Restated Project Definition and Project Plan

Team 21

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Submitted to:
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TITLE AND GROUP MEMBER INFORMATION

The title of this project is the Underground Robotic Gopher Tortoise Scope.

Jane Bartley (Team Leader) - Jane Bartley is a Mechanical Engineering senior originally from Springfield, Ohio. She has a particular interest in Fluid Mechanics, Propulsion Systems, and Naval Ship Building. After graduation, she plans to work in the Naval industry developing nuclear submarines.

Colin Riley (Lead Electrical Engineer) - Colin Riley is a senior pursuing a Bachelor of Science in Electrical Engineering at Florida State University. After graduating Colin plans to work full time as an Electrical Engineer at Bell Helicopter.

Bridget Leen (Chief Editor) - Bridget Leen is a senior mechanical engineering major at Florida State University. She is originally from Boca Raton, Fl. Her interests include furniture making, and playing guitar. Upon completion of her degree she plans to start her own custom furniture and guitar company while pursuing a career in the music industry.

Lester Nandati (Lead Mechanical Engineer) - Lester, raised in Tallahassee, FL, is graduating with a Bachelor's in Mechanical Engineering in Spring 2015. His area of interest deals with robotics and dynamic systems. After graduation, he desires to utilize his engineering experience to serve at the U.S. branch office for Jehovah's Witnesses to further international design and construction efforts.

Jordan Muntain (Chief Financial Officer) - Jordan Muntain, from Jacksonville Florida, plans on graduating with a bachelor’s degree in mechanical engineering in May 2015. After graduation, Jordan will commission as a 2nd Lieutenant in the United States Air Force as a Combat Systems Officer.

Sina Sharifi-raini (Webmaster) - Sina Sharifi-raini is a senior in electrical engineering at FSU. After graduating with a bachelor's he is going directly into graduate school to pursue a career in power systems. Upon graduating with a master's he is going to work at a power plant company in order to advance the smart grid system.

Acknowledgement

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ABSTRACT

Over the last four months, the design team has had to overcome many challenges. Finding solutions to these challenges has required team members to learn new skills, both in their fields of study and in the field of project management. In this paper the design team will reflect on the previous semesters work and create a revised goal statement and project objectives. The team will review the challenges that were encountered such as meeting the size constraints for the rover design, finding off-the-shelf components that meet design requirements and effectively utilizing team meeting times. Next, the team will summarize how these challenges were resolved by reprioritizing design objectives and restructuring team meetings. Then, the revised goal statement and project objectives will be clearly stated. Finally, the design team will present a comprehensive plan for the upcoming semester based on the new project objectives.

I. Background

The purpose of this project is to enhance the surveying capabilities of gopher tortoise burrows at Tall Timbers Research Station and Land Conservancy. The Gopher tortoise is what is considered a keystone species, meaning that other animals take refuge in its burrow during Tall Timbers' controlled burnings. During the first semester of the year, the team completed brainstorming sessions, chose a final design, began ordering parts, and started the beginning stages of prototyping. It was decided that a rover with linear tracks would be chosen in order to maximize traction in the burrow, a custom chassis and case would be developed, the tether system for the rover was designed, and programming of the electrical components was begun.

II. Review of Previous Semester

This section highlights the challenges faced by the team during the Fall semester, the lessons that were learned, and the plans for improvement for the upcoming semester.

A. Challenges

There have been multiple challenges that the team has encountered during its initial semester of designing and prototyping. As with all group endeavors, scheduling was an issue. Since all the team members are also taking classes, and have activities outside of school as well, there were many conflicts in schedule, and finding times throughout the week that everyone could meet proved to be quite difficult.

A challenge that faced not only this team, but engineers as a whole, was deciding what exactly the customer was after, and which criteria were the most important. One of the criteria for this specific project is for the rover to fit in the smaller burrows. This means that the minimum amount of components on the rover is preferred.

Another challenge is creating a final product that will be operating in harsh Florida conditions. Purchasing durable parts is a necessity. However, multiple parts cannot be ordered and compared for durability due to budgetary constraints. For this reason, extensive research has to be done before deciding on parts to purchase.

The team also experienced obstacles when trying to procure parts that had been selected for purchasing. Even though the team put in the order forms for the part as soon as the specific part was chosen it was quickly apparent that backordering and other shipping related issues could seriously set back the timeline of the prototype and final project.

There were also many challenges related to the electrical aspects of the project as well. The electrical components take up a majority of the rover's interior space. In order to fit these parts into a small form factor they must be placed closely together. When doing this though, it is imperative to avoid short circuits, as all the soldering points are not shielded by the manufacturer.

