screen
- Come up with more badges, and also have hidden achievements to surprise user
- Make the connection easier and have more prominent status message
- Have more interactions with friends such as messaging and sending challenges

## 4.8 Final Design and Decisions

We summarized findings and recommendations by the users from both usability testing and the diary study, and then created Github issues and subtasks for each recommendation. We then prioritized the issues based on the time constraints and worked on them to iterate through the next version. The changes and the final design are as following:

- Goal
  - Modify the layout of the goal list and the start button so it follows the workflow better
  - Highlight the selected goal
  - The first goal will be selected as default and the start button will always be clickable, so the call for action will be consistent through the whole experience
  - Add slider when inputting goal details
- Friendlist
  - Remove the top-left heat map block, and integrate the information into the friend list by highlighting the current user

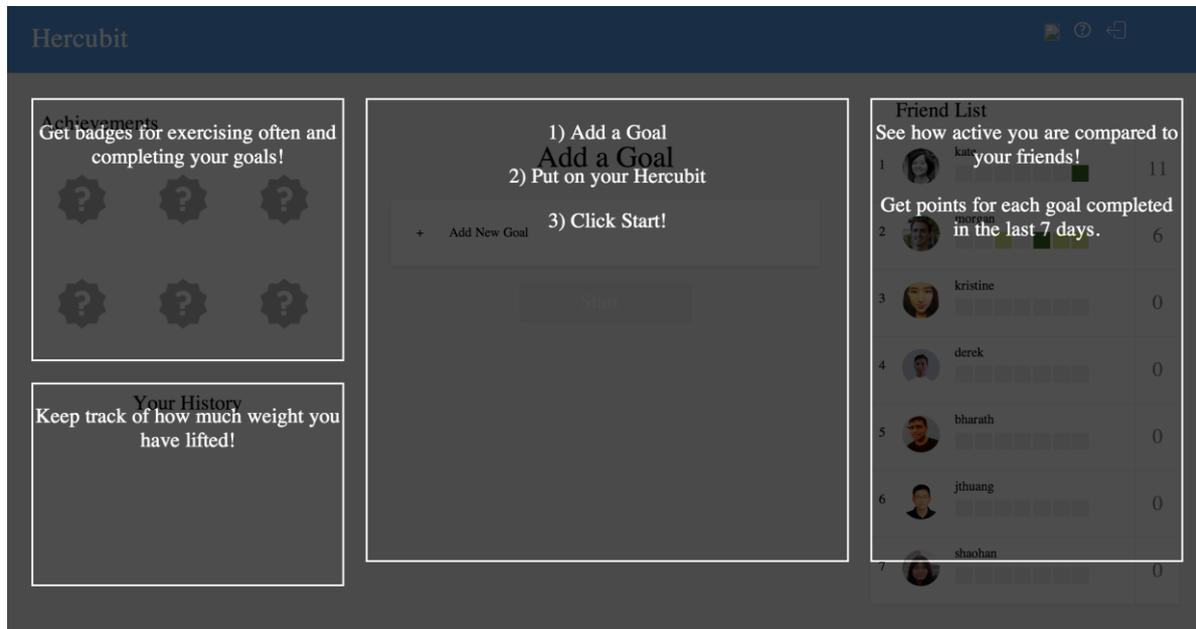
- Show the score of each user to increase the competition between users
- Show more metadata (e.g. exercise information) when hovering the block
- Personal Progress
  - Add personal progress chart



- Exercise
  - Make the status message more prominent
  - Add the instruction gif to the exercise screen
  - Add visualization to the exercise screen



- First-time user experience
  - Add an instruction layer when first time signing in, the layer should be able to toggle on/off afterwards



## 5. Hardware Development

### 5.1 Arduino Module

#### 5.1.1 Overview

We implemented our hardware based on the Arduino platform because of its capacity for rapid development. We use motion sensors and Bluetooth to get maximum information from the device while still being portable. We chose Femtoduino (<http://www.femtoduino.com/spex/femtoduino-usb>) as our Arduino model due to its small size, I2C support, and sufficient computing power.

#### 5.1.2 Sensors (Accelerometer, Gyroscope, Magnetometer)

In order to detect the movement of users' arm motion and gestures, we decided to use a 9-axis module which includes

- a 3-axis gyro (L3G4200D), a low-power three-axis angular rate sensor,
- a 3-axis acceleration (ADXL345), an accelerometer that detects acceleration for x, y, and z axis,
- a 3-axis magnetic field (HMC5883L) + BMP085, a magnetic sensor that detects the orientation of user's facing.

The module also includes a I2C communication protocol with supply voltage 3~5V. For each Hercubit device we attach 1 module. The module we use is [Sunkee 10DOF 9-axis Attitude Indicator L3G4200D ADXL345 HMC5883L BMP085 Module Arduino].

