

January 20<sup>th</sup>, 2003

Lakshman One  
Simon Fraser University  
Burnaby, British Columbia  
V5A 1S6

RE: ENSC 440 – Proposal for a Voice Activated Control System

Dear Mr. One,

Attached, please find our project proposal for ENSC 440: Capstone Engineering Project. Our project involves expanding ProBed Medical Technologies Inc.'s existing "Freedom Bed: a programmable, automatic, laterally rotating bed. The product expansion includes an add-on device implementing voice control to allow disabled patients unable to operate the button-based user interface to control the bed and gain independence.

Our project proposal includes a summary of our team's vision and mission, an overview of the design problem, a comparison of possible solutions and our proposed design solution. We have also included the sources of information we have consulted to date and that we intend to extract knowledge from in the future. We have provided a preliminary budget and funding plan, and an initial schedule.

The Dokkō Design team members include five energetic, talented, and hardworking senior engineering students with special interests including electronics, computers, physics, systems integration, and biomedical applications. I invite you to refer to our team organization and company profile sections to learn more about the Dokkō Design team members.

If you should have any comments or queries about the included document please feel free to contact me by email at [jmcalist@sfu.ca](mailto:jmcalist@sfu.ca) or the team at [lannj-440@sfu.ca](mailto:lannj-440@sfu.ca).

Sincerely,

*Jessica McAlister*

Jessica McAlister  
President & CEO  
Dokkō Designs

Enclosure: Proposal for a Voice Activated Control System



## Proposal

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Jessica McAlister  
Loïc Markley  
Nick Meisl  
Adam Stefanski

Contact Person: Jessica McAlister  
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Submitted to: Lucky One – Ensc 440  
Steve Whitmore- Ensc 405  
School of Engineering Science  
Simon Fraser University

Date Issued: January 20th 2003

## **Executive Summary**

Decubitus ulcers, more commonly known as bed sores, are caused by pressure or friction against the skin and can range in severity from a slight pink discoloration to a deep wound extending through internal organs to the bone. Patients who suffer from a lack of mobility and spend much time in bed are at a high risk of developing bed sores unless they are rotated at regular intervals. This work is usually performed by a care aid. The patient is dependent upon another individual.

Pro Bed Medical Technologies Inc., has developed the Freedom Bed, “a programmable, automatic, laterally rotating bed designed to meet the needs of those patients with, or at risk of developing bedsore and other complications of immobility”. The bed may be programmed to perform a series of rotations or controlled in real time using a series of buttons. Many patients are physically unable to operate the bed controller and therefore someone must still control the bed for them. The patient is still dependent upon another individual.

## ***Dokkō*** **Self-reliance, autonomy, independence**

Independence is a luxury often taken for granted. When reduced or limited, independence becomes a great desire. This document proposes an add-on device to Pro Bed’s Freedom Bed aimed to greatly increase the independence of the user. Using speech recognition technology, all the functionality of the Freedom Bed will be put at the disposal of the user. In order to operate their bed and prevent bed sores and improve comfort, the patient will have no dependence on another individual.

Dokkō Designs is composed of five senior engineering students whose chosen study concentrations and work experience cover a wide range of engineering fields: computer, biomedical, physics, electronic, and systems integration. The pooled skill sets of its members include signal processing, analog/digital circuit design, microprocessor programming, and hardware design.

The development of this project will take place over a 13-week period, culminating with a working prototype by April 1st 2003. This will be accomplished on a projected budget of just over \$700 with funding coming from Pro Bed Medical Technologies Inc.

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## Introduction

Immobile patients, who spend much of their time in bed, are at a high risk of developing bed sores and accumulating unhealthy amounts of fluid in their lungs if they are not rotated periodically. Previously, a patient needed to be physically rotated by a care aid regularly during the day and night, confining the patient to be dependant on a care giver.