There were also challenges with system integration. Three of the major components, the Arduino Micro; Raspberry Pi B+; and the Logitech F310 gamepad, need to simultaneously communicate with one another. All three components have their own respective programming language. There are guides to have code cooperate, but the guides are not perfect when troubleshooting. This makes programming these different components very difficult.

B. Lessons Learned

Throughout the fall semester, the design team learned many lessons, the first being that all team members need to be flexible. Having a large team of six students can make coordinating schedules difficult. Each student needs to do their best to meet with their teammates as often as possible to progress the project forward in a timely matter. Separating into smaller, two-person groups to complete separate modules of the project will be easier than all six members meeting simultaneously.

The team also learned that it is okay to spend money on high quality components. Having a budget in mind is great, but by forecasting the spending rate and seeing money is left over, the team can purchase higher quality components. Higher quality components usually work better than their budget counterparts. The rover will be under harsher conditions and for a much longer duration than in the lab, so testing in the lab may not predict the durability of the budget components in the field.

Another lesson learned was that not only is research in finding a guide to solve a problem needed, but also research on how to troubleshoot problems is necessary in making progress. Programming in languages not familiar with the programmer becomes challenging to follow open-source community guidelines. Before testing components, research in making sure they are compatible is very crucial in not wasting money or time.

The team also learned to order early. Parts ordered rarely come in a timely manner and therefore the team must find ways to work around not having those materials. One strategy was recycling material from previous projects in order to build prototypes while waiting for ordered parts to be shipped.

C. Plan for Improvement

Considering the difficulty of working around six people’s schedules, it was decided that team meetings would be reserved for making decisions on the rover design. Apart from the two weekly meetings the team will be broken up into smaller two person units to work on specific parts of the rover. This will occur outside of the designated meeting times and the individual subgroups will report on their progress during the required two week full team meetings.

Instead of buying a premade chassis, a custom chassis will be made out plexiglass. This decision was made to alleviate the problem of fitting all the essential components onto the chassis. It is also essential to make a custom chassis due to the fact that it can be made with the purchased tracks in mind.

As stated in the lessons learned section, the team must keep the budget in mind but also not be too frugal with buying parts for the rover and its system extensions. It will be in the field, and low budget parts will most likely not hold up as well as their higher end counterparts. This means that going forward, the team should still keep the budget in mind, but also make sure that the parts being ordered are up to standards.

III. Revised Goal Statement and Objectives

Considering the limited amount of time left in the semester the objectives for the project were broken into primary and secondary importance.

A. Primary Objectives

Due to the fact that the scoping system will be used in the field, it is essential for it to be resistant to water as well as dirt, and be able to withstand temperatures from 0 to 100°F. It should be resistant to shock as well in case it is dropped or hits any obstacles. The system must also have enough power available to complete a full days worth of work. The entire system should be able to be carried by one person and weigh less than the current scope at Tall Timbers. Gopher tortoises begin to burrow as soon as they hatch, with some of their burrows being as small as 4 to 6 inches. Because of this, the scope should be small enough to navigate inside these smaller burrows. Not disturbing the animals in the burrow is important as well; therefore the camera used will be infrared. The system will also have a user interface that will be relatively intuitive for the user. The scope will be attached to a tether that is 15m long in order to help aid in the retrieval of the rover and it will also help supply power to the rover system. The entire system will also be completed within the team's budget.

B. Secondary Objectives

In order to not disturb the species present in the burrows while also maximizing efficiency, the scoping system will move quietly and quickly down each burrow. The scope will also collect temperature and humidity reading and have the capability to record videos and take still images. In order for the user to be able to see a wide range of the burrow, the infrared camera will have panning capability.

"The main goal is to design a mechanism that has testing sensors, better durability, and more advanced video capabilities than the current system in order to enhance the surveying process of gopher tortoises."

IV. Project Plan

This section highlights the team's method of purchasing, a summary of the project budget, and an overview of the team schedule for this semester.

A. Procurement

Before the break, the team was able to purchase a variety of parts so as to obtain a rough prototype and provide some simple testing. The first component obtained was the chassis. This was a simple kit that consisted of a rubber tracked tread, dual gearbox, two motors, and a baseplate. Four 6V DC motors were purchased; two to power the pan system and an additional two in case a backup was needed. In order to control the motors, Seeed Studio L298 dual H-bridge motor drivers were bought. Another main component ordered was an infrared camera with LED's. To read the feed from the camera to the monitor, a USB 2.0 video capture adapter was purchased. To store the video feed and pictures from the camera, a 32GB micro flash card was aqcuired. The Raspberry Pi B+ and Arduino Micro were purchased in order to start programming. To allow the two to communicate with each other, a Rosewill micro USB connector was purchased. Much of the programming will deal with the game pad controller, already received, in order to maneuver the rover, along with other capabilities. To manage and distribute the voltage from the power supply a USB buddy portable power pole (12V) to USB (5V) converter and device charger was ordered.

