January 25, 2016

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia

Re: ENSC 305W/440W Project Proposal for a Powerlifting Monitor & Warning System

Dear Dr. Rawicz:

The attached document, *Proposal for a Powerlifting Monitor & Warning System*, outlines our project for ENSC 305W/440W (Capstone Engineering Science Project). Our goal is to design and implement a stand-alone system that can 1) immediately warn a powerlifter when their form is poor and 2) be able to provide a researcher/trainer the ability to see time-synced physiological data: EMG, force generated, body mechanics, etc.

The purpose of this proposal is to provide an overview of our proposed product, an outline of the design considerations, funding and information sources, a tentative projected budget, and information on project scheduling and planning. This document also includes a product rationale that justifies the need for this product on the market place.

Omaro consists of four final-year students: Amid Sedghi, Chris Esterer, Henry Hein, and Jarid Warren. If you have any questions or concerns about our proposal, please feel free to contact me via email at jaridw@sfu.ca.

Sincerely,

Jarid Warren
CEO
Omaro GP

Enclosure: *Proposal for a Powerlifting Monitor & Warning System*

# Proposal

*for a*

# Powerlifting Monitor & Warning System


Project Team: *Amid Sedghi*
*Chris Esterer*
*Henry Hein*
*Jarid Warren*

Contact Person: *Jarid Warren*
*jaridw@sfu.ca*

Submitted to: *Dr. Andrew Rawicz – ENSC 440W*
*Steve Whitmore – ENSC 305W*
*School of Engineering Science*
*Simon Fraser University*



Issue Date: *January 25, 2016*

Revision: *1.0*

# Executive Summary

Humans have always had an insatiable drive to improve themselves and the technology around them. When it comes to improving physical performance and fitness, it is no surprise that we are still attempting to push forward. Despite the significant advancement of existing technologies, there still exist windows of opportunity for a product that can help progress our knowledge of exercise science.

From commercial sales to education and research, Omaro's OptiFit will open the door to numerous markets and sales opportunities by providing its customers an easy, efficient, ready-to-go solution for monitoring the performance of athletes. Our product will combine synced information about force production, muscle activation, and form in one graphical display for the user to see. It will also be able to issue warnings should the user be using poor technique. The appeal for our product is threefold:

- Enabling researchers the ease of analyzing cross-referenced data,
- Provide health professionals better tools to help patients, and
- Empower educators and help their students learn physiology

Not only are current products on the market implemented in an inefficient way, they also are narrow in scope and fail to deliver a range of information to their customers. In addition, researchers are forced to create their own ad-hoc configurations that ineffectively combine separate sensors during a study.

This diversified market is ideal for a new company and a product as we will be able to sell low volume, high-margin units to research labs and businesses to accrue additional capital for further R&D. As the product improves and cost reduces, our business module will shift to lower-margin, higher volume sales to steadily increase revenue.

Omaro's business structure is a general partnership between its four founding members. As a result, our motivation to succeed couldn't be higher. We are fully dedicated to not only delivering a fantastic product, but also to push each other to be the best engineers we could be.

This proposal is to provide an overview of our proposed product, an outline of the design considerations, funding, a tentative projected budget, and information on project scheduling and planning. This document also includes a product rationale that justifies the need for this product on the market place.

 

# Table of Contents

# List of Figures & Tables

# 1. Introduction

## 1.1 Background

Studies have found that not only has the popularity of weight training increased in the past fifteen years, but related injuries have as well. According to the Center for Injury Research and Policy of The Research Institute at Nationwide Children's Hospital, "… more than 970,000 weight training-related injuries were treated in U.S. hospital emergency departments between 1990 and 2007, increasing nearly 50 percent during the 18-year study period."[1] This linear rate of increase of weight lifting-related injuries can be seen in Figure 1. Although injuries are common, the benefits of weight lifting are bountiful, including: increased metabolism, lowered risk of diabetes and osteoporosis, increased heart health, improved muscle strength, better insulin control, reduced back pain and higher self-confidence. Weight lifting is also as effective as prescription drugs when it comes to curing depression.

The problem is that despite positive results one can achieve by lifting weights, there still exists a significant chance of serious injury. From our research of popular weight training journals, with the exception of a sedentary lifestyle there is one primary cause for a large percentage of injuries; exercising with improper form leads to excessive force on connective tissue, joints, and muscle. Most of the time, the incorrect form is either due to lack of education or poor self-assessment. The real question here is how can we address this issue, or more importantly at what level does an appropriate solution exist?

