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# Workout with Friends

## Health Monitoring for Fitness Gaming

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16:332:567 - Software Engineering

Report 1



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| Change Log |  |                |                      |
|------------|--|----------------|----------------------|
| Version    | Changes Effectuated  | Effective date | Created / Changed By |
| 1.0        | Part 1 - Initial draft version (1.0)                             | 10-01-2012     | Mateus Santos        |
| 1.1        | Added Glossary / General Editing                                 | 10-02-2012     | Kevin Kobilinski     |
| 1.2        | Functional Requirement/Work plan                                 | 10-03-2012     | Daihou Wang          |
| 1.3        | On Screen Appearance Requirement/General Editing                 | 10-3-2012      | Brien Range          |
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|            |  |                |                      |

| Contribution Breakdown                       |        |       |       |       |        |        |
|--|--------|-------|-------|-------|--------|--------|
| Task   | Mateus | Kevin | Brien | Abdul | Daihou | Sujana |
| <b>1) Customer Statement of Requirements</b> |        |       |       |       |        |        |
| Customer Statement of Requirements           | x      |       |       |       | x      |        |
| Backgrounds on Self-monitoring               | x      | x     |       |       | X      |        |
| Project Overview                             | x      |       |       |       | X      |        |
| Glossary of Terms                            | x      | x     |       |       | X      | X      |
| Editing                                      | x      | x     | X     | X     | X      |        |
| <b>2) System Requirements</b>                |        |       |       |       |        |        |
| Functional Requirements                      | x      | x     | X     | x     | X      | x      |
| Non-Functional Requirements                  | x      | x     | x     | x     |        |        |
| On-Screen Appearance Requirements            | x      |       | x     |       |        |        |
| Acceptance Testing                           |        |       | X     |       |        |        |
| Editing                                      | x      | x     | x     | X     | X      |        |
| <b>3) Function Requirement Specification</b> |        |       |       |       |        |        |
| Stakeholders                                 | x      |       |       |       | X      |        |
| Actors and Goals                             | X      | x     | x     |       | X      |        |
| Use Case Description                         | X      | X     | x     |       | X      |        |
| Use Case Diagram                             |        |       | x     |       | X      |        |
| Sequence Diagrams                            |        |       | X     |       | X      |        |
| Editing                                      | X      | X     | X     | X     | X      |        |
| <b>4) User Interface Design</b>              |        |       |       |       |        |        |
| Preliminary Design                           | X      |       |       | x     | X      |        |
| User Effort Estimation                       | X      |       |       |       |        |        |
| Editing                                      | X      |       |       | X     |        |        |
| <b>5) System Requirements</b>                |        |       |       |       |        |        |
| Domain Analysis                              |        |       |       |       | x      |        |
| Operation Contracts                          |        | X     |       |       |        |        |
| Editing                                      | x      | X     | X     |       |        |        |
| <b>6) Project Management</b>                 |        |       |       |       |        |        |
| Plan of Work & Feedback                      | x      |       |       |       | x      |        |
| <b>7) List of References</b>                 | X      | X     | x     |       |        |        |

### Future Responsibility Allocation (TBD)

| Feature                         | Mateus | Kevin | Brien | Abdul | Daihou | Sujana |
|---------------------------------|--------|-------|-------|-------|--------|--------|
| Facebook web-app framework      |        |       |       |       |        |        |
| Messaging between users         |        |       |       |       |        |        |
| Account Management              |        |       |       |       |        |        |
| Posting results facebook wall   |        |       |       |       |        |        |
| Scoring Algorithm               |        |       |       |       |        |        |
| Facebook Android migration      |        |       |       |       |        |        |
| Wireless HRM connectivity       |        |       |       |       |        |        |
| Integration Testing & Debugging |        |       |       |       |        |        |
| Documentation Maintenance       |        |       |       |       |        |        |
| Website Maintenance             |        |       |       |       |        |        |
| Graphics Design                 |        |       |       |       |        |        |

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# 1. Customer Statement of Requirements

## 1.1 Introduction

Every January hundreds of thousands of people make it their legitimate goal to improve their overall fitness level. Although the desired targets can vary from shedding a few pounds to completing an Iron Men competition, according to fitness professionals, most people fall short from achieving their goals. Fitness Experts at Leriken Functional Fitness claims the top 10 reasons why people abandon their fitness routines are<sup>26</sup>:

1. Lack of Motivation
2. Setting Unrealistic Goals
3. Not Having a Clear Plan
4. Doing Too Much Too Soon
5. Pain / Injury
6. No Perceived Results or Rewards
7. Not Having Any Fun
8. Lack of Time
9. Can't Afford the Gym Membership
10. Self-Conscious to Train in Front of Other People



Figure 1: Friendly Competition in Cycling

For many, staying motivated is the key to being able to stick with the commitment to pursue greater fitness level. On that note, it is not uncommon for people to develop workout routines in sync with a workout partner. Friendly competition is not only a very powerful motivator, but it is also the preferred method amongst the majority of potential consumers in the personal fitness industry.

## 1.2 Background - Technology Trends

With the advances of technology in the past 15 years, we have seen new consumer products come to life attempting to address “lack of motivation” and deliver new functionalities. Functionally, the majority of features were very basic at first. One of the early products marketed for fitness applications was the Timex Ironmen Triathlon sports watch, introduced in 1984. To date the 1986-91 design and subsequent models of Timex Ironman are one of the most recognized timepieces around the world and continue to be Timex’s best selling brand<sup>32</sup>. However, the digital revolution for personal fitness industry did not come until 2001 with the beginning Apple’s iPod family of products. The iPod Classic and subsequent model Shuffle, introduced in 2005, were devices that turned consumers on to ultraportable digital audio players and were a major hit<sup>2</sup>. It brought home the ability to bring personal playlists on-the-go for a workout anywhere you’d like. Later generations of over the past 7 years include features such as: FM radio, pedometer and multi-touch interface. Until then, there was nothing in the market that could record and track workout performance meanwhile providing music on the go.

The next step in the technology evolution was in 2007: the Apple iPhone. The iPhone represents the culmination of approximately 40 years worth of R&D in computer, photography, and communications engineering. Much like its predecessor’s, the iPhone

quickly became a widespread success since its introduction, the reason being that from the consumer point of view it is a device that behaves like a pocket computer, with capability to interface with many different things and the ability to instantly connect with friends or relatives who could be located in the other side of the world. In other words, it has become the “one device that does it all”. There has been 5 other generations since the introduction of the iPhone, which is deemed by many as the 1<sup>st</sup> generation smart-phone. To date, there has not been any other company in the world as successful as Apple in capitalizing on consumer-based products.<sup>15</sup>

Another recent trend in personal health & fitness technology was very well captured in Mark McClusky’s “The Nike Experiment: How the Shoe Giant Unleashed the Power of Personal Metrics”<sup>17</sup>.

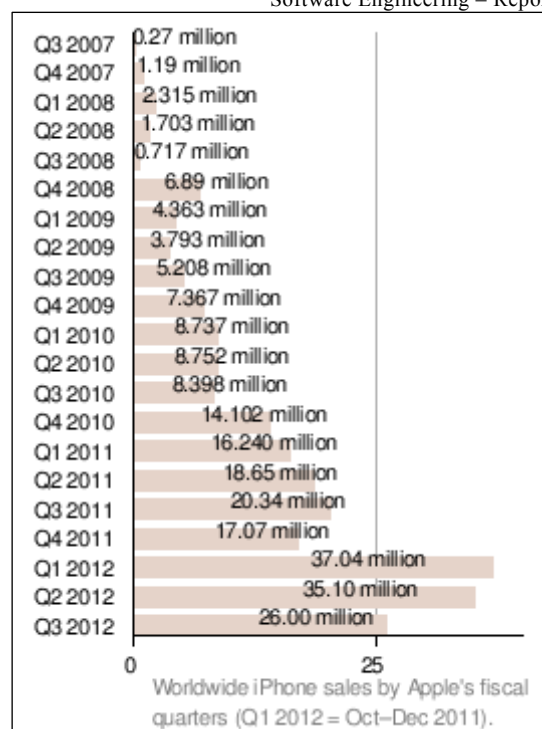


Figure 2: iPhone Sale by Quarter

*“It’s one thing if some company tells me that I’m slacking off, like when Nike+ [me] sends an email reminding me to get out and exercise. It’s a whole different thing if people whose opinion I care about get on my case. [It feels great to come home upload your data and compare against friends who were getting on my case to get out and exercise. But more importantly, if I was] sitting around the house, wondering what to do, thinking about jogging, and then realizing that if I don’t go jogging tonight I’m going to lose points and slip in the standings—now that’s true videogame motivation”*

The trend can be simply summarized as a gamification of the daily exercise. Gamification typically involves applying game design thinking to non-game applications to make them more fun and engaging. Gamification has been called one of the most important trends in technology by several industry experts. Gamification can potentially be applied to any industry and almost anything to create fun and engaging experiences, converting users into players.

One of the first examples of real world gamification is the frequent flyers programs. Typically, airline customers enrolled in the program accumulate frequent flyer miles (kilometers, points, segments) corresponding to the distance flown on that airline or its partners. There are other ways to accumulate miles. In recent years, more miles were awarded for using co-branded credit and debit cards than for air travel. Acquired miles can be redeemed for free air travel; for other goods or services; or for increased benefits, such as travel class upgrades, airport lounge access or priority bookings.

Another area where gamification has made big strides is in the gamification of health with the Nintendo Wii and Xbox Kinect platforms. There are several titles available ranging from general fitness, to yoga and general sports and games that make working out a fun activity. For example, Fruit Ninja for Xbox Kinect may seem like the game is very trivial: move your arms according to the Fruits that are perceived as being thrown

towards you in such a way that if you picture your arms as swords, it would slice the target fruits. Prolonged playing time may actually result in severe calorie burning, in addition to personal enjoyment. Although this example falls short of an actual workout, it is possible to glance at the potential in gamification of the daily exercise.

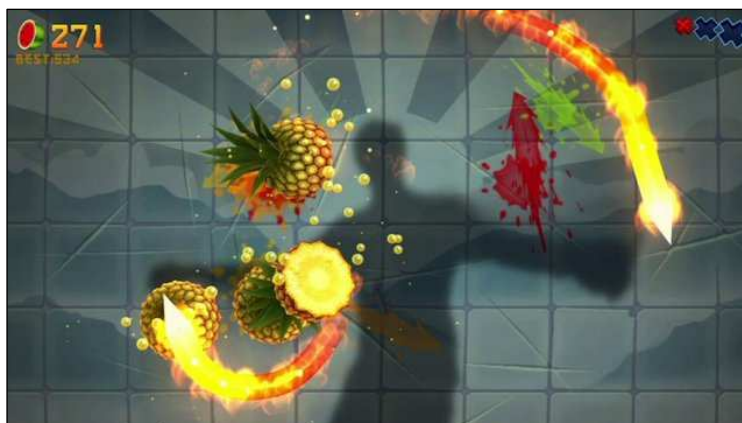


Figure 3: Daily exercise gamification - Fruit Ninja for Xbox Kinect

### 1.3 Problem Statement

Overall, the social revolution led by Facebook over the past 5 years combined with the upgrade of cellular network infrastructures in the U.S. and early gamification examples in the health industry makes it possible now to unlock the true potential of the gamification trend. Furthermore, as technology evolution drove the devices in the marketplace to the “one device that does it all” concept we’ve seen the integration of a multitude of features for fitness applications at an unprecedented rate. Although there are several devices across many platforms targeting average consumers for improved fitness purposes, the main problem with motivation to lead more active lifestyles still remains largely an unsolved problem. According to data over the past 13 years collected by the U.S. Center for Disease Control and Prevention (CDC), adult obesity rates in the U.S. has almost doubled since 1987<sup>1</sup>. Recent demographic studies point the U.S. to be the leader in population obesity (~35.7% of the population)<sup>1</sup>. In summary, there is a lack of options in the market that provide an effective *low-cost* motivational tool for fitness purposes that also streamline playability over many platforms.

