TechStyles Incorporated

January 18, 2009

Prof. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, B.C. V5A 1S6

Re: ENSC 440 Project Proposal for The Nomad Digital Pen

Dear Prof. Leung:

The attached document, *Proposal for The Nomad Digital Pen*, outlines our project for ENSC 440 (Capston Engineering Project). Our goal is to design and implement a pen that can sense the motion of the tip and save the result of drawings/writings to a memory built inside the pen. Then the user can transfer the result as an image file onto a computer. This pen will also have the ability to transfer the drawings in a real-time mode onto the computer over a wireless communication.

The purpose of this proposal is to provide an overview of our proposed product, an outline of the design considerations, our sources of information and funding, a tentative projected budget, and information on project scheduling and organization. This document also explores alternative (competitive) forms of the digital pens out in the market or the ones that have the potential to be in the market.

TechStyles Inc. consists of five motivated, innovative, and talented fourth-year engineering students: Zhen Gang Xiao, Simran Sarai, Unnati Sapre, Sam Hoque and Behzad Jazizadeh. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (604) 518-9152 or by e-mail at *nomadpen@techstyles.ca*.

Yours Sincerely,

Behzad Jazizadeh
President and CEO
TechStyles Inc.
Enclosure: *Proposal for The Nomad Digital Pen*

THE PROPOSAL FOR THE NOMAD DIGITAL PEN

Techstyles Incorporated

Project Team: *Zhen Gang Xiao*
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Submitted to: *Prof. Patrick Leung – ENSC 440*
Steve Whitmore – ENSC 305
School of Engineering Science
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Issued date: *January 18, 2009*

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EXECUTIVE SUMMARY

It has happened to almost all of us as we have been in a special situation where we needed to write a piece of information from a sign, an address or someone's phone number, then after looking for a pen and a piece of paper for a while, the sad fact that we missed the chance to somehow write and record the information at that has remained has been the frustration and the note to ourselves that: "next time I should have my pen and a piece of napkin with me!". There special cases happen to us almost every day.

The Nomad Digital Pen is hence proposed to overcome these frustrations. It can write on virtually any surface with any slope and then store the information in a memory that is built-in. The Nomad Digital Pen has great social and educational benefits. This pen eliminates the need for paper of any type, hence virtually eliminates a great portion of paper sheets needed to be manufactured. It is, as a result, a benefit to the society when it just has a fixed cost of purchase and takes off the continuous cost of purchasing paper sheets over its life time. On the other hand knowing the fact that competitive similar products are already in the market mainly targeted to students of any educational level, this pen brings the same writing functionalities with the advantages of being stand-alone, capable of storing data in its built-in memory, being paper-less and over-all being an on-the-go pen.

There are two major design branches to this fairly-complex project. In one hand is the hardware and firmware design. The information about the location of tip of the pen is sensed by a set of accelerometers (for translations) and gyro-meters (for rotations), the analog input signals are then converted to digital form and processed by the Micro-Controller. The data is then transferred to the (Nand-flash) memory.

On the other hand is the software design. The information is then transferred to the computer either in real-time mode (while writing) or after storing in the memory and connecting the device to the computer. The data transfer from the pen to the computer and then the translation to pixels being On/Off will happen in real-time. A session (file) is opened every time the pen is ON and is closed when it is OFF. A cursor is on the screen, moving according the movement of the pen at all times. The screen refreshing resolution, sampling frequency and the delay between capturing data and sending data are of the challenges to overcome in this project.

TechStyles Inc. consists of five fourth-year engineering science students with experience and expertise in analog/digital circuit design, signal processing and electro-mechanical transducers. TechStyles' members are also well trained in a wide range of software/hardware design, real time - embedded operating systems and microprocessor assembler programming. In addition to the individual member each being an initiative, the TechStyles team employs a great deal of hard work as being part of a progressive team.

The proposed engineering cycle for this project which involves extensive and continuous research, design, and implementation will span over a 14-week period with April 7th, 2009 as the scheduled completion date for an operational proof of concept. The entire project is tentatively budgeted at $1100.00, which the TechStyles team will expect to obtain from a variety of funding sources.