ProBed Medical Technologies Inc. is a young company based in Abbotsford, British Columbia that recently released the Freedom Bed. The Freedom Bed is a computer controlled, laterally rotating bed designed to meet the needs of those patients with, or at risk of developing pressure sores and other complications of immobility. The Freedom Bed may be operated in either manual or automatic mode and is smooth and silent so as to provide the user with a good night's sleep while preventing bed sores and excessive fluid build up in the lungs.

Unfortunately many users are physically unable to operate the button controls for the bed, and are therefore still dependent on aid.

To the best of our knowledge, there are currently no self-turning beds on the market that can be operated by those who are physically unable to operate a conventional button-based user interface.

Derived from the Japanese word for independence, Dokkō Designs proposes to design and build the prototype for a device that will give autonomy to the user when operating their self-turning bed: Freedom Voice Control. Freedom Voice Control will be a stand-alone, plug-in addition to the Freedom Bed and will implement all the features of the conventional button-based user interface using speech recognition technology.

As the speech patterns of the Freedom Voice Control's potential users may be irregular, Dokkō Designs will focus on ensuring that our product is highly reliable and works for each user. This will be accomplished by using a trained speech recognition system. In training the device, the system will be tailored to each user's unique speech pattern.

This document is a proposal for the Freedom Voice Control system including the system overview, a comparison of various design solutions and our proposed design solution. In addition, a budget and sources of funding are discussed and an engineering cycle schedule are presented in the form of a Gantt and Milestone chart.

It is hoped that the Freedom Voice Control system will ensure that the full functionality of the Freedom Bed may be used by a wider range of patients. Dokkō Designs aims to provide independence to a wider range of patients.

## System Overview

The Freedom Bed, a product of ProBed Medical Technologies Inc. is a self-turning bed operating in either manual or automatic mode, and has various actuators to create an array of comfortable positions including sitting, feet-up etc.

Below, figure 1 shows pictorially how the Freedom Bed rotates the patient:



**Figure 1: Turning Motion of the Freedom Bed ([www.pro-bed.com](http://www.pro-bed.com))**

While in manual mode, the user may operate a button activated control wand that changes the status of the bed as follows

- The angle to which you will be tilted on your side ( $0^{\circ}$ - $30^{\circ}$ , left or right side)
- The level of inflation or of air bellows beneath the mattress to elevate legs or head
- The level of the head or foot board of the bed, as shown in figure 2



**Figure 2: "Hi-Lo" option for Freedom Bed ([www.pro-bed.com](http://www.pro-bed.com))**

Many clients, however, are physically unable to operate the control wand, and therefore need aid from another individual in order to take advantage of the features of the Freedom Bed while in manual mode. To

eliminate the dependence of the patient on a care aid to operate the bed, Dokkō Designs proposes a novel new add-on controller: the *Freedom Voice Controller*.

By utilizing the latest voice recognition algorithms, the Freedom Voice Controller will allow a user to speak aloud and an advantageously positioned microphone will pick up their voice. Next, the command will be filtered, processed, and sent out to the command on a Controller Area Network (CAN) bus to the existing control module on the Freedom Bed. Based on the received command, the control module will control the appropriate actuators and motors on the bed. There will also be a user interface to allow programming of the Freedom Voice Controller and to disable voice control.



## Possible Design Solutions

The problem we are addressing with our Freedom Voice Control is the need for bed-ridden patients to easily control the actions of their bed, even when physically unable to manipulate a key-pad. Some possible solutions to this issue will now be discussed.

### *“Sip and Puff”*

The “sip and puff” switch can be used by extremely immobile patients who maintain only the control of core functions or facial movements. An air tube is strapped to the patient such that the open end is positioned directly in front of their mouth. The tube recognizes the higher or lower pressure in the tube created by a “sip” or a “puff” by the patient. Commands could be inputted in Morse code format and translated into electronic signals that would be sent directly to the Bed.

