January 23, 2006

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for a Smart Alarm Clock

Dear Dr. Rawicz:

Given that the average person receives 6.9 hours of sleep per night, more and more people are finding it difficult to wake up in the morning without feeling tired. Inglewood Jack Technologies Inc. is dedicated towards helping all individuals wake up feeling refreshed and alert, even when they cannot get the full recommended hours of sleep. Through a combination of light and sound that increases in intensity over a period of time, we can gently wake up an individual at the most ideal moment of their sleep cycle.

This device will require four months to complete, and a development cost of roughly $1600 CAD. Please find enclosed the proposal document entitled "Proposal for a Smart Alarm Clock." Our device and its development plans are thoroughly explained in the project proposal. The project timeline, members of the development team, and financial information will be discussed as well.

Inglewood Jack Technologies Inc. consists of five talented and innovative individuals who study engineering at Simon Fraser University: Albert Su, Christian Le, Herman Leung, William Ng, and Matthew Ng. If you have any questions or concerns, we will be pleased to answer them. We can be contacted via email at ensc440-IJtech@sfu.ca.

Sincerely,

Matthew Ng
President and CEO
Inglewood Jack Technologies, Inc.

Enclosure: Proposal for a Smart Alarm Clock

Proposal for a

Smart Alarm

Clock

Project Team: *Christian Le*
Herman Leung
Matthew Ng
William Ng
Albert Su

Contact Person: Christian Le
ensc440-IJtech@sfu.ca

EXECUTIVE SUMMARY

"There is no hope for a civilization which starts each day to the sound of an alarm clock." ~Author Unknown.

Despite the author of the quote being anonymous, the validity of the quote cannot be denied. According to the National Sleep Foundation (NSF), the amount of sleep you need is the amount that lets you wake up feeling refreshed and well. Experts suggest sleeping anywhere between seven to nine hours a day will allow the average person to feel well rested. If an alarm is required to wake you up in the morning, then you are not getting enough sleep. Unfortunately, the average American today sleeps 6.9 hours a night, a drastic decrease from over nine hours a night less than a century ago. Given the hectic schedule that people follow on a daily routine, getting the full amount of recommended sleep is difficult. As a consequence, people often wake up feeling fatigued, groggy, pessimistic and irritable.

It is possible, however, to wake up feeling more refreshed without sleeping the full recommended hours. When we sleep, our body goes through various stages: light sleep, deep sleep and REM (Rapid Eye Movement) sleep. Each sleep cycle lasts about 90 to 110 minutes, and is made up of the various stages of sleep. Depending on which stage of sleep we're in when we are awakened by an alarm, we can actually feel refreshed instead of feeling groggy. Moreover, if a light source can be used in the process, it can further enhance the feeling of being well rested. This light therapy is especially useful in regulating the body's circadian rhythms, or the body's "natural clock."

The objective of our project is to develop a Smart Alarm Clock that will help the user wake up in the morning with greater ease. Customizable music along with a controller for an arbitrary light source allows users to wake up to tunes they enjoy while their bedside lamp simulates the effects of dawn. By using adaptive volume control, only the minimum volume is used to gently wake users up from the light sleep stage – the stage where users wake up more refreshed. For heavy sleepers who often unknowingly dismiss their alarm, random daily alarms tunes will be used to prevent the brain from "tuning out' the same alarm sound.

Inglewood Jack Technologies, Inc. (IJ Tech) consists of five fourth-year engineering science students with various background and experiences in analog/digital system design, RF design, software and firmware development, and network protocol development. IJ Tech members are also knowledgeable in real-time and embedded systems requiring both high level C++ and low level assembly programming.

The scope of this project includes research, design, and development of a prototype as a proof-of-concept. The cycle will span a 13-week period with April 1, 2006 as the scheduled completion date of the prototype. The budget of the entire project is estimated to be $1600, with the possibility of obtaining external funding.

Table of Contents

1. Introduction

Sleep deprivation affects 47 million American adults, with symptoms ranging from exhaustion and fatigue to emotional moods such as sadness, pessimism, stress and anger (Sleep Deprivation Information, 2006). Although the solution to sleep deprivation is trivial – by getting more sleep – it often cannot be accomplished due to one's choice of lifestyle.

