

FollowThrough: Requirements Document - Revision 3

Djordje Petrovic
1306258
petrod@mcmaster.ca

George Plukov
1316246
plukovga@mcmaster.ca

Zayan Imtiaz
1152665
imtiaz3@mcmaster.ca

Philip Habib
1310455
habibp@mcmaster.ca

April 2017

CONTENTS

1	PROJECT INFORMATION	5
1.1	Preface	5
1.2	Background of the project	5
1.3	Motivation	5
1.4	Goal	5
1.5	Naming Conventions and Definitions	6
1.5.1	Definition of all Terms	6
1.5.2	Data Dictionary	6
1.6	Relevant Facts and Assumptions	6
1.6.1	Facts	6
1.6.2	Assumptions	6
2	THE CLIENT, THE CUSTOMER, AND OTHER STAKEHOLDERS	7
2.1	The Client	7
2.2	The Customers	7
2.3	Other Stakeholders	7
3	USERS OF FOLLOWTHROUGH	8
3.1	The Hands-On Users	8
3.2	Priorities Assigned to Users	8
3.2.1	Needs of the Primary User	8
3.3	User Participation	8
3.4	Maintenance Users	8
4	PROJECT CONSTRAINTS	9
4.1	Mandated Constraints	9
4.1.1	Solution Constraints	9
4.2	Implementation Environment	10
4.3	Operation Environment	10
4.4	Partner of Collaborative Applications	10
4.5	Off-the-Shelf Hardware/Software	10
4.6	Schedule Constraints	10
4.7	Budget Constraints	10
5	FUNCTIONAL REQUIREMENTS	11
5.1	The Scope of the Work	11
5.1.1	The Current Situation	11
5.1.2	The Context of the Work	11
5.1.3	Work Partitioning	12
5.2	The Scope of the Product	12
5.2.1	Product Use Case	12
5.3	Functional and Data Requirements	13
5.3.1	Functional Requirements	13
5.3.2	Data Requirements	14
6	NON-FUNCTIONAL REQUIREMENTS	15
6.1	Look and Feel Requirements	15

6.1.1	Appearance Requirements	15
6.1.2	Style Requirements	15
6.2	Usability and Humanity Requirements	15
6.2.1	Ease of Use Requirements	15
6.2.2	Personalization and Internationalization Requirements	15
6.2.3	Learning Requirements	15
6.2.4	Understandability and Politeness Requirements	15
6.2.5	Accessibility Requirements	16
6.3	Performance Requirements	16
6.3.1	Speed and Latency Requirements	16
6.3.2	Safety-Critical Requirements	16
6.3.3	Precision or Accuracy Requirements	16
6.3.4	Reliability and Availability Requirements	16
6.3.5	Robustness Requirements	16
6.3.6	Capacity Requirements	16
6.3.7	Scalability or Extensibility Requirements	16
6.3.8	Longevity Requirements	17
6.4	Operational and Environmental Requirements	17
6.4.1	Expected Physical Environment	17
6.4.2	Requirements for Interfacing with Adjacent Systems	17
6.4.3	Productization Requirements	17
6.4.4	Release Requirements	17
6.5	Maintainability and Support Requirements	17
6.5.1	Maintenance Requirements	17
6.5.2	Supportability Requirements	17
6.5.3	Adaptability Requirements	17
6.6	Security Requirements	17
6.6.1	Access Requirements	17
6.6.2	Integrity Requirements	18
6.6.3	Privacy Requirements	18
6.6.4	Audit Requirements	18
6.6.5	Immunity Requirements	18
6.7	Cultural and Political Requirements	18
6.7.1	Cultural Requirements	18
6.7.2	Political Requirements	18
6.8	Legal Requirements	18
6.8.1	Compliance Requirements	18
6.8.2	Standards Requirements	18
7	SYSTEM FEASIBILITY AND PROJECT ISSUES	19
7.1	Open Issues	19
7.2	Off the Shelf Solutions	19
7.3	Economic	19
7.3.1	Costs	19
7.3.2	Benefits	20
7.3.3	Analysis	20
7.4	Technical Feasibility	20
7.4.1	Method of production	20

7.4.2	Production technique	20
7.4.3	Project requirements	20
7.4.4	Project Location	21
7.5	User Documentation and Training	21
7.6	Alternatives	21

Table 1: Revision Chart

Revision Number	Revision Date	Description
1	January 4th 2017	Large general update.
2	April 4th 2017	Small update to FR numbering.
3	April 8th 2017	Added a FR.

