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December 20, 2001

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
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Re: ENSC 340 – FAWG Technologies Process Report

Dear Dr. Rawicz:

Attached, you will find the *Fawg Technologies Process Report.* The process report gives a system overview of our final project for ENSC 340. The report talks about the technical features that were implemented and some of the deviations taken from our functional specifications. An updated budget and schedule are attached along with reasons for the deviation from our original plan.

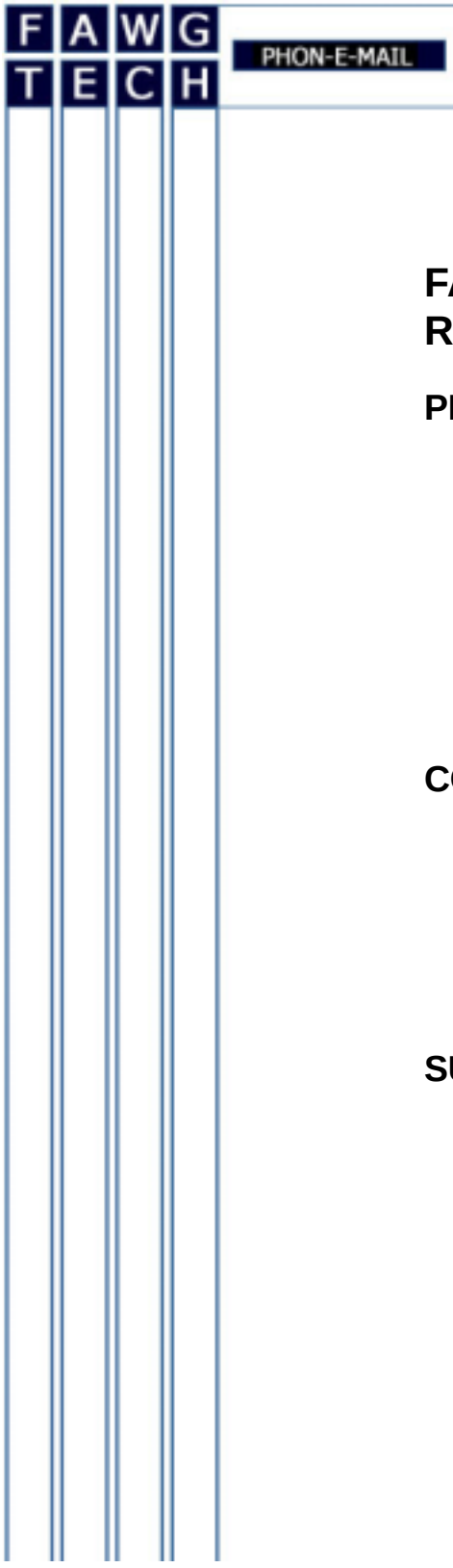
The report also discusses some of the numerous problems that we encountered during the past four months and some of the things that we may have done differently. Finally, each group member has attached a small testimonial as to what they have taken away from the ENSC 340 experience.

FAWG Technologies is comprised of five highly dedicated, ambitious, and intelligent fourth-year engineering students. Each student brings a unique skill set to the project team that will allow us to work in a fast and efficient manner. Group members include **Marvin Tom**, President and CEO; **David Ciampi**, CFO; **Raymond Ngun**, COO; **Calvin Ling**, VP Operations; and **JP Costales**, VP Marketing. Should you have any questions, concerns, or comments about our proposal, please feel free to contact me at (604) 431-6508 or via the Internet at my-aplio@sfu.ca. Thank you for your time.

Sincerely,

Marvin Tom,
President and CEO
Fawg Technologies

Enclosure : FAWG Technologies Process Report



FAWG Technologies Process Report

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1 INTRODUCTION

The Phon-E-Mail system is a project completed by five talented engineering students during the 2001 fall semester at Simon Fraser University. The concept for the project was initially developed during the summer of 2001 and over the past 4 months, the project has slowly grown into a finished product that can be used by a consumer. The concept, design and implementation of the project was all created with societal needs in the forefront of our decision making processes. To our current knowledge, the Phon-E-Mail system is the first product of its type out in the market. There are many similar devices but we believe that our design and feature set far exceeds any other type of product.

