December 1, 2003

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

Re: ENSC 340 Process Report for a Beam Pattern Measurement System

Dear Dr. Rawicz:

The attached document, *Process Report for a Beam Pattern Measurement System,* describes the process our team followed during the development of our ENSC 340 group project. This document describes what has been achieved so far in the project, as well as plans for the future. The attached document also contains a budget summary, and individual perspectives on the team process.

If you have any questions about our process report, please feel free to contact me by phone at (604) 420 3149 or by email at sonar-group@sfu.ca.

Sincerely,

Roβ Huxtable

Rob Huxtable
CEO
Sonar Works

Enclosure: *Process Report for a Beam Pattern Measurement System*

Process Report:

Multichannel Beam Pattern Measurement System

Project Team: Rob Huxtable
Tim Warner
Annie (Wan Chin)Wu
Robin Prest

Contact Person: Robin Prest
sonar-group@sfu.ca

Submitted to: Dr. Andrew Rawicz- Ensc 340
Steve Whitmore – Ensc 305
School of Engineering Science
Simon Fraser University

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1 Introduction

This document marks the end of our ENSC 340 project, and the completion of the first development phase of the beam pattern measuring system. The work done on the project includes software, signal processing, user interfaces, mechanical hardware, and integration of both software and hardware. The project has been an interesting and rewarding process, both in terms of technical development and team dynamics.

2 Achievements

We achieved our primary goal. That is, we produced a working, useable beam pattern measuring system for sonar transducers. Figure 1 shows the graphical user interface (GUI) for the main data collection application. The GUI for the data display application is shown in Figure 2. In addition to developing these two applications, we integrated a "new" motor for turning the sonar array. This integration was far from straightforward, and included writing new driver software as well as debugging legacy software *and* hardware.