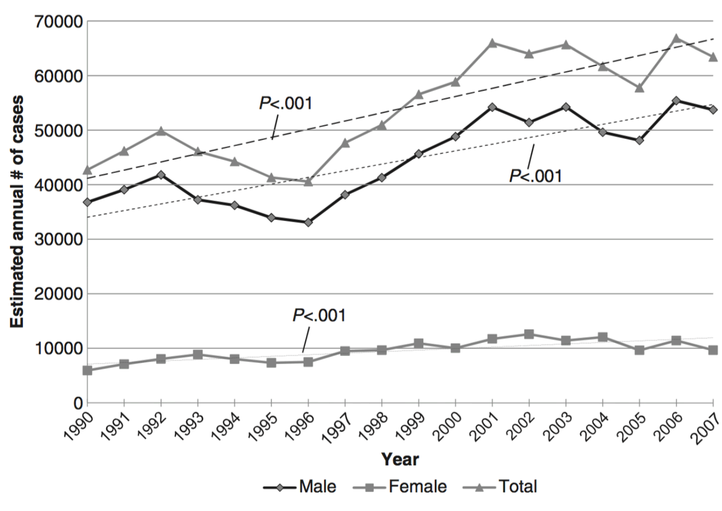


**Figure 1: National estimates of annual weight training- related injuries treated in US emergency departments from 1990 to 2007 by gender [2].**

## 1.2 Our Solution

We believe that taking a two-part approach to the solution, can drastically reduce the increasing problem of injury in weight training. First, we'd like to be able to directly warn a user when their form is poor, and second we'd like to provide more accessible information for training, research and education. The product, named "OptiFit," ultimately will be able to track body mechanics with an optical sensor, record an Electromyograph (EMG) with an analog Printed Circuit Board (PCB), measure power with a force sensitive resistor and provide immediate audio feedback when incorrect form is being used. What makes OptiFit more than just a conglomerate of sensors is the ability to use data contextually to give the user appropriate warnings. A rendition of the complete system can be seen below in Figure 2.

Our vision is that our system will give fitness facilities the ability to help improve their clients by providing them visual and graphical feedback, researchers the power to observe trends and improve the area of exercise science, teachers the platform to educate their students about physiology and weight lifters the assurance that they are getting the most out of their exercise while reducing their chances of injury.


**Figure 2: Conceptual design of OptiFit, stock photos courtesy: Men's Fitness, ElectronicSpecifier.com, Microsoft, and StaticWorld.net.**

# 2. Scope

## 2.1 System Overview

The system, OptiFit, is a solution that takes advantage of optical sensors in addition to wireless sensors interfacing directly with the body. The four major components as shown in Figure 3, are the EMG/force sensors, the Microsoft Kinect optical sensor, the software that processes the data, and the user interface.

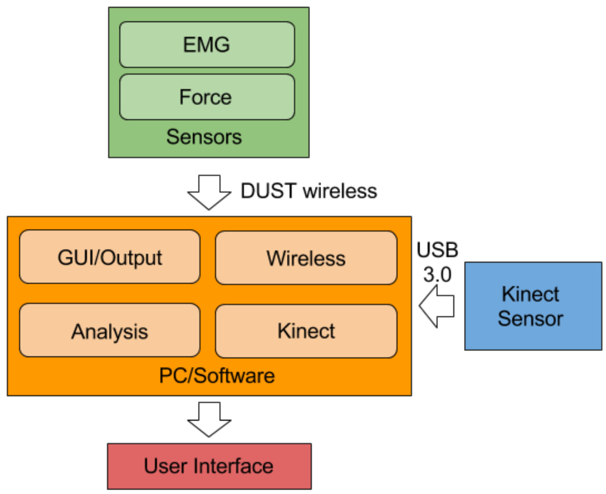


**Figure 3: System level diagram of OptiFit.**

The custom-designed EMG sensor will attach directly to the skin and interface into a microcontroller (that must include a built-in Analog-to-Digital Converter [ADC]) with some way of supporting 802.15.4 (low power) wireless capabilities. This architecture will prevent wires from tangling up during movement and allow users to process information from their desktop computer. The wireless information will get to the serial port of the PC via a USB dongle for processing. We also plan on creating the force sensor ourselves, and will use the same wireless configuration as the EMG. The force sensor will likely take the form factor of a rectangular "pad" that users can stand on during their movement.

The third sensor, the Microsoft Kinect, will interface with the PC over USB 3.0 and will be responsible for tracking body mechanics; we will do this by taking advantage of Microsoft's open source Application Programming Interface (API), development tools, and referencing the large Kinect development community online.

 

The software component is broken down into four subtasks: wireless data processing (WDP), Kinect functionality, analysis, and the Graphical User Interface (GUI). The WDP program will import data from the PC's serial port and send the information to analysis and the GUI. Similarly, the Kinect functionality will map position vectors from the sensors and communicate with the analysis/GUI programs. The analysis itself will be responsible for observing interactions with the three types of data and issuing immediate audio feedback (through the PC's speakers) should something appear wrong. The flowchart for this operation is shown below in Figure 4.