This process report will talk about our initial project plan and how that plan came to fruition. It will follow with some of the problems that we encountered along our journey and how the finished product differs from our initial view. Finally, each member will give a small testimonial as to what the learned and took away from the project.

2 SYSTEM OVERVIEW

The Phon-E-Mail system operates regularly when a standard call is received. However, when an email is received, the system will provide a distinct ring to indicate incoming email. An audio confirmation is needed so that visually impaired people will know that an incoming e-mail has been received. The figure below shows a high level system block diagram.

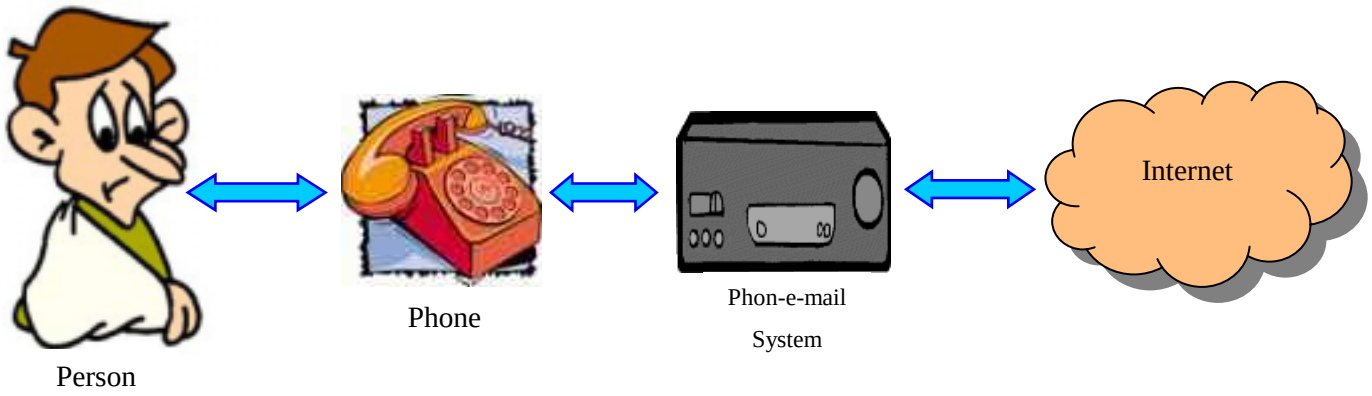

Figure 1: System Overview

Note that the system works in both directions. Once an email has been received by the user, the user then has the option of replying to the message.

2.1 EMAIL PROCESSING

Specific to this project, the Rabbit Semiconductor 16-bit microprocessor is used to retrieve emails and send emails via the Ethernet controller using TCP/IP protocols. This Rabbit to Ethernet to Internet connection is shown in Figure 2.

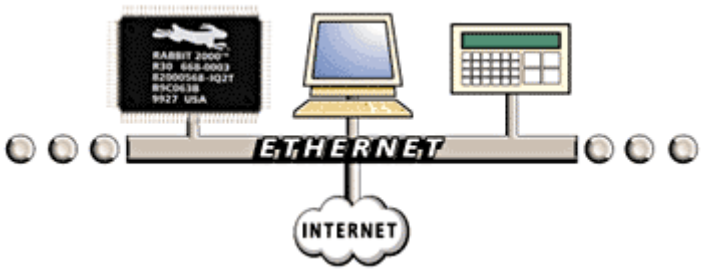

Figure 2: Rabbit Ethernet Connection

The Rabbit itself is not used as an email server and thus an external server is used. To access the remote server, a couple of standardized protocols are used. To retrieve email, Post Office Protocol version 3 (POP3) is used. The POP3 protocol is a fairly simple text-based chat across a TCP socket, normally using TCP port 110. To send email, SMTP (Simple Mail Transfer Protocol) is used. Like POP3, SMTP is a simple text conversation across a TCP/IP connection. The SMTP server usually resides on TCP port 25 waiting for clients to connect. The software on the Rabbit will have to periodically check the POP3 email server for new messages.

