Design for Manufacturing, Reliability, and Economy

Design of a Multi-Functional Mobile Robot

Team 23- Spring 2017

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Abstract

Each year the American Society of Mechanical Engineers (ASME) hosts a unique Student Design Competition (SDC) at its Student Professional Development Conference (SPDC). For the 2016-2017 school year teams have been tasked with the development of a multi-functional robotic platform to compete in a series of five athletic-based competitions: a sprint, tennis ball throw, stair climb, golf ball hit, and weight lift. While the components of the robot are still being finalized, our team has continued to iterate our design such that it addresses all of the imperative criteria for the competition determined by the team to be mobility, power, stability, size, durability, and safety. In the future, the team is looking forward to ordering and machining the remainder of the components and starting the assembly process so that testing with the actual unit can begin.

Acknowledgements

Team 23 would like to thank Dr. Camilo Ordonez and Mr. Keith Larson for their expert technical advice on the structure and many of the mechanisms to be employed by our robot. Additionally, team 23 would also like to thank the FAMU-FSU College of Engineering for funding this endeavor and as well as the ASME for organizing this competition.

1. Introduction

There are strict requirements set by the competition organizers which all robots must satisfy. The first, and arguably the most limiting, is that the robot must be able to fit within a 50 cm x 50 cm x 50 cm sizing box. This includes not only the robot itself, but the controller, any spare batteries, any spare parts, and even the weight which will be used in the second event. As the size of the weight increases (causing the score to improve), the robot must become smaller in order to fit all necessary components into the sizing box. The robot must use rechargeable forms of energy. Therefore, irreversible chemical reactions like gasoline or gunpowder are not permitted and rechargeable batteries of any kind are the only allowable core power source. Other conservable energy sources such as springs or compressed air are permitted so long as the energy can be restored to its initial state by the robot at the end of each event. These constraints are binding, and all of them must be fulfilled in order for the robot to compete in the events. In order to fulfill these constraints, the team was forced to make some concessions as far as reliability, and manufacturability.

2 Design for Manufacturing

- Answer these questions:
- **How did you assemble your project from start to finish?** Lay out the process.
- Note the time it took to build your prototype. **Did your assembly take more or less time than anticipated?**
- Note the number of components in your design. **Could you have simplified the design to create less components? Or would more complexity to your design be more appropriate?** Justify.

3 Design for Reliability

3 Design for Reliability

•Answer these questions:

•How does your prototype perform when used once? How do you think it will perform when used 100, 1000, or 10,000 times? Provide reasoning behind your performance evaluation.

•What are the main reliability concerns in your project? How would you address these?

4 Design for Economics

Economically designing an appropriate platform for this project proved to be more involved than expected. While most SPDC teams compete with very little funding this project was granted a budget of $2,500 sponsored by Boeing. Currently there are multifunctional platforms in existence but none present mechanisms to address the full spectrum of the project scope. This made general benchmarking inapplicable; however, approaching the research on a subsystem level made it possible to produce a rough breakdown of projected costs as shown in Table #. For instance, a quality off the shell pneumatic tennis ball cannon can run upwards of $400 giving the 16% allowed for the Throw Mechanism in Table #. In comparison, the mechanism that was actually built only utilized approximately 12% of the budget.

Table #

Subsystem	**Projected Percentage of Budget**
Throw Mechanism	16%
Hit Mechanism	7%
Lift Mechanism	12%
Climb Mechanism (Frame and Drive System)	21%
Additional allowance for Sprint Mechanism to be added to Climb Mechanism	12%
Electronics	10%
Remaining	22%

Further detail as to what the actual costs for individual components can be found in Figure #.

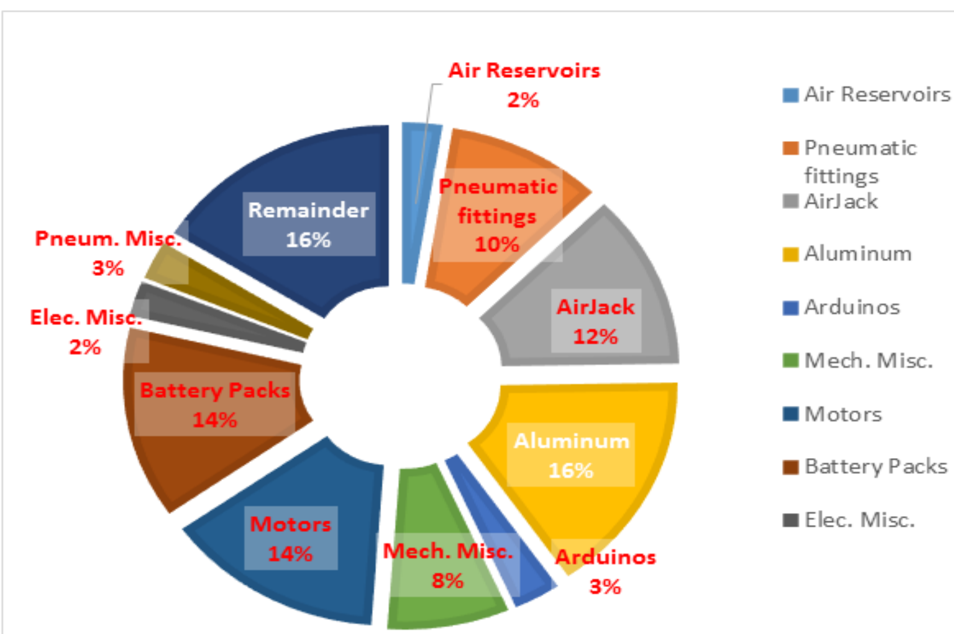

Figure #

Overall, the entire robotic platform came in at a grand total of $2,191.75 leaving 16% of the budget to be applied to the team getting to the actual competition including transportation of the robot. Certain aspects of the robot had to be iterated to cut extra costs. The Throw mechanism for to be applied to the team getting to the actual competition including transportation of the robot. Certain aspects of the robot had to be iterated to cut extra costs. The Throw mechanism for instance was modified to work with a smaller Primer stage feeding into a larger Firing stage to reduce the cost caused by purchasing multiple large diameter solenoid valves used to control the flow of air.

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Answer these questions:

- **How much does your whole product cost? How much do the components cost?**
- **Are there similar products like yours out on the market? How much do they cost compared to your project?** (hint: you can compare either your prototype or the final product or sub-assemblies for your product you *would* build with enough time)

5 Conclusion