PROJECT INFORMATION

1.1 PREFACE

This Requirements Analysis is done following the Volere template.

1.2 BACKGROUND OF THE PROJECT

FollowThrough is to be a multi-platform system which can provide basketball players with real-time feedback on how to improve their shooting form. The hardware/software involved is to film the user while practicing, processing the information on the spot and returning usable advice which can change the players game for the better. The information is afterwards sent to the cloud where users may review their advice at home. It will also be designed to keep track of score for the users convenience.

Currently there is no affordable method for an everyday player to have professional assistance in improving their shot form. Follow through hopes to be provide basketball player with a cheap and accurate alternative to expensive coaching and training camps.

Ideally the project will be able to function on any laptop camera or web cam.

1.3 MOTIVATION

When practicing alone on the basketball court, players should be able to receive real-time feedback so that they know how to improve their skills. In most situations if a player is looking for somebody to assist them in perfecting their form, they will bring another person with them so that they may assess the player and provide suggestions as to how to fix any problems in their technique. Obviously this is not an optimal solution. Not everyone is able to have someone advising them at all times. Coaches are a possibility but can be extremely expensive and availability again becomes an issue.

1.4 GOAL

The aim of FollowThrough is to eliminate the need for shot assistance while on the basketball court. FollowThrough will be software that works with any camera and laptop to provide real time advice and feedback to basketball players right on the court. FollowThrough will also save the analysis of the shot to the cloud for later review.

1.5 NAMING CONVENTIONS AND DEFINITIONS

1.5.1 *Definition of all Terms*

- **FollowThrough:** The name of the product at hand.
- **Arduino:** A simple micro-processing unit that can be programmed to complete various tasks.
- **OpenCV:** An open source computer vision and machine learning software library.

1.5.2 *Data Dictionary*

- *Not Applicable.*

1.6 RELEVANT FACTS AND ASSUMPTIONS

1.6.1 *Facts*

- A camera is required to use this software.
- The hardware associated with counting score is optional for the user.

1.6.2 *Assumptions*

- Users have a rudimentary knowledge of how to operate a computer.
- Users have a camera built into their device or an external usb web-cam.
- Users are able to follow instructions to setup and calibrate the device.

THE CLIENT, THE CUSTOMER, AND OTHER STAKEHOLDERS

2.1 THE CLIENT

- *Not Applicable*

2.2 THE CUSTOMERS

- Basketball players of any skill level.
- Coaches, teams and schools
- Programmers interested in a practical application of image recognition.

2.3 OTHER STAKEHOLDERS

- Basketball Coaches
- Project Supervisors
- Developers and Testers

USERS OF FOLLOWTHROUGH

3.1 THE HANDS-ON USERS

Anybody with both a basic understanding of Basketball and computers of any operating system.

3.2 PRIORITIES ASSIGNED TO USERS

Primary Users: Regular Basketball players

Secondary Users: Basketball coaches

Tertiary Users: Developers, testers and project supervisors

3.2.1 *Needs of the Primary User*

- Eliminate the need of other people being on the court to provide feedback.
- Provide real time advice to growing basketball players.
- To improve basketball shot form and shot technique.
- Works with many camera and laptop.
- Save data to be reviewed at a later date.

3.3 USER PARTICIPATION

- Users are responsible for setting up the hardware in the appropriate locations
- Users are responsible for creating an account where the information will be stored

3.4 MAINTENANCE USERS

- The developers of the project
- The testers of the project

PROJECT CONSTRAINTS

4.1 MANDATED CONSTRAINTS

4.1.1 *Solution Constraints*

Description: FollowThrough is to be very easy to set up. Setting up the physical portions of the product will be easy because of well thought out instructions to avoid confusion.