### 1.4 Customer Requirements

#### ⇒ Workout-based game

- Overall game experience should give users the perception that working out is fun
- Game should be based on real biometric data measured by a HRM (heart-rate monitor) that can capable of tracking calories, and heart rate zones
- Wireless connectivity to heart rate monitor for seamless user experience

#### ⇒ Social network integration (Facebook)

- Single Sign On (login)
- Search friends on facebook
- Post outcome of challenge on friends facebook wall
- Send message to an opponent

#### ⇒ Convenient platform for users to challenge friends and workout partners

- Web Based (embedded over facebook for users who do not own a smart-phone)
  - Users may use a HRM to record data for manual input post-workout
- Mobile API (android)

- Engaging gaming UI for that works in the background so smart phone users can focus on music selection. Data is recorded with a wireless HRM and is uploaded automatically over a wi-fi or cellular 3G or 4G connection.

## 1.5 Problem Solution

The goal of this project is to address this unmet need by developing software to achieve an integrated multi-platform solution that combines gamification of Health with mobile and social aspects to deliver a fitness tool that keeps people motivated in working out.

Historically most people that go to the gym to work out and personally own a smart-phone usually carry it on them during the workout. That holds true also for running (outside or treadmill) and cycling purposes. For most people their smart-phone is the "1 device does it all", so during a workout smart-phones are commonly used to check facebook status and browse the web but the main and most important use is still to manipulate and listen to a music playlist. The game Workout with Friends was inspired by current trends discussed in the introduction section as well as popular social games by Zynga Mobile. The idea essentially marries the social interaction aspects of playing against friends with the accessibility aspects of a central single login concept using Facebook, from a mobile gaming concept with working out given that the perceived judge is a heart rate monitor.

## 1.6 Solution Overview

The general user interface draws inspiration from the simplistic approach which has already been proved successful in social board games such as "words with friends" and "scramble with friends" by Zynga, which each have been downloaded millions of times. It is quite remarkable that such simple apps held average MAU (monthly active users) in the 15M bench mark as recent as February 2012. Regarding ratings, both "words with friends" and "scramble with friends" score high on customer feedback - each sporting a 4.5 out of 5 stars rating in customer reviews with over 1 million reviews on iTunes platform alone. In a similar model, Workout with Friends will be implemented as a facebook app that can be accessed over the internet as well as an android app for smart-phones.

The facebook app will be a simplistic approach to serve as a proof-of-concept and interoperability between different devices used to record heart rate data. On this note, the facebook (web-based) game will only support manual entry of key biometric data. The proof-of-concept model will use real physiological data recorded with a MotoACTV device paired with a wireless Motorola HRM to calculate the score of each user and consequently compare scores to identify a winner. The next path in developing Words with Friends will be to implement the game as an android app, where the app collects data from a wireless HRM.

From a functional perspective, once a new user opens the app for the first time the user will be asked to login with a Facebook account if he/she has one. The user will be asked to register a new account with values for: age, weight, gender among other preferences. Once registration is complete, there should be an introduction presentation of no more than 5 slides. The user shall be able to skip the introduction and access it at a later time. The home screen shall provide at least 4 main functionalities: allow the user to set up a new challenge, allow the user to go into



the options menu, review an open challenge awaiting opponent feedback, and review all completed challenges (which can be sorted by date or by opponent).

To setup a new challenge the user shall be prompted with four options: search by username, search via Facebook, invite an un-registered user or select a random local opponent. The user should be able to select more than 1 person to include in the challenge. Before a challenge is sent to the selected opponent the user must select some options such as: workout nickname, tags (categories: running, biking, general, lifting, p90x) and workout duration (15 minute increments). The user age and weight will never be shared with other users or third parties and the user shall be able to modify these account values freely whenever he or she chooses. The user shall also be able to include a personal message in the challenge invite.

Once a challenge invite is sent, the user will be directed to the pre-workout screen with further directions such as warm-up time, and heart rate monitor connectivity. The user should have the option to fast track this screen. Once HRM connectivity is established the user should be able to set a timer or manually click on a start icon to start collecting data. The application then goes to the background and displays the user's real-time heart rate in the top notification bar along with the elapsed time and time remaining.

Once time expires the application compiles the heart rate zone counters and calculates a workout intensity score, which is reported to the user. The system then awaits for the opponents workout intensity score in order to determine a winner. Meanwhile, the user is taken back to the home screen. The user may review at any time his or her performance. Three indicators will be displayed: time spent in zone 4, time spent in zone 5 and calories burned.

A notification is automatically sent to the opponent stating that the user has completed his workout and now is his/hers turn to complete. Once the system knows the workout intensity score of both players it uses this number to calculate the winner. Once a winner is determined both players are notified. Each player shall have the ability to review his workout data as a function of time. Additionally, the system shall keep a track record of wins and losses overall and also against each opponent the user challenges on an individual basis.

### **1.7 Current methods (devices, apps, heart rate training)**

There are several consumer grade, high-end fitness devices with HRM (heart rate monitor) connectivity over Bluetooth and ANT+ protocols. Currently the biggest players in the high-end personal fitness market include Motorola's MotoACTV and Nike's "Nike+ GPS SportsWatch". These devices have a powerful processor that calculates a user's delta in GPS position in order to derive work effort data (movement, pace, distance covered) in addition to the ability to connect to a HRM. These powerful devices are targeted for consumers predominantly with running and cycling applications in mind, where it is advantageous to the user to know real-time information such as: HR, calories burned, pace, distance covered, and time elapsed. In addition, with the increases in processing speed of the average consumer grade smart-phone, users now have the option to utilize free and low cost android and iOS applications such as: iMapMyRun and Encomodo Sports Tracker.



Figure 2: 1986 Timex IronMan Watch, MotoACTV and Nike+ GPS SportsWatch

Other devices in the landscape mentioned in the introduction include consoles and fitness related titles in the video-game platform. Although both Xbox and Wii offers many games involving fitness, both require additional expensive hardware: Xbox Kinect and Wii Board. Another drawback is that both Xbox and Wii are currently not compatible with any HRM.

Although the current methods previously described produce rich content for the user, there are some areas that leave the user striving for more. For instance, challenging other users is limited to only the set of users who happen to use the same device. There is no cross-platform challenge. Also, device cost is a big drawback and android/iOS integration with wireless HRM is very limited at this point.

There are clear benefits for mobile implementation (direct pairing) with HRM. For one, it frees users from having to connect to a PC to upload workout data since mobile applications utilize the smart-phone cellular or wi-fi networks to initiate the sync process. The main benefit to the user, however, is that it eliminates the need for users to acquire expensive hardware to record their workout data. Features and costs of current devices that are fitness oriented are shown below in table 1.

| Device                                 | Manufacturer                  | Features  | Price Range                 |
|--|-------------------------------|---|-----------------------------|
| Pure Fitness Devices                   |                               |   |                             |
| MotoACTV 8GB + HRM                     | Motorola                      | Music MP3 over wireless Bluetooth, 8GB / 16GB capacity, GPS / accelerometer, Personal Coach, Pace / Speed, Laps, HR over ANT+ or BLE, calories, wi-fi, web training portal, touch screen interface, sweat / rain proof, android app for answering calls (receive txt) and automatic data sync with web portal | ~\$200 <sup>28</sup>        |
| Nike+ SportsWatch + Sensor + HRM       | Nike                          | GPS, Personal Coach, Alarm, Pace/Speed, Laps, HR, calories, Nike+ Challenges, USB connector   | ~\$220 <sup>29</sup>        |
| Wireless HRM                           | Motorola<br>Garmin<br>Polar   | Wireless connectivity via Bluetooth and ANT+  | ~\$50 to \$70 <sup>30</sup> |
| Mobile Platform                        |                               |   |                             |
| iMapMyRun                              | MapMyFitness (iOS)            | GPS, Pace/Speed, Laps, calories   | Free                        |
| Encomodo Sports Tracker                | Encomodo (Android)            | GPS, Pace/Speed, Laps, calories   | Free                        |
| Video-Game Platform                    |                               |   |                             |
| Fruit Ninja + Xbox 360 + Kinect bundle | Halfbrick (game)<br>Microsoft | Kinect Motion Sensor for full body tracking   | ~\$260 <sup>10</sup>        |
| Wii Fit + Board + Wii Console          | Nintendo                      | Wii Motion Sensor for full body tracking, Wii scale measures the user's center of gravity,  | ~270 <sup>34</sup>          |

Table 1: Fitness & Health Monitoring Landscape (Amazon Search)

A mobile cell phone application for fitness with HRM integration requires 1 less piece of hardware than current high-end fitness oriented devices. In other words, for a similar implementation, it offers 75% lower cost based on values listed in table 1.

### Heart Rate Training - What is heart rate zones?

Heart Rate is the number of heartbeats per minute (bpm). Heart rate varies depending on your activity, from vigorous exercise to sleep. If you know and monitor your heart rate, you get maximum efficiency from your workouts. Maximum safe heart rates vary greatly in people based on age and gender and there are many formulas and tables available to calculate what those rates might be. Generally, zones 1-5 represent 50-59%, 60-70%, 71-79%, 80-90% and 91-100% of the target Max heart rate. For example, the data shown below represent the heart rate for a 25 year old male according to the equation:

$$\text{Max HR} = 220 - \text{Age} \rightarrow 220 - 25 = 195:$$

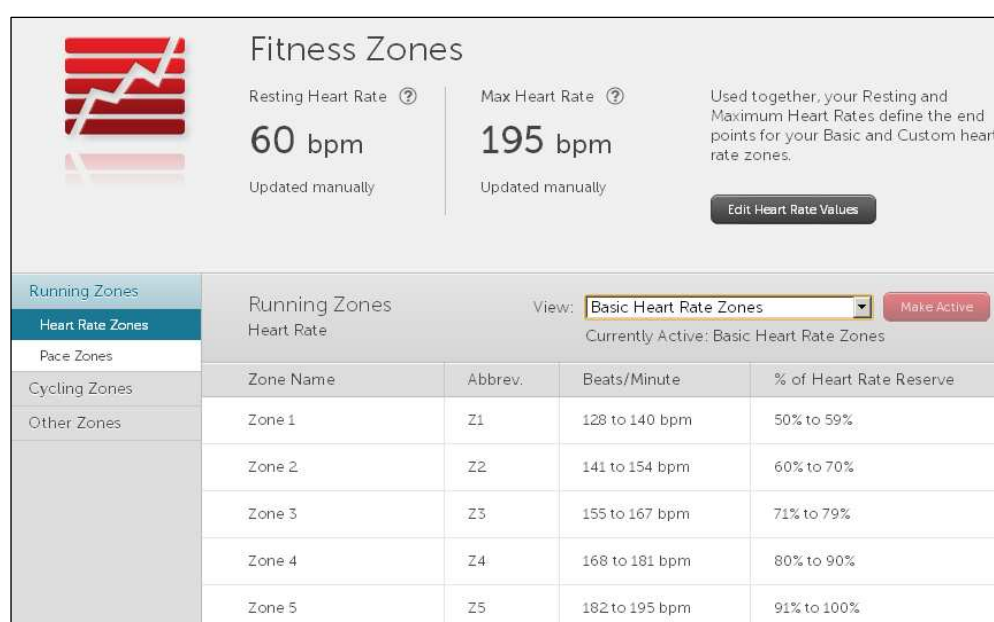


Figure 3: Heart Rate Zones for Mateus - 25 year old Male <sup>32</sup>

The concept behind the HR zones is to classify various stages of physical activity. The key differentiator between the HR zones is where the energy (calories burned) utilized by the body is coming from.

| HR Zone | % of Max HR | Description  |
|---------|-------------|--|
| 1       | 50-59       | Warm-up zone, healthy HR (calories burned 85% from fat)          |
| 2       | 60-70       | Fitness zone, optimal fat burning (calories burned 85% from fat) |
| 3       | 71-79       | Aerobic zone, endurance training (calories burned 50% from fat)  |
| 4       | 80-90       | Anaerobic, performance training (calories burned 15% from fat)   |
| 5       | 91-100      | Maximal effort, "red-line"                                       |