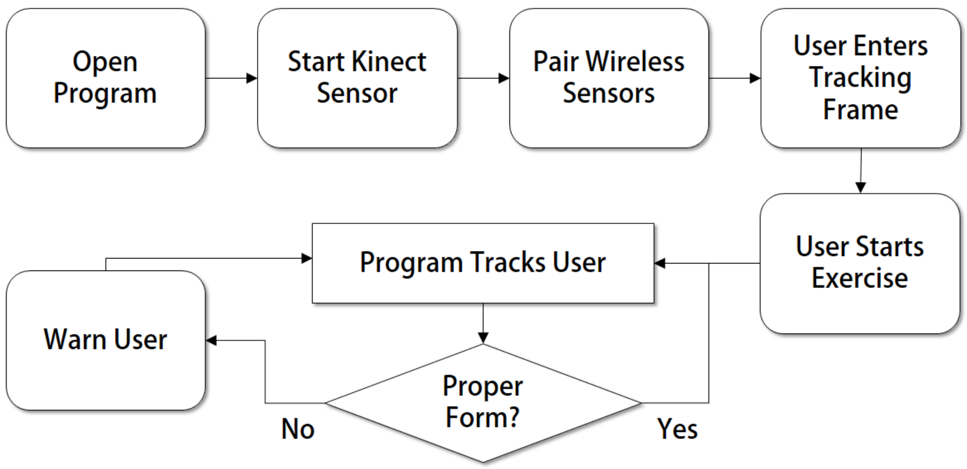


**Figure 4: OptiFit state diagram.**

Although we plan on creating a "closed-form" solution, our intention is that customers will bring their own monitor, keyboard, and mouse that will allow them to see the GUI output from the PC. Customers will be able to see the user's mechanics, EMG, and force production synced together for efficient analysis.

## 2.2 Alternate Possible Solution

Our first approach to solving the problem was to use sensors to measure the relative positions of the body during a movement. These wireless, on-body sensors would then report to a smartphone/computer their position in 3D plane (x,y,z) and time at a relatively fast rate to monitor quick, explosive movements. With this data, we would then be able to monitor the user's acceleration, velocity and positions of joints on the body. Similar to our inevitable idea, we would then be able to pair this information with other sensors to give a more holistic idea of the user's performance.

 

Multiple problems exist with this type of setup. Firstly, determining if a movement pattern is “incorrect” becomes difficult in software. To achieve our desired result, there would be weeks of trial and error to find optimal sensor placement, accelerations that are dangerous, and differential positions that demonstrate the poor form is being used. Lastly, this process would have to be adapted for each individual movement we wanted to support.

Using the Microsoft Kinect we are able to get a snapshot of the entire body during the exercise. With this we can see joint angles, absolute position, and also achieve better bandwidth by interfacing with USB 3 compared to a low-power wireless network. By utilizing Microsoft’s software support for Kinect development, we will also able to achieve much more computational ability in the span of a semester compared to a ground-up approach. In the future we will also be able to expand capabilities of our existing system with software updates that utilize the rest of the Kinect’s capabilities such as infrared or voice control.

The downsides to the Kinect present themselves more on the business side of the project. To sell the system commercially we would need to develop our own optical sensing platform to avoid licensing fees of the Kinect.

## 2.3 Benefits

Our intention is that OptiFit will benefit the commercial market by giving experts the power to thoroughly analyze their clients, teachers by allowing them to show students physiological interactions visually, users by helping them improve their form and work efficiency, and lastly researchers the tool to find new correlations and contribute to science.

These implications for OptiFit mean that it will not only benefit society as a whole, but also the individual. Should our type of solution be adopted long term, we see the following effects: children would be able to learn faster with interactive tools that are engaging, knowledge in the field of kinesiology would grow faster as researchers are more enabled, and gyms would have the equipment to help their members improve themselves faster without a costly personal trainer.

From a sustainability point of view, OptiFit will also save cost, packaging and shipping compared to separately sold and configured sensors. Not to mention that it will also be able to be powered by your own computer, further preventing additional costs and hardware (HW) that need to be manufactured and eventually disposed.

 

## 2.4 Risks

Although our proposed product doesn't have any risks to the operator, there are possibilities of danger to the user from tampered lithium polymer batteries and sensor design flaws. In addition, the activities that OptiFit will be designed to monitor, like deadlifts and squats, cause a large amount of stress on joints, muscles and the central nervous system. Although these potentially risky exercises are what justify a product like ours on the marketplace, we still need to be careful during development and take into account not only the user but Omaro as well—the last thing we want is someone getting injured, resentful, poor or overly stressed as a result of OptiFit.