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1. INTRODUCTION

The Nomad is an on-the-go device that offers a great deal of usability while it is very intuitive and easy-to-use. The Nomad is stand-alone, it does not need a second piece to come with it, has every necessary part and component built-in, by the nature of its design. It is paper-less, does not need a paper of any kind to write on, it does not need to record on a paper; it records the data on its built-in memory.

Thus, the first objective of the project is to build the pen using a certain type of positioning sensor that does not need a reference point. In other words, this positioning sensor captures a range of analog signals that are corresponding to the absolute position of the sensor and NOT relative to a reference position. In this regards, the motion is divided into two major types, namely translational and rotational. Signals corresponding to translations and rotations are then digitized using an Analog to Digital Converter.

Furthermore, since the pen is to be paper-less, the second objective is to store the digital signals (then converted to a JPEG image format) on the memory in the form of a JPEG file.

Finally, the third objective of the project is to be able to transfer the digital signals to the computer on the screen being converted to a series of ON/OFF pixels and eventually an image file. This needs to be done in real-time with a reasonably high sampling rate, so that the user is able to monitor what they are drawing, instantly on the screen.

The three milestones mentioned above, are considered to be necessary for the proof of concept of the project, before moving on to the next level which will be the steps forward in making a working prototype.

Every time the pen is turned on, the sensor will sense the movement but will not record it until we touch a surface in which case the signals are recorded. Correspondingly a file (session) will be opened to save the converted data. This session will then be closed as soon as the user turns the pen off. Now this file is the same as a regular image file ready to be transferred to the computer. The transfer method is considered to be over a normal serial connection (RS232) for the proof of concept and later on will be converted to a common Universal Serial Bus connection as we progress. Also it time permits, a second communication method is considered over Bluetooth with the use of a Bluetooth transmitter built-in to the Nomad Pen.

The Graphical User Interface (GUI) is considered to be kept simple as to make it less troublesome to design and develop. It is proposed to have basic menu components and a drawing window. However, as we move forward, certain different features can be added to the base application. One of the challenges in developing the GUI is how to make the best use of real-time programming features in a windows OS environment, although there are a couple of alternatives as to which method of real-time programming (adapted to Windows OS) we choose to work with.

Finally it comes to the documentation in this project, which would be a critical and time consuming part of it, as this project involves extensive research and investigation as to adapt certain design specifications to feasible design methods; approaches that are to be practically possible to proceed in a timely manner.

2. SYSTEM OVERVIEW

The proof of concept is proposed to be a set of components interacting under the supervision of an MCU (Micro-Controller Unit). The MCU acts as a simple Input/output black box with the analog signals from motion transducers being input and the converted digital signals transmitted to the computer from the USB or Bluetooth being output. Figure-1 below shows the schematic of the concept with the MCU illustrated as a black box. In this view, the bi-lateral control lines can be seen that provide control over all the different units for the MCU. Also, data I/O lines can be seen.