2.2 SYSTEM CONTROL (SYSTEM STATE MACHINE)

When a new message arrives and is retrieved by the rabbit, the text from the body of the server is sent to a second server that converts the text to speech using text-to-speech software. The server resides on a computer that can be accessed over the Internet by opening a TCP socket to the specific IP of the server. The server program was written in Visual Basic and contains a speech development kit that contains all of the text-to-voice sub-routines. Once the server has received the email message body, the server will parse the email and create a wave file. The wave file is then sent back to the Rabbit microprocessor for storage. On receipt of the speech version of the email, the Rabbit stores this information in memory. The Rabbit then signals to the user a new message has arrived by ringing the phone. Note that if a wave file is attached to the received email, the server will halt text-to-voice conversion and the wave file is played back as the message body instead.

When the user is ready to listen to the new message, the message is retrieved from memory and sent to a DAC at the rate of 125us per 8 bit sample. If and when the user wants to reply or send a new email, the

Rabbit enables the ADC to digitize the user's analog voice signal from the phone. At a rate of 125us per sample, the data is read by the Rabbit and stored into memory. Upon the completion of the email (triggered by the pound key on the phone), the data is packaged into an email and sent using the SMTP protocol. This sequence of data acquisition and processing for receiving and displaying in e-mail message can be summarized in Figure 3.

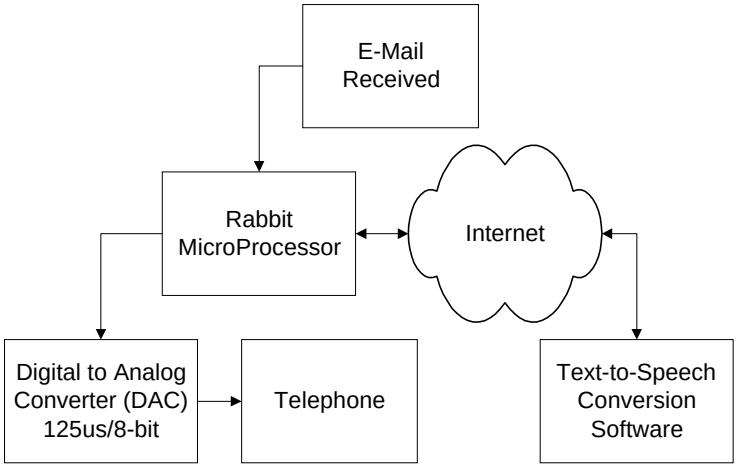

Figure 3: Data Acquisition and Processing

2.3 USER INTERFACE

As previously mentioned, the Rabbit Evaluation Board will be used as the hardware component of our system. DTMF Detection is a key functionality in the operation of the Phon-E-Mail system. Without it, the telephone and Phon-E-Mail unit would not be able to properly communicate. When a key is pressed in the telephone, a DTMF tone is generated. It is this unique combination of frequencies that will determine what action the Phon-E-Mail unit will execute. A diagram of the DTMF detection circuit is shown in Figure 4.