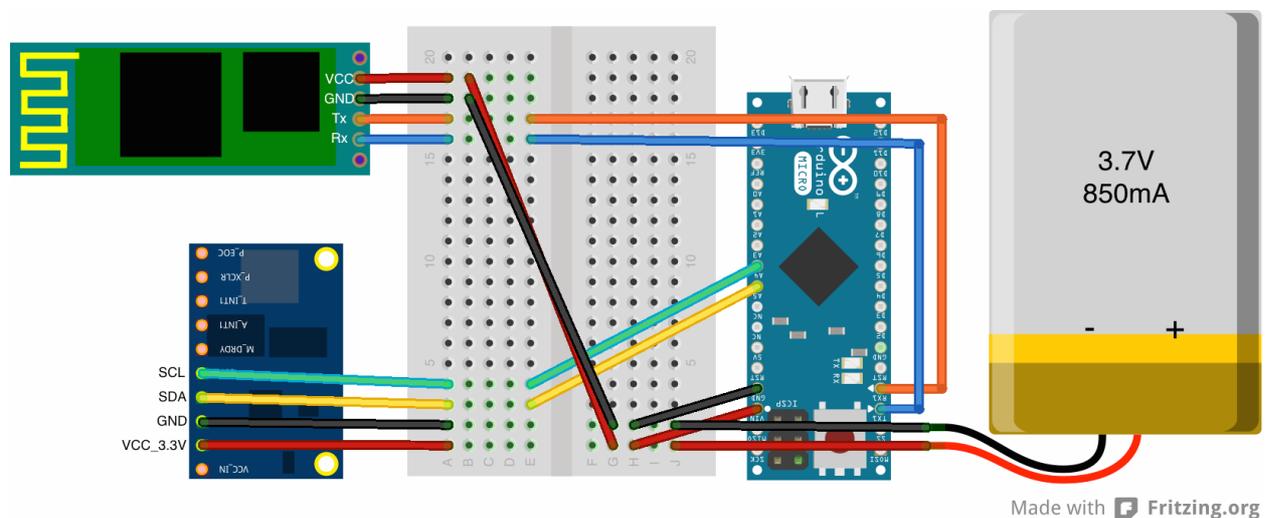
### 5.1.3 Wireless (Bluetooth 2.0)

We use Bluetooth 2.0 to send and receive data between the Hercubit device and the computer. Bluetooth is a wireless technology for exchanging data over short distances (2.4GHz). We chose Bluetooth over Wi-Fi due to its low cost, low power consumption and easiness to use for short-distance data transmission. While Bluetooth 4.0 (BLE, Bluetooth Low Energy) has even lower power consumption and is considerably smaller size, due to its lack of backward-compatibility with the previous Bluetooth protocol, the implementation with all modern computers is relatively hard. We therefore fall back to Bluetooth 2.0 as our transmission protocol. The device model we use is [Arduino Wireless Bluetooth Transceiver Module Slave 4-Pin Serial].

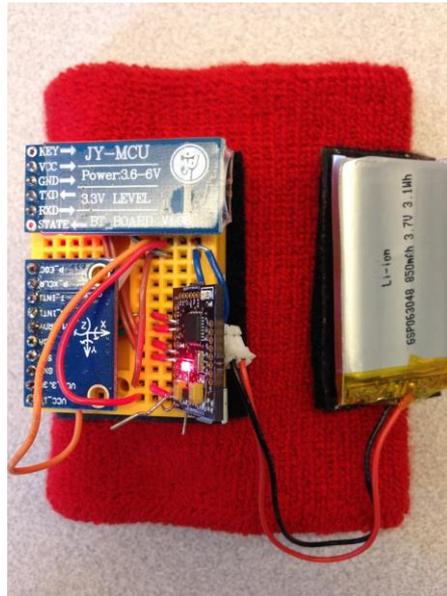
### 5.1.4 Battery and Power

Based on the operating voltage of each component (Femtoduino: 3.3~5V, Sensors: 3~5V, Bluetooth: 2.7~4.2V), we tested out a 9V battery on Femtoduino's Vin, which has a on-board voltage regulator (10V max, converts to 5V) and it worked well. However, in order to reduce the size of the whole component, we decided to change to a smaller size Polymer Lithium Ion Battery (3.7V, 850mAh).

### 5.1.5 Wiring the components



The wiring diagram is drawn by Fritzing. Due to the lack of Fritzing parts library, we use Arduino Micro to replace the Femtoduino in the above circuit diagram.



### 5.1.6 Programming

The device is programmed in Arduino (based on C programming language). The device is programmed to load libraries for the accelerometer, gyroscope, and magnetometer. It then uses I2C communication protocol to send samples from the sensor to the bluetooth serial port of the computer every 100 milliseconds. Each sample is a string that can be interpreted into a Python dictionary. Example: `{'magnet': (127.88, 559.36, -168.36), 'gyro': (2011, 2612, 1406), 'accel': (-0.19, -0.84, -0.27), 'time': 1399510477.63}`

## 5.2 Hercubit Device

### 5.2.1 Components Anatomy (Arduino Module, Arm Band, Velcro, Battery)

The Hercubit is composed of Femtoduino, Bluetooth 2.0, 9-degree-of-freedom sensor (accelerometer, gyroscope, magnetometer). These components are connected to a sweatband with velcro.

### 5.2.2 Mechanical Product Design/Ergonomics

The first version was mounted on an exercise glove but we moved it to a sweatband because they are easy to put on and take off, cheaper, and also more casual than weight lifting gloves. We mount the device and battery separately; they are to be worn on the top of the wrist and side of the wrist respectively. This allows for decent weight distribution and not giving the device a feeling of being top-heavy.