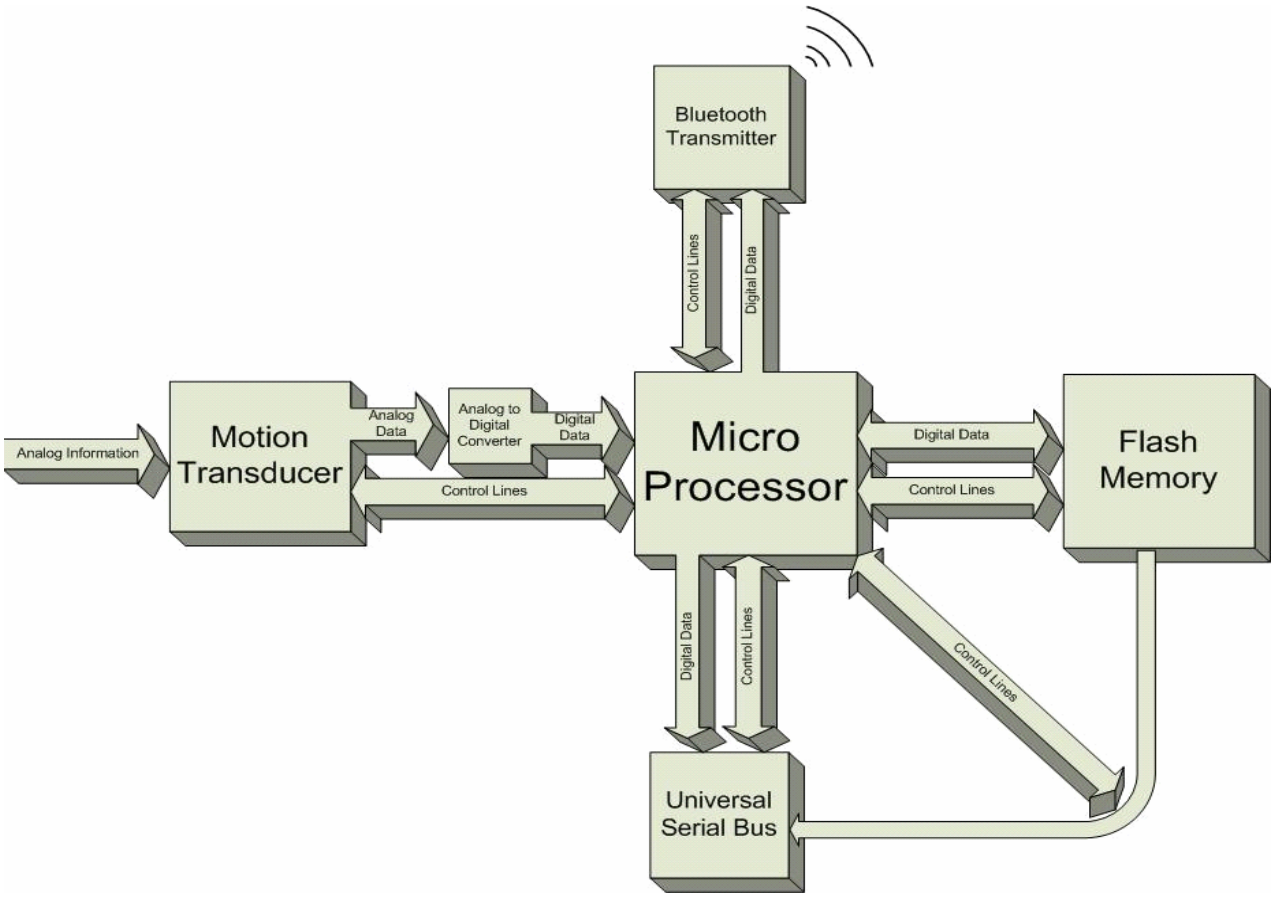

Figure-1, Basic Functional Diagram

The MCU has a built-in oscillator that generates the clock signals and takes care of the timing. The diagram on the next page illustrates a more detailed schematic of the concept with some of internal connections to the MCU and other units.

In this diagram (Figure-2 below), all the data lines and control lines are shown as single conceptual connections. The MCU consists of the following main sub-units: CPU, two forms of memory: RAM (Random Access Memory) and EEPROM (Electronically Erasable Programmable Read Only Memory), the GPIO (General Purpose I/O), the A2D (Analog to Digital converter). The CPU communicates with the Bluetooth transmitter and also the NAND-flash memory via the SPI connection mode.