Table 2: HR Training Zones <sup>33</sup>

**Why does heart rate zones matters?**

The biggest reason why this matters is because a person can tailor his or her training based on HR zones in order to achieve a particular benefit from working out such as: increased endurance, fitness, maximum sprint pace, performance capacity. It will also allow him or her to ensure that he or she is working out at a proper intensity level. Often when people just go by their ‘feel’, they may not be challenging their body as much as they could be. Knowing your real-time HR can be an indicator to increase intensity. The table shown below illustrates this concept:

|                      | Target zone            | % of max HR bpm range  | Example duration    | Training benefit  |
|----------------------|------------------------|------------------------|---------------------|---|
| Maximize Performance | <b>5</b><br>MAXIMUM    | 90-100%<br>171-190 bpm | Less than 5 minutes | <b>Benefits:</b> Increases maximum sprint race speed<br><b>Feels like:</b> Very exhausting for breathing and muscles<br><b>Recommended for:</b> Very fit persons with athletic training background  |
|                      | <b>4</b><br>HARD       | 80-90%<br>152-171 bpm  | 2-10 minutes        | <b>Benefits:</b> Increases maximum performance capacity<br><b>Feels like:</b> Muscular fatigue and heavy breathing<br><b>Recommended for:</b> Fit users and for short exercises   |
| Improve Fitness      | <b>3</b><br>MODERATE   | 70-80%<br>133-152 bpm  | 10-40 minutes       | <b>Benefits:</b> Improves aerobic fitness<br><b>Feels like:</b> Light muscular fatigue, easy breathing, moderate sweating<br><b>Recommended for:</b> Everybody for typical, moderately long exercises                                     |
|                      | <b>2</b><br>LIGHT      | 60-70%<br>114-133 bpm  | 40-80 minutes       | <b>Benefits:</b> Improves basic endurance and helps recovery<br><b>Feels like:</b> Comfortable, easy breathing, low muscle load, light sweating<br><b>Recommended for:</b> Everybody for longer and frequently repeated shorter exercises |
| Lose Weight          | <b>1</b><br>VERY LIGHT | 50-60%<br>104-114 bpm  | 20-40 minutes       | <b>Benefits:</b> Improves overall health and metabolism, helps recovery<br><b>Feels like:</b> Very easy for breathing and muscles<br><b>Recommended for:</b> Basic training for novice exercisers, weight management and active recovery  |

Figure 4: Benefits of Heart Rate Zone Training<sup>25</sup>

If your goal is to burn fat as a fuel source during your workout session, you'll want to be working out at a lower overall heart rate because for your body to burn fat (optimally), you must be doing lower intensity exercise (since fat takes longer to break-down so the fuel will be delivered at a slower rate). The desired zones for this type of exercises are Zones 1 and 2. The energy system at play for low intense exercise is much different for high intensity exercise, so depending on your overall workout goals, you can adjust your heart rate to match.

If you're aiming to boost your fitness level on the other hand, then you'll want to be working out at a much higher heart rate, often at a percentage of your maximum heart rate such as 80-90%, which corresponds with Zone 4. It would be very difficult to tell if you're reaching these intensities without a heart rate monitor.

### How can a heart rate monitor improve your workout performance?<sup>13</sup>

Heart rate monitoring is a widely used training method by athletes of all levels. The very reason why even use a heart rate monitor is to help improve performance by ensuring that the user is working out at a sufficient intensity level to derive proper benefits. The simple answer is that HRM gives users a tool to record, measure and track performance. For example, a MotoACTV device equipped with a heart rate monitor records 1 sample per second. Below is an example of the data recorded for a ~43 minute bike workout (heart rate and elevation data is displayed):



Figure 5: Real data for a 43 minute workout with MotoACTV <sup>32</sup>

Contrasting the workout data collected with a HRM over time should clearly show if more time is spent in Zones 4 and 5 during a workout.

The second reason why using a heart rate monitor is beneficial in increasing running or cycling performance is because it will provide a very good way to increase lactic acid threshold. Since a user is able to engage in more intense workouts over time by monitoring the heart rate data collected and adjusting their workout accordingly, a long term consequence is increased the lactic acid threshold by your body.<sup>16</sup>

### 1.8 Other Applications Considered (outside scope of the project)

- ⇒ **After-Care Management Systems for Hospitals:** Increase hospital efficiency through better management of patient re-admission rates through monitoring re-admission risk for patients in after-care stage who were treated for a heart condition.
  - System that continuously monitors a user's vital signs (heart signal, heart rate) to provide Hospitals a tool to rank the re-admission risk of a patient who has been discharged after being treated for a cardiovascular condition
  - Algorithm that can detect when patients treated for heart conditions have re-occurring events such as: Tachycardia, Bradycardia, Arrhythmia.
  - Algorithm that can automatically dispatch EMS services if a red flag is observed<sup>19</sup>
- ⇒ **Telemedicine Practices for Senior Citizens**
  - Software to remote monitor the overall health of Senior Citizens, resting heart rate after / before sleep
  - Algorithm that can automatically send a red flag for a patient's doctor to get in touch with the patient when abnormal heart condition is observed

## 1.9 Glossary of Key Terms

**Resting Heart Rate** - The heart rate, measured in beats per minute (bpm), measured when the subject is awake, but has not performed physical activity/ exerted themselves recently. The resting heart rate is an indicator of general health.

**Max Heart Rate** - The highest rate of heart beats per minute that is achieved during exercise with 100% exertion. Percentages of this rate are used to indicate exercise intensity.

**Heart Rate Training** - Monitoring heart rate data through the use of a measuring device and adjusting one's exercise accordingly to achieve specific fitness goals.

**Heart Rate Zones** - 5 ranges which are grouped as a percentage of maximum heart rate. Each zone has varying benefits to exercising within that heart rate zone, and a user can choose to exercise within a particular zone, based on their exercise goals.

**Lactic Acid Threshold** - Under normal exercise, the production and removal of blood lactate is equal. At this threshold of exercise intensity, there is an abrupt increase in the production of blood lactate

**Player / User** - A participant of the Workout with Friends application.

**Game / Challenge** - A competitive workout between either two players or a player's own history. A winner is determined through a score comparison based on points assessed based on calories burned and time spent in heart zones (with highest weight placed in zone 4 and 5).

**Device** - The heart rate monitor used to collect heart rate data during exercise, and upload the results to the Workout with Friends application.

**Administrator** - The manager who has access to maintenance of the Workout with Friends system

**Database** - The storage of all relevant Workout with Friends data, including player profiles (name, age, gender, weight), player heart rate data and calories burned.

## 2. System Requirements

---

### 2.1 Requirements Summary

To fulfill the user requirements for the problem statement, Workout with Friends provides multiple platforms (web-based and mobile based) that allow users to challenge friends or themselves based on key biometric data. The service provided to the end user must be reliable in determining a workout intensity score in addition to being accessible with ease by a large audience. Workout with Friends strives to address key limiting factors that drive most people to halt their workout activities: lack of motivation. By providing a user-friendly gaming platform, Workout with Friends entices friendly competition in order to motivate users to workout.

The basic requirement for any user to be able to play Workout with Friends is that biometric data must be recorded with a heart rate monitor for the duration of the challenge. Any user equipped with a HRM should be able to play Workout with Friends regardless of the device used to collect the required key biometric data (calories burned and heart rate zones).

Workout with Friends' mobile platform for Android will address customer's concern over cost meanwhile Workout with Friends' Facebook Web platform will address customer's accessibility concerns. For example: a user with a Nike+ GPS SportsWatch paired with a HRM should be able to challenge a user equipped with a MotoACTV paired with a HRM or a user simply equipped with a smart phone paired with a HRM.

As a secondary goal, Workout with Friends strives to make the workout experience a more enjoyable one by the end user through an engaging user interface that marries gaming with social aspects. To this end, communication with a user's friend is central to the design. By delivering Workout with Friends as an embedded Facebook App, users are easily able to login from a central location and challenge friends in the user's Facebook friend list in a straightforward fashion. Additionally, to create a compelling and engaging user experience, Workout with Friends introduces the ability for users share the outcome of the challenge on the user's Facebook wall. This is perhaps the most exciting feature that Workout with Friends introduces, which is ahead of the competition. The ability to post user stories on their friends or opponents Facebook wall adds an additional dimension to the competitiveness nature of the game through bragging rights.

## 2.2 Function Requirements Table

| ID     | Priority Weight | Requirement   |
|--------|-----------------|---|
| REQ-1a | 5               | The system shall be able to keep a database for all user data.  |
| REQ-1b | 5               | The system shall have access to all user data for further comparison.   |
| REQ-2  | 5               | The system shall calculate a workout intensity score that correlates to a workout data set consisting of HR data and calories burned  |
| REQ-3  | 5               | The system shall be able to execute a comparison between two workout intensity scores to determine a winner   |
| REQ-4  | 5               | The system shall be able to allow users to send a challenge request against one or more registered users.   |
| REQ-5  | 5               | The system shall allow user to accept a challenge from another registered user.   |
| REQ-6  |                 | The system shall allow users to designate the length of a challenge as it relates to the workout length that user is challenging the opponent in real life  |
| REQ-7  | 5               | For the web platform, the user shall be allowed to enter workout data to complete a challenge   |
| REQ-8  | 5               | For the mobile platform, the system shall be able to establish wireless connectivity with a heart rate monitor prior to start of a challenge  |
| REQ-9  | 5               | For the mobile platform, the system shall display the user's real-time HR at the top of notification bar while the application runs in the background for the duration of the challenge.  |
| REQ-10 | 5               | For the mobile platform, the system shall allow the user to either manually trigger or establish a "warm up" timer to start collecting data   |
| REQ-11 | 5               | For the mobile platform, the system shall collect data from the wireless heart rate monitor and store it locally in the smart phone. Only once a workout is completed the system shall synchronize the data with a database automatically |
| REQ-12 | 4               | The system shall allow users to be able to view his or her's overall record against previous opponents.   |
| REQ-13 | 2               | The system should allow users to communicate with opponents via in-challenge messaging.   |
| REQ-14 | 2               | The system should allow the user to register an account with their Facebook profile and enter personal information.   |
| REQ-15 | 1               | The system should allow the users to post the outcome of a challenge on his Facebook wall as well as the opponents Facebook wall (if permission is granted)   |
| REQ-16 | 1               | The system should allow users to search for a friend (opponent) via his facebook friend's list or user name.  |
| REQ-17 | 1               | The system should allow the users to send an invite an unregistered friend.   |
| REQ-18 | 1               | The system should allow users to be able to set up a challenge against a random opponent with similar ranking.  |
| REQ-19 | 1               | The administrator should be able to access user account data.   |
| REQ-20 | 1               | The administrator should be able to retire a user's account.  |



## 2.3 Non-Functional Requirements Table

| Non-Function Requirements |                 |   |
|---------------------------|-----------------|---|
| ID                        | Priority Weight | Requirement   |
| REQ-21                    | 5               | All user data shall be stored in the system's database. No user information should be stored on the user's device. Users shall not be able to directly modify any data. There must be two copies of every record in case of system failure. |
| REQ-22                    | 5               | Users shall not be able to access the user accounts of other users. Users shall not be able to access administrator accounts.   |
| REQ-23                    | 3               | The system should require minimum maintenance, and of at most once per week.  |
| REQ-24                    | 3               | The system should be able to maintain function in the event of any changes to Facebook's API.   |
| REQ-25                    | 2               | The system shall be simple and easy to use. Data should be presented to the user in such a way that the user's focus is automatically drawn to it when the users view the page.   |
| REQ-26                    | 2               | The system content should be centered in the center of the page. The user should not need to scroll down to view the data or access the majority of the options on the page.  |
| REQ-27                    | 2               | The user must be able to set up a challenge in 2 clicks or less.  |
| REQ - 28                  | 2               | During registration the system should provide the user with instructions on how to play. It should also give the users the ability to skip the introduction and return to it at a later time  |

## 2.3 On-Screen Appearance Requirements

Because of the intention to integrate the game with Facebook as an app, the application must adhere to all policies as outlined on Facebook's Policy Section - Features and Functionality, found at [https://developers.facebook.com/policy?fb\\_noscript=1](https://developers.facebook.com/policy?fb_noscript=1). As it relates to Facebook integration, there shall be an explicit "Log Out" button for both the application and Facebook (6). There shall be no Facebook icons nor shall there be any Facebook derivative icons (8). Any non-Facebook content displayed by the application shall explicitly state that it is not Facebook content. The applications shall not obscure any Facebook elements. Although the implementation may use pop-ups to alert the user to new messages, these messages shall not obscure and Facebook-required functionalities.