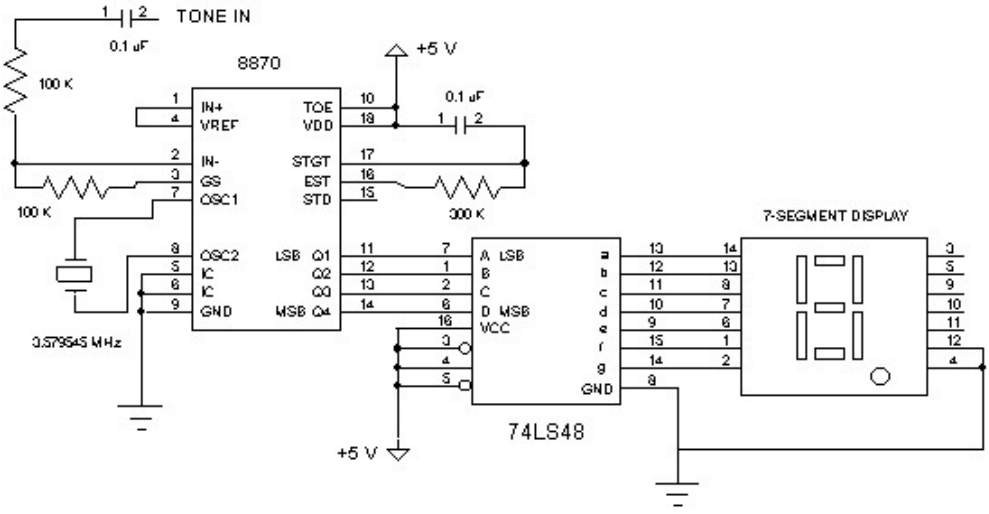

Figure 4: DTMF Detection Circuit

The Phon-E-Mail system features an audio-based user interface similar to that of a voice mail menu system. The main menu items will include options to either listen to new messages, listen to saved messages, or compose a new message. The production version of the Phon-E-Mail System will have full voice-to-text and text-to-voice capabilities. However, for the prototype version, in order to meet the required deadlines, only text-to-voice capabilities will be available. When sending messages via the Phon-E-Mail System, the recorded audio will be saved as a wave file and attached to the outgoing email message.

However, the Phon-E-Mail prototype will still adheres to the following Menu Requirements.

- Ability to recite both new e-mail messages and old, saved e-mail messages
- Recite an e-mail in its entirety using a corresponding audio message that is coherent to the user
- Can save, sort through, and process at least three e-mail messages at one time
- Ability to either save or delete the message after it has been listened to
- Will allow the user to reply to the message and compose a new e-mail message
- If a new e-mail message is composed, the ability to send the new e-mail message
- Ability to program five email addresses via a web browser to which a user can compose stand-alone messages to.

3 PROBLEMS ENCOUNTERED

There were numerous problems encountered during development of the project. Some of the major problems are highlighted in this section

3.1 PROGRAM SPACE (VOICE-TO-TEXT AND TEXT-TO-VOICE)

One of our first major problems was the lack of available program memory available. The Rabbit 16-bit microprocessor only contained 128 Kbytes of program memory space so all of our required functionality would have to fit within this allotted space. However, all open source versions of voice-to-text and text-to-voice would far exceed the 128 Kbyte limitation. Our solution was to do some of the processing off the board and thus an external server was used to perform the text-to-voice conversion. Whenever text-to-voice conversion is needed, the text is sent to the external server and the resulting wave file is sent back to the Rabbit.

However voice-to-text conversion was never completed because of the crudeness of the available software. We researched and downloaded many voice to text software packages and none of the packages that we sampled could guarantee the quality of service that would be necessary. Bell Labs has created quite a reliable voice-to-text software package but at a price of approximately $80000, we believed that it was out of our reach. We also considered writing our own voice-to-text software but it would have taken all five of us the entire 4 months to create a reliable voice-to-text converter. So, we decided to omit this functionality in our initial prototype. Whenever the user replies to a message or composes a message on the system, the audio is saved as a wave file and attached to an outgoing email message. We believe that this still demonstrates the vision of our project and is still quite acceptable in the consumer market.

3.2 RABBIT SEMICONDUCTOR TECHNICAL SUPPORT

Our initial reasoning for choosing the Rabbit 16-bit Microprocessor was that the evaluation board came with existing TCP/IP sub-routines that would make connecting to the Internet easy. Because of the large number of voice prompts needed for menu navigation, the Rabbit data memory space was large enough to hold all of the menu prompts. We explored many solutions to increase data memory capacity (note that

this is a different problem from program memory space). Luckily, Rabbit Semiconductor offered an 8 MB Flash Memory add-on. This was an ideal solution for our problem. We believed that using a Rabbit solution for memory expansion would eliminate some of the compatibility issues. However, after we purchased the 8 MB Flash, we quickly realized that Rabbit had never tested the Flash memory with our version of the evaluation board. It took four painstaking weeks of continuous emails and telephone calls with Rabbit technical support until we were able to get the Flash to work properly. This involved many software hacking and surface mount changes to the evaluation board. The technical support staff was also slow to respond and sometimes it seemed that they had no idea what they were doing.

3.3 VOICE-TO-TEXT SOFTWARE PACKAGES

There is quite an abundance of available voice-to-text software packages that can be found via the Internet. However, it was difficult for us to choose one that could be easily integrated into our server program. We eventually found a speech development kit from Microsoft written in Visual Basic. This is one of the primary reasons for us choosing to write our server program in Visual Basic. It would have been ideal for us to choose the language we wish to write our server program rather than let the voice-to-text software dictate which language we had to use. But sometimes decisions have to be made on what is available.

