Texas A&M University at Qatar
Electrical and Computer Engineering Program

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Electrical Design Laboratory I

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Customer Needs Report

Data Logger for Mechanical Systems

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Due Date: Sept 28th, 2014

"On our honor, as Aggies, we have neither given nor received unauthorized aid on this academic work."

Table of Contents

Introduction

The objective of this report is to conduct a thorough analysis of the customer needs and feedback regarding our senior design project "Data Logger for Mechanical Systems." The outcome of the report will help us formulate our design and optimize its features to match the needs of the customers. We have targeted people with different backgrounds to get a wider range of results and different views about the project, in order to satisfy more potential customers. The report will include the methods used in getting the data, a brief summary of the design, current project status, data analysis, evaluation of the assignment, and the tasks for next assignment.

Methods

Since our customers are all related to the industry field, a survey was sent out to three Qatari oil and gas companies. Google Docs was used for conducting the survey and it was sent by email. A phone interview was conducted with an electrical engineer in the oil and gas department in an international company, and his responses were taken into consideration. In addition, two interviews were also conducted with two mechanical engineering professors from the faculty of Texas A&M University at Qatar. These professors were recommended by our mentor since they have a lot of experience with downhole tools.

Design Summary

The project aims to add an electronic component to passive mechanical systems that work in harsh environments. This electronic component will act as a data logger that logs various types of data versus time, turning the passive mechanical system into a self-aware active tool for failure detection and improving the efficiency of the tool.

Project Status

We are currently working on designing and simulating a real time clock that is synced to the processor clock for use in the data logging process. Moreover, we are in the process of searching for the components for our PCB. This will be finalized later by the help of our mentor after checking that these components can withstand the harsh conditions that the tool will be exposed to.

Customer Needs Analysis

In-Person Interviews:

We conducted two interviews, both with mechanical professors who had background information about mechanical systems and data logging. These face-to-face interviews helped us gather some essential feedback regarding our project with professional engineers who have a lot of experience.

In the first interview, the professor discussed many points that support our data logging activity during the drilling process. He focused on the friction, depth, and acceleration of the mechanical tool that he suggested, such as drill string dynamic tool. In addition, he mentioned the weight on bit measurements, and he suggested we take these measurements into account when building our circuit board. The professor also pointed out that it is better for the users to get the data that are being logged instantaneously so that the users would get to know what is happening at any certain moment or time during the drilling. Finally, the professor recommended us to search more for the module of these tools such as the components, parts, and even how the tools function. The reason for this search is to help us better understand the requirements of these tools, especially when designing a circuit board with sensors that need certain constraints to be considered.

In the second interview, we also discussed drilling tools and downhole tools. The professor said that such device should have priority in accuracy more than anything. She explained that the device will have many factors affecting its accuracy and that we need to concentrate on minimizing the outside effects for a better product. She also mentioned another problem that should be considered, which is the correlation of logged data that might change for different tools; for example the dependence of speed and rotation. As for harsh environment capability, the professor thinks that temperature, friction and vibration are the most important to deal with. Finally, the size of the board itself would have to be properly selected in order to avoid vibration effects and those larger boards need to be more robust.

Phone Interview:

A phone interview was completed with an electrical engineer in the oil and gas department in an international company regarding our product. He mentioned that they don't have any constraints regarding the size of the board, however it should be within an appropriate range. He also added that their tools aren't used in harsh conditions, therefore there is no need for extreme protection. His recommendation was to focus on measuring the vibrations, temperature, flow rate and pressure, since these are the main measurements their mechanical tools use.

Survey:

For the survey portion of our analysis, we targeted oil and gas companies to get information from people who deal with mechanical systems in their everyday lives. Our survey questions weren't detailed, but rather focused on getting quick details about

a) the type of data is mostly needed from their respective mechanical systems, and
b) the type of environments that our data logger has to withstand.

For the type of data that needs to be logged, all responders chose to log vibration data. That shows us just how important it is, as it was also emphasized by our interviews. This is mostly because downhole tools were the most common mechanical systems that our responders worked with, and vibration would benefit them the most since it is the quickest way of sensing sudden changes in motion.