### *Light Touch Buttons*

This solution uses large size ultra-low touch buttons to convey minimal commands to the bed. Very few buttons can be used as even the slightest movements are sometimes very strenuous. A light tap or touch and hold can represent different commands allowing the patient to control basis features of the Bed.

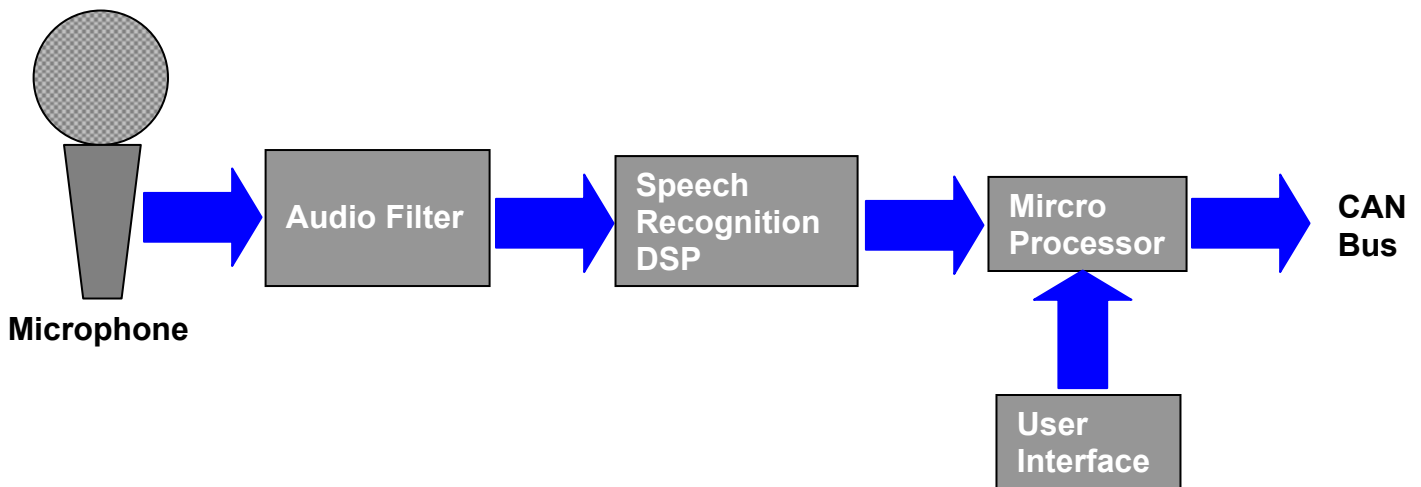
### *Voice Control*

Voice control utilizes on-the-market DSP chips that can decode the spoken voice and match words with a database for voice recognition. The chip can be personalized to a specific patient by recording the patient’s voice into the database for future match-up. This allows for patients with weak and strained voices to be able to control their bed. A directional microphone can be used to filter out undesired voices.

## Proposed Design Solutions

To implement the voice recognition feature of the Freedom Bed we will create a stand-alone device that can be integrated into the bed by simply plugging it into the existing system. The device will be a small box containing the control board with a phone jack at one end and a microphone on the other. A user interface with several buttons and LEDs will be used to initialize the device to a specific patient.

The signal path from voice to bed will flow through a microphone, DSP voice recognition chip, micro-controller, CAN controller, and finally to a CAN transmitter. The DSP chip we are currently looking at functions also as a micro-controller but we may need to incorporate an external Flash memory to our DSP chip to be used as a database to store the voice recordings of the patient's voice commands. Off the micro-controller, we will also setup a small speaker system to be used as feedback during the programming phase. The below figure shows the high-level implementation of Freedom Voice Control proposed by Dokkō Designs.



This device is to be used by people who, because of their physical disabilities, have difficulty using a touch pad or button control to operate the functions of their Bed. In some cases, the patient's condition may have degenerated to the point where clear speech itself becomes difficult. For these reasons, our voice recognition device becomes more than just an electronic issue, but a usability issue as well.