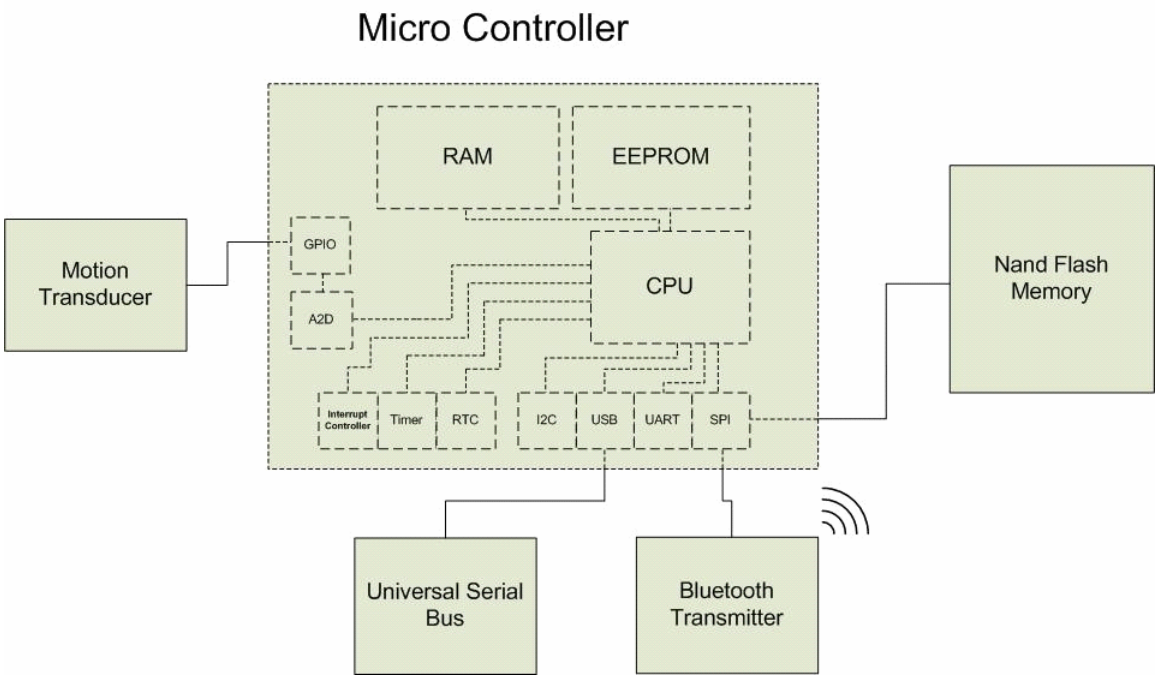

Figure-2, a more detailed functional diagram

Figure-3 below shows a conceptual schematic of how the Nomad Pen would ideally look like. The usability and intuitiveness as well as the stand-alone characteristic of the pen are well being illustrated in this concept design package.

Figure-3, Concept Design [8]

3. POSSIBLE DESIGN SOLUTIONS

Currently in the world of digital and mobile devices, there are a number of different ways to capture and store hand-drawn information. Although current devices do similar jobs for capturing written/drawn as digital information in similar conceptual form, the technological approach which is mainly related to the sensing mechanism is sometimes quite different. Based on the technology, these pens still have many disadvantages. One of which is that these devices are not stand-alone, always requiring extra pieces such as base station, wireless module and all types of cables and connectors. The need for a device that can come in one single piece with no other accessories or peripherals is sensed. The other disadvantage is the fact that some of the devices in the market require papers and writing sheets and some of them need a special form of paper to write on. Some of the devices currently used are listed below.

3.1 EPOS Digital Pen

EPOS pen employs a technology of position sensing based on a base station as the reference point and the pen that moves relative to the base. The position of the pen is continuously sensed relative to the base via the ultra-sonic waves as the sensing technology. The ultra-sonic waves are being transmitted from the pen to the base (which acts as the receiver). Thus this pen comes in two separate pieces, the pen and the base (which is also a USB flash memory). To use the EPOS pen, the user must install the base onto the paper on which they want to write, as a clip, as the distance is a critical issue when transmitting ultra-sonic waves. The base records the position data constantly for later upload to the computer.

3.2 LifeScribe Pulse

LifeScribe on the other hand utilizes a very simple and straight forward technology, image capture using a small camera installed near the tip of the pen. This way when the user starts writing, the camera starts capturing the images, continuously. There is also a microphone built in the pen that can capture voice while recording the images. Later on when the user reads over the notes, based on the previously captured images, the pen starts playing the voice. But for one fact, the LifeScribe requires the user to have a special type of paper that has certain symbols, lines and characters printed on. These symbols such as play forward and stop help the camera to execute the corresponding functionality that is play, forward or stop.

4. PROPOSED DESIGN SOLUTION

TechStyles proposes a design solution in which virtually all the disadvantages of the other competitive/alternative products on the market are eliminated. The concept of this design is based on the type of sensing technology that does not require a base station or a reference point to communicate with. It also does not require any type of paper to write on.