Typical alarms only go as far as alerting the user by means of a loud "beeping" or "buzzing" sound. These alarms do little in terms of helping users cope with sleep deprivation as it tends to aggravate the users. The snooze button available on these alarms is even more detrimental because the restorative value of rest is diminished, especially when the snooze increments are short. According to one source, "sleep-deprived snooze-button addicts are likely to shorten their quota of REM sleep, impairing their mental functioning during the day.[1]"

The objective of our project is to develop a Smart Alarm Clock that will help the user wake up in the morning with greater ease and feeling more refreshed. This is accomplished by waking up the user at the proper sleeping cycle. By using a combination of light and sound, it is possible to wake the user during the light sleep stage while simulating the effects of dawn. The therapeutic affects of light will not only regulate the body's natural clock, it will also cause the body to produce certain hormones that increases metabolism (NSF, 2006). Although sophisticated products that target specific sleep cycles exist in the market today, they are often cumbersome to use and are rather expensive. Alarms that employ the use of light are often inflexible and cannot be used with existing bedside lamps.

With prolonged use of the Smart Alarm Clock, it is possible to condition the body's circadian rhythm such that it synchronizes again with the external environment, thus eliminating many sleep disorders known as "sleep phase disorders." Sleep phase disorders occur when the body's circadian rhythm is "out-of-sync" with the external environment, causing one to sleep too early and wake up too early, or sleep too late and wake up too late (Sleepchannel.com, 2006).

This document gives an overview of our product, including design considerations, timeline and milestone schedule, sources of information as well as development costs and funding sources.

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[1]American Psychology Association, *Why sleep is important and what happens when you don't get enough*, accessed January 2006 <http://www.apa.org/pubinfo/sleep.html>

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2. System Overview

Figure 1 gives the overview of how the Smart Alarm functions. Similar to a traditional alarm, the user will set the time that he/she wishes to wake up. After the user has gone to sleep, the Smart Alarm monitors the time until the given deadline. As that time approaches, the alarm begins to play music at a low volume and slowly illuminates a connected light bulb. This low intensity of the alarm brings the user out of a deeper level of sleep. As the music becomes louder and the light bulb brighter, he/she is more likely to wake up feeling alert and full of energy.
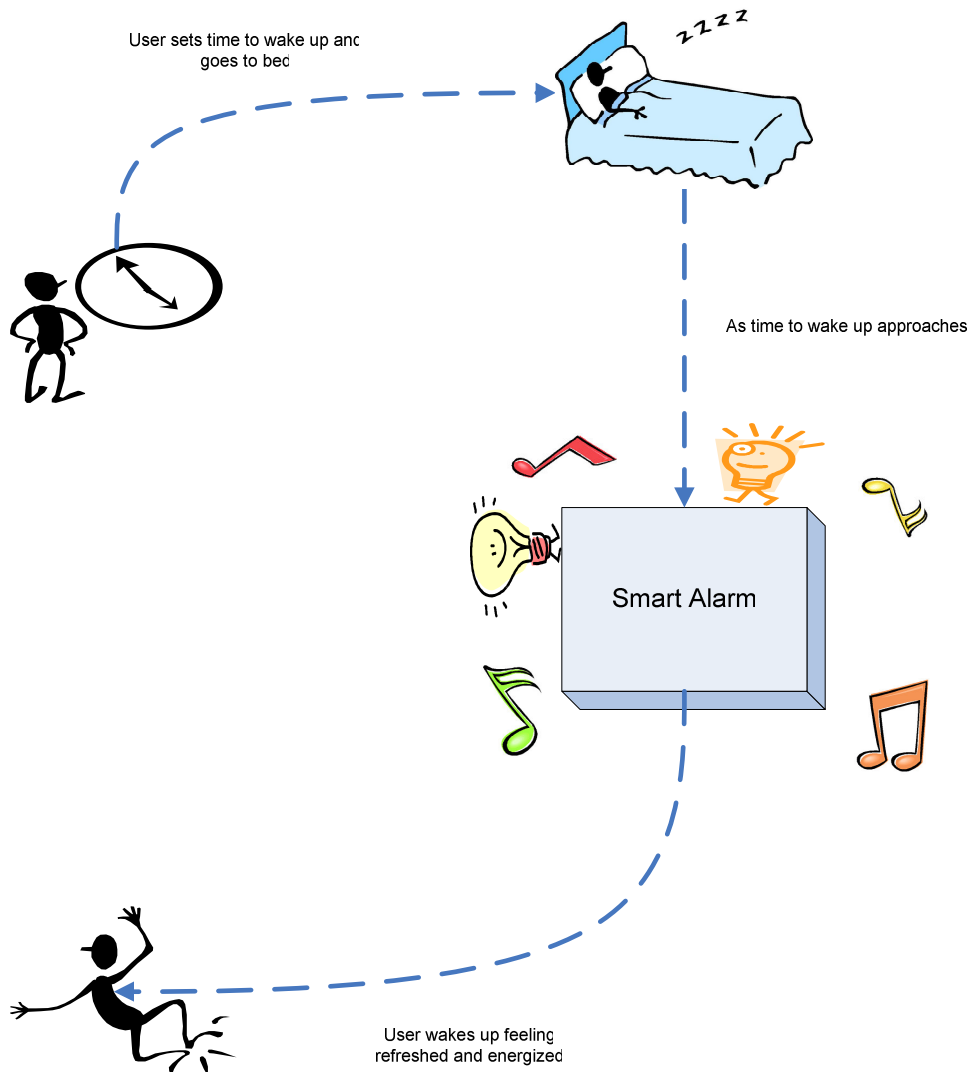
User sets time to wake up and goes to bed