Over break, the team ordered a variety of parts to enhance the current prototype so that more rigorous testing could occur. The team ordered 10-gauge wires in order to transfer the power from the battery to the rover and the data acquisition unit. In addition, a component of the data acquisition unit, 7 inch 1280*800 IPS screen monitor, was purchased. In order to display the images and videos from the camera to the monitor, an HDMI male to male adapter coupler was bought. To help with communication between the electrical components, a 7 Port USB hub for the Raspberry Pi was purchased as well as a 25W/3A DC volt converter battery regulator in order to apply the correct voltage to different electrical components.

Recently the team has ordered 1/8 inch Plexiglas IR transmitting sheets to construct the body of the rover along with Lynxmotion 2 inch tracks, 9 tooth track sprockets, and passive idler hubs to connect the sprockets together. The tracks and components are more durable than the current tracks and are intended to be the tracks for the final design.

The team still needs to purchase a few products. Some of the main products that need to be ordered are the sheath for the tether, the power supply, and sensors. These products are expected to be purchased within the next couple of weeks to ensure everything arrives in a reasonable amount of time so the proper testing can be applied.

B. Budget

Time, product quality, and financial management are three key components of the design that will continue to remain pertinent. Figure 1 displays the current rate of spending based on a $2,000 project budget. To date, the project has spent $632.11 – about 32% of the total budget. This figure includes the initial prototype chassis kit, motors for the pan-tilt design, motors for the rover mobility, a camera, game pad controller, screen monitor, more durable tracks, Plexiglas, and spare parts. In addition to parts for a mock-model, the majority of the spent money was directed towards permanent components. These parts include the infrared camera for the final product, Arduino Micro, Raspberry Pi B+, the user-interface controller, the screen display, Plexiglas to construct the body of the rover, and the new tracks. Hence, the majority of the amount currently spent reflects long term project investments.

Items that have not yet been ordered include the casing for the tether, and the battery power source. In addition, new gear sets will need to be acquired for the modified pan-tilt system. With these costs accounted for, the projected remaining budget will be a surplus of $930.51. This surplus allows for the possibility of spare parts in case of product failure, as well as accessories and additional components the sponsor may later desire. The cost of the final product of course will be much lower than the total amount spent, since the amount that was spent includes temporary parts, prototype fabrication, and testing.

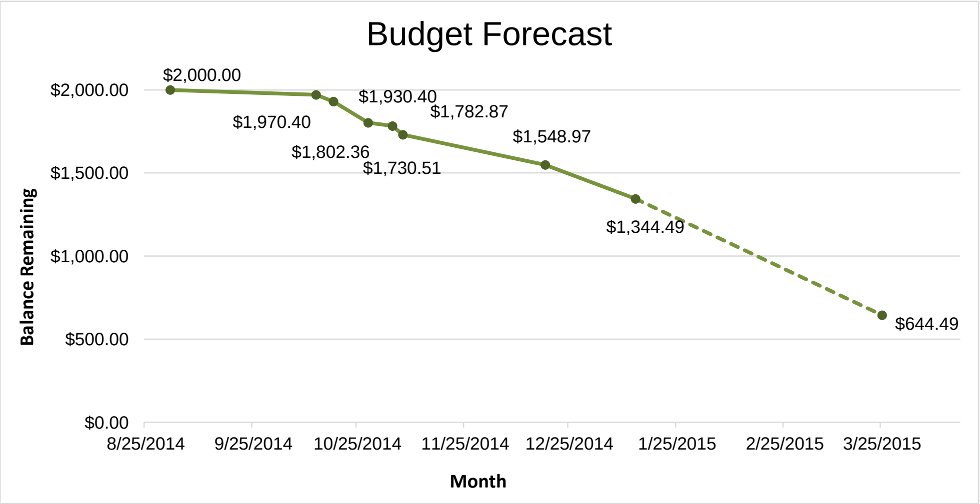

Fig. 1 Burn chart of budget forecast

C. Gantt Chart

The aim of the design team in creating this schedule is to complete the design objectives in time for the Senior Design Fair hosted by the electrical engineering department on April 9th. While prototyping and testing was started in late November, there is still a significant amount of work that needs to be done to meet this deadline. The Gantt chart in the Appendix shows a detailed outline of how the design team plans to meet this goal.