## Sources of Information

During the research, design and implementation phases in the creation of the Freedom Voice Controller, there are various sources of information that should prove invaluable.

As the Freedom Voice Control system will be created for the Freedom Bed, created by ProBed Medical Technologies Inc., the technical staff at ProBed will be consulted on a regular basis. A dialogue with the company has already been established and a thorough overview of the Freedom Bed product was given. In particular, personnel at ProBed who directly relate to clients of the ProBed will be used as a means of determining how the Freedom Voice Controller can best be designed to meet the needs of patients.

While solving problems of a technical nature, course textbooks and articles will be consulted. As the field of speech recognition has seen major advances very recently, the Internet will serve as a great source on information and ensure that our product will employ the latest algorithms in its digital signal processing capabilities.

As there are professors at the School of Engineering Science at SFU whose specialties include Biomedical Engineering, their expertise will be consulted regularly. The field of voice recognition has been investigated in the past by students in order to implement a Voice Controlled Submersible and a Voice Controlled Television Remote Control.

## Budget and Funding

### *Budget:*

Table 1 shows a tentative budget for the prototype development of the Freedom Voice Control based on our proposed system concept. The resources are grouped by system modules to simplify the budget. These are preliminary figures and are subject to change. Also included is a 20% contingency fund to allow for some unpredicted expenditures.

**Table 1: Freedom Voice Control**

<b>Resource</b>	<b>Estimated Cost</b>
Voice Recognition Module	\$200
Logic Module	\$150
CAN Connection Module	\$75
Microphone Module	\$75
User Interface Module	\$100
<b>SUBTOTAL</b>	<b>\$600</b>
20 % Contingency Fund	\$120
<b>TOTAL</b>	<b>\$720</b>

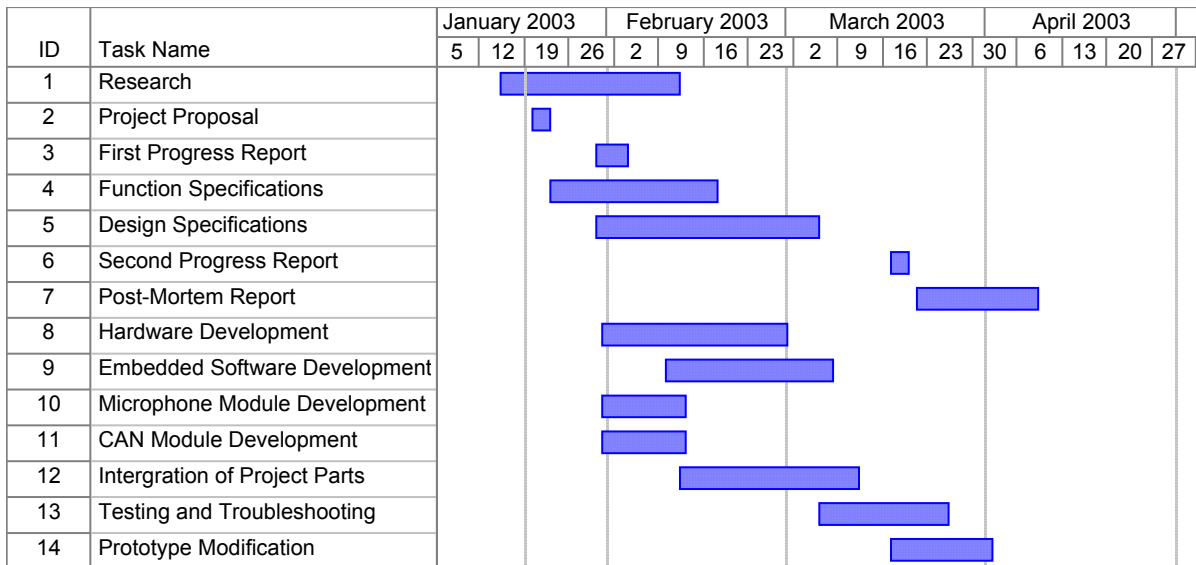
### *Funding:*

The development of the Freedom Voice Control requires a significant amount of capital to complete a functional prototype. As this project is designed to be an add-on device for the Freedom bed, thereby increasing the market value, Pro-Bed Medical Technologies Inc. will be covering the development cost of the project.