Having said that, the following are the major On-Screen Requirements:

**1. Landing page:** on Facebook Market App. When users search for apps, the results takes to landing page. Landing page gives users the option to look at game description, info, screen shots, supportability, permissions, profile and cover pictures. It gives user the option to play the game via an embedded app or send to mobile.

**2.e - Login** with Facebook account: takes users to registration page, sets up single-sign-in services from facebook to take users automatically to home screen next time.

**2.d - Registration:** for new and 1st time users (some info should also be available in About Screen)

2.d.1 - part 1 - game description and how-to-play

2.d.2 - part 2 - disclaimers & permissions

**2.d.3** - part 3 - user info (name, user name, gender, age, resting heart rate, weight, sports preferences, share stores (y/n), share location (y/n), alerts..)

**2.a - Home Screen** major building blocks:

- 1) high level status bar: (number of challenges: completed, waiting for opponent, won; weekly points, delta of wk-to-wk) - button takes users to "Performance Tracker screen" (2.j)
- 2) About
- 3) Start a new challenge
- 4) Open challenges
- 5) Challenge History
- 6) Help

**2.b - Start a new challenge screen**

**2.b.1** - Search for facebook friends, random local opponent, search by username, select previous workout (self-trainer mode)

**2.b.2** - (from select facebook friends) - populates list of FB friends, allow to select 1 or more opponents

**2.b.3** - Pre-challenge screen: shows selected friends, asks users to input: challenge nickname, workout duration, options (web or mobile), message opponents

**2.h - Game Screen**

**2.h.1** - Web Game Screen - Directions: please make sure to wear a HRM device to capture calories, HR and HR zone data. Empty spaces for user to input these 3 required fields

**2.h.2.1** - Mobile Game Screen - Directions: connect HRM (wireless), warmup options (timer, or start data collection when HR passes warmup threshold (40% of max target HR)), and manual start. Program goes to background once data collection is initiated,

displayed in top android notification bar: instant HR, time elapsed, time remaining,  
**2.h.2.2** - Game Results screen - from 2.h.1 and 2.h.2.1, shows calculated points for calories, HRZ 5, HRZ 4. (opponent results may not be known yet). clicking "next" uploads data to database

**2.c - Open Challenge:** function residing in Home Screen, lists open challenges waiting for opponents turn

**2.f - Help:** FAQ's, report user, send feedback to dev team, upgrade SW.

**2.g - About:** users can find more info (links) on HR, training and tips. Users can also access how-to-play and game description available at registration, Help (takes users to help screen) and Account (takes users to Account Management screen)

**2.i - Account:** users can review and/or edit account attributes such as: nickname, weight, resting HR, alerts, sharing options, age

**2.j - Performance tracker:** shows numerical values for challenges completed, winning %, margin won/lost, calories counter (toggle monthly vs weekly vs all-time view). Also users may select to graph such attributes

The following sketches illustrates these concepts.

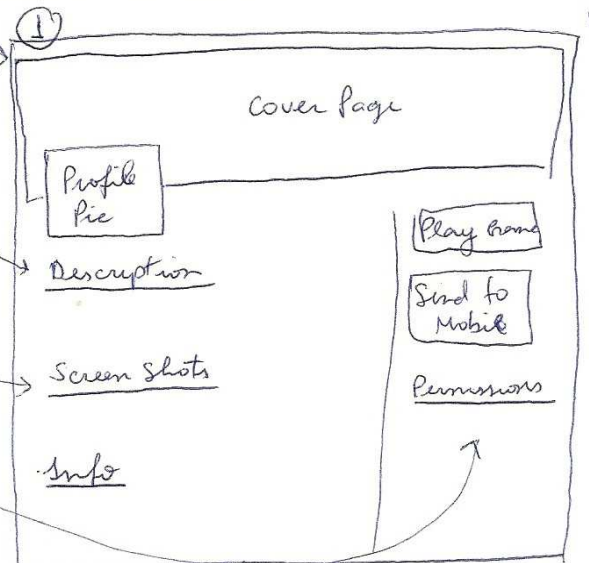
# WORKOUT WITH FRIENDS - USER INTERFACE PRELIMINARY DESIGN

MATEUS SANTOS  
10/15/12

pg 1

## ① Landing Page on Face Book

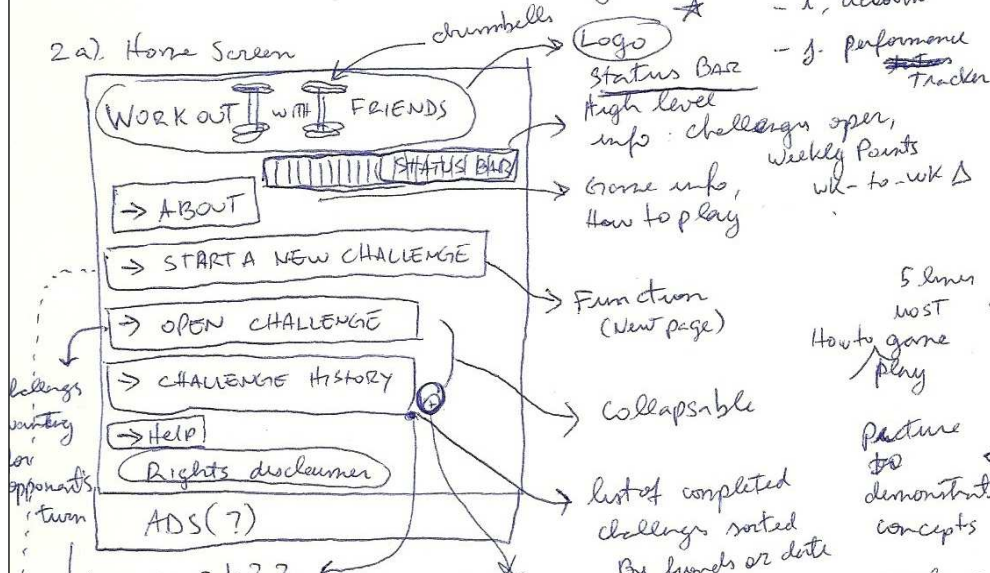
- Game description, info (game fitness)
- screen shots, supportability list
- Permissions
- "Profile Pic" + "Cover Page"



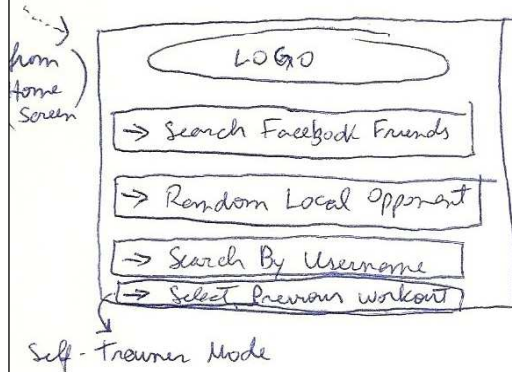
## ② UI - Game concepts

- a. Home Page
- b. New challenge Page
- c. Open Challenge
- d. Registration
- e. Login
- f. help
- g. about
- h. game
- i. account
- j. performance Tracker

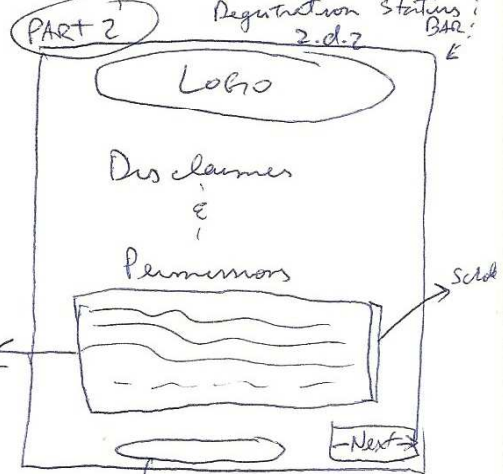
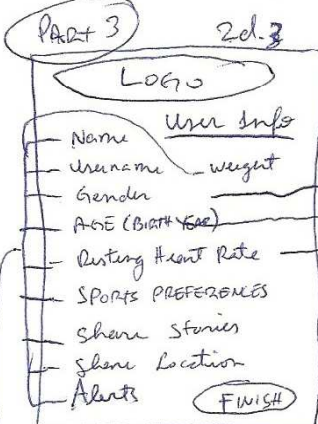
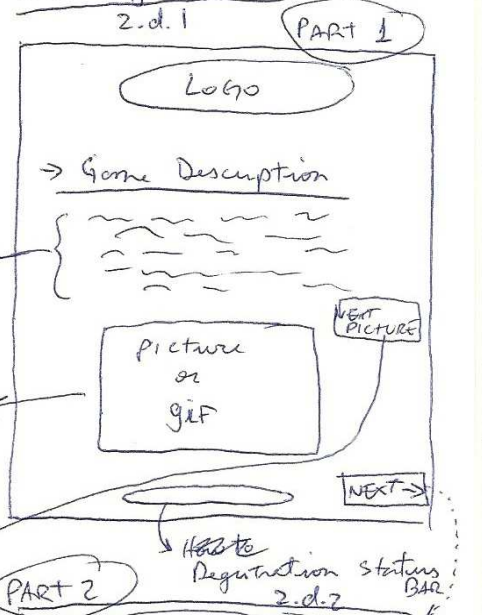
### 2.a) Home Screen