Rationale: The product has to be easy to use.

Fit Criterion: The product is to have minimal requirements for set-up.

Description: FollowThrough will provide both auditory and visual feedback to the user.

Rationale: This will increase the accessibility of the product and open it up to for use to people with disabilities and even further assist both auditory and visual learners.

Fit Criterion: The output will be extensively tested and approved before release.

Description: The user manual will be user friendly.

Rationale: This is quite important to ensure that a user will thoroughly understand how to set up the product, which will make the product easier to use.

Fit Criterion: The manual will be tested extensively by a number of people.

Description: The product will run using any modern laptop camera.

Rationale: This will allow our user base to be quite large and inclusive.

Fit Criterion: This will be ensured by using a variety of different laptops during the testing stages.

Description: The product will be able to be used on a variety of operating systems such as Windows 7, 8, 10, Mac OSX etc.

Rationale: The product being cross-platform will make it easier for a large market of people to access.

Fit Criterion: The product will be tested on various platforms to ensure compatibility.

Description: The product will upload all the gathered information in a readable form to a cloud database and the user may access this later to review their progress.

Rationale: This will allow users to analyze and utilize the data tracked.

Fit Criterion: A page will be developed and tested to ensure it works fluidly.

4.2 IMPLEMENTATION ENVIRONMENT

- The tracking software will be written in OpenCV.
- The web interface will be written in a combination of PHP, HTML, CSS, and javascript.
- The camera will be the computers default webcam.
- The remaining hardware will be on the Arduino.

4.3 OPERATION ENVIRONMENT

- A basketball court.
- The users home.

4.4 PARTNER OF COLLABORATIVE APPLICATIONS

- *Not Applicable.*

4.5 OFF-THE-SHELF HARDWARE/SOFTWARE

- A built in laptop camera.
- The general interface of whichever operating system is being used.

4.6 SCHEDULE CONSTRAINTS

- Proof of Concept Demonstration November 21st25th 2016.
- Demonstration Revision o February 13th17th 2017.
- Final Demonstration Exam Period 2017.

4.7 BUDGET CONSTRAINTS

- Budget constraints can be seen in the system feasibility section, under costs and benefits.