4 BUDGET CONSTRAINTS

The following table outlines the tentative and actual budget for the Phon-E-Mail system.

Category	Cost Range	Actual Cost
Micro-controller development board	$200	$600
Telephone Handset	$15	$50
Electronic Components	$50	$250
15 % Contingency	$40	N/A
Total	**$310**	**$900**

There are many reasons for the large discrepancy of our budget. The micro controller development board was previously purchased for previous project and used in this project. The original cost of this board was not taken into account since it was already acquired ($350). It was decided that the actual cost of this development board was to be included in the final project costs. We were forced into an expensive memory solution due to the nature of the development board we chose. We did not have many options along with all the option being extremely difficult to implement. The most effective, yet expensive, way to solve the memory problem cost a total of $250. The handsets were quite a small cost relative to the entire project. The electronic component cost could have been reduce, however the decision to not strip the original breadboard for parts for the vector board was the best decision of the entire project. The extra cost of the parts ($100) to create the hardware interface was well worth the unforeseen hours of headache that would have been if the bread board (in working condition) was stripped. The 15% contingency was well underestimated. The best estimate would have doubled. When it comes down to project work, there needs to be a balance between spending money just to be safe and wasting money. We do not believe any money was wasted and in the end we achieved a good balance between spending and wasting.

5 SCHEDULING ISSUES

Because of other course conflicts and commitments, it was very difficult for us to stick to our initial schedule. The Fawg Technologies project group was formed in June, 2001. By July, we had already begun to come up with ideas and we began to make a few decisions on parts that needed to be acquired. Some preliminary programming to gain familiarity with the development environment was also completed before the start of the semester. However, none of the pre-term planning prepared us for the workload that we encountered during the term. At the beginning of the term, we set a goal date of December 1, 2001 to have our project completed. However, we slowly found out that we needed to spend a lot of time waiting for parts to arrive and waiting for other group members to complete their tasks. At times, it was difficult to perform tasks in parallel as one task could not be done until the previous task was completed. Thus, many group members were often waiting for another group member to finish their portion of the project.

Conflicts between group members schedules also made it difficult to perform system integration. It is very difficult to debug somebody else's code so many of the group members needed to be present when we were performing system integration. The majority of our time was spent performing system integration. Our initial schedule did not allocate much time to system integration and we have definitely learned that future projects will require at least half, if not more, of the total project time to system integration and system testing. We initially planned for most of the bugs in the system to be found during module testing. However, system testing was the development phase where we found the majority of our bugs.

Our initial schedule did not take into account that other course commitments would take us away from the project. We found that project development slowed down during mid-terms and during the final exam period. Future schedule should reflect this by performing easier and lower priority tasks during these time periods.

6 TEAM DYNAMIC ISSUES

As with any type of engineering team, we encountered a number of team dynamics issues. There were issues of if everybody was pulling their own weight and of the time commitments people were devoting to the project. Over the past four months, each member of the group has learned that everybody has different priorities and it is not safe to assume that one person in the group will have the same priorities as everybody else.

Some people will naturally tend to lead and drive the project and others will need guidance and direction. It was important that everybody in our group recognized their roles "accepted" their roles. Often, team dynamics conflicts arise when people do not accept what role they play in the team.

We believe that we have worked through our differences and finished the project in a timely fashion. Some feelings may have been hurt through the process but it was all a part of the learning process for this course.

7 FUTURE ENHANCEMENTS

This section will discuss features that have been omitted and future enhancements of the project.

7.1 VOICE-TO-TEXT AND TEXT-TO-VOICE

Future versions of the system will have voice-to-text and text-to-voice capabilities built straight into the system rather than using an external server. The need for the external server is only because of the limited program space available on the Rabbit. In the future, open source voice-to-text sub-routines should be improved, small and relatively inexpensive. A better microprocessor with larger program memory would be ideal to host all the application software. A DSP could also be used to develop our own voice-to-text subroutines or an external hard drive could also be used to store the large amount of program memory needed.