The first consideration during development that needs to be accounted for is financial risk. Although this doesn't concern our users we also want to mitigate any kind of detriments to the members of Omaro; no member wants to front costs to complete the project due to lack of funding. To help reduce the possibility of this, we have been proactive by securing funding before the semester ($400) and spreading out the chance of more capital secured throughout the semester as outlined in section 0.

We'll also have to bear in mind stress and personal/professional relationships during progress on the project. We've made a conscious effort to work in small, consistent blocks of time and always keep communication clear to keep sanity in check. Omaro also takes advantage of an upbeat, humor filled culture that helps keep us unified and motivated.

The last risk is to ensure that the sensors on our system are safe enough to interface directly with the user's body. The EMG sensor does have the potential to cause a small electric shock to the body. To avoid this, we will be investing in a high quality instrumentation amplifier with high input impedance that prevents excess current to/from the system. The force sensor will also need some serious consideration. We'll be requiring the pad to support and measure up to 5000 N of force without causing any risks to the user. The electronics will need to be nested inside a strong, affordable piece of material like wood (assuming the user is wearing shoes to prevent splinters) to ensure heavy exercises like the deadlift can be performed safely.

 

# 3. Product Rationale

## 3.1 Commercial Market & Competition

Currently on the market there exists two prominent products that track EMG wirelessly and report the information via Bluetooth to a smartphone. First, the MPower Pod shown in Figure 5, tracks EMG signals and does a very extensive analysis to find types of power, activation, and balance. The Pod is small, unobtrusive, and isn't agitating when in contact with the user. Next, the Athos range of smart fitness apparel shown below in the right side of Figure 5, does an excellent job at reporting EMG data; it has sensors covering every major muscle group in the body. In addition, it provides its users with real-time data that can be viewed immediately following an exercise.

The MPower Pod and Athos do have some limitations however: the data tracked is limited to the smartphone and accompanying proprietary apps themselves, users do not receive immediate feedback during their lifts, in addition to both products lacking force measurements and body mechanics compared to OptiFit. By going the route of a wearable it does make the product more available to an individual, but we feel the true value in the information we are collecting is having it in the hands of a professional.

From a consumer's perspective, not many people seem to be attracted enough to make a $200+ purchase of a bulky, awkward product. Most likely, this is the result of a $20B wearable market that is saturated by the likes of FitBit, Microsoft, Samsung, and Apple. An area that hasn't been exploited (save for an auxiliary input on a cardio machine) is smart technology for fitness-centered businesses such as gyms and physiotherapy offices. According to statista.com, the wholesale fitness center equipment has grown to over $1.3B despite the fact that there still lacks any creative modern technology. [3]

The OptiFit, from the perspective of a physiological monitoring solution, is more complete as it offers abilities extending past the realm of just muscle activation. Users will be able to pair muscle activation with force production and mechanics, giving more value behind the numbers. The feature of immediate feedback during a lift is also unique to OptiFit based on our research. By marketing towards fitness centers, kinesiologists, trainers, physiotherapists, and teams rather than individuals, we can justify the entire system at a higher price by giving more value.

 

**Figure 5: Left: Mpower pod, courtesy: mpower-bestrong.com.**
**Right: Athos activity tracking apparel, courtesy LiveAthos.com.**

## 3.2 Research Potential & Existing Solutions

Although the OptiFit has commercial potential, it has the capability to make a significant impact in the research community. As such, we have included analysis for both markets, as we truly believe our product bridges the gap. Powerlifting, bodybuilding, and Olympic lifting all have large pools of research and OptiFit could help further investigation. In a sense, OptiFit's commercial potential expands into research potential, considering that our technology brings a fresh outlook to the science of exercise, fitness and physiology.

Despite the fact that the individual pieces are available to researchers today, no complete solution is offered that is ready to analyze parameters with respect to others. Wireless EMG sensors like the one in Figure 6 for example, are fairly common today and are used to track EMG signals in dynamic movements. Force production, on the other hand, is generally approximated by tracking bar speed from video via software rather than an actual measurement; lastly, motion tracking requires an additional piece of software that essentially does the same thing – annotate a video.

The benefit of having a pre-packaged system is that we can analyze how different types of data interact. For example, if force production is low but EMG activity high, we can conclude that the movement isn't very efficient. This type of analysis can give researchers new methods of finding physiological correlations, and more optimal technique. As the software matures we will be able to provide more in depth analysis about not only mechanics and form tracking, but other data such as temperature via the Kinect's infrared camera.


