January 16th, 2012

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

Re: ENSC 305/440 Project Proposal for an Automatic Music Transcriber

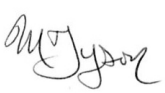
Dear Dr. Rawicz:

The attached document, *Proposal for an Automatic Music Transcriber*, outlines our project for ENSC 305/440 (Project Documentation and Team Dynamics/Capstone Engineering Science Project). The goal of our undertaking is to design and implement a portable unit that will be able to take a song or a musical tune and transcribe it into sheet music. Not only will our product have recording and playback functionalities, it can also be used as a tuner and a metronome.

The purpose of this proposal is to provide you with an overview of our production plan. It includes an outline of our design considerations, our funding sources, projected budget, and sources of information. It also contains information about project scheduling and our organization.

ScribeWare Inc. consists of one sixth-year student and three fourth-year students: Mike Tyson, Henry Huang, Patrick Wong, and Shu Hui Wong respectively. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (778) 886-0523 or by e-mail at mjt4@sfu.ca.

Sincerely,



Mike Tyson
President and CEO
ScribeWare Inc.

Proposal for an

Automatic Music Transcriber

Revision: 1.0

Prepared for: Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 305
School of Engineering Science
Simon Fraser University

Prepared by: Mike Tyson
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Patrick Wong
Shu Hui Wong

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Date: January 16th 2012

Executive Summary

"Without music, life would be a mistake." – Friedrich Nietzsche

Music in its many forms has showcased its versatility throughout the years. It is generally seen as an art form that promotes culture. Yet, it has also been used as a means to communicate peace and to protest wars. It can act as a bridge, bringing people from different backgrounds together. Music, in its essence, is its own language, meant to be shared with all.

> *Music Transcription: notating a piece or a sound, or rewriting a piece of music for another instrument than the one with which it was originally intended for. (Wikipedia)*

The role of music transcription has had a tremendous impact in allowing music to be shared between people. It has allowed for the documentation of music pieces to be used for the generations to come. However, the act of transcribing itself is a long and arduous task for the creative mind and many solutions have been provided to help simplify this process but they do not actually carry out the actual transcribing.

This document proposes developing a portable device that can be used for automatic music transcription. The device will record music as it is played and from the recording, transcribe it onto sheet music. It will also have playback functionality with a tuner and metronome add-on that would prove useful not only for people in the music industry but also in an educational setting.

ScribeWare Inc. consists of three fourth-year engineering students and one sixth-year engineering student with experience in analog/digital circuit design, signal processing, embedded systems and multimedia communication systems.
We propose a 13-week engineering cycle for this project that will encompass research, design and integration. Our scheduled completion date for an operational prototype is April 2nd 2012 and we have an anticipated budget of $488.00, which we expect to obtain from a variety of sources.

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1. Introduction

The music industry is a huge market in today's society. A lot of time and labor has been placed into being able to document and manipulate not only new compositions, but also existing ones. The process of documenting music has thus far been a laborious procedure in which people would sit down, listen to a composition, and write down the notes onto sheet music.

The objective of our project is to develop a portable device that will be able to automate music transcription. This device (the AutoTab) will receive an input through an audio jack or a microphone and manipulate it as needed prior to the creation of the sheet music through frequency and pitch recognition.

The AutoTab will help in simplifying the music creation process. An artist will be able to plug in their instrument, pick a tempo, and play while our device records their piece. With the recording saved, the artists will then be able choose to print out the sheet music and adapt the composition for other instruments with ease. This is valuable even for the skill musician versed in written music, as it will allow them to focus on their creative output while letting our product work out the transcription.

In the digital domain, our device is arguably even more valuable. Due to the nature of the technology, 'percussive' instruments such as keyboard or drum pads are the only devices for which MIDI recording is easily implementable. Using the AutoTab, notes played on any instrument can quickly be extracted reused in any Digital Audio Workstation (DAW). This is especially useful for guitar players who are just getting into composition, as it will allow them to use the instrument they are most familiar with for sequencing.