### 2.b) Start New Challenge



### 2.d) Registration

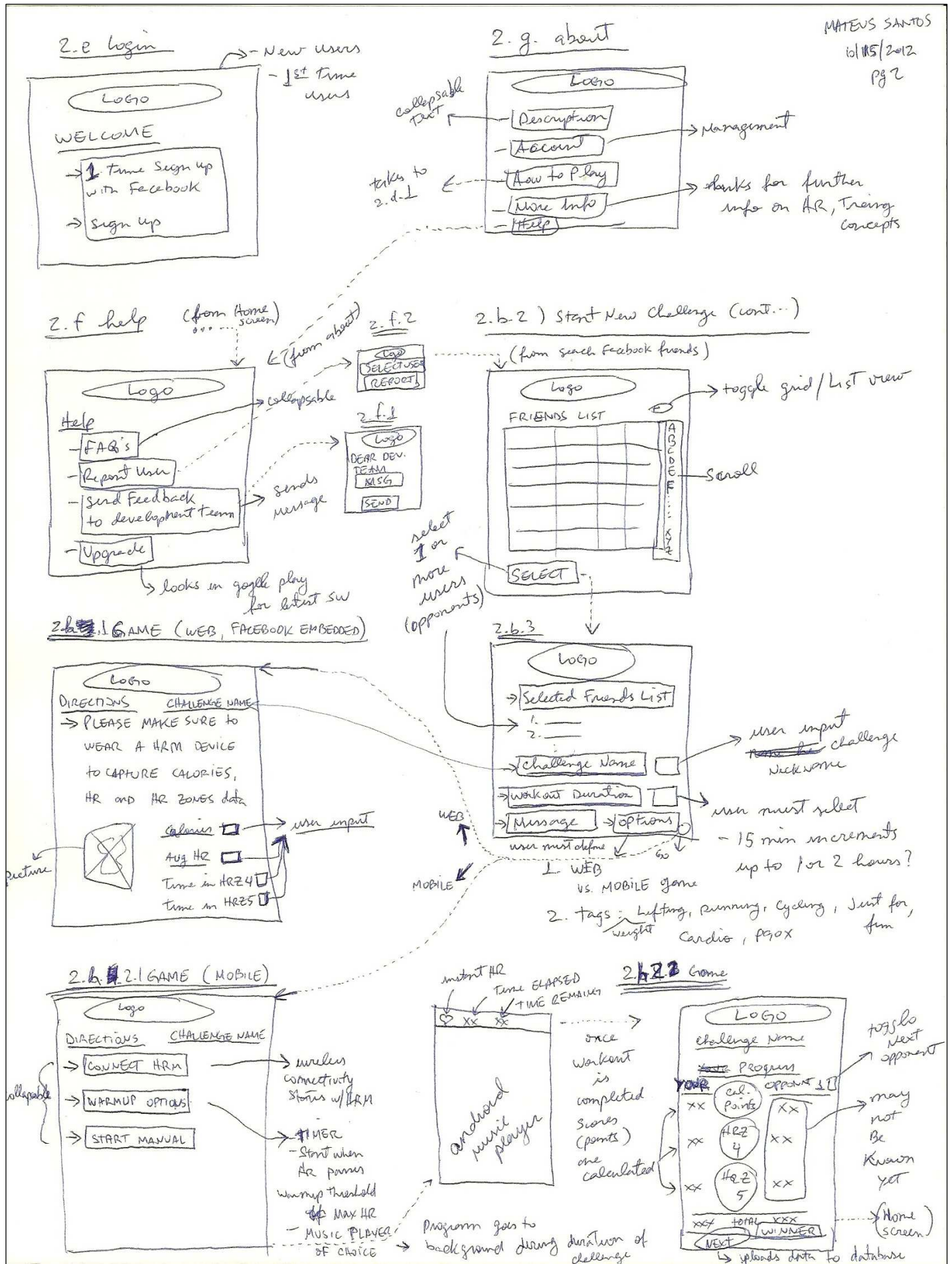


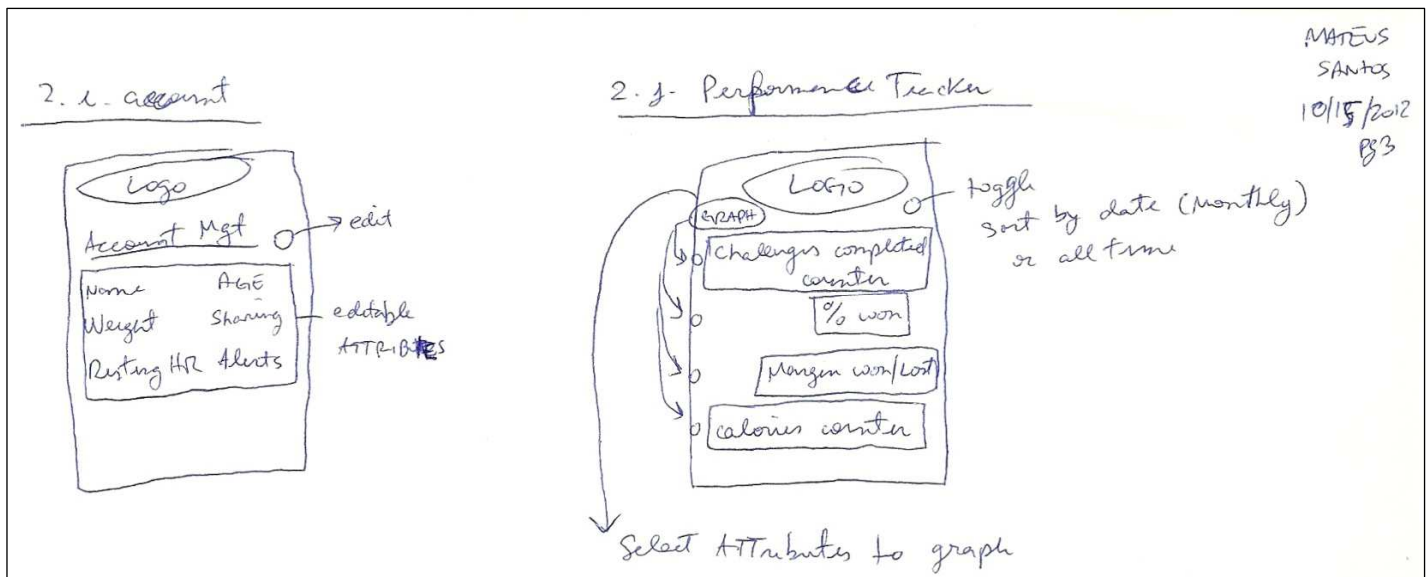


MATEUS SANTOS

10/11/2012

pg 2





## 2.4 Acceptance Tests

In order to confirm the implementation of the major requirements listed in sections 2.1 and 2.2 the following acceptance tests need to be met.

1. A user can register a new account with the system.
2. A user can log in so that he/she can gain access to his/her personal account.
3. An administrator can log in so that he can gain access to his and all user accounts.
4. A user can log out so that he/she can restrict access to his/her personal account from that computer session.
5. An administrator can log out so that he/she can restrict access to his/her administrator account during that computer session.
6. A user can deregister so that he/she can no longer access the account.
7. An administrator can deregister an account so that the user associated with the account can no longer gain access.
8. A user can find a user profile by via entering username or real name so that he/she can gain access to the user's public profile.
9. A user can match himself/herself via game type so that he/she can initiate a challenge.
10. A user can enter workout statistics into the interface to complete a challenge.
11. A user can enter workout statistics into the interface to track statistics.
12. A user can request a historical view so that he/she can track workouts for a given range of dates.
13. A user can display a graphical representation of workout statistics so that he/she can track workouts.
14. A user can set a workout goal so that he/she can initiate a game.
15. A user can get a workout goal so that he/she can see a previously set goal.
16. A user can set a long term performance goal so that he/she can track long term performance.
17. A user can get a long term performance goal so that he/she can see the performance previously set.
18. A user can compare goals with another user so that he/she can track the other user's progress for comparison.
19. A user can get a score so that the workout statistics are more easily understandable.
20. A user can upload a message to another user so that he/she can correspond with another user.
21. A user can download messages that have been uploaded by other user so that he/she can correspond with another user.
22. A user can get a local rank so that he/she can compare his/her overall score to all of his/her friends.
23. A user can get a global rank so that he/she can compare himself/herself to all other users.
24. A user can challenge another user so that he/she can initiate a game.

- 25. A user can accept another user's challenge so that he/she can initiate a game.
- 26. A user can add friends to his/her friend list so that he/she can foster social aspects of the game.
- 27. A user can delete a friend so that he/she can no longer see the other user on his/her friend list.
- 28. A user can accept a friend so that the two will both appear on the other's friend list.

## 2.5 Acknowledgements

At this stage of development the expected initial implementation is a Facebook embedded app for web based applications. The game will function as an app existing within the Facebook environment. Players will register their facebook account with the system in order to play the game and will enter workout data to complete a challenge and/or track workout statistics.

Future development will expand the functionalities supported (including wireless connectivity to a HRM) in addition to platform supportability to mobile android smart phones.

Thus, currently we have not yet analyzed the use case descriptions for the mobile implementation. We do not expect for the system to meet all customer requirements until final implementation. Additionally, acceptance testing and new concepts may need to be formulated at a later time.

## 3. Functional Requirements Specification

---

### 3.1 Stakeholders

There are several primary end-users for fitness based social gaming. First, there are the fitness oriented individuals (and their partners) who exercise daily and who may use heart rate training to achieve their personal goals. This category includes athletes of all levels and people who are just old enough to use their local weight-lifting gym and treadmills, but also kids and adults of many ages. The secondary set of end-users are the people who aim to lose weight through exercising or who will use social gaming to stay motivated to achieve their workout goals. Given the low upfront cost to use and play the game.

Other possible proponents of this game may also include fitness experts, coaches and local gyms that may be use the game as a tool to teach healthy training principles via HR monitoring.

As the game matures, further specialization can be tailored to certain sports type such as: marathon (running), cycling and weight-lifting; in order to address certain groups of fitness

### 3.2 Actors and Goals

- a. Player - a registered user of the software;
- b. Opponent - a special case of Play actor, defined relative to the Player who initiated the given use case; this actor can do everything as Player, however, it should be distinguished from the initiating Player to be able to describe the sequence of interactions in use case scenarios;
- c. Visitor - an unregistered user;
- d. Database - records of all the Player' s performance;
- e. Facebook - provider for all social information of Players and Visitors;
- f. Administrator - a special user of the software who have top priority access to the software database

### 3.3 Use Case Descriptions

**UC-1: MonitorExercise-** Allows the Player to get the self monitoring data analyzed.  
Derived from REQ-1a, REQ-1b.

**UC-2: ChallengeFriend-** Allows the Player to challenge an Opponent to play a competition based on their analyzed monitoring data. Derived from REQ-4.

**Initiating Actor:** Player

**Actor's Goal:** To create a new game with a friend

**Participating Actors:** Challenged Player, Database

**UC-3: ChallengeSelf-** Allows the Player to challenge his previous workout performance.

**UC-4: ViewRecord-** Allow the Player to view the ranking of his/ her result against other local users. Derived from REQ-11.

**UC-5: SendMessage-** Allow the Player to send a message to the Opponent while a challenge session is open. Derived from REQ-12.

**UC-6: Register-** Allow a Visitor to register an account for the software with his/ her Facebook profile.  
Derived from REQ-13.

**Initiating Actor:** Player

**Actor's Goal:** To create an account

**Participating Actors:** Database, Facebook

**Precondition:** The system must support account creation.

**Postcondition:** A new account is in created for the user. This account will store player information and game history.

**Flow of Events for Main Success Scenario:**

- 1 → The player navigates to the application Facebook's website and clicks "Get App"
- 2 ← Facebook displays page asking if the player will allow the app to access information.
- 3 → The user clicks "Allow" .
- 4 ← Facebook authenticates the user.
- 5 ← The system signals to the database to create a new account with the above information.
- 6 ← The database creates the user account and signals to the system that the account was created.
- 7 ← The system signals to the user that an account has been created.
- 8 → The user proceeds to registration screen (2.d.1)

**UC-7: PostResult-** Allow a Player to post the result of a challenge on his Facebook wall as well as the Opponent' s Facebook wall.

Derived from REQ-14.

**UC-8: SearchFriend-** Allow a Player search for a friend in the registered users.

Derived from REQ-15.

**UC-9: InviteFriend-** Allow a Player to send an invitation to an unregistered friend on Facebook.

Derived from REQ-16.

**UC-10: ChallengeRandom-** Allow a Player to challenge a random Opponent with a similar ranking from the registered users. Derived from REQ-17.

**UC-11: AccessUserAccount-** Allow Administrator to access a registered user' s account.

Derived from REQ-18.

**UC-12: DeleteUserAccount** - Allow Administrator to de-register a user and delete the user' s account. Derived from REQ-19.

### 3.3.2 User Case Diagrams

The use case diagram is shown in Figure 3-1. Player, Opponent, Visitor and Administrator <<initiate>> all use cases, except for UC-2 (ChallengeFriend), UC-3 (ChallengeOneself) and UC-10 (ChallengeRandom), which are <<extend>> from UC-1 (MonitorExercise) as sub-use-cases. Database and Facebook store monitoring data and social relation data for Player, Opponent and Visitor, so they are <<participate>> in all use cases. Opponent is generated from a Player when the Player chose to run UC-2 (ChallengeFriend).



### 3.3.3 Traceability Matrix

Use cases are designed to meet the system requirements, the traceability matrix in Table 3-1 shows the mapping relation between system requirements and use cases of this software.