**Figure 6: Example of a wireless EMG.**

 

# 4. The Company

## 4.1 Members

Jarid Warren – CEO

Jarid is a graduating undergraduate electronics engineering student at Simon Fraser University with prior internship experience at Linear Technology Corporation doing VLSI and testing wireless sensor networks. He'll be heading back to Silicon Valley working on RF Digital Baseband systems for smartphones in May. Most of his passion is directed towards both analog/digital hardware and tech management, which is why he will be pursuing a MS and MBA in the future. He has experience with VHDL/Verilog, Python, C/C++, Analog Design, RF Design, documentation, and leadership. Jarid will be responsible for coordinating the overall progress and organization of the project, the primary writer for technical documents and will be contributing to the hardware development of the OptiFit.

Chris Esterer – CTO

Chris is a Systems Engineer finishing his degree in 2016. His co-op experiences at ASCO Aero space and Mercedes-Benz Fuel Cell have given him adept experience within manufacturing systems. His eight months at MBFC was spent on both the production and manufacturing engineering team. He utilized his creativity to create a program developed to measure tolerances of hydrogen fuel cell stack layers written in C++. The program worked with a non-contact profilometer that measured a hydrogen fuel cell stack. It interpreted the data to show if the fuel stack was within specification of the design. At ASCO Aero space, Chris maintained a strong work ethic with the engineering team to solve CNC manufacturing problems regarding tools. His dedication to engineering and execution of his craft are intrinsic to his personality. What makes Chris the perfect CTO for Omaro is his analytic software development, ability to collaborate, and experience working with complex systems.

Henry Hein – Vice President, Hardware

Henry is a fifth year electronic engineering student with four months of research experience and four months of industry co-op experience at LineSpect. During his time in the industry, he designed, debugged, and tested analog circuits that interface robotic sensors. He was also responsible for integrating electronic subsystems of the multi-rotor aircraft. His interests are in analog/digital hardware development. Apart from his interests, he has experience in digital signal processing, communication networks, C, C++, and Matlab. His work for Omaro will be focused on hardware and microcontroller software development.

Amid Sedghi – Vice President, Software

Amid is a fourth year computer engineering student at Simon Fraser University with previous co-op experience at SAP Global Product Support where he worked with SAP customers, including Fortune 500 companies, on real-time complex software issues. His strengths are in methodological approach towards software troubleshooting, debugging and analyzing environments where C++, C, Java, and HTML are the dominant programming languages. He is passionate about creating value in projects and bases the success of a project on the group's detail orientation, interpersonal skills, teamwork and adaptability to change. He will be assisting his group members in developing software and documentation for the project.

## 4.2 Name Origins

Upon identifying the need for a product that delivered what we have described in this document, we eventually fell in love with the idea of using the Microsoft Kinect's open source APIs to track the body. The Kinect, of course, uses optics to get information about the body's mechanics. The Greek word for vision is "όραμα" or "orama" in English; after a few days we manipulated the sound until one of us announced "Omaro" and the rest knew we had just found *our* name. The product, "OptiFit" has dual meanings. First, it's a combination of "Optical" and "Fitness" to play on the fact that we're monitoring physical movements with an optical sensor. Secondly, we also like to think of the first part of the name to also be "Optimal," which is what we hope our product can be in a multifaceted way.

## 4.3 Organization

As the OptiFit has considerable hardware and software components, Omaro is organized into two sub-teams for parallel development. This configuration will ensure that a task can be achieved by at least two members of the team should unfortunate circumstances occur. The software team will be led by our CTO, Chris, who will oversee all programming efforts on the PC side of OptiFit. Amid, our VP of Software, will also have a significant role ensuring the success of development with the Microsoft Kinect. The CEO, Jarid, will oversee technical documentation, the progress of the hardware team and collaborate with Chris for HW/SW integration. Henry, our VP of Hardware, will direct hardware research, test, and PCB design in addition to wireless deployment.

## 4.4 Structure

Omaro is a general partnership (GP) between its four founding members, sharing costs, liabilities, and responsibilities for the company. Although these factors are shared equally across the members, the CEO will still operate Omaro in good faith with the remaining partners.

# 5. Project Planning

## 5.1 Timeline

The project planning for OptiFit is divided into five major categories: logistics, documentation, hardware, software, and system-level. The first phase of the project, one month prior to the semester, was mostly in the logistics category. Here, we identified problems that at least one member felt strongly about; at the same time, the whole team researched the solutions and marketplace to go along with these problems. Near the start of the semester, we also created a name for our company/product and started iteration on a logo. The logistics category is shown in orange in Figure 7.

The next phase of the project runs from the start of January until the end of February: hardware and software development. As far as deliverables are concerned, this phase is the most significant component of the project. As described in the previous section, the hardware and software teams will work on development in parallel.