Our device will not only be a MIDI transcriber and a WAV recorder; it will also function as a tuner and a metronome. The AutoTab will be essential as an educational tool to those who do not have a musical theory background—who play music "by ear" as it gives them the opportunity to play a piece and correspond the pitch with the notes that will be transcribed by our device.

This document is a proposal that provides an overview of our product. It outlines our design considerations, sources of funding and project scheduling. Projected financial requirements are provided, as are the project's Gantt and milestone charts.

2. System Overview

A conceptual overview of how the AutoTab will work is shown below in Figure 1. The device will have an audio input fed into it and this input will be recorded and saved as a WAV file. Next, utilizing the embedded frequency and pitch recognition system, the user will then be able to manipulate and convert the recording into a MIDI file so that sheet music can be created.

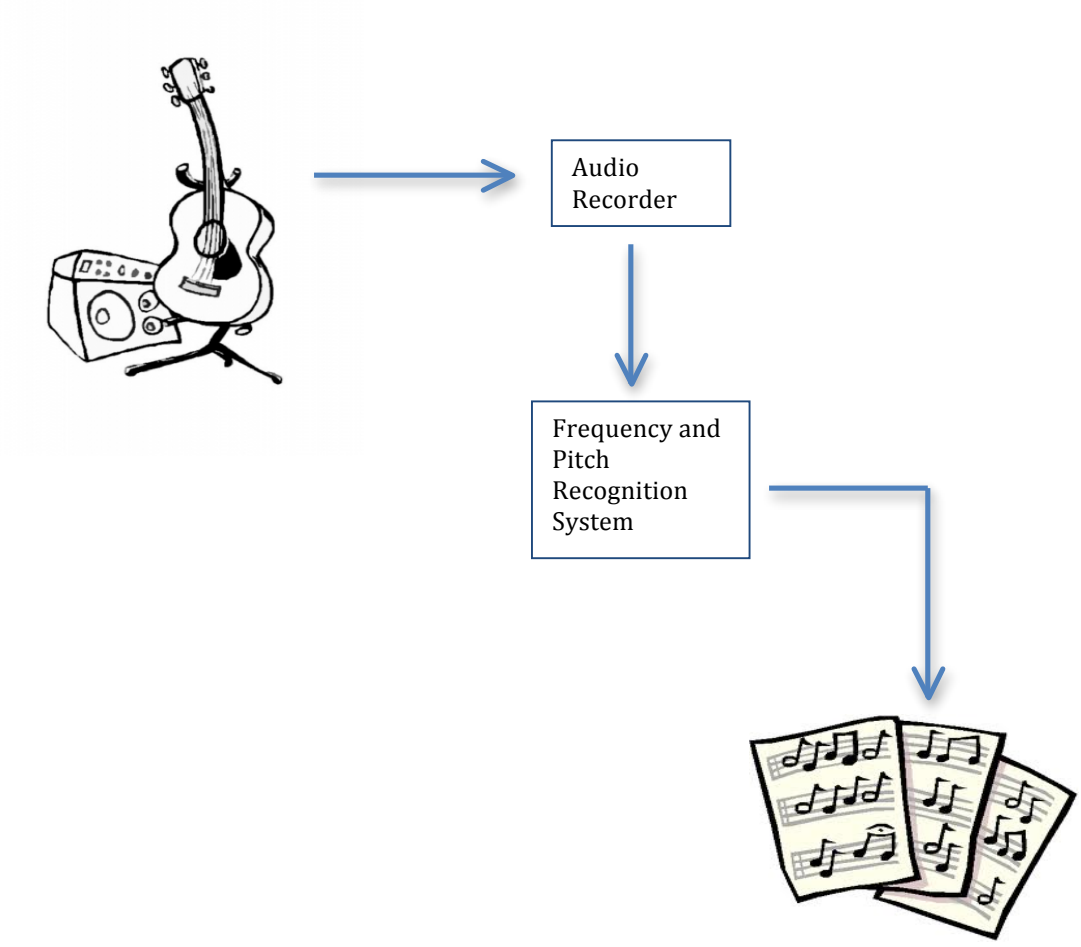

Figure 1 – Conceptual Overview

3. Proposed Design

Given our target market, we are prioritizing the following key design features to be realized before the device can be considered functionally viable:

- **Portability** – the device needs to compact enough to travel to wherever music is being made.
- **Accuracy** – as a product, our device is useless if it cannot reliably produce accurate results.
- **Ergonomics** – given the spontaneous and creative nature of the composition process, the AutoTab must be easy to use and quick to set up, allowing the artist to focus wholly on the music.

Once these benchmarks have been achieved, the following secondary considerations must be realized before the device will be commercially feasible:

- **Affordability** – in order to fall in with existing markets and to compete with software driven solutions (cell phone apps) the AutoTab should not be much more expensive than a guitar tuner. This puts our price point at around $30.
- **Visual Attractiveness** – we are governed (more than we like to admit) by aesthetics and how we think others will perceive us. In order for the AutoTab to be a desirable product it must therefore look and feel “cool” to use.

As has been previously mentioned, our device will act as a tuner, a metronome, a recorder, and a transcriber. It is important to note, however, that the real innovation is found in the transcription. In order to successfully perform this task, the device must already be able to detect pitch and record audio at a particular tempo. Thus, once the transcription algorithms are implemented, the remaining features should be trivial to introduce.

Much of our design efforts will therefore be in developing and implementing an effective algorithm. As this is an active area of study, much of our initial work will be research, determining a procedure that best suits our usage. Once the theory is set, we will first implement and test it in software using sampled audio. An advantage of this project is that its scope is intrinsically modular; we can start verifying results by playing single notes and from there expand our device to process chords, different types of instruments, and perhaps eventually multiple instruments simultaneously.

As a minimum benchmark our device must be able to accurately transcribe a single guitar. Given that tuners are primarily purchased by guitarists; they represent the easiest and most cost effective client-base towards which we can market our value-added 'all-in-one' solution.

Once our algorithms have been verified in software they can be implemented on the FPGA's soft processor. Using a tool like MATLAB, we will analyze the transcription process in order to determine any bottlenecks, which will be delegated to hardware whenever possible. In preparing the AutoTab for commercial release, the device would be entirely converted to hardware and realized on an ASIC in order to further increase processing speed while also reducing cost and size.

Additional efforts will include the conversion of MIDI data to written staff (sheet music) accomplished by software installed on the client's computer, the construction of the device's physical and graphical interfaces, and the management of internal memory and files.

4. Sources of Information

The research and development of our product will be aided by a variety of sources: textbooks, publications and component specification sheets.

The Internet and the library will be essential in helping us locate technical information, potential sources of funding and any existing projects/ideas that are similar to ours.

In addition, several members of the SFU Engineering faculty will be valuable sources of information with their experience in signal processing.

Finally, we will also be drawing upon the knowledge and experience of a few of our colleagues who work with music on a regular basis seeing as not only are they our target market, they will also be in invaluable source of information.

5. Budget and Funding

5.1 Budget

Table 1 outlines a tentative budget for the development of the AutoTab. We have grouped items with similar functionalities together. For example, components used to interface with our device such as switches, buttons, an LCD display and similar are grouped under "User Interface". The total cost takes into consideration an overestimation of 15% to provide for contingencies.

Table 1 – Tentative Budget

Equipment List	**Estimated Unit Cost**
Altera Cyclone II – DE2 University Dev Board (Terasic)	$269 – Educational pricing
Batteries	$10
Memory	$34
User Interface	$69
Audio Interface	$12
Casing	$30
Total Cost	$424
Total Cost with 15% contingency	$488

5.2 Funding

As with the development of any prototype, the initial engineering cycle cost will be greater than the cost of the finalized product.