#### 5.2.2.1 Minimization & Weight Reduction

For wearable devices, size is important. We wanted to make Hercubit smaller. Hercubit devices were

made with Arduino Micro (48mm by 18mm) but we replaced it with the smaller Fentoduino (20.7mm by 15.2mm) . Additionally, we replaced the 9 volt battery with a 3.7 volt Lithium ion battery that is 20% the size of the 9 volt.

## **6. Software Development**

### 6.1 Front-End (UI/UX)

#### 6.1.1 User Sign-Up Page

The first time the user signs in to Hercubit, the username he or she inputs will be created and stored in the database, as well as in the session cookie on the client side. Therefore, the user won't need to sign in everytime when opening Hercubit.

#### 6.1.2 Personalized Progress Report

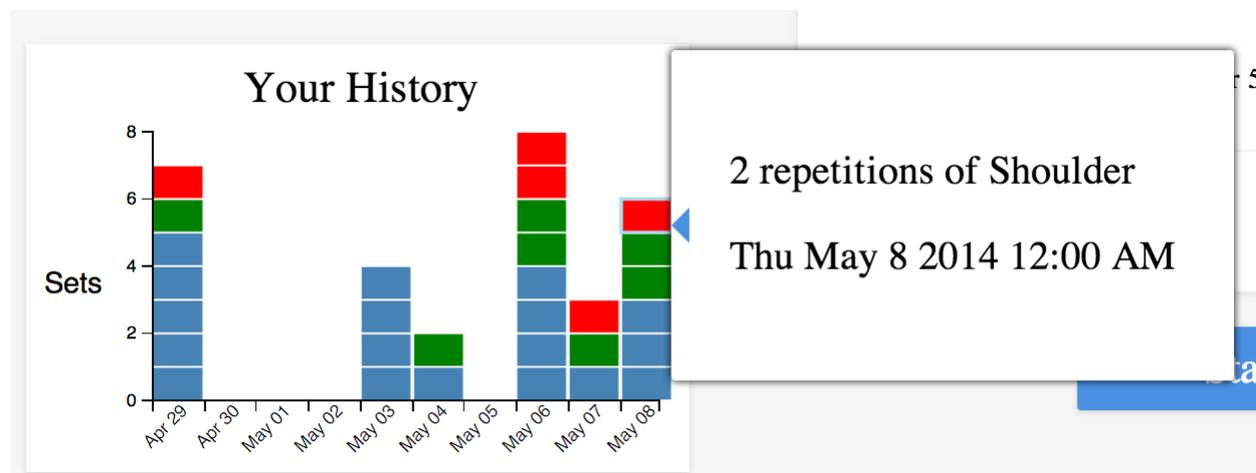
##### *6.1.2.1 Badge Accumulation Board*

The achievement board shows all the badges the user has earned/collected. Currently we have 6 kinds of achievements. Once an action has been done (e.g. complete an exercise), we check whether the user has the according badges (e.g. "First-time complete a goal", "3-day strike", "7-day strike") already. If not, a GET request will be sent to the PHP server, which then executes a SQLcommand to determine whether the condition of the badge is fulfilled. Finally, if the user gets a new achievement, a modal window pops up with a new badge with description, and the achievement board will be updated as well.

##### *6.1.2.2 Progress Report*

The progress report shows the line chart of user's progress of whole time. With x-axis as "time" and y-axis as number of exercise sessions or sets per day. Each exercise is represented as a block, colored by type of exercise (red is shoulder press, green is tricep kickback, and blue is bicep curl). Hovering over blocks gives a tooltip detailing repetition count, type and time. The chart is drawn by custom code using

d3.js (<http://d3js.org>).

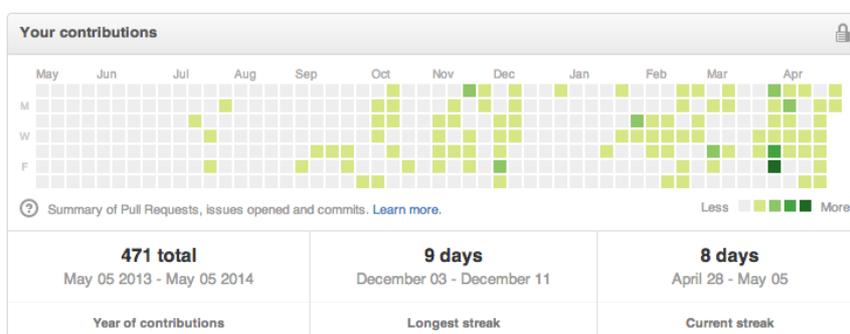


### 6.1.3 Exercise Goals Add/Remove Block

The goal list includes all the goals user created and stored in the database. The user can either add a new goal (which will insert a new row to the database) or delete an existing goal (which will delete the specific row in the database). By clicking on a goal, the goal is selected and clicking the start button will prompt the user to start exercising towards that goal. The first goal will be selected as default unless there are no goals listed.

### 6.1.4 Friend's Activity List & Heat Map

Friends on the list are ranked by the total score, which is how many exercise he or she did for the past 7 days. We referenced the Github's Contribution Activity Heat Map (image below) and decided to show the intensity of exercising activity for each day. The darker the block is, the more exercise have been done on that day. There are 4 levels of color (#EEE, #DBE089, #9CBF66, #386323) from grey, light green, to dark green, specified in the CSS. The color of each block is assigned in jQuery after getting the exercise information from the database. We also highlight the current user to distinguish from the user's friends.