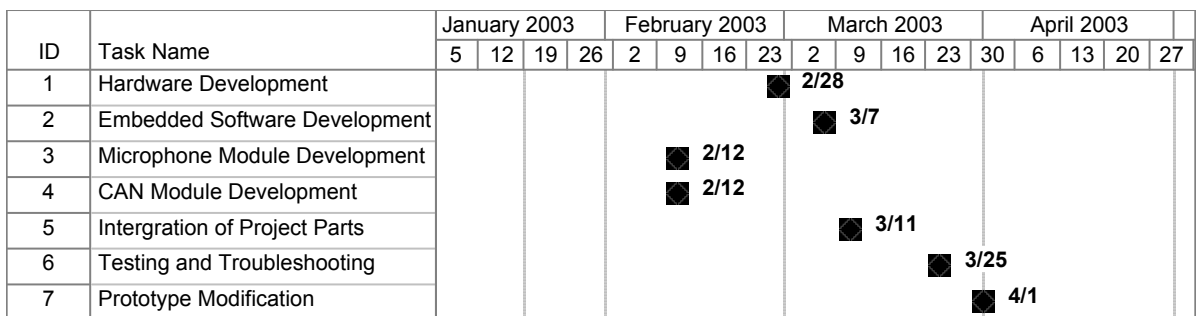
## Schedule

The following figures contain an outline of the proposed completion schedule for the Freedom Voice Control. Figure 3 shows the Gantt chart of the expected time to be spent on the development of the different modules and also the documentation required. Figure 4 shows the technical milestones for the Freedom Voice Control.

**Figure 3: Freedom Voice Control Gantt Chart**



**Figure 4: Freedom Voice Control Milestones**



## Team Organization

Dokkō Designs is made up of five engineers with various specializations including computers, electronics, physics and biomedical applications. Synergistically coming together to produce this device, each team member brings his or her expertise to the effort.

The major tasks and areas of focus have been tentatively designated as follows. Jessica McAlister will act as President and Chief Executive Officer (CEO), orchestrating team interactions as well as industry relations with ProBed Medical Technologies Inc. Nick Meisl will act as Chief Operating Officer (COO) in charge of Software and Hardware integration. Adam Stefanski, the ex-business major, is acting as CFO and will manage all budget and financial concerns. Loic Markley is Vice-President Hardware and Natisha Joshi is Vice-President Software.

The Dokkō team recognizes that to succeed with a project, of this magnitude, positive team dynamics will be paramount. To ensure beneficial dynamics, regular, productive team meetings and efficient distribution of tasks will be practiced.

Dokkō Designs convenes for a formal meeting every Monday evening at 4:30PM. Informal gatherings in the lab or pub are also common as well as the occasional impromptu foosball game. During meetings weekly progress and problems encountered will be discussed. Most importantly, meetings are for coming up with action items for the following weeks.

Meetings will also be a time for task distribution. To achieve the highest efficiency and performance, Dokkō Designs will acknowledge the strengths and weaknesses of its members in order to ensure individuals will work on a task where their strengths are an asset. Dividing the work is based on individuals volunteering to perform a task. The Dokkō team consists of five over-achievers with varied enough skill sets that we do not foresee a problem in dividing the work evenly.