FUNCTIONAL REQUIREMENTS

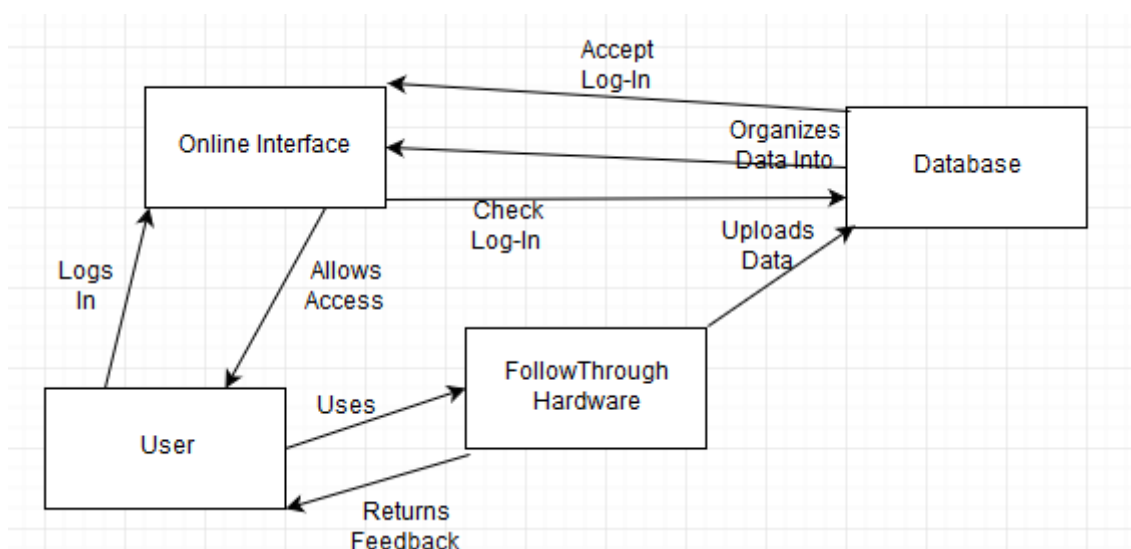
5.1 THE SCOPE OF THE WORK

5.1.1 *The Current Situation*

When practicing alone on the basketball court players should be able to receive real-time feedback so that they know how to improve their skills. In most situations if a player is looking for somebody to assist them in perfecting their form, they will bring another person onto the court with them so that they may assess the player and provide suggestions as to how to fix any problems in their technique. Obviously there is a major question of unavailability of the people you can have advising you. What if your person of choice has no time during the periods when you choose to train basketball?

The solution for the proposed problem is quite a simple one; what if there was a tool that could give you real time diagnostic results whenever you plan to practice? FollowThrough is the tool to do exactly this. The device would be optimally set up in a position where it can track your movements and how they correspond to the quality of your shots. It would examine the arch of your shots and depending on the location you are throwing the ball will tell you how much higher or lower it needs to be or how much more or less force you need to put to the shot.