## 6.2 Back-End (Data Storage/Device Communication)

### 6.2.1 MySQL Database

We applied for an iSchool MySQL account to share by all members of our group. MySQL has been a popular open-source database management system. Database Management Systems (DBMS) extends the operating system to include the facilities needed to manage an application's data. A DBMS stores application information in a database, which is simply a collection of information organized as discrete *tables*. We created three tables in our database: the *Goal* table, the *Exercise* table, and the *User* table.

The job of the DBMS is to store and protect data, making it available to multiple concurrent users. The iSchool MySQL database provides mechanisms that permit usage and administration of the database. The *User* table stores a user's basic profile, his or her badge information, and daily activity level in the past seven days. Our system rewards users using a badge system, by granting them medals whenever they achieve the corresponding, predefined milestones. Currently the system defines six different badges that Hercubit users may earn. These are 1) *Signed up for Hercubit*, 2) *Set your first goal*, 3) *3-day Strike*, 4) *7-day Strike*, 5) *Five sessions*, 6) *Complete your first exercise*. The *Goal* table stores a new goal record for users every time when a new set of goal is created, with basic information such as exercise type, dumbbell weights and repetitions. The *Exercise* table, on the other hand, stores the actual fitness data from the user's working session. The column field *goal\_complete* is 1 if the user completes the exercise with the selected goal.

Below we summarize the three tables used in our database:

USER	GOAL	EXERCISE
<b><u>user_id</u></b>	<b><u>goal_id</u></b>	<b><u>exercise_id</u></b>
username	username	username
age	exercise	count
gender	count	weight
email	weight	session_time
badge1	time	exercise
badge2		goal_complete
badge3		
badge4		
badge5		
badge6		

## 6.2.2 Flask Web Framework

In order to facilitate communication between the device over bluetooth to the web browser where our front end exists, we had to implement a local server. We decided to go this route instead of building a native Mac or Windows application because the team has experience coding in Python, JavaScript and HTML. Additionally, a HTML based front-end allows our team to leverage much of the Internet's open-source knowledge for our own development.

For the server we chose Flask because it is easy to install and we had planned to use a plugin for web sockets called 'Flask-socketIO' (ultimately, we replaced websockets with simpler AJAX calls so reduce complexity upon installation).

## 6.2.3 AJAX

AJAX (Asynchronous JavaScript And XML --- a method of sending asynchronous HTTP requests) is the messenger between the server which manages the bluetooth connection to the device and the user interface in the web browser. AJAX also allows the site to update without refreshing, thus, behaving more like an application.

## 6.3 Data Science (Real-Time Feedback/Machine Learning)

### 6.3.1 Sample/Training Data Collection

#### 6.3.1.1 *Experiment Design*

We invited five subjects to test our Hercubit prototype on the I-School Project Showcase Day (March 14th, 2014). We asked them to perform a few repetitions of the three types of exercise, namely *biceps curls*, *triceps kickbacks*, and *shoulders press*. We collected their data for later use in machine learning in an attempt to categorize the three types of exercises based on the readings from the sensors (accelerometer, gyro and magnetometer).

#### 6.3.1.2 *Data Format*

Data is stored as comma-separated values (CSV) format. For each work-out session, the CSV file contains rows of sensor readings and the timestamp. Each row is represented as a 9-element vector:  $[acc\_x, acc\_y, acc\_z, gyro\_x, gyro\_y, gyro\_z, magnet\_x, magnet\_y, magnet\_z]$ , where  $acc\_x$  stands for the x readings from the accelerometer,  $gyro\_x$  stands for the x readings from the gyro, and  $magnet\_x$  stands for the x readings from the magnetometer. Other attributes follow the same naming fashion.

### 6.3.2 Algorithms Implementation

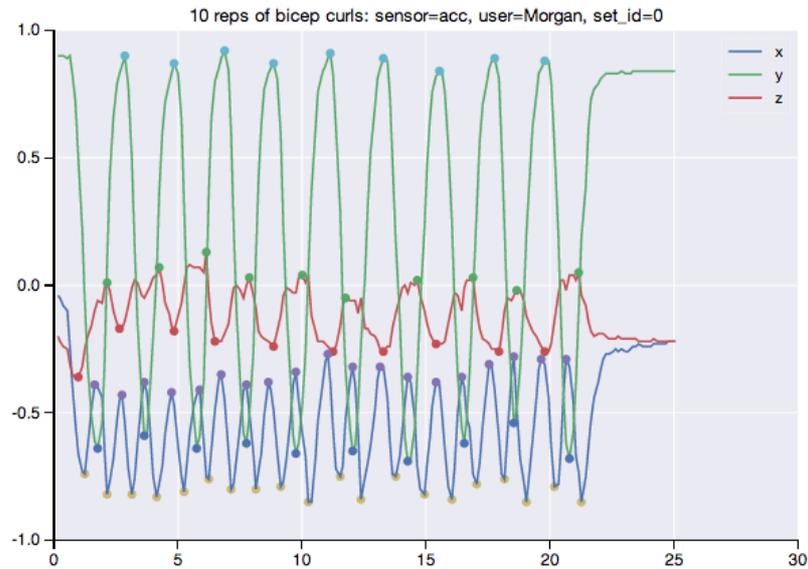
Our device detects patterns in our sensor data similarly to how pedometers work. However, the challenge specific to our device is that we must output results to the user in real time. This means we must instantly know not only when a repetition is complete but also what type of repetition it is (e.g. bicep curl or shoulder press). Unlike previous research ([‘Tracking Free-Weight Exercises’](#)) where an entire set of exercise was completed first before classification and then peak detection (repetition counting) happened, we were challenged to do both instantly - or with minimal delay.