The movements of the tip are divided into two main categories, namely translational and rotational. A tri-axis accelerometer (possibly with a built-in A2D, although the MCU would provide that in any case) will sense the motion in all three x, y and z axes, thus providing three degrees of freedom for the movements. The accelerometer chosen for this project is the KXPS5 made by Kionix Corporation and has a sensitivity of ± 3g. However, the problems rises when the tip of the pen goes through rotational movements in which case the accelerometer is not going to be able to sense the motion. Here we propose the idea of using the angular sensor as to compensate for rotations. Thus a tri-axis angular sensor or alternatively three single-axis angular sensors will provide sufficient information about the angular movements. The sensitivity of the angular sensor is ± 100 °/s and the special angular sensor proposed for the purpose of this project is the XV-3500 CB by SureElectronics Corporation.

Micro Controller Unit (MCU) is the brain to the entire Nomad Digital Pen concept. The MCU controls the timing for all data transfers to the unit and from the sensors and vice versa, with clock pulses generated via the built-in oscillator internal to the MCU. The MCU model proposed for this project is the PIC182550 28-pin DIP by Microchip Corporation. This MCU is USB compliant and on-chip USB transceiver with built-in EEPROM, featuring four timer modules.

In the proposed design, the user turns on the pen and a session will open. As long as the tip is touching the surface, the pen records the movements, but the sensors are constantly sensing the movements whether or not the tip touches the surface, so long as the pen is on. Turning off the pen will close the session and save the image file. However in case of connection (wired or wireless) to the computer, sensors constantly sense the movement and show it as a cursor on the screen.

Apart from the design challenges, the main constraints in completing the project are the limited time interval and limited funding. This project is to be completed in less than three months (thirteen weeks), while the members of TechStyles will need a larger time interval for the project to fit and reach to the stage of prototype. On the other hand, members must seek funding on their own initiative within the proposed project timeline. Nevertheless, the members of TechStyles will deliver a working proof of concept within the time frame. It is however worth noting that as the time permits and the funding is provided, TechStyles would be able to develop a more robust unit and move towards making a prototype.

5. SOURCES OF INFORMATION

The Nomad Digital pen, unlike many other engineering projects, requires a great deal of research, analysis and investigation which will be going on from the beginning to the end of the project that the proof of concept is ready to test and after that for prototyping. In this regard, TechStyles team will require having access over a considerable amount of information from a variety of resources.

Course textbooks are a great set of resources. Specifically related to hardware design, the TechStyles team could find a number of text books that are going to be largely useful throughout the entire design and implementation process. In addition the engineering handbooks as well as references for software design and embedded programming.

Electronic papers and articles along with some public patents were and still are going to be useful, in order for us to find any possible competitors and/or alternatives to the Nomad design. They also help the team in examining different ideas at least up to a theoretical level to watch out for failures as much as it is possible.

Data sheets for different pieces of components from their corresponding are all absolutely essential pieces of information to us in this project. They give the exact and specific information about different operational characteristics and any hardware/software features available with the product.

The Internet itself in general is an invaluable source of information. In regards to purchasing equipments and components, searching for funding resources, online communities of experts in a certain engineering field are just a few of the very large number of ways internet can facilitate our approach in research for the project.

Furthermore, several faculty members and staff in the school of engineering science are great sources of information and help in virtually any aspect of our project. The laboratory staff, also, have always been extremely helpful and them being there in the lab gives the great feeling that they are always going to be there for you virtually whenever you need their advice, help and considerations in different aspects.

Finally, individuals from other universities and/or companies who have a great deal of expertise, knowledge and experience are willing to help us in more detailed technical problems through-out the project.

6. BUDGET AND FUNDING

6.1 Budget

The outlined budget for the proposed project, The Nomad Digital Pen is as follows in Table-1. Note that this budget outline is tentative and is subject to increase at any time during the time frame of the project. For a majority of the list the name of the main component has been listed having any accessories or other sub-components or parts grouped and embedded in the name of the main component. Also it is worth noting that all the estimated prices do include possible shipping costs, customs agency tariffs and any other applicable taxes and/or fees and therefore they may have been overestimated by at least 15% to compensate for contingencies.