Other common types of data were temperature and rotation. Temperature being frequent mostly tells us that it is needed in order relate it with other data, i.e. to detect the kind of environment the mechanical system was in when an even happened. Rotation was less frequent than vibrations, but it is till important to us because it gives more details about how the mechanical system is performing. There were also a few responses about logging linear motion pressure (part of others). They don't appear to be as important, and they were mostly chosen by people who don't work with downhole tools. Figure 1 shows a bar chart of the responses to the type of data question.

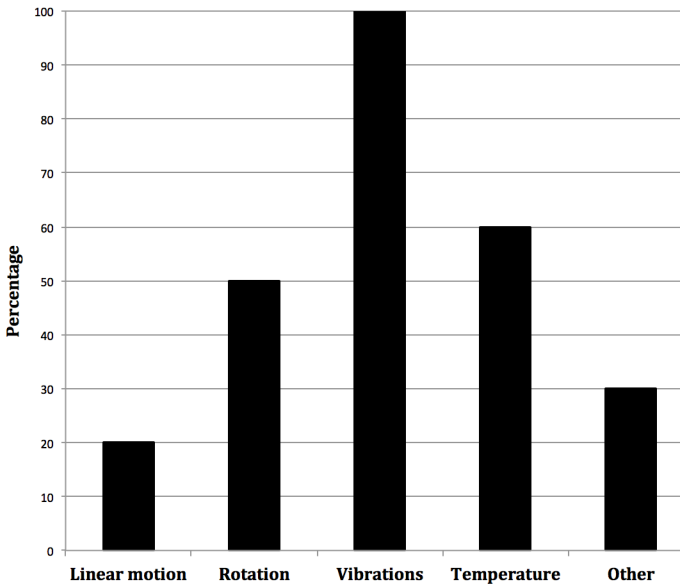

Figure 1: The responses to the question: "What type of data could our data logger collect in order to help improve your tool?"

The other set of questions were about the environment that our data logger has to withstand. Again since most responders were people who deal with downhole tools, we wanted to know what kind of harsh conditions are commonly encountered in downhole applications. We classified the environment question into three categories:

a) Temperature
b) Depth
c) Surrounding materials

The temperature results were varied. The majority chose temperatures ranging from 0 to 50 ° C, while the rest chose more than a 100 ° C. Nonetheless, this means that we have to cater for all ranges to satisfy all customers.

The depth results were as expected, with most responders choosing more than 500 ft. This just enforces our predictions. The surrounding materials results, on the other hand, were very dispersed, which means that we have to account for every common response. This includes the "other" category, where responders suggested we account for oil and gas as surroundings. The results of the environment question are shown in three pie charts in Figure 2.