Some elements of the ‘Tracking Free-Weight Exercises’ paper were influential to our product. We decided to only use one wrist sensor instead of a wrist sensor with a twin sensor on a belt clip. With just one sensor, we chose to recognize only 3 exercises for our first prototype. These 3 arm exercises (biceps curls, triceps kickbacks, and shoulders press) together make a well rounded arm workout while they also appear very different in their sensor patterns and are easier to classify.

Despite our best efforts of optimizing these algorithms, they are not and will not ever be perfect. However, more training data and adding consideration for the many edge cases (eg. picking up weights and shrugging could be incorrectly counted as a shoulder press repetition) will increase accuracy even still.

#### 6.3.2.1 Peak Detection (to count exercise iterations)

The stream of data is processed in a Python script using a moving window. The window is up to 5 seconds worth of samples (the 9-element vector; see 6.3.1.2) and appends every new sample to a list. We then send all 3 accelerometer axes of the sample to a peak detection algorithm (we use a slightly modified version of this [algorithm](#)) which returns a list of peaks.



### 6.3.2.2 Pattern Recognition (to recognize gestures/types of exercise)

- 6.3.2.2.1 If Else Rep Tracker
  - We process the live stream of sample data from the Hercubit in a repetition tracker. The repetition tracker uses a combination of a peak detection algorithm and a few features like standard deviation of all accelerometer axis to accurately predict count and type of exercise. For example, if the standard deviation of all the accelerometer axes is low, then it is likely to be a shoulder press, and then if there are both peaks and dips detected the repetition tracker will output a rep to the website.
- 6.3.2.2.2 SVM
  - As a side project for Data Mining Spring 2014 final project, Morgan trained a Support Vector Classifier (SVC) using almost 800 examples of bicep curls, shoulder press, and tricep kickbacks. The classifier will be implemented in the Hercubit system in the near future but it not yet in use. The classifier is able to get 88% accuracy on a holdout set of data. However, it must also be combined with the real-time rep\_tracker\_svc.py which uses the SVC model to get the probability at any given time that the action being performed is a certain type of exercise. With a high probability guess and a local min and max detected for the dominant axis for that exercise, the rep tracker will return 1 verified and classified repetition. The link to the Github repository is here: [https://github.com/morganwallace/classify\\_exercise](https://github.com/morganwallace/classify_exercise)

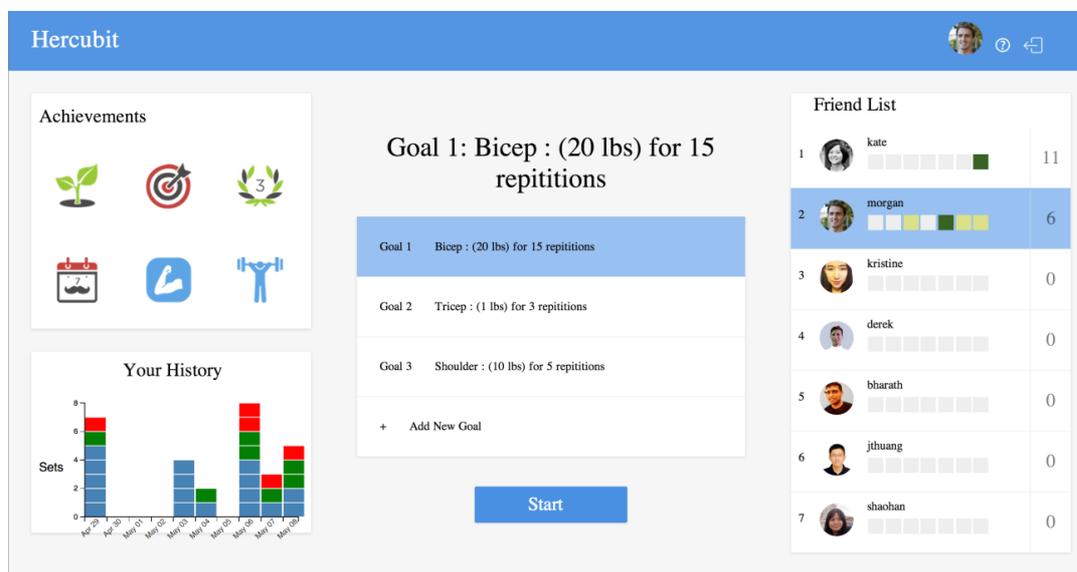
## 7. Final Product

### 7.1 Components Break-down

7.1.1 Arduino architecture with motion and wireless sensors that accurately tracks user's body movement while they are doing fitness exercise. The circuit is attach to an armband by using velcro so the user can easily wear it and moving around.