5.1.2 *The Context of the Work*

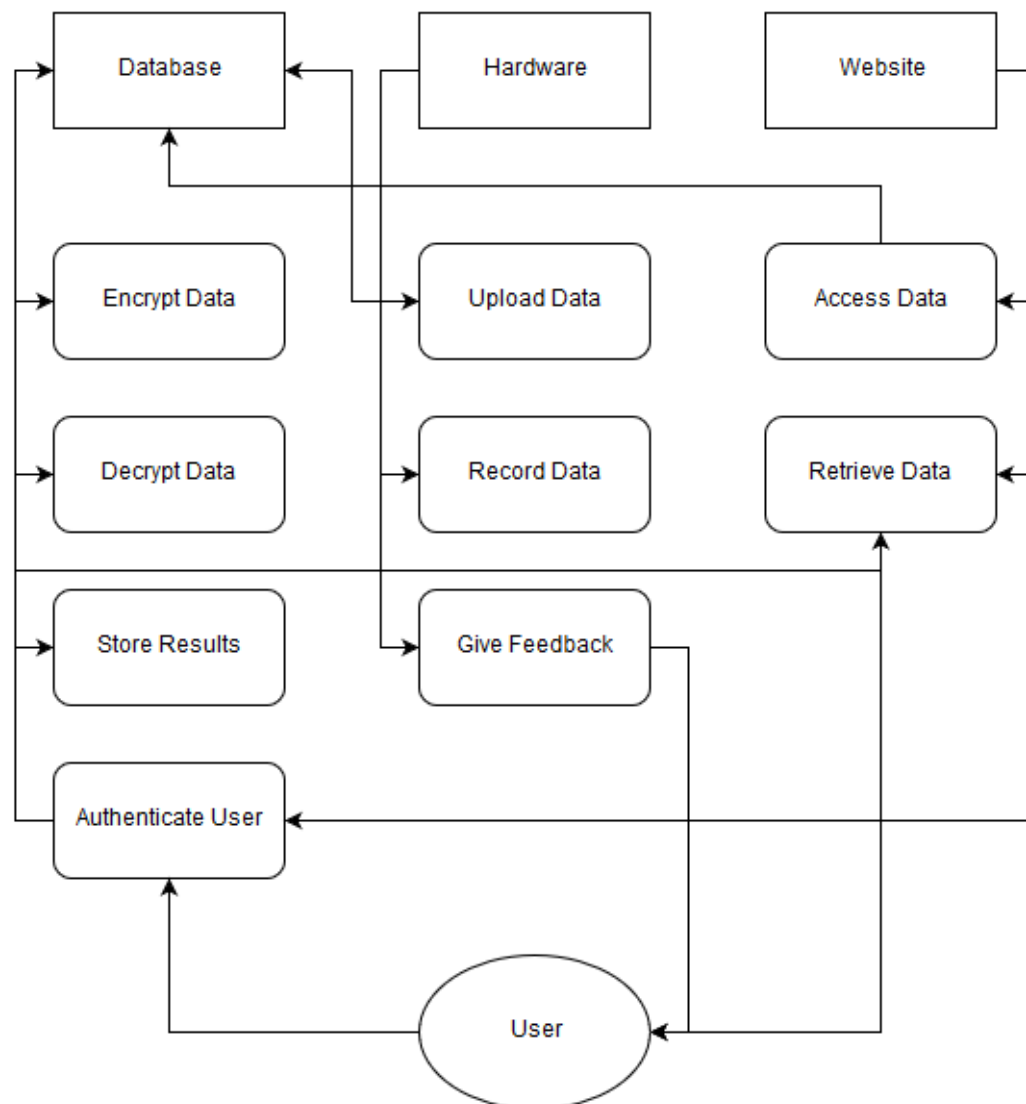


5.1.3 Work Partitioning

Event Name	Input/Output	Summary
Online Interface	Check Log-In(out)	Verifying user identity
Online Interface	Accept Log-In(in)	Giving the user access
FollowThrough	Uses(in)	User starts using the product
FollowThrough	Returns Feedback(out)	User receives feedback
Database	Uploads Data(in)	Data is uploaded into the database
Online Interface	Logs In(in)	User tries to access interface
Online Interface	Allows Access(out)	User enters interface

5.2 THE SCOPE OF THE PRODUCT

5.2.1 Product Use Case



5.3 FUNCTIONAL AND DATA REQUIREMENTS

5.3.1 *Functional Requirements*

Requirement: 1. Encrypt Data

Description: The database must encrypt all data.

Rationale: This is to keep all of the user's data safe.

Fit Criterion: Incorrect or fake user name/password combinations cannot work.

Requirement: 2. Decrypt Data

Description: The database must decrypt all encrypted data.

Rationale: This is to ensure that all inputted data is readable.

Fit Criterion: All correct login information will be accepted.

Requirement: 3. Store Results

Description: All the results gathered by the hardware are stored in the database.

Rationale: This is done so that the user may review their feedback.

Fit Criterion: The correct information, and all the information is returned.

Requirement: 4. Authenticate User

Description: The user can view only their own information.

Rationale: This is to enforce security measures.

Fit Criterion: The user can only see their own information.

Requirement: 5. Upload Data

Description: All the gathered data is to be uploaded to the database.

Rationale: This is done so that the user may review their information at a later time.

Fit Criterion: All the information is given.

Requirement: 6. Record Data

Description: All the data will be gathered and recorded correctly.

Rationale: This will ensure that the user is given the right information.

Fit Criterion: The database contains all the correct information.

Requirement: 7. Give Feedback

Description: The user will receive real time feedback while on the court.

Rationale: This requirements is the basic idea of the entire project. The user should be able to use this feedback to improve their form right then and there.

Fit Criterion: The user receives real time feedback.

Requirement: 8. Access Data

Description: All the data can be accessed from the database at a later time.

Rationale: This allows the user to review the data they gathered following the real time feedback.

Fit Criterion: The data is accessible by the user.

Requirement: 9. Retrieve Data

Description: The website pulls all the necessary data from the database.

Rationale: This will ensure that there isn't an excessive amount of data overloading the user's interface.

Fit Criterion: Only the necessary information is retrieved.

Requirement: 10. Hold Connection

Description: The application will hold a steady wireless connection between all hardware.

Rationale: This will ensure that all the hardware and software can work in unison, and also that many other requirements work.

Fit Criterion: The hardware remains connected for as long as necessary.

