

Product Design Specification for an Autonomous Robot

For: Axiom Electronics

Due 2/4/2014

By Team 1:

Tyler Cone

Kenneth Hangartner

Ngan Nguyen

Hoang Huy

Richard Eisenblatter

Portland State University

Contents

Introduction to the Project..... 2

Purpose of this PDS Document 2

Mission Statement 2

Project Plan..... 2

Identification of Customers 4

Customer Interview and Feedback Summary 4

PDS Table..... 4

House of Quality 6

Conclusion..... 7

Appendix 1 – Gantt Chart..... 8

Introduction to the Project

Axiom Electronics (AE) is a leading high end circuit board production company. Part of their employee's current tasks is to maneuver circuit board loaded totes around their factory floor from station to station. The company has determined that the man power and the time spent moving their product around their floor is increasing their overhead and reducing the company's net gain. Engineers at Axiom have decided that the company would like to purchase an autonomous robot capable of carrying eighty pounds and moving at a rate of fifty feet per minute. However, the cost of the robot technology that meets AE's criteria lies above their preferred price range. Axiom Electronics expressed interest in a Portland State University capstone team to design, build, program, and implement an autonomous robot to their production floor by June 16th 2014.

Purpose of this PDS Document

This Product Design Specification document includes a project mission statement which summarizes what needs to be designed, customer base, expected completion date, and robot performance requirements and constraints. Furthermore, it contains a Top-level project plan which outlines major design milestones based on design research and discussion in design reviews, prototyping and evaluation. Attachments to this document contain a more in-depth project plan than the text body. Included is a section on identification of customers as well as their feedback and the results of interviews. The PDS table contains the customer needs, priority, engineering metrics, targets, basis for target selection, and verification methods. The House of quality connects important customer requirements with measurable characteristics of the product. This document concludes with a summary of the issues addressed and some of the important specifications and obstacles needed to be overcome.

Mission Statement

To develop an autonomous robot that is capable of transporting electrical circuit boards inside Axiom Electronics' manufacturing site. The robot must carry at least 80 pounds at a speed of 50 feet per min. Its loading platform will consist of two 22.5"x17.5" rectangular bins for holding the components needed to be moved. The robot must travel between specified point while avoiding humans and other various obstacles.

Project Plan

The plan of this project is to design and manufacture a tote transportation robot that has the ability of self-navigation inside Axiom's manufacturing floor. The major design milestones for the project is listed below. A Gantt chart is provided in appendix 1 It will be updated as the project progresses. In addition, milestone deadlines are subject to change depends on the project requirements. The following table shows the major milestones along with the related dates.

3 | PDS Report

| TASKS | START DATE | END DATE | DEADLINE |
|---|------------|-----------|-----------|
| WEEKLY MEETING | | | |
| Weekly Progress Report (to advisors and Axiom contact) | 1/6/2014 | 6/2/2014 | |
| PRODUCT DESIGN SPECIFICATIONS | | | |
| PDS Document | 1/6/2014 | 1/25/2014 | 2/4/2014 |
| EXTERNAL AND INTERNAL RESEARCH | | | |
| Brainstorming | 1/13/2014 | 1/31/2014 | |
| Study existing solutions | 1/20/2014 | 2/6/2014 | |
| CONCEPT EVALUATION AND SELECTION | | | |
| Initial Design | 2/3/2014 | 2/27/2014 | |
| Selection of Mechanical Design parts | 2/10/2014 | 3/7/2014 | |
| Selection of Electrical Design parts | 2/10/2014 | 3/7/2014 | |
| Selection of Control Design parts (microcontroller, software) | 2/10/2014 | 3/7/2014 | |
| Progress Report | 2/10/2014 | 2/27/2014 | 3/13/2014 |
| Progress Report Presentation | | | 2/25/2014 |
| DETAIL DESIGN | | | |
| Model the design on computer | 2/24/2014 | 4/3/2014 | |
| PROTOTYPE AND TEST | | | |
| Manufacture | 3/10/2014 | 4/24/2014 | |
| Test | 3/17/2014 | 5/3/2014 | |
| Redesign as needed | 3/31/2014 | 5/10/2014 | |
| DOCUMENTATION | | | |
| Deliver product to customer | 5/5/2014 | 5/29/2014 | |
| Final Report | 5/12/2014 | 5/29/2014 | |
| Final Presentation | 6/2/2014 | 6/6/2014 | 6/5/2014 |

Identification of Customers

Customers are defined as either a person, group, or entity that sets requirements for a project. They have been identified by the Capstone team as:

1. Axiom Electronics (AE) is the main customer and most performance metrics will be done for them.
2. Dr Yi is the professor who will be grading our progress. Most documentation will be oriented towards him.
3. The Capstone Team - The Capstone team is a customer since they will be the ones working on the project and assembling it.