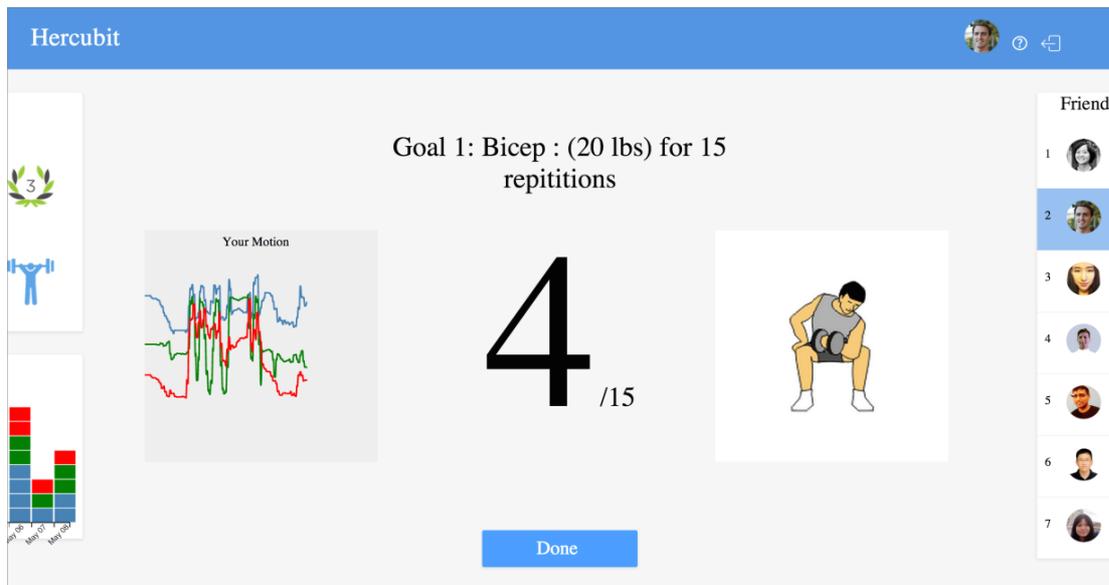


7.1.2 A social platform which allows multi-player competition and ranking system that we hope can engage the users more into exercising and thus benefit their health.

The screenshot shows the Hercubit app interface. At the top is a blue header with the name 'Hercubit' and a user profile icon. The main content area is divided into three sections: 'Achievements' with icons for a plant, target, and medals; 'Your History' with a bar chart showing sets over time; and 'Goal List' with three goals: 'Goal 1: Bicep : (20 lbs) for 15 repetitions', 'Goal 2: Tricep : (1 lbs) for 3 repetitions', and 'Goal 3: Shoulder : (10 lbs) for 5 repetitions'. A 'Start' button is at the bottom. On the right, a 'Friend List' table shows a ranking of friends with progress bars and scores.

Rank	Friend Name	Score
1	kate	11
2	morgan	6
3	kristine	0
4	derek	0
5	bharath	0
6	jthuang	0
7	shaohan	0

7.1.3 A visualization of user progress with count, animating instruction, and real-time visualization chart.



## 7.2 Putting things together

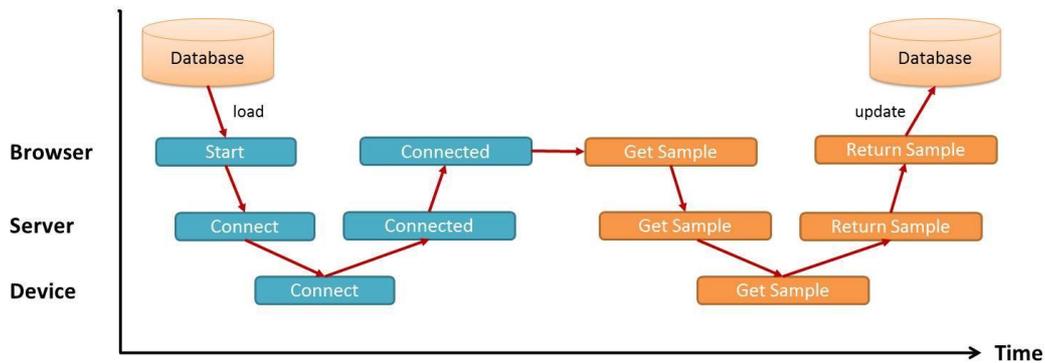


Image: Data flow between browser (Front-end UI), server (Flask), device (Hercubit), and database (MySQL)

## 7.3 Potential Use Cases

### 7.3.1 Strength-Training Coaching

Hercubit is like a strength-training coach which provides step by step instruction that beginners can easily start their training lessons without hurting themselves. Hercubit provides accurate weight lifting suggestion based on user level that people can enjoy their workout while at the same time improve their level gradually.

### 7.3.2 Daily Exercise Tracker

Hercubit works as a casual exercising tool that people can do exercise at home anytime based on their own schedule. The data tracking technology accurately record user's every movement during the session and provide instant feedback and achievement rewards after the session to motivate users exercise constantly.

### 7.3.3 Fitness Game Equipment

With its social interaction and gamification features, Hercubit also works as fitness game equipment that helps people relax and get rid of tiredness after long hours sitting in front of desk. User can start a training session anytime during their break time and can also send challenges to their friends to compete.