As time to wake up approaches

Smart Alarm

User wakes up feeling refreshed and energized

Figure 1: System Block Diagram

While the alarm is playing music and illuminating the light source, it awaits for the user to wake up and deactivate the alarm. However, if the user fails to do this before the previously set deadline, random sound effects will be played at high volume to ensure that the user wakes up. These random sound effects will vary day to day so the body does not get conditioned to only one type of alarm sound. Figure 2 shows the operational flow diagram of the alarm clock.
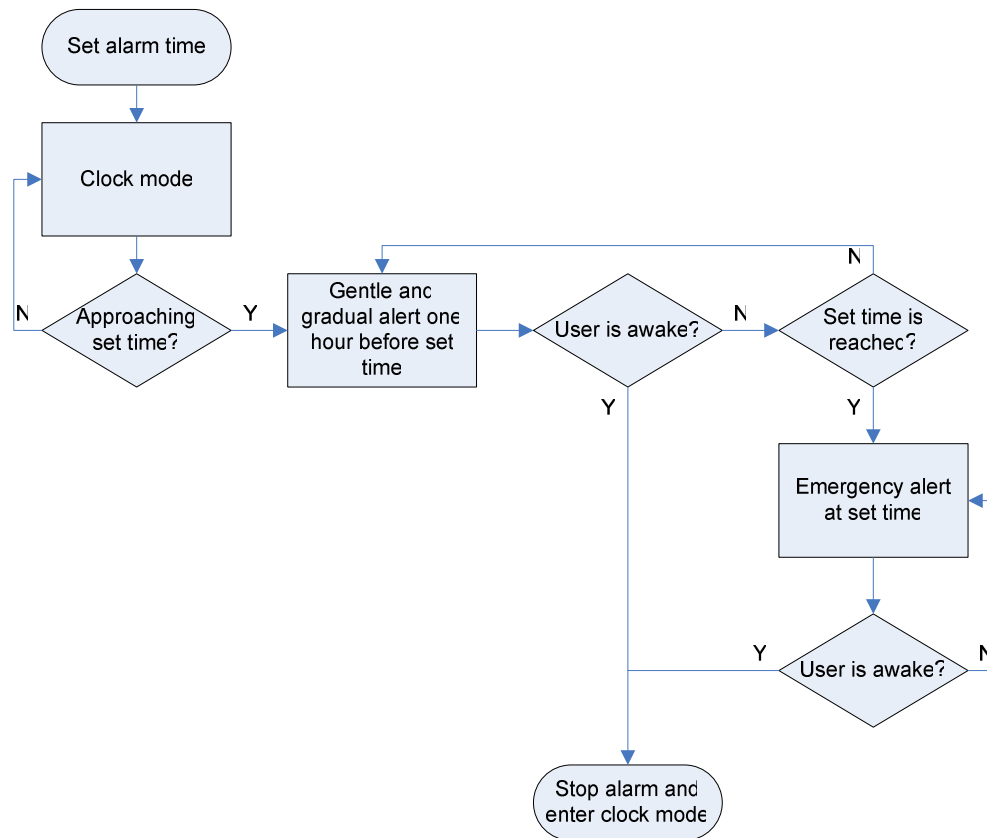