Customer Interview and Feedback Summary

All Axiom Electronics requests were made in writing or vocalized in the initial meeting with our contact, Dolly Blanda. The performance requirements can be found in the Robot Specifications page they provided us. Work for Dr. Yi is done per instructions given in ME-492 lecture or Syllabus. Project Requirements set by the Capstone Team are self-imposed metrics that were decided on to make assembly easier.

PDS Table

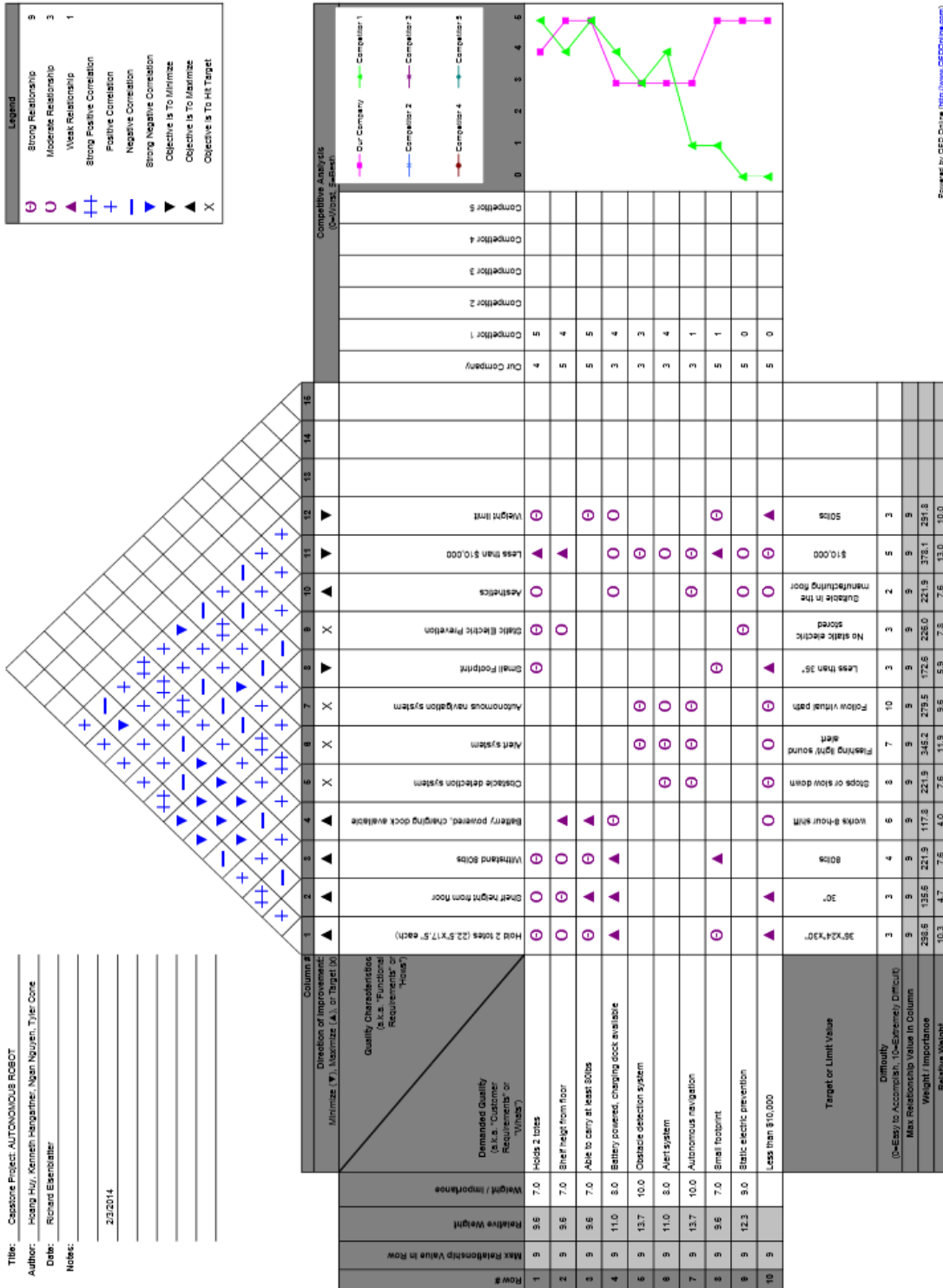
The following is the Product Design Specification for this product. It has been sorted by priority from highest priority to lowest priority.