As can be seen in the Gantt Chart, the focus early in this semester will be on programming and building the rover body. In order to accomplish these two tasks, many subtasks will have to be completed such as programming the microcontroller to send and receive data from the microprocessor or building the chassis body. As the semester progresses and the rover body and controls near completion, the team will shift their focus towards building the user interface and tether. As before, many subtasks will need to be completed to accomplish these tasks.

In conjunction with the tasks outlined above, extensive testing of each subsystem will be completed with the goal of the first field test being conducted in early March.

V. Conclusion

This project has evolved beyond the calculation, planning, and design modeling stages. This in itself indicates that the group has made headway into the production of a new product – the robotic gopher tortoise scope. As the prototype process continues, the team faces new challenges and tasks. These include determining how many features can feasibly be added to the rover, digital communication, testing durability, and compensating for time lost from shipping delays. These challenges are difficult to anticipate. This requires the team to stay alert to potential changes, and have a back-up work plan.

To facilitate the progress of the project, the team learned that flexibility is key. It is very possible that there does not exist any convenient time for the group to meet together. Hence, compromises must be made by every member to ensure that the sponsor’s desires are the priority. Due to delays, a second lesson is to find ways around potential work obstacles. Waiting for the parts to come in before working on the task slows down the entire project. Hence, brainstorming ways to work around the absent components is a very valuable ability. The team agrees to be willing to make larger purchases. The spending rate is safely below the maximum, allowing for the team to purchase more expensive equipment for a better product. Starting early, actively seeking help, and finding new ways to accomplish tasks are useful strategies for every member.

Applying these lessons has led to work compartmentalizing, deciding a final body material and machining method, finalizing and stipulating heavy purchases, and proposing more detailed work assignments. By taking a more active approach to communication and to the project tasks, the possibility of finishing with a complete product is within the group’s budget, time, and technical ability.

APPENDIX

A-1 GANTT CHART

Interfacing	**50 days**	**Mon 12/1/14**	**Thu 2/5/15**
Camera to Raspberry Pi	4 days	Mon 12/1/14	Thu 12/4/14
Gamepad to Raspberry Pi	5 days	Mon 12/1/14	Fri 12/5/14
Raspberry Pi to Arduino	5 days	Fri 1/9/15	Thu 1/15/15
Screen to Raspberry Pi	3 days	Mon 1/12/15	Wed 1/14/15
Arduino to Temp/Humidity sensc	5 days	Fri 1/30/15	Thu 2/5/15
Camera Mount	**23 days**	**Wed 12/31/14**	**Fri 1/30/15**
Material Acquisition	16 days	Wed 12/31/14	Wed 1/21/15
Installation	8 days	Wed 1/21/15	Fri 1/30/15
Tether	**61 days**	**Sat 1/3/15**	**Fri 3/27/15**
Prototype	54 days	Mon 1/5/15	Thu 3/19/15
Testing	7 days	Thu 1/29/15	Fri 2/6/15
Final	5 days	Mon 3/23/15	Fri 3/27/15
Casing	**15 days**	**Mon 1/12/15**	**Fri 1/30/15**
Assembly	6 days	Mon 1/12/15	Mon 1/19/15
Dimensioning and cutting	9 days	Mon 1/12/15	Thu 1/22/15
Installation	7 days	Thu 1/22/15	Fri 1/30/15
Motor control	**12 days**	**Thu 1/15/15**	**Fri 1/30/15**
Programming	4 days	Thu 1/15/15	Tue 1/20/15
Building	10 days	Mon 1/19/15	Fri 1/30/15
Testing	10 days	Mon 1/19/15	Fri 1/30/15
Baseplate Assembly	**20 days**	**Tue 1/20/15**	**Mon 2/16/15**
Complete Acquisition	8 days	Tue 1/20/15	Thu 1/29/15
Assembly	20 days	Tue 1/20/15	Mon 2/16/15
Installation	2 days	Tue 1/20/15	Wed 1/21/15
Glare Mitigation	**13 days**	**Tue 1/27/15**	**Thu 2/12/15**
Material Bonding	5 days	Tue 1/27/15	Mon 2/2/15
Weatherproofing	8 days	Tue 1/27/15	Thu 2/5/15
Testing	12 days	Wed 1/28/15	Thu 2/12/15
Mock Burrow Testing	**20 days**	**Fri 2/27/15**	**Thu 3/26/15**
Burrow Construction	6 days	Fri 2/27/15	Fri 3/6/15
Testing	15 days	Fri 3/6/15	Thu 3/26/15
User Interface	**10 days**	**Tue 3/10/15**	**Mon 3/23/15**
Screen Casing	5 days	Tue 3/10/15	Mon 3/16/15
Weatherproofing	7 days	Thu 3/12/15	Fri 3/20/15
Testing	3 days	Thu 3/19/15	Mon 3/23/15