Equipment List	**Estimated Unit Cost (in Canadian)**
Tri-Axis Accelerometer	$50
Tri-Axis Gyro-Meter	$100
Micro Controller	$50
MCU Programmer	$50
Cables / Connectors	$100
Serial Interface Chip	$50
PCB / Signal Conditioning components	$200
Other	$500
Total Cost	**$1100**

Table 1: Tentative Budget

6.2 Funding

As it is the case with research, design and implementation of any proof of concept and eventually a prototype, the development stage of the project requires a relatively considerable capital to inject in, than the cost of the product in the assembly line. Due to the high cost of this project, many sources of funding are being considered. TechStyles has been in the process of applying for the Engineering Science Student Endowment Fund (ESSEF). We are also planning to enter our design in several competitions in the future, such as WECC (Western Engineering Conference and Competition) in January 2010 and other engineering competitions hopeful of reimbursing our members.

The team is also searching for other possible funding options that either the school of engineering science or the faculty members are offering. With no doubt, the subject of this project has been of interest to some of the members from the faculty of business. Thus TechStyles is hoping they can get sufficient help from possible venture capitalists from that department as well.

TechStyles has also proposed this project and its business, marketing and financial aspects in the Ken Spencer competition where the TechStyles won the second prize of $1500 (of which only one fifth can be considered to be dedicated to the project since only one member of that competition is involved in this project). Our team members are willing to accept that we may not be able to generate enough original capital to sufficiently fund the entire project. If such circumstances arise, our team members are willing to share the remaining financial costs of the project equally. An accurate account of all financial transactions will be kept to ensure proper reimbursement to members.

7. SCHEDULE AND MILESTONES

The Gantt chart below shows a tentative timeline for the project. The mentioned dates are rough estimates and may vary and change over the time frame of the project. Figure-4 shows this chart. Also corresponding to expected completion dates for different tasks the diagram in Figure-5 is provided.