With this in mind, ScribeWare Inc. is in the process of applying to both the Engineering Science Student Endowment Fund and the Wighton Development Fund. We are also currently in discussion with a few external sources (audio manufacturers, Terasic) regarding their interest in funding our endeavor.

If unsuccessful in generating enough capital to sufficiently fund our project, our organization will be sharing the remaining financial costs equally between our members.

6. Schedule

Figure 2 shows the proposed Gantt chart of the expected time to be spend on the tasks involved with our project while Figure 3 is the timeline of expected completion date for our project.

ID	Task Name	Jan 2012				Feb 2012				Mar 2012					Apr 2012	
		1/1	8/1	15/1	22/1	29/1	5/2	12/2	19/2	26/2	4/3	11/3	18/3	25/3	1/4	8/4
1	Project Proposal															
2	ESSEF Proposal															
3	Research															
4	Functional Specification															
5	Oral Progress Report															
6	Design Specification															
7	Coding/Testing															
8	Written Progress Report															
9	Integration/Debugging															
10	Final Presentation/Demo															

Figure 2 – Gantt Chart

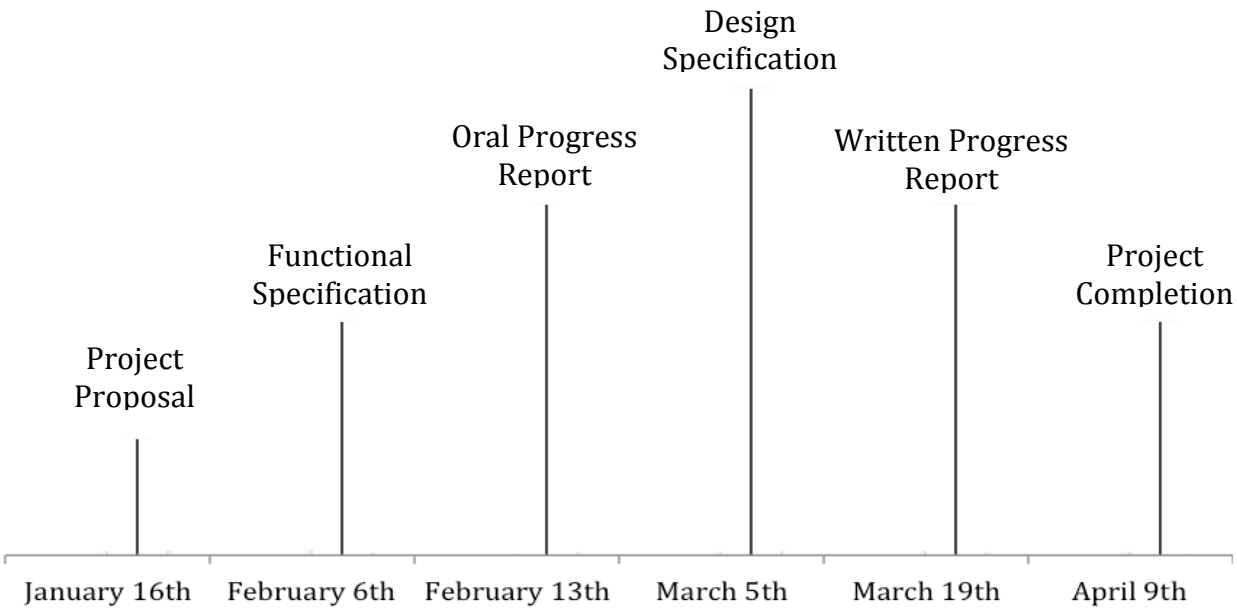

Figure 3 – Milestone Chart

7. Team Organization

ScribeWare Inc. consists of four creative and driven engineers: Mike Tyson, Patrick Wong, Henry Huang and Shu Hui Wong. All members are fourth/sixth-year engineering undergrad students with different program specializations. Each member's specific skills are mentioned in the next section, Company Profile.