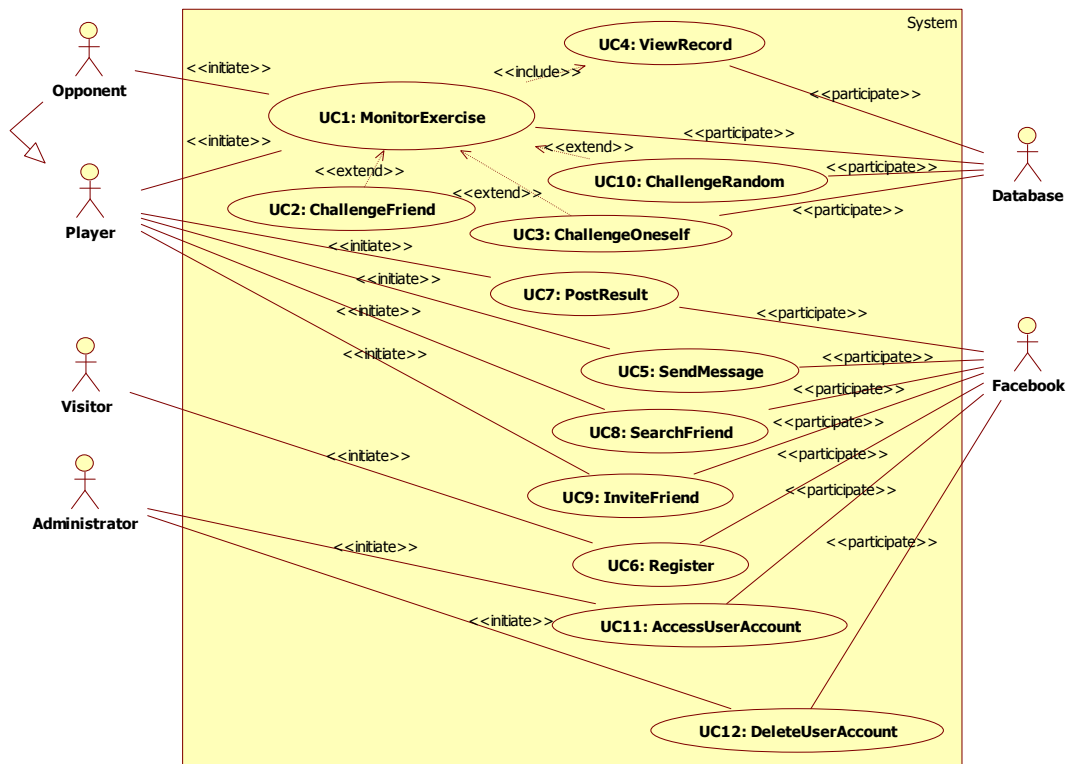


Figure 3-1: Use Case Diagram

| REQ # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
| UC1   | x |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| UC2   |   |   |   | x |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| UC3   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| UC4   |   |   |   |   |   |   |   |   |   |    | x  |    |    |    |    |    |    |    |    |    |
| UC5   |   |   |   |   |   |   |   |   |   |    |    | x  |    |    |    |    |    |    |    |    |
| UC6   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| UC7   |   |   |   |   |   |   |   |   |   |    |    |    |    | x  |    |    |    |    |    |    |
| UC8   |   |   |   |   |   |   |   |   |   |    |    |    |    |    | x  |    |    |    |    |    |
| UC9   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    | x  |    |    |    |    |
| UC10  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    | x  |    |    |    |
| UC11  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | x  |    |    |
| UC12  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    | x  |    |

Table 3-1: Traceability Matrix

### 3.4 System Sequence Diagram

In this section, the system sequence diagrams of some use cases defined above will be illustrated.

#### 3.4.1 UC-1: MonitorExercise

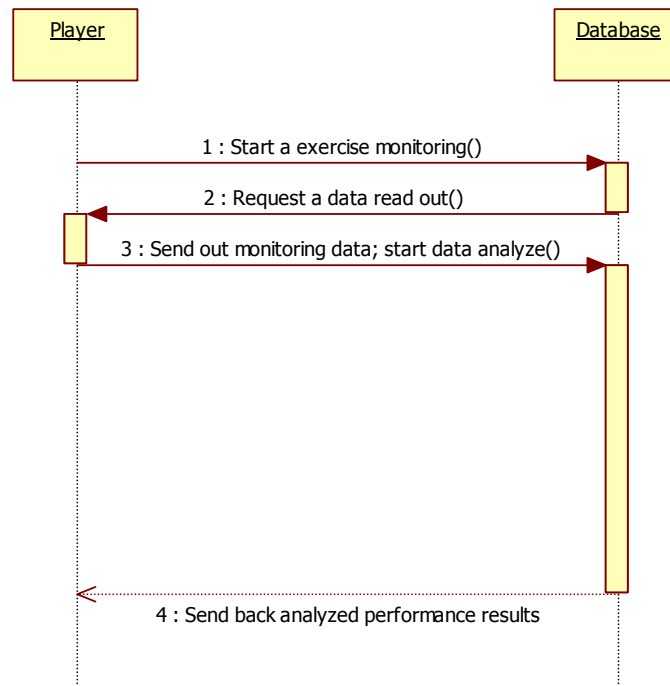


Figure 3-2: Sequence Diagram of UC-1: MonitorExercise

### 3.4.2 UC-2: ChallengeFriend

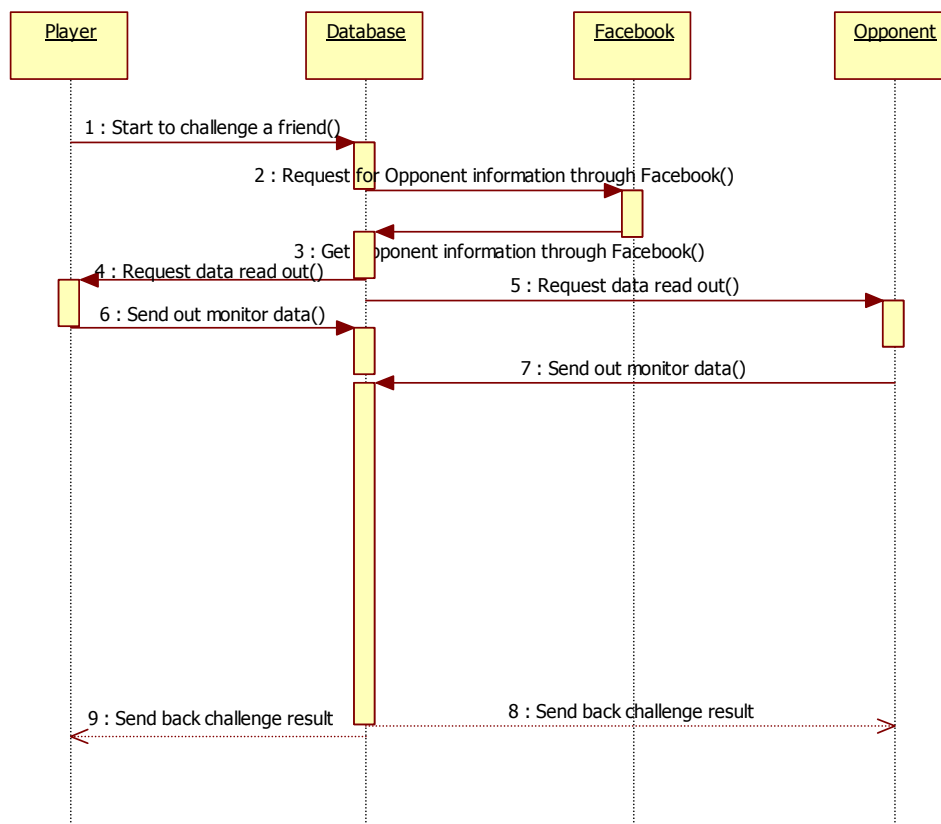


Figure 3-3: Sequence Diagram of UC-2: ChallengeFriend

### 3.4.3 UC-3: ChallengeOneself

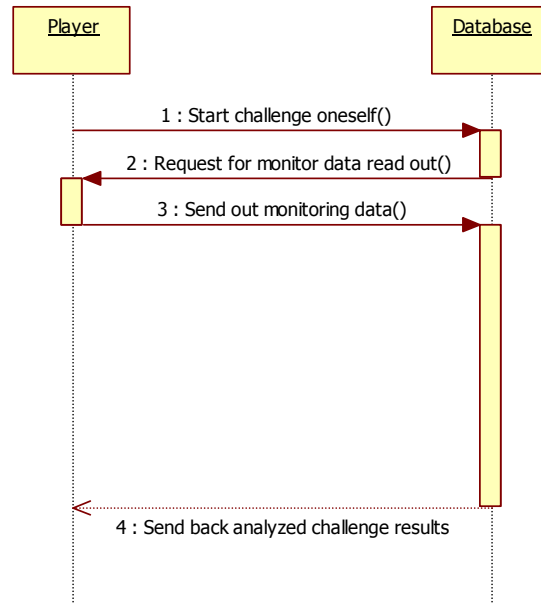


Figure 3-4: Sequence Diagram of UC-3: ChallengeOneself

### 3.4.4 UC-10: ChallengeRandom

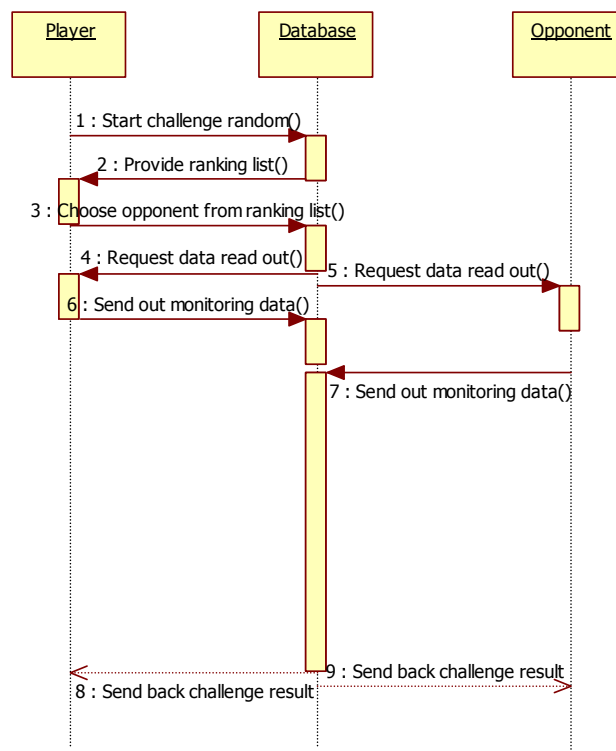
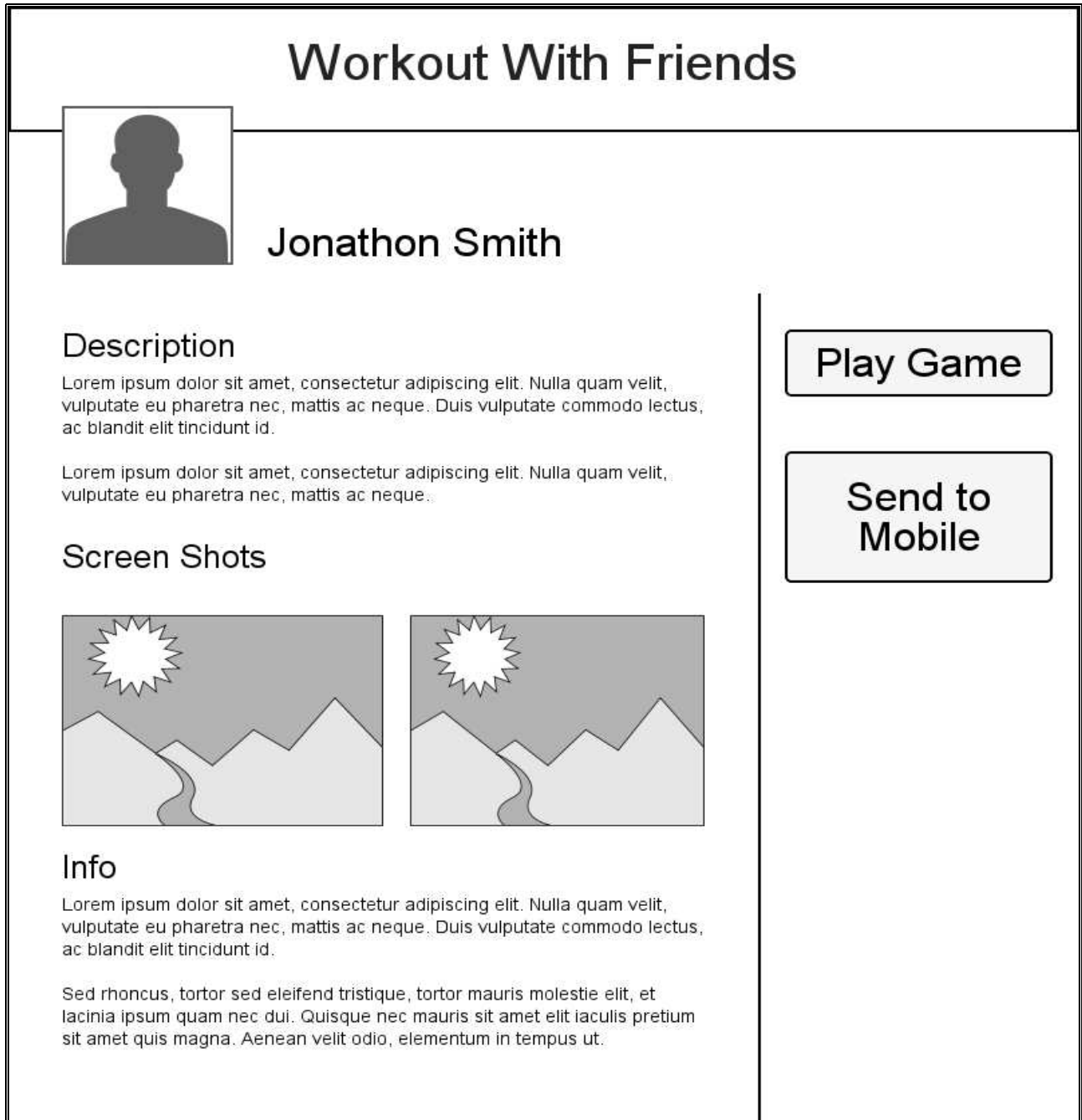