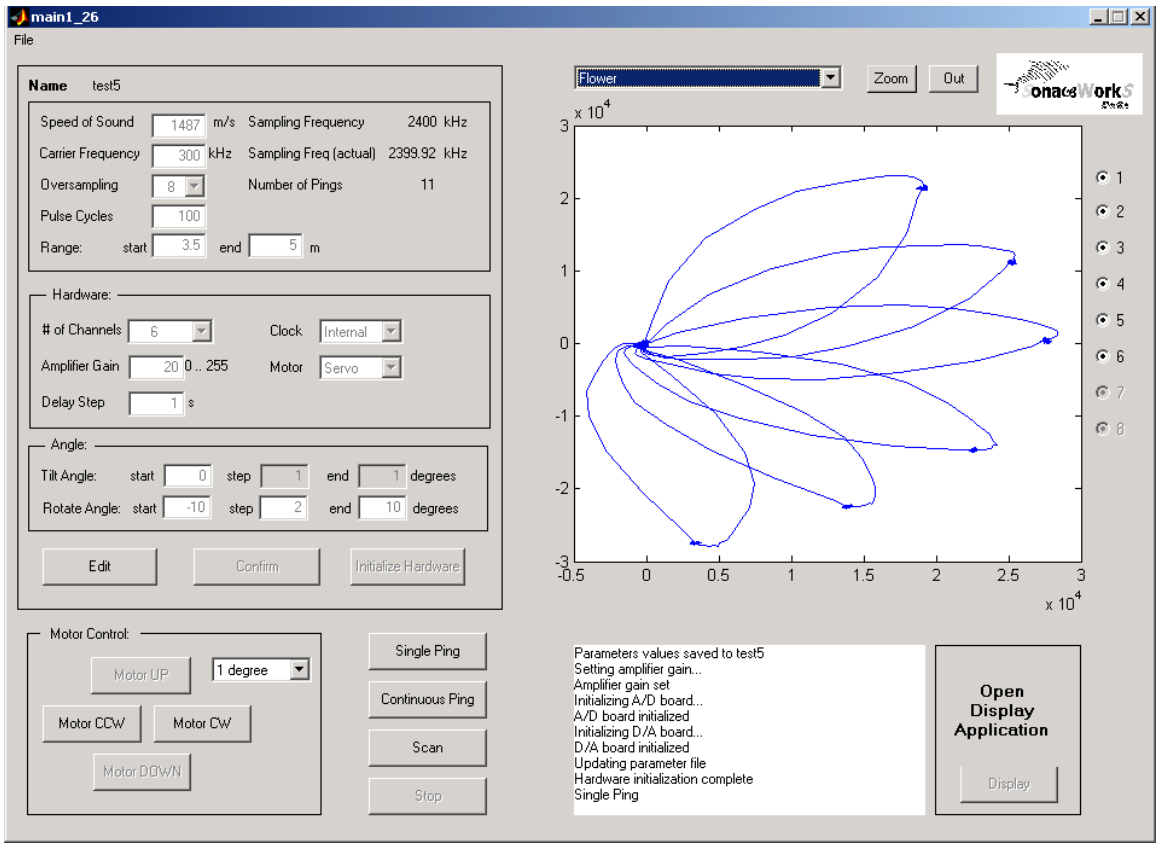

Figure 1: GUI for Main Data Collection Application

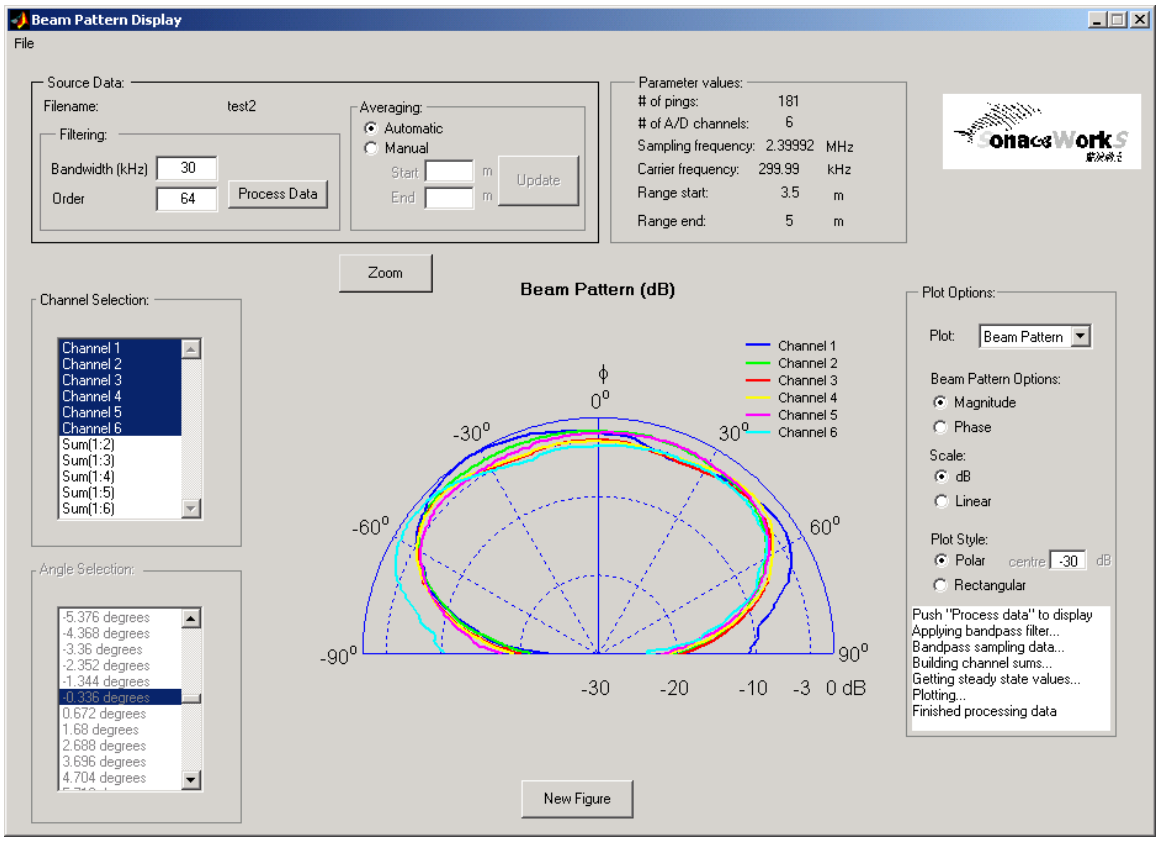

Figure 2: GUI for Data Display Application

The system has yet to be fully tested and calibrated, but initial results are good. Figure 3 shows a beam pattern plot for a 6-channel transducer array. The corresponding phase plot for this array is shown in Figure 4. Furthermore, initial feedback on the system from both Dr. Bird and Dr. Asadov has been very positive.