The software team will begin by setting up the Kinect and Wireless programs. The Kinect C++ code will need to grab the appropriate data from the sensor and send vector information for analysis. The wireless code, on the other hand, will enable data entering the COM port via the 802.15.4 receiver to be imported to the analysis program and GUI. Next, the GUI itself will take information from the sensors and display them graphically in sync to the user in real time. The analysis program will be developed simultaneously with the GUI and will process information to issue audio feedback for the user.

The hardware team meanwhile, will begin by prototyping the EMG. After the circuit is fully functioning, it will then be implemented on a PCB. At the same the wireless network motes will be configured to convert analog data so that it can be transmitted over the 802.15.4 network. The last step for the hardware team will be to create and debug the force sensitive resistor used for the force pad. The specific timelines for the software (purple) and hardware (green) development described above are shown in Figure 7.

The last phase of the project (the dark colour in Figure 7), will reunite the two sub-teams in March to integrate hardware and software into a working system. The exception of this, is the wireless back end set up, which is required to get work on certain aspects of software development. This phase also includes debugging and testing leading up to the demonstration of the system in April.

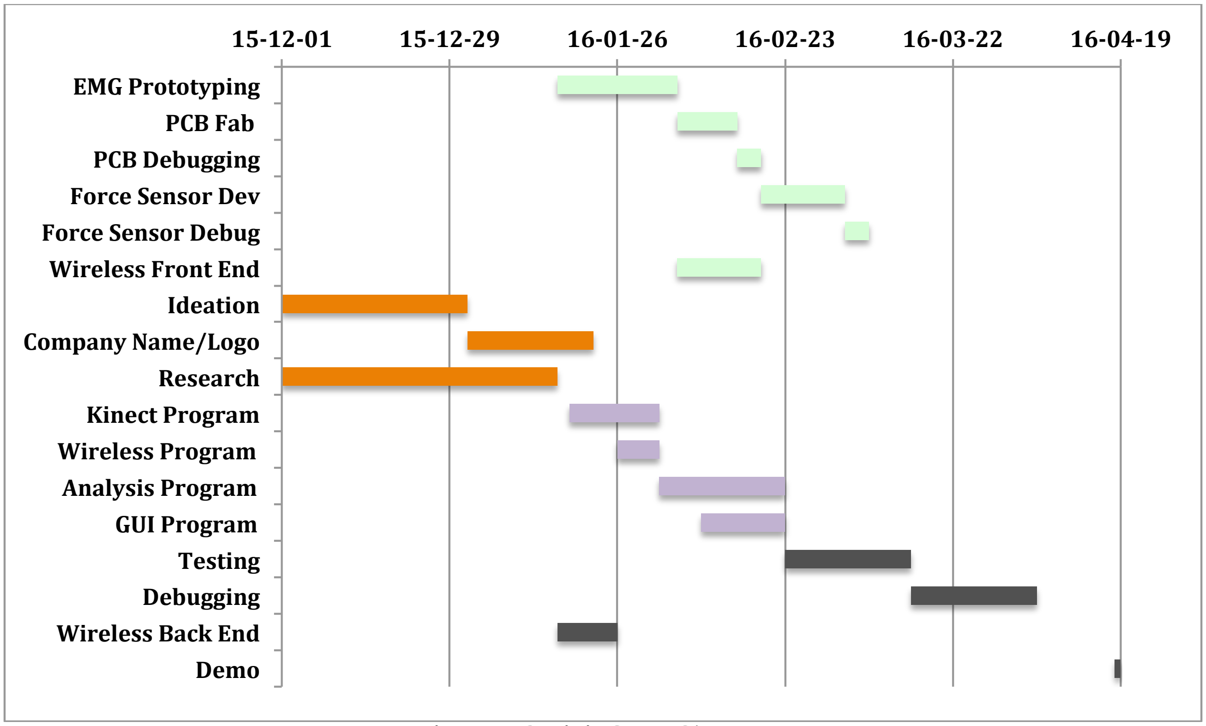


**Figure 7: OptiFit Gantt Chart.**

## 5.2 Milestones

The fifth category, documentation, will be completed throughout the semester in addition to the breakdown mentioned on the previous page. As documents and critical system points will have strict time constraints, their due dates have been shown on a timeline below in Figure 8.