Figure 2: Operational Flow Diagram

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3. Potential Design Solutions

Currently, there are many solutions on the market that can wake users up in the morning. These alarms typically range from simple alarms that alert the users at a set time to complex alarms that monitor the users' bio-rhythm to wake them up during the ideal sleep cycle. However, simple alarms do not help the users wake up feeling refreshed whereas the complex alarms are often too cumbersome to use. The following describes various products/methods that are currently available to wake users up in the morning.

3.1. Regular Alarm Clocks

These inexpensive devices only serve one purpose: to wake up the user at the set time. Loud sounds are employed to wake the user, without regards to the sleep stage the user is currently in. As a result, the user may wake up feeling groggy, fatigued, and annoyed by the sound. These devices usually have a snooze button to temporarily disable the alarm for 5 to 15 minutes. The prolonged use of the snooze button feature is shown to be detrimental to our performance throughout the day. In addition, users can get so accustomed to the sound of their alarm they often disable the alarm without knowledge of doing so.

3.2. Wake Up Calls

This service is similar to ones provided by hotels where at a set time in the morning, someone calls you to wake you up. Wake up calls are usually accurate, but like regular alarm clocks, they do not wake you up at the right sleep stage. Moreover, wake up call services typically charge a monthly fee, which can quickly add up over a year.

3.3. Bio-rhythm Alarm Clocks

Expensive alarm clocks that monitor the user's bio-rhythms are available. These devices can accurately track the user's sleep pattern through a variety of means, such as brainwave activity and motion, waking up the user at the appropriate sleep stage. However, they require the use of cumbersome monitoring devices, such as a headband or a wrist watch, which may have the risk of an electrical shock. Also, these alarms are intrusive since it does not provide a means of waking up the user gradually.

3.4. Light-based Alarm Clocks

These alarm clocks of midrange costs use light as the primary means to wake users up. It allows the body to respond naturally to the light by gradually increasing in brightness. However, this device does not target the proper sleep stage. Light-based alarm clocks also replace the user's existing bedside lamp, and is large and bulky, requiring a constant source of AC power for proper operation.

4. Proposed Design Solution

Our proposed design solution involves combining sleep stage detection along with the usage of light to create a comprehensive alarm system that is both cheap and easy to use. In conjunction with advice that doctors recommend for waking up in the morning with greater ease, the Smart Alarm Clock implements the following features:

- Gentle, non-intrusive music aimed at targeting the light sleep stage without the use of uncomfortable monitoring devices

- User customizable music and alarm sound through MP3

- Ability to use existing bedside lamp as means of simulating sunrise

- Modular design allows ease of portability and future expansion

By playing user-defined music an hour prior to the alarm going off at a low enough of volume threshold, it is possible to wake the user up during the light sleep stage and not during deep sleep or REM sleep stage. This is due to the brain's ability of perceiving external aural stimulus being higher during light sleep than any other sleep stages. Based on this fact, there is no need for extra monitoring devices such as a headband. The ability to wake up to non-intrusive music that the user enjoys provides a rich and pleasant feeling. The modular design approach separates the main alarm clock from the light source. An external wireless device that can be plugged into the wall socket will allow users to use their existing bedside lamp to simulate the effects of dawn, providing more flexibility. This design approach also makes the overall system portable since the alarm itself runs on battery, making it an excellent companion for people on the go.