7.2 PSTN PHONE LINE CONNECTION

Our project proposal indicated that our system will have the ability to switch between regular public switched telephone network use and the Phon-E-Mail system. We contacted Telus about what requirements were needed to develop products that would be attached to their network. Telus has strict standards as to what products can be hooked up to their networks as the amount of loop current they supply is closely monitored. Only products that are CSA approved can be used when plugging devices into a wall socket. Telus indicated that there are no exceptions to this rule. Thus, the PSTN connection is omitted from the project. However, we have already prepared the required schematic to insert this functionality in if our project is to ever meet CSA approvals. It would not be a great deal of work to add this feature and could be easily done in approximately 2 weeks in the future.

7.3 WEB PAGE CONFIGURATION

Our current implementation includes a web page that allows the user to configure five different email addresses that the system can compose email messages to. Future enhancements to this web page would allow the user to receive updates on the status of the system and allow the user to access their stored messages via this web page.

7.4 CASING AND SURFACE MOUNT BOARDS

We currently have a housed casing and enclosure for our system. The user can simply plug in the Ethernet connector, the power connector and the telephone and instantly start using the system. If the project is to ever go into production, all the hardware components would need to be placed on surface mount boards. The majority of the space being used is for power supplies so the actual size of a production product would be quite small.

8 INDIVIDUAL EXPERIENCES

Marvin Tom (CEO, Communications, Protocol Development and System Design)

I could list a hundred different things that I have taken away from this project but the most important thing that I have learned is the importance of team management and organization. The technical aspects of the project were interesting and I would not be an engineer if I did not say that I enjoyed making a product from scratch and watching the product evolve from one IC on a breadboard to a finished product. But after four grueling months of working until the wee hours of the morning, I have found that the success of a 340 project does not lie in the idea but rather the people.

I was involved in many of the aspects of team management and ensuring that things that needed to be done got done. Some people may say that this task is easy but from the past four months, I can safely tell anybody that it is quite a daunting task. When working with five engineers, all who have ideas they want to put forward, it is difficult to find a balance between what is best for the individual and best for the team. People must be used so that their strengths are utilized and their weaknesses are masked. At other times, people may have to perform tasks that they may not want to perform yet must do so for the good of the team.

I have enjoyed the time spent on this project and the technical and team experiences that I have learned will be invaluable to me in the future.

Raymond Ngun (COO, Software Development Lead)

I believe this project is a very important stepping stone for me and for those who participated in such projects. Such a project educates us in the fundamentals of team work and project management. Personally, this project gave me the insight into the operations of a business.

I have learned three important lessons from completing this project. The first lesson learned is how to allocate time properly. Along with the heavy workload of Engineering Science, it is easy to put the project aside while working on other assignments. In addition to personal life and other school work, I must also allocate sufficient time for this project so that it will be completed in four months time. The second lesson learned is project management. With a team of size five, it was sometimes hard to keep everyone busy at the same time. Thus we must make sure everyone is putting in their time while keeping

all dependencies. For example, most of the hardware must be completed before sufficient software can be written. Thus, during the early parts of the project, those who worked on the hardware put in more time. And during the later parts of the project, those who worked on the software put in more time. During the early stages of the project, it was hard to efficiently separate the project into five parts (for five team members). Thus, several meetings were held to discuss how everyone can contribute to the project. The third lesson is the communication among group members. Miscommunication can be costly in the number of hours spent on the project. Thus, all group members must be periodically informed of all development happening.

Overall, this project allowed me to gain insight on the complications and requirements of following a project from the beginning to the end. The lessons I have learned here will undoubtedly be a stepping stone in my Engineering career.

David Ciampi (CFO, Hardware Development Lead)

This project has been a great learning experience. I will leave engineering with many important lessons that I have obtained from this project. One important thing I have learned is the idea of priorities. I have always thought I knew everything there was to know, and now after this project I know I was right. However, it is always good to get first hand experience to know for sure. Learning how to prioritize is not very complicated because prioritized tasks pretty much fall in place. At this point in my life, my priorities are set. I know what is important to me and what I do. In all of my life experiences I know exactly what comes first and second, and I really do not need to think about it. The hard part is figure out other people's priorities and to try to mix the two. They do not always mix. If I were to give some advice to future projects it would be:

1) When in doubt, use a capacitor.

2) Always duplicate your work. In the end, it will make a big difference.

3) Spend the extra money to buy extra parts. You will be amazed on how high your marginal value is for a part at 3:00 AM on Saturday night.

4) A good project will be a project that can be developed in parallel, not serial.