### 7.3.4 Bodybuilding Facilitator

For people who have specific goal behind strength training (ex: improve health condition, get rid of insomnia, build lean muscle, etc.), Hercubit helps them break the big goal down into small daily exercise goals that people can easily follow and achieve day by day. Hercubit works like a personal trainer which analysis user's exercise data and suggest training paths based on user's condition.

## 7.4 Branding (Product Name/Logo)

The name "Hercubit" comes from the combination of "Hercules" and "bit", which represents the concept of the product - a strength training device with digital communication signals. Based on this concept, we integrated the concept of dumbbell into out icon and logo (see below).

	
Icon	Logo

## 8. Challenges

Building a tangible devices comes with many challenges. First and foremost are issues with broken or incomprehensible hardware. There are 2 broken Arduino Micros, 3 broken Bluetooth modules, and 4 broken 9-degree-of-freedom sensors.

Showing Bluetooth output in a user interface is a challenge for our team because we don't have experience writing native desktop or mobile applications. However, we were able to devise a way to use

Python to set up a local server and use a web browser as an interface. While it was challenging at first to set up; it resulted in a rich front-end experience because of the advanced possibilities of modern web development.

Lastly, there were so many different pieces of the software that have to interoperate for the whole system to work properly (see diagram in 7.2). The Hercubit system is a gigantic set of relays: communication from a device written in C sends streaming data to the serial port to a Python script that makes sense of the streaming data to a server that shows the user feedback and then to a database which saves state of all the users' activity.

## 9. Future Considerations

Based on the interview, usability testing, and the diary study, we received valuable feedback from the users. We hope to integrate the feedback into the next iteration of our product.

- Incorporate higher level goals and recommended instructions while doing the exercise with Hercubit
  - By letting user to choose higher level goals (e.g. losing weight, building muscle) and having preset sub-tasks, we believe that it would increase user engagement and motivation to exercise. We also hope to provide a more detailed instruction when users' doing exercise, such as real-time feedback on adjusting the gesture to prevent users from getting hurt.
- More types of exercise
  - Currently Hercubit only detects 3 types of exercise (bicep curl, tricep curl, shoulder press). From the usability testing and the diary study we learned that users hope the device to classify more types of exercise such as push up and sit-up. As we keep working on gathering data and improving the classification, we expect Hercubit as a holistic wearable device.
- Source of the friend list
  - While in this iteration, we hard-coded the friend list on the website, we are working on integrating the friend list with popular social networks such as Facebook or Twitter. As the Hercubit community grows, we also consider to have our own independent community that focuses on fitness and health.
- More games & social features
  - While the achievement (badge) system and friend list ranking received a lot of positive feedback, we hope to emphasize more on gaming and social feature such as increasing

the amount of achievement, adding hidden badges to surprise users, and sending message or challenge to the friends to increase user engagement.

- Increase the mobility
  - Currently the Hercubit device is connected to the computer to receive immediate feedback. We hope to increase the mobility of the device by connecting to the mobile phone, and sending/receiving immediate feedback while users are moving around and even in a casual circumstances or a short period of time

## **10. Conclusion**

The main goal of the Hercubit project was to realize the popular concepts of wearable and health monitoring technologies. To achieve this goal we followed a user-centered design approach and made an interactive prototype, which consists of an Arduino-based hardware device along with software that allows social interaction, real-time data display and user progress visualization. We believe that our work not only eases the mental weariness of monotony weight-lifting exercise, but it also makes the whole fitness exercise experience more motivated and enjoyable. Finally, we encourage you to explore the product of our work by registering at <http://www.hercubit.com/>.

## **11. Acknowledgements**

We thank our advisor, Prof. Kimiko Ryokai, for her countless suggestions to improve our product design. We also appreciate all the users and interviewees for their precious advice. Finally, we are grateful to the ISchool staffs and faculties who have made our two year graduate life treasurable.

## **12. Appendices**

### 12.1 Usability Test Script

#### **In the beginning:**

Before we begin, we have some information for you, and I am going to read it to make sure that I cover everything.

[Project info and session details]

We are asking people to try using a wireless device with the bundled website that we are working on, called “Hercubit”, so we can see whether it works as intended. The session should take about 30-40 minutes.

[Re-emphasizing user’s position in this test ]

The first thing I want to make clear right away is that we are testing the service, not you, so please don't worry about making mistakes.

[Remind the user to think out loud]

As you use Hercubit, we are going to ask you as much as possible to try to think out loud: to say what you're looking at, what you're trying to do, and what you are thinking. This will be a big help to us.

[Explain our situation]

Also, please don't worry that you're going to hurt our feelings. We are doing this to improve the service, so we need to hear your honest reactions. If you have any questions as we go along, just speak out. I may not be able to answer them right away, since we're interested in how people do when they don't have someone sitting next to them to help. But if you still have any questions when we're done, I will try to answer them then.

[Ask permission for recording]

We would like to ask for your permission to record the whole testing session. The recording will only be used to help us figure out how to improve Hercubit, and it won't be seen by anyone except the people working on this project. [Video, audio, screen (optional)]

### **Collect user info: (5min)**

OK. Before we start, I would like to ask you just a few quick questions.