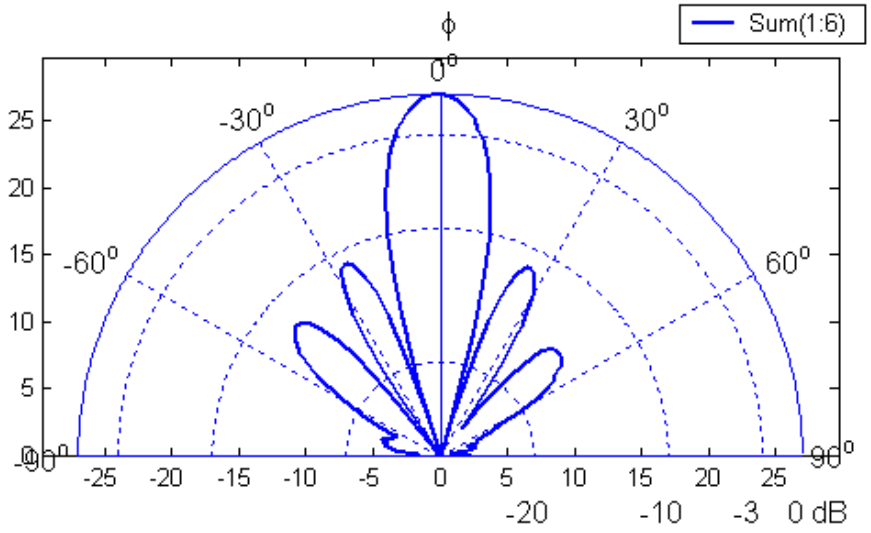

Figure 3: Beam Pattern for 6-Channel Array

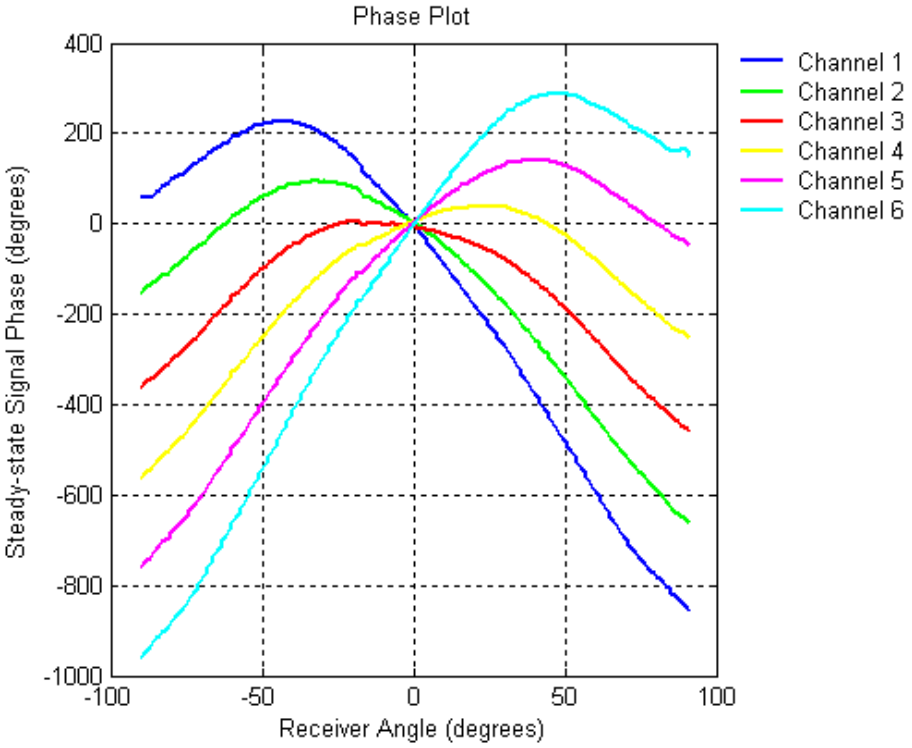

Figure 4: Phase Plot for 6-Channel Array

3 Organization

Organization has been key to the successful and timely completion of this project. To assist us in our planning and organization, we made good use of the Internet. A team web page was set up to help us manage our ENSC 305 documents, Matlab code, and any other relevant technical information. A caucus group for the team was set up to assist with the sharing of information and ideas. Caucus proved to be useful in the early stages of the project in helping to put together a team strategy, but later gave way to the website and group email list. One of the drawbacks of Caucus is that team members needed to log in every time to check the latest messages, whereas email messages are being all the time anyway.

We also looked into the use of Microsoft Project planning software, but quickly concluded that the learning curve was too long and steep, with marginal benefit for such a small group. We held regular Monday meetings, with other meetings scheduled as required. Importantly, we followed Steve's advice about deciding what product features were important, thus allowing us to prioritize our goals. During the last four weeks of the project, we put a strict weekly schedule on the website, as well a prioritized list of outstanding work items.

4 Future Plans

4.1 Technical

Our main priority for technical upgrades is to complete a comprehensive calibration of our system so that we can provide our customers with statistics guaranteeing the BPMS's accuracy. Providing a benchmark for measurement accuracy is also of value so that we can establish standards at which transducers will be tested, possibly paving the way for future ISO-type certification. As mentioned in previous documents, this type of technical precision will be the basis for our marketing strategy, and is thus paramount to our success.