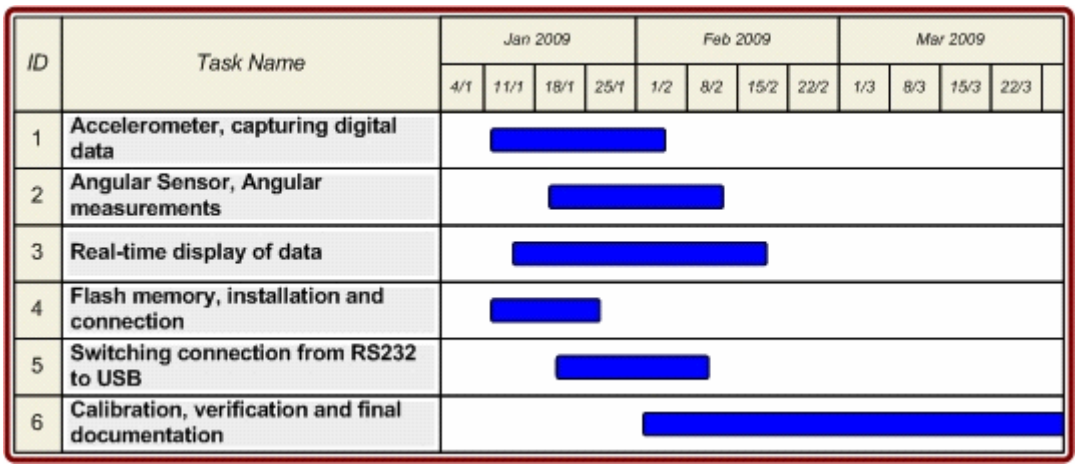

Figure-4, Gantt chart and Milestones of the Nomad project

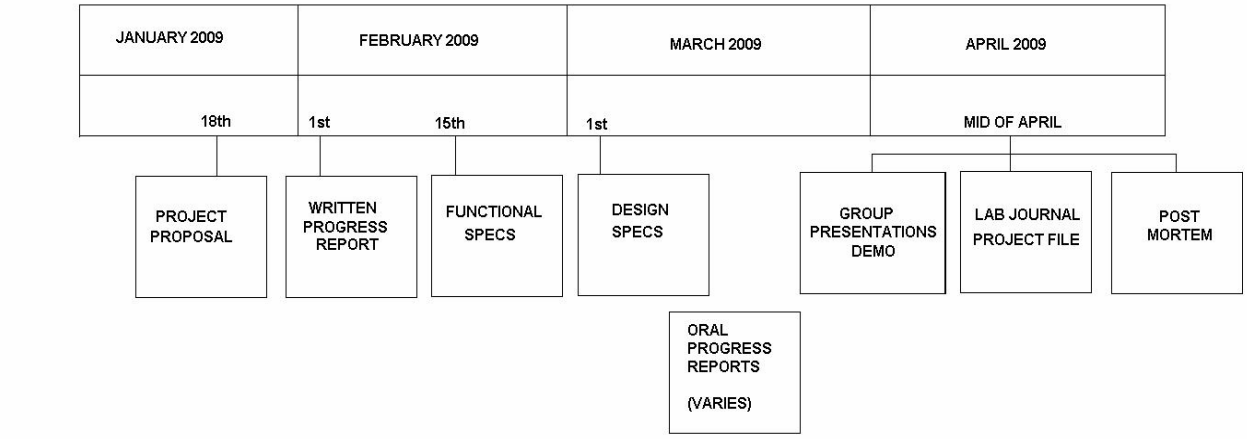

Figure-5, Diagram for deadlines and Milestones of the Nomad project

8. TEAM ORGANIZATION

In the organizational frame of TechStyles Inc. the following five engineering students with different engineering options are getting to gether in order to make this project and this course a success. Zhen Gang Xiao, Simran Sarai, Unnati Sapre, Sam Hoque and Behzad Jazizadeh are all in their final year in engineering science, with options listed as Systems and Electronics engineering. This variety plays a key role is all member's contribution to the project. It also has a great deal of importance when different skills and experiences tend to overlap to create a solution for a problem that involves both systems and electronics fields.

TechStyles is organized as follows: for every team member there is specific roles, officialities and responsibilities considered for the corporation to run, while at the same time, many of the tasks assigned to members are done done in teams, as the scale of the project suggests. Behzad Jazizadeh is the Chief Executive Officer (CEO) and also the Chief Financial Officer (CFO). Behzad is in charge of general management of the organization and performs an overall supervision on the project team. Simran Sarai, Chief Operations Officer (COO) manages the operation of the project in a high level. She also sets the overall milestones and project timelines and deadlines. Zhen Gang Xiao is the Chief Technical Officer. Zhen is going to be the technical manager and he sets different technical tasks to members. Unnati Sapre is the Vice President of Technical. She is a right wing for Zhen in technical decisions as well as the division of the work load among members. Sam is going to be the Vice President of Operations, who is responsible for detailed weekly and daily timelines and helps Simran in setting operation milestones for the overall project.

TechStyles Inc., through its friendly atmosphere and team-working skills of its members represents a potential future successful corporation in which proper team dynamics and straight forward communications among members are practiced daily. Our team has set a weekly schedule for the meetings to be twice a week, each for approximetly half an hour in order to discuss achivements, reports and future tasks. The meetings are formal and minutes are written and are later posted to all members. TechStyles also has set a scheme for individual members' daily progress in order to maintain a proper working attitude throughout the semester. At the end of the each day, email their daily achivements as for other members to read them and record them.

As the Nomad Digital Pen project consists of two major parts, hardware design and software development, TechStyles has decided to put the members into two group, one with three members and the other one with two, to take care of software development and programming tasks and hardware design and implementation, respectively. This grouping as well the task assignment has been established based on each member's technical strengths, dept of experiences and overlapping expertise.

9. COMPANY PROFILE

Behzad Jazizadeh – Chief Executive and Financial Officer (CE&FO)

Behzad will soon be completing a double major in Systems Engineering/Applied Mathematics, currently finishing his last year of studies at Simon Fraser University. Behzad is a member of the IEEE. He has been involved in numerous engineering project managements. He has also been involved in several research projects on a variety of topics including, but not limited to, Computational Mathematics, Operations Research, Electro-Mechanical Transducers, Embedded Systems Design and Control Engineering. His expertise in critical problem solving and project management, as well as his strong technical/operational background will definitely support TechStyles Inc. well into the future.