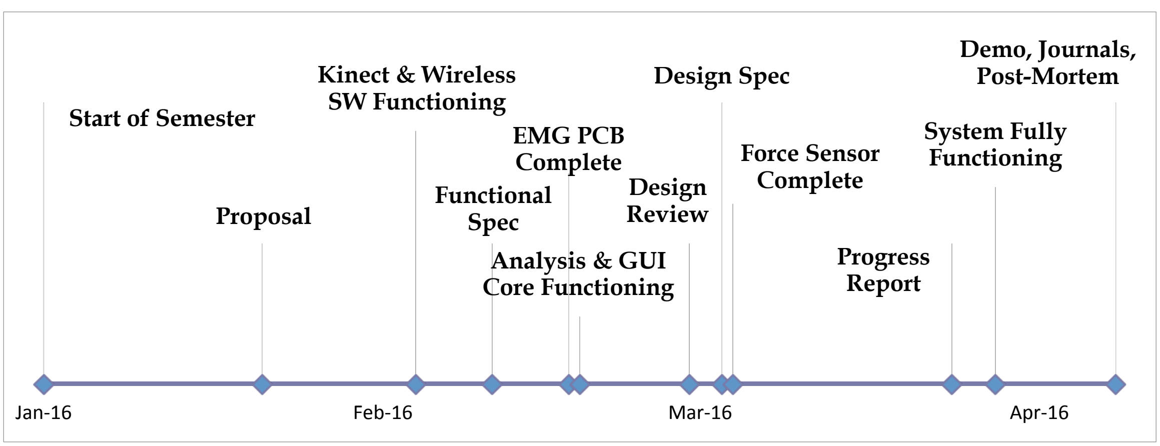


**Figure 8: Milestone Chart for documentation and completion.**

# 6. Finances

## 6.1 Funding

There are currently three primary sources we are relying on to fund our project before we dip into our own pockets: the Engineering Science Student Endowment Fund (ESSEF), the IEEE Canadian Foundation Special Grant, and the Wighton Development Fund (WDF).

The project has also already received $400 from the ESSEF for the previous semester as its origins began as an independent student project. Combined with this semester's ESSEF grant we should expect $800-1200 in total funding to start the project. To fully cover our estimated costs, we're expecting to front costs until grants from the IEEE and WDF are potentially issued. If we fail to secure enough capital to develop the prototype, our members have agreed to split the remainder of the costs to ensure our vision of the product is completed.

## 6.2 Budget & Costs

With a one-off device that gives users as much information as we plan to, there are obviously a slew of associated costs. The first considerations correspond to the computing platform and the Microsoft Kinect. The Kinect itself retails for around $150, which is economical, considering the capability, support, and APIs available from Microsoft. With that comes a PC that can sufficiently run it; from our initial research we require at least an Intel Core i5 processor with ~8GB of RAM, running us into the $500 range. Additionally, a special $60 USB adaptor was required to run the Kinect on one of our personal machines.

The wireless EMG and force sensor takes up the remainder of the costs. Setting up the wireless infrastructure requires a microcontroller and a low-power mesh network used to get information from the sensors to the PC. Fortunately, Linear Technology has donated us a complete start up kit of their Dust Networks wireless sensor network. The kit includes five motes (with on board ADC, microcontroller and 802.15.4 wireless) as well as a USB manager to interface with the PC.

For the EMG sensor, we plan on designing it ourselves. Although we could use a pre-fabricated circuit, we feel that by doing a custom analog design our project covers both substantial hardware and software components to apply all of our knowledge. To create the EMG circuit we require: coaxial cables, batteries, EMG pads, an instrumentation amplifier, and about 8-10 Operational Amplifiers (OpAmps) to complete the rest of the circuits filtering and amplification. The total of these components will cost approximately $110.

 

Lastly, the force sensor will also be made rather than purchased. The reasoning however, is because we won't be able to economically integrate a force sensor that can handle the loads of a powerlifter into our design. To make it, we will require two relatively large sheets of copper (~2'x3') with a similarly sized piece of conductive foam sandwiched between them. With some additional circuitry we will send the output voltage into the analog pins of the mote. The estimated cost of materials for the force sensor is $210.

A summary of these costs is shown below in Table 1. This table includes an estimate of 10% of the total to be additional taxes, as well as a $100 contingency. Although we plan on purchasing components locally when possible, shipping costs may occur (they are absent in Table 1).

**Table 1: Tentative Budget**

| Equipment | Estimated Cost |
|---|---:|
| Standalone PC for Prototype | $500 |
| Microsoft Kinect | $150 |
| Contingency | $100 |
| USB Adapter for Kinect | $60 |
| Electronics for EMG | $20 |
| OpAmps | 60 |
| HW & Electronics for Force Pad | $190 |
| EMG Cables | $20 |
| Batteries | $20 |
| EMG Pads | $20 |
| Taxes (10%) | $114.0 |
| Pre-Tax Total | $1,140 |
| **Total** | **$1,254.0** |

## 6.3 Pricing Strategy

By making OptiFit be modular in nature, it reduces the buyer's initial sunk cost of obtaining OptiFit by only buying the necessities (ie. the optical sensor and software). The rest of the system will be sold as additional purchases to enable features that allow for more computation like EMG or force. We will require some initial capital to eventually develop our own optical sensor and release the first commercial version. Selling our optical sensors alone with $350 margin (with volume production) sold to 1% of gyms in North America [4] per year generates $140K annually. Most importantly, that number is large enough to continue development and support Omaro should we pursue the project.