5.3.2 *Data Requirements*

- The data will always be saved correctly and without discrepancy.
- The data will be secure from malicious intent.
- The data can only be accessed by the people who are authenticated to do so.
- Only the necessary data will ever be revealed.

NON-FUNCTIONAL REQUIREMENTS

6.1 LOOK AND FEEL REQUIREMENTS

6.1.1 *Appearance Requirements*

The graphical interface designed to provide the user with feedback will be very simple to understand. It will be designed to display properly on all modern web browsers.

6.1.2 *Style Requirements*

Stylistically the software and hardware will not be obtrusive to the user in any sense.

6.2 USABILITY AND HUMANITY REQUIREMENTS

6.2.1 *Ease of Use Requirements*

A guide will be provided that will instruct the user on how to set up the application. For the web application where the data will be sent, the interface will be intuitive so that the user will be visually guided to relevant information.

6.2.2 *Personalization and Internationalization Requirements*

FollowThrough will have very few elements in which translation is needed. Basketball statistics are referenced in similar manners all over the world, mostly in English.

6.2.3 *Learning Requirements*

The only part that requires learning in the case of this product would be setting up the hardware in appropriate positions. That will be accommodated for by giving the user a guide. The rest of the program is fairly straight forward and requires nothing more than common sense.

6.2.4 *Understandability and Politeness Requirements*

This product will use terminology that is friendly for any user and on top of that will also hide any unnecessary processes from the user to avoid confusion.

6.2.5 *Accessibility Requirements*

The product will give both auditory and visual instruction throughout its features to ensure accessibility.

6.3 PERFORMANCE REQUIREMENTS

6.3.1 *Speed and Latency Requirements*

FollowThrough will provide feedback in real time to the user. This means that within a few seconds of recognizing the ball has been shot the user should hear or see some feedback.

6.3.2 *Safety-Critical Requirements*

This product was not built to work during inclement weather. It must be protected from the rain or not used outside.

6.3.3 *Precision or Accuracy Requirements*

This product will return to the user information that is accurate with only a small degree of error so that the player does not find FollowThrough detrimental to their form.

6.3.4 *Reliability and Availability Requirements*

This product is designed to be used on a Basketball court and will be available to anyone who wishes to purchase the equipment and set up the devices..

6.3.5 *Robustness Requirements*

In the case of battery failure or any sort of power related disruption the product is to save any data that it can.

If any component of the product becomes disconnected the software will inform the user so that they may remedy the problem.

6.3.6 *Capacity Requirements*

As of right now the capacity of the product is only a single person. This may change in a later revision.

6.3.7 *Scalability or Extensibility Requirements*

FollowThrough is to be able to scale from one device to another and work cross-platform.

6.3.8 *Longevity Requirements*

This product is designed to last as long as any average computer.

6.4 OPERATIONAL AND ENVIRONMENTAL REQUIREMENTS

6.4.1 *Expected Physical Environment*

The expected physical environment for this product would be on the Basketball court.

6.4.2 *Requirements for Interfacing with Adjacent Systems*

As mentioned previously this product is to work with various operating systems on various devices.

6.4.3 *Productization Requirements*

This product will require installation both physically and on the Basketball court.

6.4.4 *Release Requirements*

This product must be complete by April 2017 for its final demonstration.

6.5 MAINTAINABILITY AND SUPPORT REQUIREMENTS

6.5.1 *Maintenance Requirements*

The product is to be maintained when necessary by the development crew.

6.5.2 *Supportability Requirements*

Not Applicable.

6.5.3 *Adaptability Requirements*

The product will be available on any common operating system.

6.6 SECURITY REQUIREMENTS

6.6.1 *Access Requirements*

The web interface will need to be accessed with a user name and password. Due to this so will the hardware so that the two are connected.

6.6.2 Integrity Requirements

Not Applicable.

6.6.3 Privacy Requirements

The statistical information gathered will not be shared anywhere.

The user's information will not be shared anywhere.

6.6.4 Audit Requirements

Not Applicable.

6.6.5 Immunity Requirements

Not Applicable.