Figure 3-5: Sequence Diagram of UC-10: ChallengeRandom

## 4. User Interface Specifications

### 4.1 User Interface Preliminary Design

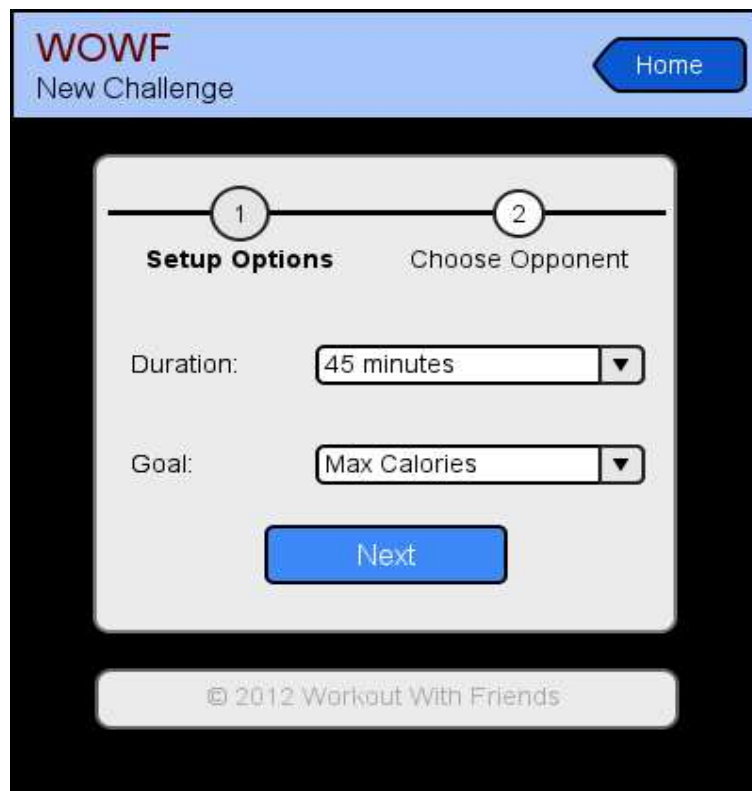
Here are a sample of screen-shots of the current work in progress:



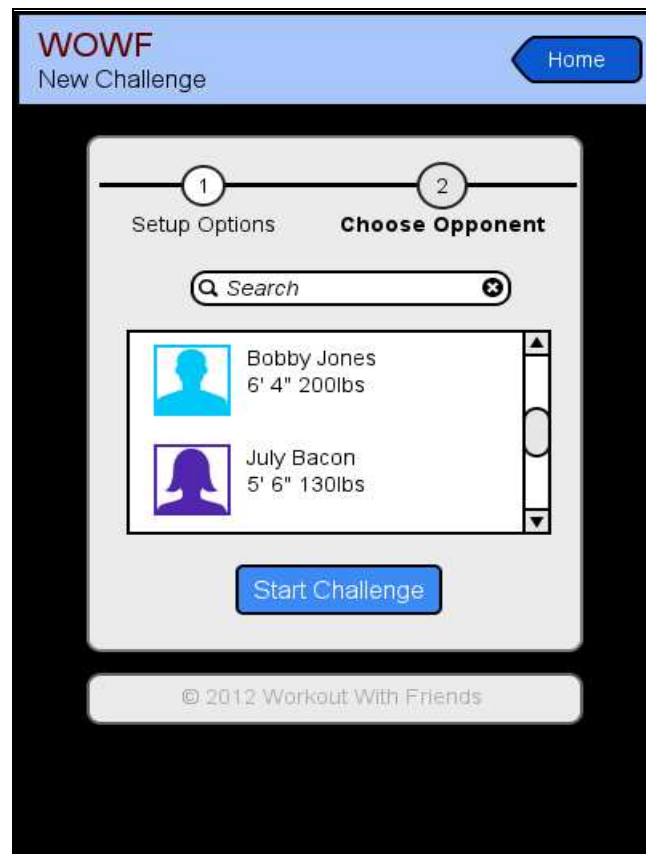
**Facebook App Landing Page Concept (On-Screen Requirement 1)**



Facebook App Landing Page (On-Screen Requirement 1)



New Challenge - Setup Options (On Screen Requirement 2.b.3)



The screenshot shows the 'WOWF' app interface for the 'New Challenge' screen. At the top, there's a blue header with 'WOWF' in red and 'New Challenge' in white. A 'Home' button is in the top right. Below the header, a progress bar shows two steps: '1 Setup Options' and '2 Choose Opponent', with '2' being the active step. A search bar with a magnifying glass icon and a 'Search' label is present. Below the search bar, a list of opponents is shown: 'Bobby Jones' (6' 4" 200lbs) and 'July Bacon' (5' 6" 130lbs). Each entry has a placeholder profile picture. A 'Start Challenge' button is at the bottom of the list. A copyright notice '© 2012 Workout With Friends' is at the very bottom.

WOWF  
New Challenge

Home

1 Setup Options 2 **Choose Opponent**

Search

Bobby Jones  
6' 4" 200lbs

July Bacon  
5' 6" 130lbs

Start Challenge

© 2012 Workout With Friends

New Challenge - Choose Opponent (On Screen Requirement 2.b.2)



The screenshot shows the 'WOWF' app interface for the 'Manage Account' screen. At the top, there's a blue header with 'WOWF' in red and 'Manage Account' in white. A 'Home' button is in the top right. Below the header, a form is displayed with fields for: 'Name' (John Doe), 'Age' (33), 'Gender' (Male), 'Height' (5 ft 10 in), 'Weight' (23), and 'Resting HR' (88). Each field has a corresponding input box. A copyright notice '© 2012 Workout With Friends' is at the bottom.

WOWF  
Manage Account

Home

Name: John Doe

Age: 33

Gender: Male

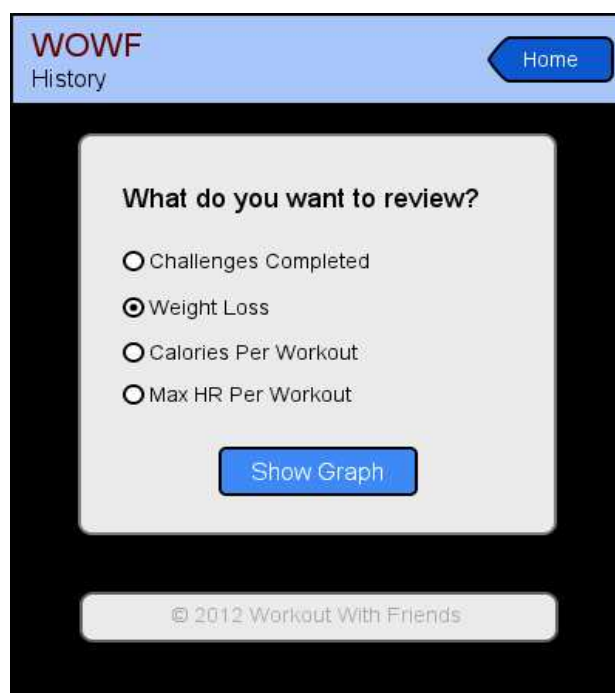
Height: 5 ft 10 in

Weight: 23

Resting HR: 88

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Account Manage (On Screen Requirement 2.i)



**Challenge History (On-Screen Requirement 2.j)**

## 4.2 User Effort Estimation

Regarding challenge set up, the game takes an estimated 5 minutes to set up from scratch. In total, there are (9) screens from initial login and registration to challenge set up:

- 1) Login with facebook account
- 2) Account Registration Part 1 (Instructions and how to play)
- 3) Account Registration Part 2 (Disclaimers and Permissions)
- 4) Account Registration Part 3 (User information)
- 5) Home Screen
- 6) Set up Challenge - Search Facebook Friends List
- 7) Select Friend(s) and send invitation
- 8) Challenge Setup Screen (options setup)
- 9) Manual start / timed start (warm-up)

However, once a user is registered subsequent challenge invitations will take substantially less time to set up. In total there are (5) screens once a user is already registered.

- 1) Home Screen
- 2) Set up Challenge - Search Facebook Friends List
- 3) Select Friend(s) and send invitation
- 4) Challenge Setup Screen (options setup)
- 5) Manual start / timed start (warm-up)

This does not yet meet the customer requirement of challenge set up in 2 “clicks” (screens) or less.

## 5. Domain Analysis

### 5.1 Domain Model

#### 5.1.1 Concept Definitions

To analysis the domain model, we first derive domain model concepts and corresponding responsibilities from the formerly defined system use cases. Table 5-1 lists all the domain model concepts and corresponding responsibilities.

| Responsibility  | Type | Concept                       | Use Case                   |
|---|------|-------------------------------|----------------------------|
| Load data from HRM  | D    | MonitoringDataReader          | UC-1: monitor exercise     |
| Store data into Database  | D    | MonitoringDataStorer          |                            |
| .   | D    | MonitoringDataAnalyser        |                            |
| Compare analyzed results between Player and its Opponent.   | D    | FriendChallengeReferee        | UC-2: challenge friend     |
| Compare analyzed results between Player and his/ her former record.   | D    | OneselfChallengeReferee       | UC-3: challenge oneself    |
| Show challenge result.  | D    | RecordViewer                  | UC-4: View record          |
| Send a message to its Opponent during a challenge.  | D    | MessageSender                 | UC-5: send message         |
| Allow Visitor to register through a Facebook account.   | D    | FacebookRegisterInterface     | UC-6: register             |
| Allow Player/ Opponent post the challenge result on Facebook wall.  | D    | FacebookPostInterface         | UC-7: Post result          |
| Allow Player to search for a friend through Facebook.   | D    | FacebookFriendSearchInterface | UC-8: Search friend        |
| Allow Player to invite a friend to join the App through Facebook.   | D    | FacebookFriendInviteInterface | UC-9: Invite friend        |
| Provide a ranked list of all the Player' s results from Database, as well as the Player' s ranking in the list. | D    | PerformanceRanker             | UC-10: Challenge random    |
| Allow Player to choose a random Player with certain performance rank to challenge.                              |      | RandomChallengeSelector       |                            |
| Compare analyzed results between Player and another random Player with certain performance rank.                | D    | RandomChallengeRefree         |                            |
| Allow Administrator to check user account information.  | D    | UserAccountViewer             | UC-11: Access user account |
| Allow Administrator to delete invalid user account.   | D    | UserAccountOrganizor          | UC-12: Delete user account |

Table 5-1: Domain Concept Definition

#### 5.1.2 Association definitions

Some of the concepts defined above as domain concepts have to work in certain pattern to finish some target, Table 5-2 gives the corresponding association definitions based on the defined domain concepts.