Our corporate structure is organized in a manner such that each member is largely responsible for a specific field of operation. However, collaboration between members is highly encouraged to avoid miscommunications. Mike Tyson, the President and Chief Executive Officer (CEO), is the driving force behind our current project, the AutoTab, and is in charge of the overall progress of the project. Patrick Wong, Chief Financial Officer (CFO), is responsible for managing the budget and for resolving any financial issues. Henry Huang, Chief Technology Officer (CTO), is the lead technical designer of the company. Shu Hui Wong, Chief Operating Officer (COO), is responsible for the day-to-day operations and for resolving organizational conflicts.

To ensure efficiency within our organization, we have scheduled meeting times to discuss the progress of our tasks and also of any emerging issues. We will also host team-building activities to boost team morals and to maintain a positive group dynamic between members. With our members focused work ethic, we believe that ScribeWare Inc. will be successful in completing its project.

8. Company Profile

Mike Tyson – Chief Executive Officer (CEO)

Mike Tyson is a sixth year engineering student taking courses in both the systems and electronics options. The course of his education has led him to accrue experience in designing both analog and digital systems ranging from multi-stage amplifiers to large-scale FPGA-driven digital circuits. In parallel to hardware design, he has also been called on to learn a variety of programming languages and methodologies, from organizing ADTs in high level languages such as C++ or Java to real-time embedded systems in C or Assembly. Additionally, Mike has a year of industry experience, having served internships at Icron Technologies and PMC-Sierra. These work terms saw him learning not only specific technologies, such as USB or SAS protocol, but more importantly the team dynamics and design processes of real-world leaders in each industry. Finally, Mike has entrepreneurship experience of his own, having owned and operated a quarter-million dollar construction company with a staff of 12 over the first three years of his degree.

Henry Huang – Chief Technical Officer (CTO)

Henry Huang is a fourth year engineering student in the electronics option here at SFU. Over the years, he has gained many experiences both locally and abroad. His time at the National Research Council of Canada gave him the opportunity to develop his research skills while modeling hydrogen fuel cells. Not long after, he took the opportunity for an international research internship with JFE Steel Corporation in Japan, where he analyzed model transformers. Aside from his past research, his main areas of interest are digital and analog system design. Through his coursework, he has knowledge of embedded systems and FPGAs where he utilizes C and VHDL to complete his projects.

Patrick Wong – Chief Financial Officer (CFO)

Patrick Wong is a fourth year electronics engineering student at SFU. Over the course of his studies he has worked with FPGAs, analog circuits, and digital embedded systems, primarily working with C, C++, assembly programming languages and, to a lesser degree, Java. He has worked for Safeway Ltd. as a software tester and analyst providing him with experience in software integration testing and working with DB2 databases. It has also exposed him to software project development lifecycles and, having had to work with individuals often situated in offices located around the United States, he has had the opportunity to further develop his written and verbal communication skills.

Shu Hui Wong – Chief Operating Officer (COO)

Shu Hui Wong is a fourth year engineering student in the systems options at SFU. Through her previous co-op placements at Research In Motion (RIM) and most recently, with Global Relay Communications, she has gained familiarity with many different types of communication protocols with an emphasis on security. She has also had experience with designing test schemes and with simulating network clients to validate real-world performance. Through the course of her education, she has learnt a variety of different programming languages like C++, Java and VHDL. However, more importantly, she has the interpersonal skills to work well with others.

9. Conclusion

ScribeWare Inc., with their passion in the music industry, is committed in developing products that will help expand the industry and to simplify the many processes that stunt an artist's creativity.

By providing users with an instrument recorder, transcriber, metronome, and tuner, the AutoTab serves to not only streamline the music creativity process but also to become a powerful educational tool.

The provided Milestone and Gantt chart along with the available resources cited and funding plans indicate our plan to deliver a functional prototype on time and within budget.

Our proposed device will allow musicians to spend more time creating new music instead of worrying over having to write it down. It is our "all-in-one" solution to the artist's compositional needs.

10. Sources and References

1. Altera

2. DigiKey Corp.

3. TigerDirect

4. Lucky One, faculty at SFU's Engineering department