Simran Sarai – Chief Operations Officer (COO)

Simran is currently pursuing her studies in Electronics Engineering at Simon Fraser University. As a fourth year student, she has worked on various application-based as well as research projects in the fields of Embedded Systems Design, Optics, Lasers, and Microelectronics. Her areas of expertise include GUI development in Windows based environment, knowledge of hardware communications using various protocols, hardware design and microcontroller programming. Having an Electronics and Computer Engineering degree from BCIT, Simran has extensive operational and management experience in technical projects which will be assets to TechStyles Inc.

Zhen Gang Ziao – Chief Technical Office (CTO)

Zhen is now in his last year of Electro-Mechanical Systems engineering at Simon Fraser University. He has extensive knowledge and experience in software programming and verification. His strong hardware programming skills are definitely assets for TechStyles. His persuasive and initiative manners in a project as well as his high-level of team working background is fundamentally critical to the Corporation and specifically throughout the Nomad Digital Pen project. In addition Zhen has a thorough knowledge of firmware design, embedded programming and software project management.

Unnati Sapre – Vice President of Technical (VP Technical)

Unnati is currently in her last year of Engineering Science Program, Electronics major, at Simon Fraser University. Unnati has been involved in a number of research and development projects requiring graphics/GUI development. Her experience in visual and interface applications programming extends to Windows XP, UNIX, Linux as well as Maemo development platforms. Her expertise in graphics development and software programming will definitely help TechStyles Inc. make its products more user-friendly and easy to use. Additionally, Unnati has has extensive technical management background, which would definitely be useful in the Nomad Pen project.

Sam Hoque – Vice President of Operations (VP Operations)

Sam will soon be completing his Bachelors of Applied Science in Electronics Engineering as Simon Fraser University. His areas of interests are power electronics, power distribution, analog and digital communication, telecommunication methods, actuators & sensors and systems engineering. Along with these interests, an ability to think outside the box and a strong desire to succeed beyond all odds makes him an excellent addition to the TechStyles Inc. team. His strong problem solving skills and great team spirit will contribute to our success. Sam has also had extensive experience in team management and group project dynamics.

10. CONCLUSION

TechStyles Incorporated is dedicated to applying technology to help create benefits for the society, environment and spread the word of knowledge. The result of the Nomad Digital pen is financially beneficial to its entire user such as students, executives and anybody else who needs this pen on-the-go. Along with the financial savings resulting from less consumption of papers, comes the peace of mind in knowing that in any given situation, none of the users would have the frustration of losing valuable information, thus would not say: “next time I should have my pen and a piece of napkin with me!”.

Our proposed digital pen would employ one of the most modern and complex technologies in pursuit of bringing a product which is as user friendly as a normal pen and the flexibility of a modern data capturing device to its user. This technological approach, although costly at the very early stages of its development, is going to be more cost effective than similarly existent digital pens in the market. Systematically and functionally this pen is superior to all other already existing products and alternatives in the market.

The Gantt chart and milestones presented in the section for schedule, clearly demonstrate that this proof of concept can and will be completed in the time frame allotted. The sources of information for research material are extensively illustrated and detailed. The potential financial sources have clearly been defined and the fact that this project has won the second prize in the Ken Spencer Business Plan competition, are all excellent proofs to our unique idea and the in-demand market for it to grow and achieve its goals .

11. CITATIONS AND REFERENCES

[1]. KXPS5 Data Sheet, *Kionix Corporation*, available at:
http://www.kionix.com/Product%20Sheets/KXPS5%20Series.pdf

[2]. Steve Whitmore, Mike Sjoerdsma, Schedule and Lecture Material, *Simon Fraser University*, available at: http://www.ensc.sfu.ca/~whitmore/courses/ensc305/materials/Example%20Proposal.pdf

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[9]. Title page picture, taken and edited by Zhen Gang Xiao [email to: zgx@sfu.ca]