The system will also appeal to couples who have different waking schedules and deaf people. Couples can solely use the non-intrusive sound features of the alarm (without lights) to wake the intended individual while producing minimal disturbance on the other. Conversely, deaf people can solely use the light features to wake them up in the morning.

One major constraint in the completion of this product is the amount of time available. Only thirteen weeks are available in the Spring 2006 semester to complete this project, which includes research, design, development, integration and final testing. This means that production related designs such as layout, mechanical enclosure and packaging will have less focus. Unfortunately, thorough studies will not be conducted to prove or disprove the claims of the device; this includes the benefits of prolonged use.

Another constraint is the amount of cost of the entire project. Using off-the-shelf modules and development kits means that parts are usually more expensive. External sources of funding must be pursued, which further limits the amount of time available for this project.

With more time and resources, however, we can develop a system that is more robust and have more features that appeal to the end user. Such features include adaptive software that keeps track of the amount of time and intensity required to wake the user and adjusting itself as necessary. We would also like to conduct studies on various controlled groups to determine the effectiveness of our device against devices that are currently on the market.

Although we intend to design the Smart Alarm Clock to have room for future expansion, for the purpose of satisfying ENSC 440 requirements, only the alarm system and light controller module will be developed.

5. Sources of information

As with any project, the development of the Smart Alarm Clock requires reference to many different types of information. One of the major sources of information will be textbooks and other resources from the library. Textbooks help review the foundations of engineering concepts; these quick references save time in analysis and can also give good techniques in solving problems. Books for programming languages will also be used for any software components. Medical journals such as that of the British Medical Journal provide valuable references to further our understanding toward circadian rhythm and chronobiology, two subjects that are applicable to our project.

What will probably be our biggest source of information is the Internet. This is where anything and everything will be available. Up-to-date information on the technology being used in the Smart Alarm can be found. Another important benefit is access to order any required parts. Moreover, Manufacturers' datasheets are available during the development of the device.

Additionally, we are fortunate to have Dr. Ash Parameswaran from the School of Engineering Science at Simon Fraser University as a technical advisor for this project. Dr. Parameswaran has kindly donated his time for any questions that the team will have, and his expertise in electronics will no doubt be an absolute asset to the success of the project. Inglewood Jack Technologies will occasionally meet with the professor for insight on today's technology. In addition, Dr. Andrew Rawicz of the School of Engineering Science at Simon Fraser University has invaluable experience in biomedical engineering as well as entrepreneurial knowledge which provides us with insights in the application of our product for the healthcare sector.

Finally, one of our unique sources of information is a team member's sister, Cathy Su. Cathy holds a Bachelor's degree in Psychology Honours, and will be able to give her insight on issues such as human behaviour and circadian rhythm.

6. Budget and Funding

6.1. Budget

The main goal of the current project is to develop a proof-of-concept model. Table 1 summarizes the anticipated expenditures incurred through the development phase.

Table 1: Budget for the Smart Alarm Clock Development in Canadian Dollars

Module	Component Description	Cost
Alarm Console	MP3 Decoder Module and Development Kit	$ 220
	LCD Modules	$ 90
	Audio Amplifier and Speakers	$ 30
	Microprocessor and Development Kit	$ 120
	Buttons and Inputs	$ 20
Light Controller	Microcontroller and Development Kit	$ 15
	Power Regulation and AC-DC Conversion	$ 30
	Light Dimmer Analog Circuitry	$ 15
	Buttons and Inputs	$ 10
Wireless Intercommunication module	Wireless Communication Module Development Kit	$ 700
Prototype Development	Boards and Miscellaneous Components	$ 150
Contingency (15% of total cost)	May include, but not solely entitled to, extra components required and shipping costs	$ 210
	Total	$ 1610

A conservative cost estimate and a 15 percent contingency have been imposed on the budget in response to the variety of components and development kits required.

6.2. Funding

As the primary source of funding, the School of Engineering Science provides us with 250 dollars toward general component purchases. The fund is based upon a grant of 50 dollars per individual participating in the project.