Once the calibration is complete, we will then be able to accept transducer arrays for in-house testing. Before we can begin the sale of turnkey systems, we will have to fully iron out existing bugs in our software and obtain extensive user feedback regarding our interface. After we have finished our beta testing, we will then be able to ship our software and hardware to customers with confidence.

As the first version of our system begins to ship, we will need to consider new features for an upgraded version. Two main features that we would like to establish in an upgrade are the addition of frequency scanning, and the auto generation of transistor reports. Frequency scanning will allow us to characterize our transducers for their frequency

response, in addition to the current characterization of angular response. The auto generation of reports feature will compile the test data in one package without manual interference, thus increasing the productivity of our technicians in the testing process.

4.2 Business

The additional technical plans mentioned above will enable us to implement our business plan. The next phase involves developing two main streams of revenue. The first stream that we intend to tap into is the fee-based transducer test and characterization business. We expect the technical issues to be resolved to permit launch in the first half of 2004. As this stream ramps up, we will be researching ways to reduce costs for assembling turn-key systems so that we can tap into another revenue stream.

Aside from product development there are several significant tasks that will be required for us to be ready to bring our services and products to market. Firstly, we must invest in marketing efforts, including market research, advertising and promotion so that we can understand and penetrate the sonar market. Secondly, we must resolve the split of intellectual property between SonarWorks, Dr. Bird and the University. Finally, we must seek financing to take us through to cash flow break-even.

Sales and cost projections are shown in Figure 5.

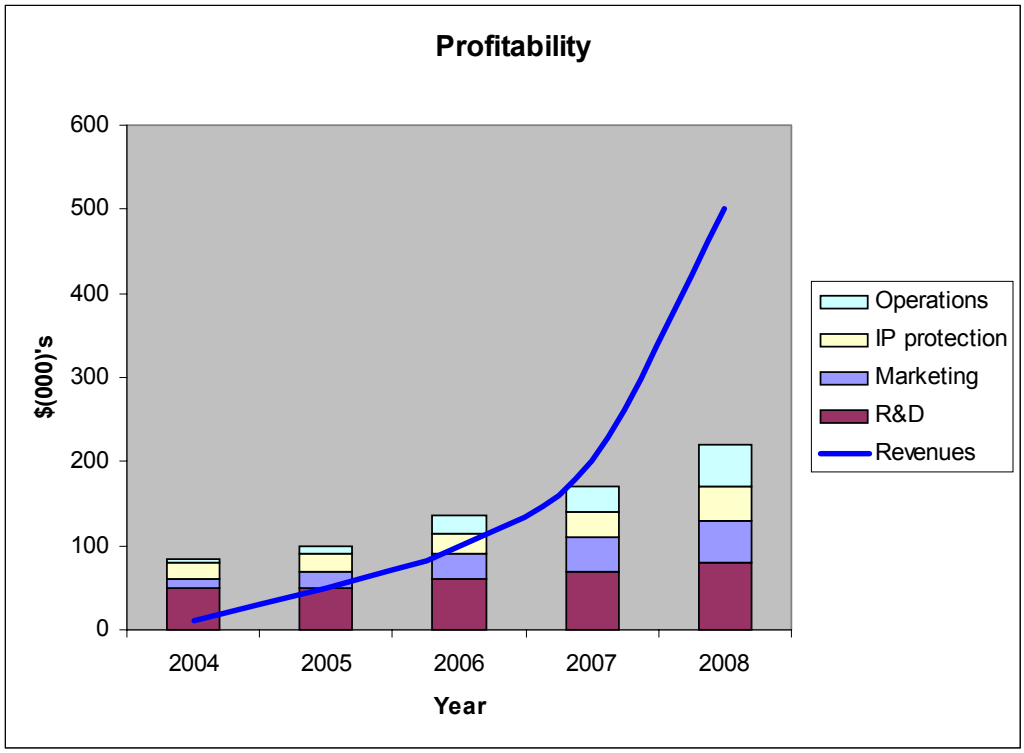

Figure 5: Sales and cost projections

5 Budget

As indicated in Table 1, SonarWorks did not incur significant cost in completing the BPMS. This was due in large part to the availability of existing components from the URL.