6.7 CULTURAL AND POLITICAL REQUIREMENTS

6.7.1 Cultural Requirements

This product will not carry any cultural bias.

6.7.2 Political Requirements

This product will not carry any political bias.

6.8 LEGAL REQUIREMENTS

6.8.1 Compliance Requirements

Not Applicable.

6.8.2 Standards Requirements

Not Applicable.

SYSTEM FEASIBILITY AND PROJECT ISSUES

7.1 OPEN ISSUES

Creating a GUI which works on a multi-platform basis.

As of right now, the tracking cuts very slightly when the ball passes through the hoop.

7.2 OFF THE SHELF SOLUTIONS

The GUI can adapt to the platform it is being used on.

We are currently working on making a haar cascade file for tracking, which will improve tracking capabilities greatly.

7.3 ECONOMIC

The end goal of this hardware is to be able to be used by the general population, which means costs must be kept relatively low. We wish our users to be able to purchase the hardware for and set up their own FollowThrough system as we will not be selling or distributing the product. This economic feasibility report will include analysis of costs, benefits, and project timing.

7.3.1 *Costs*

The below lists all expected costs, direct and indirect, with an approximation of how much it will cost.

Direct Costs:

- Purchase of hardware pieces that the FollowThrough utilizes.
 - Arduino/Raspberry Pi (\$50).
 - Distance sensor (\$15).
 - Webcam (\$25).
- Purchase of basketballs for testing (\$20).
- Renting gym space for testing (\$150).

- Web server costs (\$40).

Indirect costs:

- Six months of development time from four student developers (No cost).

Total Costs: \$300.00

7.3.2 *Benefits*

The benefits of this project are non-monetary since it will be open source. However, the project does provide non-monetary benefits to not only the creators, but anyone who uses the open source software.

- Allowing players to further improve their basketball skills without incurring massive costs.
- Creating an open source version of the software in an attempts to lower costs.
- Completing the capstone course at McMaster University.

7.3.3 *Analysis*

Since the development costs for this project are so low there is very little downside to developing a product like this. The benefits of a developing this system far outweigh the minor monetary costs, therefore this analysis shows that the project should proceed.

7.4 TECHNICAL FEASIBILITY

7.4.1 *Method of production*

Inputs have been listed above under costs. There is no limit in availability of hardware, however there is limited availability of gym time which could be a limiting factor in our ability to test. A potential problem with the development of the system will be whether features have to be cut to fit the development period into a six month time frame. Developing three separate subsystems will take a significant amount of time and unfortunately we cannot devote ourselves full time to this project.

7.4.2 *Production technique*

For the development of this project we will use synchronous development. The tasks of the project will be divided and the three subsystems will be developed at the same time by different developers. This will allow optimal use of developer time and allow us to demonstrate functionality of all subsystems as development occurs.

7.4.3 *Project requirements*

All project requirements are listed above.

7.4.4 *Project Location*

This project does not have a specific location, the device should be able to be moved and be used on any basketball court. One limitation to this is outdoor use, in which favorable weather is necessary.

7.5 USER DOCUMENTATION AND TRAINING

A user manual will be provided to the user. Ultimately they will be responsible for setting it up and using it responsibly. The manual will be descriptive enough that the user should not have any questions. On top of that the user interface will be equipped with a help section which will alleviate all concerns.

7.6 ALTERNATIVES

Currently the main alternative to FollowThrough is the use of a Shooting Coach. This has been the established way to improve shooting percentages from the beginning of basketball. However, in recent years there have been a few ventures into comprehensive systems to track shooting statistics. The current system that we hope FollowThrough will be able to compare to is Noah. The Noah system provides similar stat tracking functionality (arc, depth, left/right) and allows a player to track their analytics via the web. However, Noah comes at a large cost of nearly \$4000.00 for use on only one half of a basketball court, a full court system costs nearly \$5000.00. At this price point only large institutions would be able to provide their players with this service. FollowThrough hopes to provide the ability for any player to purchase the components and setup the system by themselves.