Competitive funding is also available through applications from the Engineering Student Society Endowment Fund (ESSEF) and the Wighton Development Fund. The two sources provide financial assistance towards undergraduate project development in the School of Engineering Science at Simon Fraser University.

In addition to these accessible funds for reimbursement of the development costs, we will actively search for industry and academic sponsors to aid in the funding of the project. The social and economic benefits that arise as a result of the Smart Alarm Clock project should entice some investors. Further costs will be shared amongst the members of the project development team.

7. Schedule

Table 1 shows the Gantt chart summarizing our time allocation towards individual tasks related to the project. Figure 3 shows the projected dates for various milestones completion. We aim to complete the project before April 1st, 2006.

Table 1: Gantt Chart

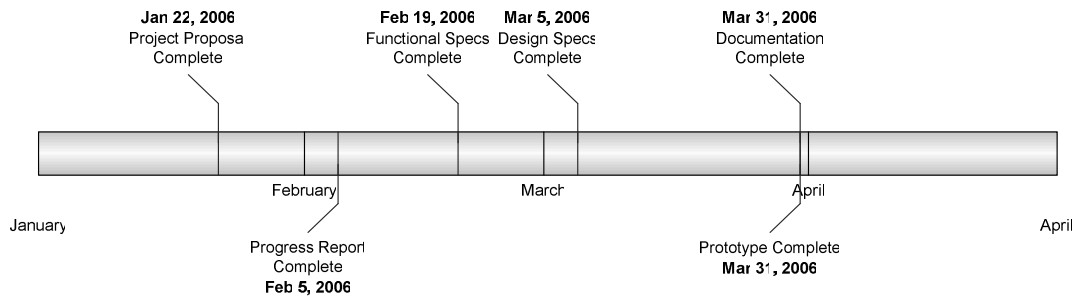| ID	Task Name	Duration	Jan 2006				Feb 2006				Mar 2006				Apr 2006			
			8/1	15/1	22/1	29/1	5/2	12/2	19/2	26/2	5/3	12/3	19/3	26/3	2/4	9/4	16/4	23/4
1	Research	19d																
2	Proposal	7d																
3	Functional Specification	32d																
4	Design Specification	33d																
5	Progress Report	3d																
6	Development/Assembly	28d																
7	Integration/Testing	32d																
8	Debugging/Modification	16d																
9	Documentation/User Manual/Website	83d																

Figure 3: Milestone Chart

8. Team Organization

Inglewood Jack Technologies Inc. strives to provide value-added healthcare products in response to global consumer needs. A dedicated and interwoven executive team consisting of Matthew Ng (CEO), Christian Le (COO), William Ng (CFO), Herman Leung (Chief Hardware Engineer) and Albert Su (Chief Firmware Engineer) provides the central pillar to foster the goal of developing competitive, exciting and novel products. A multidisciplinary knowledge base from this team with diverse technical and organizational experiences will contribute to the success of the Smart Alarm Clock project.

The overall development of the Smart Alarm Clock is shared equally amongst the executive team, while each member is responsible in the management of specific technical or organizational sectors. As the CEO, Matthew Ng oversees the project as a whole and manages organizational issues. Our COO, Christian Le, ensures prompt communication and leads daily operation. William Ng, as the CFO, will undertake the roles of budgeting, fundraising and bookkeeping for the company. Hardware development and integration will be the focus of our Chief Hardware Engineer, Herman Leung, and Chief Firmware Engineer, Albert Su.

Unique to our team design is a shared interdependence structure that promotes efficient coordination and minimal integration bottleneck. Each team member will have opportunities to obtain technical proficiency and understanding in different segments of the project. Such segments include developing the alarm console, light controller and the wireless intercommunication module. These tasks will be assigned to members by not only their strengths, but their interest in the project. Using this strategy will produce a successful project, while allowing team members to work on something they like.

As an ambitious project under a short timeframe, weekly progress report meetings ensure the various milestones are met. The use of the Simon Fraser University Caucus and the eSnips online storage space encourages further communication amongst members for faster decision making and centralization of resources for effective collaboration.