| Concept Pair                                     | Association Description   | Association Name          |
|--|---|---------------------------|
| MonitoringDataReader← → MonitoringDataStorer     | MonitoringDataStorer store down-sampled data read out from MonitoringDataReader to Database.                | Data read & save          |
| FriendChallengeRefree← → MonitoringDataAnalyzer  | FriendChallengeRefree give the comparison result based on the output of MonitoringDataAnalyzer.             | Analyze and compare       |
| OneselfChallengeRefree← → MonitoringDataAnalyzer | OneselfChallengeRefree give the comparison result based on the output of MonitoringDataAnalyzer.            | Analyze and compare       |
| RecordViewer← → MonitoringDataAnalyzer           | RecordViewer shows the analyzed results got from MonitoringDataAnalyzer.                                    | Show analyzed data        |
| PerformanceRanker← → RandomChallengeSelector     | RandomChallengeSelector allow Player to choose randomly based on the rank list PerformanceRanker gives out. | Choose from analyzed data |
| RandomChallengeRefree← → MonitoringDataAnalyzer  | RandomChallengeRefree give the comparison result based on the output of MonitoringDataAnalyzer.             | Analyze and compare       |

Table 5-2: Association Definition

### 5.1.3 Attribute definitions

Among the defined concepts, some concepts share the same attribute, and only different from each other as they have different operands. These concepts are listed in Table 5-3.

| Concept                       | Attributes              | Attribute Description   |
|-------------------------------|-------------------------|---|
| MonitoringDataReader          | Data access and storage | Read in and store monitoring data from the device.                |
| MonitoringDataStorer          |                         |   |
| MonitoringDataAnalyser        | Data analyzer           | Analyze data.   |
| PerformanceRanker             |                         |   |
| FriendChallengeRefree         | Challenge referee       | Compare the performance between from different users.             |
| OneselfChallengeRefree        |                         |   |
| RandomChallengeRefree         |                         |   |
| RecordViewer                  | User interface          | Store user input to the system, or show analyzed result to user.  |
| MessageSender                 |                         |   |
| RandomChallengeSelector       |                         |   |
| FacebookRegisterInterface     | Facebook interface      | Communicate with Facebook database.                               |
| FacebookPostInterface         |                         |   |
| FacebookFriendSearchInterface |                         |   |
| FacebookFriendInviteInterface |                         |   |
| UserAccountViewer             | User account interface  | Allow Administrator have access and control of the user accounts. |
| UserAccountOrganizer          |                         |   |

Table 5-3: Attribute Definition

### 5.1.4 Traceability matrix

| UC   | Domain Concept       |                      |                        |                       |                        |              |               |                           |                       |                               |                               |                   |                         |                       |                   |                      |
|------|----------------------|----------------------|------------------------|-----------------------|------------------------|--------------|---------------|---------------------------|-----------------------|-------------------------------|-------------------------------|-------------------|-------------------------|-----------------------|-------------------|----------------------|
|      | MonitoringDataReader | MonitoringDataStorer | MonitoringDataAnalyser | FriendChallengeRefree | OneselfChallengeRefree | RecordViewer | MessageSender | FacebookRegisterInterface | FacebookPostInterface | FacebookFriendSearchInterface | FacebookFriendInviteInterface | PerformanceRanker | RandomChallengeSelector | RandomChallengeRefree | UserAccountViewer | UserAccountOrganizer |
| UC1  | x                    | x                    | x                      |                       |                        |              |               |                           |                       |                               |                               |                   |                         |                       |                   |                      |
| UC2  |                      |                      |                        | x                     |                        |              |               |                           |                       |                               |                               |                   |                         |                       |                   |                      |
| UC3  |                      |                      |                        |                       | x                      |              |               |                           |                       |                               |                               |                   |                         |                       |                   |                      |
| UC4  |                      |                      |                        |                       |                        | x            |               |                           |                       |                               |                               |                   |                         |                       |                   |                      |
| UC5  |                      |                      |                        |                       |                        |              | x             |                           |                       |                               |                               |                   |                         |                       |                   |                      |
| UC6  |                      |                      |                        |                       |                        |              |               | x                         |                       |                               |                               |                   |                         |                       |                   |                      |
| UC7  |                      |                      |                        |                       |                        |              |               |                           | x                     |                               |                               |                   |                         |                       |                   |                      |
| UC8  |                      |                      |                        |                       |                        |              |               |                           |                       | x                             |                               |                   |                         |                       |                   |                      |
| UC9  |                      |                      |                        |                       |                        |              |               |                           |                       |                               | x                             |                   |                         |                       |                   |                      |
| UC10 |                      |                      |                        |                       |                        |              |               |                           |                       |                               |                               | x                 | x                       | x                     |                   |                      |
| UC11 |                      |                      |                        |                       |                        |              |               |                           |                       |                               |                               |                   |                         |                       | x                 |                      |
| UC12 |                      |                      |                        |                       |                        |              |               |                           |                       |                               |                               |                   |                         |                       |                   | X                    |

Table 5-4: Traceability Matrix

## 5.2 System Operation Contracts

### MonitorExercise

Preconditions:

- User has an account
- User has completed a workout

Postconditions:

- The associated challenge is updated accordingly

### ChallengeFriend

Preconditions:

- User has an account
- Player to be challenged has an account

Postconditions:

- The game is created and made available to both users

### ChallengeOneself

Preconditions:

- User has an account

Postconditions:

- The game is created and made available to the user

### **ViewRecord**

Preconditions:

- User has an account

Postconditions:

None

### **SendMessage**

Preconditions:

- User has an account
- Player to receive message has an account
- A game has been created between the two players

Postconditions:

- The message is visible to both users

### **Register**

Preconditions:

- User has a Facebook account

Postconditions:

- User is stored in the database

### **PostResult**

Preconditions:

- A game has been completed between the two users

Postconditions:

NONE

### **SearchFriend**

Derived from REQ-15.

Preconditions:

- User has an account

Postconditions:

NONE

### **InviteFriend**

Preconditions:

- User has an account
- Invitee has a Facebook account.

Postconditions:

NONE

### **ChallengeRandom**

Preconditions:

- User has an account
- Player to be challenged has an account

Postconditions:

- The game is created and made available to both users

### **AccessUserAccount**

Derived from REQ-18.

Preconditions:

- Account Administrator is logged in
- Player to be challenged has an account

Postconditions:  
NONE

### DeleteUserAccount

Preconditions:

- Account Administrator is logged in
- Player to be deleted has an account

Postconditions:

- Deleted user data is no longer in the database

## 5.3 Mathematical Model

### 5.3.1 Scoring Algorithm

The workout intensity score is computed based on the weighted score of three different inputs: workout time spent in HRZ 5, HRZ 4, and calories burned. For the simplistic model:

1.  $Score_1$  : Time (in seconds) spent in heart rate zone 5 (90-100% of target max HR) x factor of 10 (Weighting = 40%)
  - Example: 1:45 min = 105 seconds x 10 = 1050
  - $Score_1 = 1050 \times 40\% = 420$  points
2.  $Score_2$  : Number of calories burned - (Weighting = 25%)
  - Example: 850 calories
  - $Score_2 = 850 \times 25\% = 212.5$  points
3.  $Score_3$  : Time (in seconds) spent in heart rate zone 4 (80-89% of target max HR) - (Weighting = 35%)
  - Example: 21:45 min = 1305 seconds
  - $Score_3 = 1305 \times 35\% = 456.75$  points
4. Final Score =  $Score_1 + Score_2 + Score_3$ 
  - Example: Final Score =  $420 + 212.5 + 456.75 = 1089.25$  points

Based on this model, when calories and HRZ 4 and 5 are known, the calculation is straightforward and the process to determine a winner is simple.

In the embedded Facebook web-app case, where no specific calories burned and HRZ are known, we will use a formula to calculate the calories burned. The starting conditions (known variables) are: gender, weight, age, exercise duration and average heart rate of the workout. The equations derived by LR Keytel, JH Goedecke, TD Noakes, H Hiiloskorpi, R Laukkanen, L van der Merwe, and EV Lambert for their study titled "Prediction of energy expenditure from heart rate monitoring during submaximal exercise" are shown below:<sup>11</sup>

$$\Rightarrow \text{Male: } C = ((-55.0969 + (0.6309 \times HR) + (0.1988 \times W) + (0.2017 \times A))/4.184) \times 60 \times T$$

$$\Rightarrow \text{Female: } C = ((-20.4022 + (0.4472 \times HR) - (0.1263 \times W) + (0.074 \times A))/4.184) \times 60 \times T$$

Where:

C = Calories burned

HR = Heart rate (in beats/minute)

W = Weight (in kilograms)

A = Age (in years)

T = Exercise duration time (in hours)

Therefore, using the example from section 1.7, the following represents the known variables:

HR = Heart rate (in bpm - beats/minute) = 169 bpm

W = Weight (in kilograms) = 160 lbs / 2.2047 (lbs/kg) = 72.57 kg

A = Age (in years) = 25

T = Exercise duration time (in hours) = 44 min - 4 warmup = 40 min / 60 (min/hr) = .66 hr

$C_{\text{calculated}} = 666.9$  calories

$C_{\text{Motoactv}} = 663$  calories

$\Delta$  Difference = 0.6%

It is worth noting that had the 4 minutes minutes of warmup (where no strenuous exercise was factored) been factored into the calories burned calculation, there would be 10.7% difference between the calculated Calories burned and the calories burned measured by MotoACTV.

This shows that such calculations are susceptible to “external noise” depending on how the data is compiled and subsequently calculated. This is the reason why calories burned has the lowest weighting factor when determining the workout intensity score for Workout with Friends.



## 6. Project Management

### 6.1 Plan of Work

| Task \ Week               | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
|---------------------------|----|----|----|----|----|----|----|----|----|----|----|
| Website Maintenance       |    |    |    |    |    |    |    |    |    |    |    |
| Web Interface Design      |    |    |    |    |    |    |    |    |    |    |    |
| Mobile Interface Design   |    |    |    |    |    |    |    |    |    |    |    |
| Database Structure Design |    |    |    |    |    |    |    |    |    |    |    |
| Algorithm Design          |    |    |    |    |    |    |    |    |    |    |    |
| Algorithm Test            |    |    |    |    |    |    |    |    |    |    |    |
| Debugging                 |    |    |    |    |    |    |    |    |    |    |    |
| System Test               |    |    |    |    |    |    |    |    |    |    |    |
| Report Drafting           |    |    |    |    |    |    |    |    |    |    |    |
| Report 1                  |    |    |    |    |    |    |    |    |    |    |    |
| Demo 1                    |    |    |    |    |    |    |    |    |    |    |    |
| Report 2                  |    |    |    |    |    |    |    |    |    |    |    |
| Report 3                  |    |    |    |    |    |    |    |    |    |    |    |
| Demo 2                    |    |    |    |    |    |    |    |    |    |    |    |
| Archive Documentation     |    |    |    |    |    |    |    |    |    |    |    |

### 6.2 Next Steps & Feedback

Currently, more work needs to be done implementing the framework for the facebook app. Additionally more experimental work needs to be done regarding the scoring algorithm. The scoring must be fair, and even though there is a potential for cheating in the web-based implementation (when players report incorrect scores) there is also the possibility that even a correct score may not reproduce reliable results. This needs to be investigated and we will only get to it once the basic foundation framework is setup.

Regarding difficulties, it has been very difficult to conduct effective group brainstorming and discussion, particularly its been difficult to moderate discussions at times. Consolidating everyone's schedule to hold meetings has been near impossible. There hasn't been a single meeting where all group members were present. Many of the times, meetings have been limited to online Skyping. These difficulties make it extremely tough to keep everyone on the same page.

Moving forward, feature ownership will be divided among sub-groups of 2 or 3. The major features (total of 11) include: Facebook web-app framework, messaging between users, account Management, Posting results on facebook wall, scoring Algorithm, Facebook Android migration, Wireless HRM connectivity, Integration Testing, Documentation Maintenance (coordinator), Website Maintenance (coordinator) and Graphics Design.

One thought to experiment is to create "sprint" goals for SW development in accordance with Agile practices. Also, the teams could rotate ownership every 2 weeks for a total of 4 rotations until the last demo and final archive documentation in wk50.

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