5) Try to make you final presentation box the color black. Grey is way to dull and cheap looking.

6) Late night is the best time to work on the project when no one is around and there are no disruptions

7) Note the down side suggestion 6 (refer to suggestion 3)

The infamous project course can be a very interesting experience. Some people leave the course hating group members and never speaking again. I am not going to say my relationship with my team members grew in any way, however it did not deteriorate. I am very glad to have this type of outcome.

There are not that many people I would like to thank, but there are two people that have had been instrumental to completing the project. Fred Heep has been a key asset to our project. There has been countless number of times I asked him questions and requested parts when I should have accumulated an entire list of parts and should have requested them all at once. Thank you Fred for your patience. Dan Frewing, my high school electronics teacher, has allowed me access to machinery to complete the enclosure of the system. He has also offered me plenty of advice on problems faced during the development. Thank you Dan for everything you have done for me in the past and for this project.

Calvin Ling (Director of Engineering, External Server Development Lead)

The Phon-E-Mail project has provided me with valuable experience in working as a team and working as an individual within a team. I have gained valuable technical skills and time management skills and I have learned a great deal about team dynamics.

I found that having a project that was easily broken down into several parts very advantageous when working as a group. It gave everyone the opportunity to work on his own parts at his own time and as a team when stitching the project together. This way less time was wasted have one member of our team watching over another member's shoulder while doing work. Each member of our team was assigned a part were they utilized their skills.

Having many skills and experience with software, I was given the task of creating the server software. I gained many skills with working with TCP/IP, using Microsoft's Speech SDK, and coding with Visual Basic. It is now apparent to me how simple instant messaging programs are such as ICQ and Instant Messenger.

Time-management was a real challenge when taking the project course and three upper division Ensc courses and being involved in many extra-curricular activities at the same time. I found planning my

days and weeks in advance very helpful in getting the project done, handing in homework and labs for other courses, studying for exams, and participating in with extra curricular activities.

As for group dynamics, communication was and will always be the key to success. I found emailing, clarity, and patience very important when trying to get things done as a group. There were too many "Didn't you read my email?", "Why don't you guys read emails?", "Didn't you say this in your email?", and "What email?"

John-Paul Costales (Director of Operations, Marketing and System Integration)

The process of implementing a project from its inception to the development of a working prototype has been a very memorable and rewarding experience. Fortunately I was working with exceptional project partners, where every member was willing to sacrifice his time and efforts for the betterment of the groups' goals and overall vision. The Phon-E-Mail System was a fantastic idea; one which took us nearly a year and a half to develop. After the idea's inception, a snowball effect occurred, and our excitement quickly lead to the development of a preliminary prototype on breadboards and partially working, FAWG developed, hardware and software. This preliminary prototype then developed into a nearly-market-ready standalone project, which met most, if not all, of our forecasted functional requirements.

I personally learned the true value of clear communications in a group dynamic. Weekly meetings were regularly occurring early in the semester, but as projects and assignments from other classes took precedence, e-mail correspondence was the main form of group communications. Fortunately, we were able to clearly relay our ideas via e-mail, and were able to finish our project on schedule. I had a great time working on this very exciting project, and had the honor of working with four other exceptional engineering students.

It is unfortunate, however, that ENSC 340 is only worth 3 credits, and that currently it is scheduled with 4 other upper level ENSC courses, in addition to an elective. Such a schedule leaves little, if any, time for the true time that this project demands, during the semester. However, luckily the bulk of my project group was not taking these other upper level courses, as they were completed last fall. I would like to suggest that ENSC 340 go from a 3 credit course to either a 4 or 5 credit course, and should be taken with only one or two other engineering courses. This would then raise the standard of projects undertaken, and

allow engineers to devote some real time and effort through the semester to design, and implement the projects.

9 ACKNOWLEDGEMENTS

We would like to acknowledge some individuals who have been invaluable to the completion of this project. It is with their support that we are still sane.

Steve Whitemore and Andrew Rawicz: We would like to thank these two instructors for giving us the freedom to explore and create our own projects.

Roch Ripley and Maria Trinh: We always felt that we could approach our TA's at any time for help.

Fred Heep: We never stopped hassling Fred and we thank him for not kicking us out of his office.

Patrick Leung: Patrick was always available for help when we needed him.