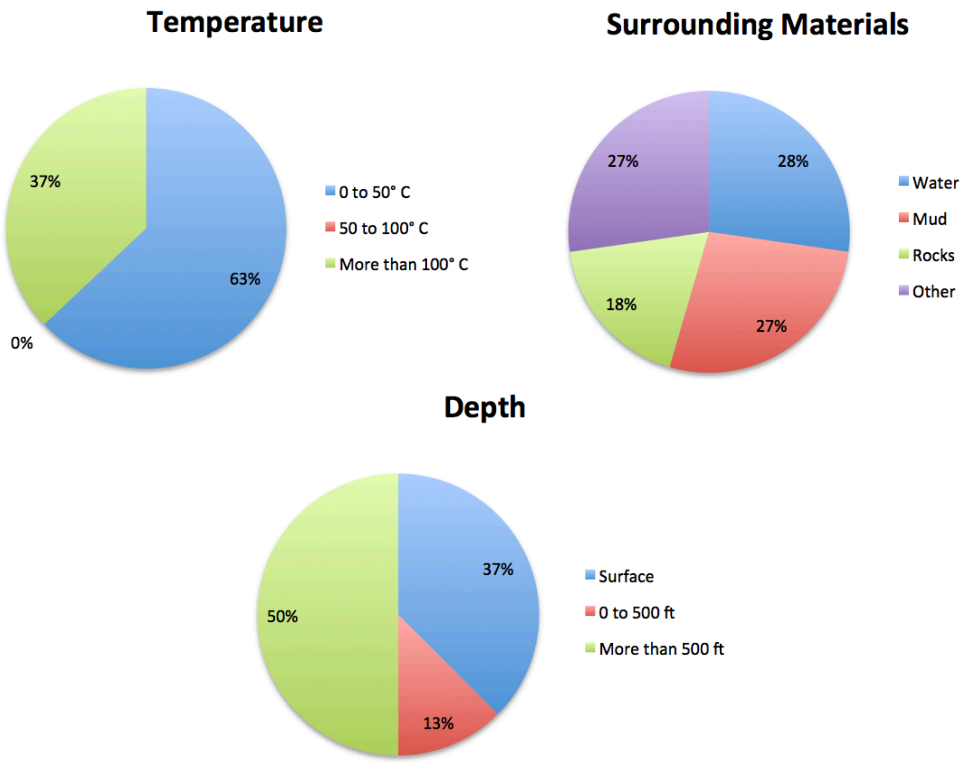

Figure 2: The responses to the question: "What kind of environment does your mechanical system operate?"

Evaluation of Assignment

In this assignment, we were asked to gather information about our potential customers to gain better insight into their needs and the problems they face in their career. This was performed in two ways; personal interviews and surveys.

For the personal interviews, we learned more about the different tools that we are researching and their specific functions. The people we interviewed have a lot of experience regarding the subject of our project; from their experience we were able to get some knowledge about the design and limitations. After the interviews we can now anticipate some difficulties that we can work around in the design process before implementing the circuit.

For the surveys, we gained valuable information from our potential customers about the types of data that our data logger has to record, plus the environment that it will operate in. This will help us immensely in picking our components and designing our PCB to fit the results that we got.

Division of Tasks for the Next Assignment

For the ethnographic study, we will meet with people of the Oil and gas industry to interview with them. We will also interview some Mechanical and Electrical professors who have previous research experience in this field. All team members will participate in deciding on the companies and their respective interview questions. The specialized roles are shown in Table 1.

Table 1: Specialized team member roles for the ethnographic study

Team Member	**Role**
Faisal Al-Mutawa	Public Relations Person
Yasmin Hussien	Interviewer
Mohammed Alsooj	Cameraman
Abdulrahman Al-Malki	Movie Editor

Appendices

Appendix A: Interview Script

We are conducting a survey on our electrical senior design project, the data logger for mechanical systems. It is a harsh-environment electronic circuit to be added to passive mechanical systems for data logging capabilities. It will record the system's variables for later retrieval by the user. It could help in early failure detection and reduction in repair costs.

The mechanical systems that would benefit from such project are passive mechanical tools. Examples are drilling, downhole, or motorized tools.

1. After hearing our design proposal can you think of mechanical system that fits the description, please describe its functions?
2. What kind of measurements would benefit such tool, and why?
3. What kind of environment, does the tool operate at? In terms of temperature, pressure, other factors that affect the measuring accuracy?
4. Do you have any comments/suggestions/ideas to improve our design?

Appendix B: Survey Questions

Data Logger for a Mechanical System: Bringing Passive Tools to Use

This is a survey to gather customer ideas about our senior design project, the Data Logger for a Mechanical System. It is a harsh-environment electronic circuit to passive mechanical systems for data logging capabilities. It will record the system's variables for later retrieval by the user, for early failure detection and reduction in repair costs.

* Required

Do you work for the oil and gas industry? *

- ○ Yes
- ○ No

Are you familiar with/have you ever worked with mechanical systems? *

Mechanical systems are any machinery or tool that carries out various tasks such as motors, drilling tools, downhole tools etc.

- ○ Yes
- ○ No

If yes, please elaborate on the function of that/those mechanical system(s).

What type of data could our data logger collect in order to help improve your tool?

Choose all that apply.

- ☐ Linear motion
- ☐ Rotation
- ☐ Vibrations
- ☐ Temperature
- ☐ Other:

What kind of environment does your mechanical system operate in in terms of a) temperature?

- ○ Below 0° C
- ○ 0 to 50° C
- ○ 50 to 100° C
- ○ More than 100° C

What kind of environment does your mechanical system operate in in terms of b) depth?

- ○ Surface
- ○ 0 to 500 ft
- ○ More than 500 ft

What kind of environment does your mechanical system operate in in terms of c) materials around it?

Choose all that apply.

- ☐ Water
- ☐ Mud
- ☐ Rocks
- ☐ Other:

What kind of improvements would you suggest to make our data logger better for you?