## Company Profile

### Natisha Joshi

Natisha “Latisha” Joshi is a young, attractive, East-Indian with a steady boyfriend. She comes from a stable Saskatchewan family with good values and can bring more than just her brilliance to this group. A culinary expert and owner of exotic plant species, Natisha is an aspiring Computer Engineering student with a good background in both software and firmware programming. She has added her expertise to EDFX and Datotech Systems and in more lucid moments, was involved in the marketing of a self-trolling fishing lure. Natisha is our Vice President of Software and we expect great things from her. – by Loïc



### Nick Meisl

This fella weighs in at 230 pounds and when not trimming his fierce Grizzly Adams facial hair with his 27” Stihl saw, you'll find him checking out Asian princesses on HotOrNot.com. Rough-and-tumble on the outside but all heart within, Nick lives in New West with his mommy and daddy. Nick is the co-op guru of the group with twenty months of high-tech work under his massive belt buckle. Nortel, Galian Photonics, Creo, and NTT (in Japan) are all proud to list "Big Nick" as one of their past employees. He is a moral engineer-in-training specializing in both the Physics and Biomedical streams with high hopes for the future. He hopes to change the world one project at a time. – by Adam



### Loïc Markley

Hailing from Whitehorse, Yukon Territory, Loïc Markley has proven himself quite capable of surviving in sub-arctic temperatures. Other than grooming his husky “Sparky”, Loïc lists the development of technology for biomedical applications as his foremost professional interest. Through his work at Nortel, Western Clinical Biomedical Engineering and XXCAL he has become skilled at software and hardware integration. Loïc spent the past six months of his life hitch-hiking, trekking and camping through the backwoods of Japan with little more than



a camp-stove and smile for any burly trucker willing to pull over. Performing the facilities of “Vice President of Hardware” should be a walk in the park. – by Nick

## **Adam Stefanski**

Adam joins the Dokkō team from Warsaw, Poland. He immigrated to Canada with his family when he was six years old and proceeded to settle in beautiful Surrey, BC. He is a young, energetic, single, white male eager to take on any challenge. Adam joins the engineering discipline from his previous field of study, Business Administration. He enjoys skiing, snowboarding, windsurfing, golf, soccer and roller-hockey. Adam is particularly talented at and finds especially exciting hobbies



including modern and dynamic control of feedback systems, sensors and actuators, data communication, real-time and embedded systems. His future plans include an internship in Japan and settling down at his parents' family residence in Surrey BC. – By Jessica

## **Jessica McAlister**

As President and CEO, Jessica provides Dokkō Designs with a wealth of knowledge, expertise, and inspiration. Born and raised in Abbotsford, British Columbia, Jessica has developed her technical skills during her time at Silent Witness and Yaskawa in Japan. Now specializing in Electronics Engineering, Jessica's previous physics and mathematics background has provided her with a strong foundation for system modeling. A fan of beverages, Jessica mango slushie bubble tea and Bubba kegs and is currently in a long-term relationship. In her spare time, she works out and enjoys sports such as basketball, in preparation for the Ironman competition. A tough competitor on and off the court, Jessica is equipped with the necessary skills to lead the Dokkō team to success. – By Natisha





## Conclusion

Dokkō Designs is driven to provide self-reliance, autonomy and independence. This document has proposed the Freedom Voice Controller, a system that will do just that. The Freedom Voice Controller will be an add-on system to the Freedom Bed, a self-turning bed developed by ProBed Medical Technologies Inc. Currently, when operated in manual mode, the Freedom bed is controlled using a button-based user interface. Many patients are physically unable to operate the button controller.

The proposed Freedom Voice Controller will allow all patients to take advantage of the many features of the Freedom Bed. Using advanced voice recognition digital signal processing technology, Dokkō Designs aims to ensure that the system is easily trainable, thereby allowing it to be used by any patient, regardless of voice type.

This document has proposed the mechanisms by which a reliable prototype will be developed for the Freedom Voice Controller. The shown Gantt and Milestone charts illustrate that this project will be completed on time. The funding section has described that full funding for this project has been obtained. The Dokkō Designs team is eager to accomplish our objective: providing independence to more.

## References

1. ProBed Medical Technologies Inc.,  
Contact Person: Steven Plummer  
[www.pro-bed.com](http://www.pro-bed.com)