Table 1: Comparison of Actual Costs to Budget

Equipment	Budget	Actual
Computer and high performance D/A and A/D cards	$25,000	*
Transducer Arrays	$5,000	*
Stepper motor and controller	$2,000	*
Receiver/transmitter electronics	$1,000	*
Power Supply	$200	*
Enclosures	$150	$8
Supplies	$200	$40
Total Cost	**$33,550**	**$48**

*obtained from the URL

6 Personal Experiences

6.1 Annie (Wan Chin)Wu

I really enjoy doing this project, not only that I gain skills in programming languages and understanding in beam pattern measurement system, but also I have obtained skill in project documentation and most important of all, team works. We could never have got this far without working together and helping each other. I feel really lucky being able to work with Rob, Tim and Robin. Rob would make sure that we are kept up with the schedule, Tim being the oldest in the group, is also the most experienced and knowledgeable, he would provide helpful insight for solving the problems we were facing. Robin's outstanding documentation skills help us enormously in the project documentation and his dry humor always shines light into the group. We were also very lucky to have the expertise of Dr. Bird , Dr. Asadov and Pavel Haintz helping us along the way.

I think the most important thing I learned in this project is that team work is very important especially in a project like this. At the beginning of semester, we broke down the whole projects into to parts and assign each team member with different tasks. Not only that we have weekly meeting to keep each other up to date, but also whenever one of the group members has difficulty completing the task, other group members will jump in and helping the person solving the problems and get the project moving. In this way, we

make sure no one is behind and we are up to date with the schedules and I believe that is one of the reasons why we were able to finish the project as scheduled.

6.2 Tim Warner

I found this project to be very rewarding, both in terms of technical education, but also as a means of personal growth. From my perspective, the SonarWorks group operated very effectively as a team. The commitment level to the project was evident by the success in completing on time and according to our expectations. I appreciated Rob's organization efforts, which helped to keep us on track and ensured that integration went smoothly. Robin and Annie were both successful in getting the motor operating. The way we broke the project up was optimal in keeping all aspects of development moving in parallel and facilitated integration. The assistance given by Dr. Bird and Dr. Asadov was greatly appreciated, as was the prior work done by Pavel Haintz in the predecessor system.

The most important lesson that I learned from an engineering perspective was the benefit of beginning the integration early on in the process. We were able to identify integration issues over three weeks prior to delivering the final product. Having completed this stage, we were able to keep other minor 'nice-to-have' features in perspective and became focused on first achieving core functionality. From a personal point of view, I learned the importance of open dialog, appreciation of diversity in roles played by different team members, and the benefits of finding a balance between breaking certain tasks up and working through others as a group.

6.3 Robin Prest

I was originally drawn to the Sonar Works project because of it consisted of all the makings of a good project—interesting technical material, a diverse group of people to work with, and the backing of an organization that could properly finance project activities. Throughout this process, I have come to appreciate the skills of various individuals that help in pushing a project along to completion. Rob, in particular, I would like to acknowledge for his organizational capacity and vision in seeing the project from start to finish. Annie's coding skills and ability to direct a meeting assisted the group meeting its deadlines and unifying its approach towards each aspect of the project. Tim's background in physics and ability to organize a clean, user-friendly interface made him an invaluable piece of the Sonar Works puzzle. I brought a creative imagination to the table and baked good cookies. Damn good cookies.

It was said early on that this is the course where one enters as a student, but leaves as an engineer. Although it would be somewhat of an exaggeration for me to call myself an engineer as of yet, I do feel that I have a better idea about how to operate in a team, how to see a project from conception to completion, and how to provide technical documentation throughout the process. I am quite satisfied with the end result of our

work, and have had the chance to work with and get to know some outstanding individuals.

6.4 Rob Huxtable

This project has been a very rewarding experience for me. I have worked with Tim before on numerous engineering labs and assignments. As always, it is great to work with him. In addition, I have had the opportunity to meet (and work with) two new people – Annie and Robin. Together, we formed a good team. Or at least I think we did. Our collective skill-set and experience, combined with good communication and co-operation, allowed us to get the job done on time. I have an ongoing interest in project management and organization. Throughout the project I was fortunate to have been in an organizing/planning role, and of course fortunate to have agreeable team members who assisted me with their constructive input. From a technical point of view, this project has been very interesting for me because it encompasses a good range of engineering areas. In particular, it has allowed me to further my interest in sonar and related subjects.

7 Acknowledgements

We wish to acknowledge the support of the Underwater Research Lab. In particular we would like to thank Dr. John Bird, Dr. Sabir Asadov and Mr. Pavel Haintz for their help and expertise during the development and testing of our product.

8 Conclusion

This project has required a broad range of engineering skills, including software, signal processing, user interface development, and hardware and software integration. In addition, the successful completion of our project has required us to organize, plan ahead, and work together as a team.