## 7. Conclusion

With OptiFit, Omaro is dedicated to creating a product that helps advance the science and performance of athletes by giving them the tools they need. Ultimately, we'd like to see researchers and fitness professionals be able to leverage our product to help not only further develop the scientific literature, but also help athletes perform safely and optimally.

Our proposal will be superior to any available product or tool on the market today. Unlike commercial competitors, it will have the ability to simultaneously monitor force production and mechanics *simultaneously*. More importantly, OptiFit gives the user comprehensive analysis and intelligence unlike other sensors/app combinations. For research, our proposed product will leverage this intelligence to make OptiFit greater than the sum of its individual constituents.

From our breakdown of the project schedule and budget, it is evident that not only is this proposal feasible to accomplish during the semester, but it also has room to grow and mature over time. As a company, the potential to enter the marketplace and accrue enough revenue to survive is high due to OptiFit's high-margin, low volume, business-to-business model.

We're confident that when our future customers have time to discover the potential of our product, they will be able to drastically open our understanding of physical performance and safety.

## Glossary of Acronyms

| | |
|---|---|
| **ADC** | Analog-to-Digital Converter |
| **CEO** | Chief Executive Officer |
| **CNC** | Computer Numerical Control |
| **CTO** | Chief Technology Officer |
| **EMG** | Electromyograph |
| **ENSC** | Engineering Science |
| **ESSEF** | Engineering Science Student Endowment Fund |
| **GP** | General Partnership |
| **GUI** | Graphical User Interface |
| **HTML** | Hypertext Markup Language |
| **HW** | Hardware |
| **IEEE** | Institute of Electrical and Electronics Engineers |
| **MBA** | Masters of Business Administration |
| **MBFC** | Mercedes-Benz Fuel Cell |
| **MS** | Masters of Science |
| **OpAmp** | Operational Amplifier |
| **PC** | Personal Computer |
| **PCB** | Printed Circuit Board |
| **RAM** | Random Access Memory |
| **R&D** | Research and Development |
| **SAP** | Systems, Applications & Products in Data Processing |
| **SW** | Software |
| **USB** | Universal Serial Bus |
| **VHDL** | VHSIC Hardware Description Language |
| **VHSIC** | Very High Speed Integrated Circuit |
| **VLSI** | Very Large Scale Integration |
| **VP** | Vice President |
| **WDF** | Wighton Development Fund |
| **WDP** | Wireless Data Processing |

 

## Sources & References


[1] ScienceDaily, "Weight training-related injuries increasing", 2016. [Online]. Available: http://www.sciencedaily.com/releases/2010/03/100330115925.htm. [Accessed: 04- Jan- 2016].

[2] Z. Kerr, C. Collins and R. Comstock, "Epidemiology of Weight Training-Related Injuries Presenting to United States Emergency Departments, 1990 to 2007", *The American Journal of Sports Medicine*, vol. 38, no. 4, pp. 765-771, 2010.

[3] Statista, "Fitness center exercise equipment U.S. sales 1996-2014 | Statistic", 2015. [Online]. Available: http://www.statista.com/statistics/236125/us-fitness-center-equipment-sales/. [Accessed: 18- Jan- 2016].

[4] Statista, "Number of health/fitness clubs in North America 2009-2014 | Statistic", 2015. [Online]. Available: http://www.statista.com/statistics/275051/total-number-of-health-clubs-in-north-america/. [Accessed: 18- Jan- 2016].

[5] Lee's Electronics, Vancouver

[6] RP Electronics, Burnaby

[7] Dr. Ash Parameswaran, SFU

[8] Dust Networks' SmartMesh IP Easy Start Guide for the Embedded Manager (PDF)

[9] Dust Networks' SmartMesh IP Mote Serial API Guide (PDF)

[10] Dust Networks' SmartMesh IP Tools Guide (PDF)

[11] msdn.microsoft.com, "Kinect for Windows SDK", 2016. [2016]. Available: https://msdn.microsoft.com/library/dn799271.aspx. [Accessed: 19 - Jan - 2016].

[12] Wang, Jingpeng, Liqiong Tang, and John E Bronlund. "Surface EMG Signal Amplification And Filtering". *International Journal of Computer Applications* 82.1 (2013): 15-22. Web.