9. Company Profile

Matthew Ng – Chief Executive Officer (CEO)

Matt is a fourth year student studying Electronics Engineering at Simon Fraser University. He is a well rounded individual with previous coop experiences at Agilent Technologies and Total Care Technologies. Matt has had extensive experience programming in Java, but is also capable of coding in C++ and assembly language. Past projects that he has completed includes programming a video game using J2ME, an intelligent traffic control system, and the programming of a robotic arm with unique block detection capabilities on its conveyor belt. Not only does Matt have programming experience, he has also gained circuit design and implementation experience from completing many labs in various electronics courses. In addition, Matt has excellent communication and organization skills and has demonstrated that while working in various occupations such as the City of Coquitlam's program leader and Electronics Boutique's sales associate.

Christian Le – Chief Operations Officer (COO)

Christian Le is completing his fourth year in electronics engineering at Simon Fraser University. He has completed two co-op terms at Glentel Inc. as a systems administrator assistant, where he was involved in projects improving the stability and security of the company's network. His skills include hardware and circuit design, although his strengths lie in software and programming, including C++, VHDL, and assembly. Outside of engineering, Christian enjoys playing tennis, volleyball, poker, and having a nice cup of coffee. At this point, he claims he does not have a coffee addiction or a gambling problem.

William Ng – Chief Financial Officer (CFO)

William Ng is a fourth year student at Simon Fraser University and is pursuing a major degree in Systems Engineering and a minor degree in Business Administration. His areas of expertise are in electromechanical process automation and computer aided design. Through biomedical research in the Experimental Robotics Laboratory and other various projects, he has gained software development proficiency in Java, C, C#, Perl, and assembly language. His work experience at Business Objects involved contractor management and cross-team project organization, and helps to contribute positively to team collaboration and financial organization. A business administration background has given William managerial accounting and organizational behaviour skills for the role of Chief Financial Officer.

Herman Leung – Chief Hardware Engineer

Herman Leung is a fourth year Electronics Engineering major at Simon Fraser University. He has completed 3 hardware related co-op work terms at Novax Industries, VTech, and Quantitative Imaging. He has a passion for electronics which motivates him to excel in his projects inside and outside of work. Aside from his strength in hardware design, Herman is also familiar with VHDL, C/C++, and assembly. Outside of Engineering, Herman enjoys socializing with friends over coffee or beer. On his leisure time, he also enjoys reading about cars and the latest high tech gadgets.

Albert Su – Chief Firmware Engineer

Albert Su is currently in his fourth year studies at Simon Fraser University majoring in Electronics Engineering. He has completed work terms at both Dyaptive Systems as Embedded Software Engineer and Nokia as Electronics Design and Test Engineer. He specializes in mixed signal processing and has a keen interest in developing embedded systems. Besides engineering, Albert enjoys reading magazines about investing and personal finance. On good days he also enjoys going out for a jog or bike ride, or hitting the gym for weight training.

10. Conclusion

William Shakespeare once wrote about the elation of sleep in one of his famous plays:

We are such stuff
As dreams are made on, and our little life
Is rounded with a sleep.
"The Tempest" (1611, 4.1.168-170)

Today, sleep is still gratifying to everyone. With today's society and daily routine, however, millions of people suffer from fatigue due to lack of sleep.

Inglewood Jack Technologies is dedicated to applying technology and knowledge to produce a product that will benefit society and to help people feeling refreshed and energized every morning. Along with this gain, the Smart Alarm Clock also has the potential to allow society to be more productive and successful in their work because of their new-found energy and drive.

Similar devices already exist on the market, ranging from inexpensive clocks to devices using bio-rhythm. The Smart Alarm Clock, however, is more practical, innovative, safe, and easy-to-use. With its unique and useful features, our device will appeal to today's society.

The proposed Gantt and milestone charts show that this project is realistic and can be achieved in the given time frame. Inglewood Jack Technologies is confident that we will use our sources of information, financial sources, and project strategy to make the Smart Alarm Clock a success.

11. Sources and References

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