- Exercise habit
  - Type of exercise
  - Exercise plan
  - Duration per session
- Wearable device experience
- Reasons for doing / not doing exercise

### **Main tasks:**

**Task 1: Please login to Hercubit with userid="test" and connect your device to the system**

### **Goal:**

- 1) To understand how people start the service and to see if the designed user flow is intuitive enough and easy to operate

2) To understand if the designed signal is obvious enough that user knows when the device is connected or disconnected

**Success Criteria:** The task will be succeed if a participant find the box to login within 30 seconds, and have the whole system ready within 1 min

**Task 2: Please setup your goal of the day: 10 reps for bicep curl for 3 pounds**

**Goal:**

To understand if the flow for setting up goals is intuitive enough and easy to operate

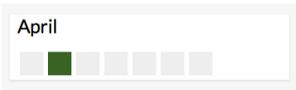
**Success criteria:** The task will be succeed if a participant find the correct block to fill in the assigned goal within 1 min

**Task 3: Now, start exercise with the goal you just set up. Think out loud about what do you think is happening on the screen.**

**Goal:**

- 1) To understand if the call for action is clear enough on our dashboard
- 2) To observe user's reaction on the real-time visualization
- 3) To understand if the information given on the screen does make sense to the user

**Success criteria:** The task will be succeed if the user completed the exercise

**Task 4: Explain what**  **is.**

**Goal:** To understand if the information and symbols given on the dashboard do make sense to the user

**Success criteria:** The task will be succeed if the user gives the correct definition (a calendar heat map view for the last 7 days, the darker the color is, the more exercise is accomplished)

**Post usability testing:**

- Is there any features that you think would be nice to have
- How do you feel about the achievement system
- How do you feel about having a friend list

**Evaluation Criteria:**

1. Time to complete each task
2. Number of attempts to complete each task
3. Task success rate
4. Number and types of errors
  - Observations and comments (difficulty, unusual behavior, obvious cause of error)
  - Non-critical errors (participant was able to recover)
  - Critical errors (participant was not able to recover)

## 12.2 Diary Study Guide



Dear \_\_\_\_\_,

**First, we would like to thank you again for participating in Hercubit diary study!**

**Below are the details of the diary study plan, please kindly take a look and always feel free to let us know if any questions!**

**Duration:** 7 days, from April 11th (Friday) to April 17th (Thursday)

**Testing Kit:** One Hercubit device

One dumbbell

One notebook

One pen

**Instruction:**

- **How do I make the diary study entries?**

We've set up a private Blogger (online diary) account for you to use during the diary study week. Only you and Hercubit's team members (Morgan, Kate, Shaohan,

Charles) will be able access to this blog so your information remains confidential.

You should have received an invitation to this blog, please let us know if you didn't receive it. Besides Blogger, you may also use pen and paper to keep your diary.

**\*\* Pictures and drawings are highly encouraged! \*\***

- **How do I post my updates to this private blog?**

There are three ways to make a post to your private Blogger site:

(1) Through [www.blogger.com](http://www.blogger.com) with:

username: \_\_\_\_\_

password: your password

(2) Send your post to \_\_\_\_\_ [@blogger.com](mailto:_____@blogger.com)

- Please post subject as email title and diary content as message body
- You can include images & video clips as attachments to these emails and they will be associated with those blog posts
- Only you and I have this 'secret' email address, so no one else can post to this blog

(3) Install the Blogger app on your mobile device (optional):

- App store (iPhone/iPad):  
<http://itunes.apple.com/us/app/blogger/id459407288?mt=8>
- Android market:  
<https://play.google.com/store/apps/details?id=com.google.android.apps.blogger>
- Windows Mobile:  
<http://explore.live.com/windows-live-essentials-other-programs?T1=t5>

- **WHEN should I make an entry?**

- Please maintain a diary and make an entry when
  - You are about to start exercising at home, either using Hercubit or not
  - You finish exercising at home, either using Hercubit or not
  - You are making a plan for your home exercise
- If you're not sure if something is important, it's best to make a note.

- We ask that you try to document your thoughts throughout your day and at the very least at the end of each day, so it's most fresh in your mind.
  
- **WHAT should you make an entry?**
  - If you're about to start exercising,
    - What is the incentive of starting this exercise?
  
  - If you finish exercising,
    - Detail of this exercise
      - Time, duration, location of doing the exercise
      - What exercise is it
      - What equipment you use
      - The process of this exercise
      - Any record (if any) of this exercise
      - Are you alone or with anyone else
    - What did you do after the exercise
    - How do you feel about this exercise
  
  - If you are making a plan for your home exercise
    - The detail of this plan
    - What media did you use to make the plan
    - What did you consider when making the plan
  
- **OTHER information**
  - While doing exercise, do you feel any limitation and think there should be a better way to improve your experience?
    - What did you want to do?
    - What would you do if you had a magic wand?
  - What kind of exercises do you think can be replaced by Hercubit?
  - Do you prefer using Hercubiit by yourself or with others? Why or why not?

**Best,**

**Team Hercubit (Morgan, Kate, Charles, Shaohan)**

### 12.3 Code Repositories

<https://github.com/morganwallace/Fitness-Tracking>

### 12.4 List of Software Tools/Packages/Libraries Used

- I. Python
- II. Python libraries:
  - PySerial
  - Flask
  - SciPy
  - Matplotlib
  - Numpy
  - Sklearn
  - Pandas
  - Flask SocketIO
- III. HTML
- IV. JavaScript (jQuery, D3)
- V. Photoshop, Illustrator, Sketch

### 12.5 User Testing Photographs