| Criteria | Requirement | Customer | Metrics | Target | Basis | Verification | Priority |
|----------------------------|---|-------------------|--------------------------|----------------------------|----------------------|------------------------|----------|
| Environment (navigation) | Ability to Navigate around obstacles | Axiom Electronics | Collisions and accidents | No Collisions or accidents | Customer Interview | Testing and Validation | High |
| Processes | Ensure that the process is correct | Capstone Group | Not Applicable | Not Applicable | Capstone Decision | Testing and Validation | High |
| Laws, Codes, and Standards | The robot be legal | State | Doesn't violate laws | Zero infractions | Regulations | Careful study | High |
| Documentation (customer) | A User's Manual | Axiom Electronics | Instructions | Well Written | Capstone Decision | Careful Validation | High |
| Time Scale | Finish work based on the timeline given | Capstone Group | Date | Finish before June 10. | Project Requirements | Gantt Chart | High |
| Performance (battery) | The battery lasts for a work period | Axiom Electronics | hours | 8 | Customer Interview | Testing | High |

| Criteria | Requirement | Customer | Metrics | Target | Basis | Verification | Priority |
|-----------------------------|---|------------------------|----------------------------|------------------------|----------------------|-----------------------------------|----------|
| Performance (speed) | Speed Requirements | Axiom Electronics | inches per minute | 50 | Customer Interview | Testing | High |
| Testing | The robot works to specifications | Capstone Group | Robot | Carries weight | Capstone Decision | Testing and Validation | High |
| Safety | Does not harm anyone | Axiom Electronics | Injuries | No Injuries | Customer Interview | Testing and Validation | High |
| Size and Shape | Follow prescribed dimensions | Axiom Electronics | Inch | 36" x 24" x 30" | Customer Interview | Measurement and Design | High |
| Retail and production costs | Remain within Budget | Axiom Electronics | Dollars | \$10,000 | Customer Interview | Budget | High |
| Environment (floor) | Ability to work in factory setting | Axiom Electronics | Have grip on floor surface | Be able to turn & stop | Customer Interview | Testing and Validation | Medium |
| Legal | Not conflict with existing patents | Axiom Electronics | NA | NA | Capstone Decision | Careful Study | Medium |
| Documentation (university) | PDS Document, House of Quality | Capstone Group, Dr. Yi | Reports | 2 | Project Requirements | Not Applicable | Medium |
| Quality and Reliability | Fulfills product expectations | Capstone Group | Not Applicable | Not Applicable | Capstone Decision | Testing | Medium |
| Maintenance | Should be easy to maintained | Axiom Electronics | times per year | 2 | Customer Interview | Checking performance twice a year | Medium |
| Materials | Be easy to assembly | Capstone Group | Not Applicable | Not Applicable | Capstone Decision | Testing and Validation | Low |
| Weight | Be transportable | Capstone Group | Pounds | Less than 50 | Capstone Decision | Testing | Low |
| Aesthetics | Worthy of showcasing | Axiom Electronics | Looks Good | Customer Feedback | Capstone Decision | Visual Inspection | Low |
| Manufacturing Facility | A place with enough tools and machines to manufacture | Capstone Group | A clean Room | The capstone lab | Capstone Decision | Visual Inspection | Low |

House of Quality

The following is the house of quality for the Autonomous Robot. The highest quality parameters are shown below, along with some of the main competitors.



Powered by QFD Online (<http://www.QFDOnline.com>)

Conclusion

This project consists of many complex issues including design of the robot chassis, selection of the sensors, motors, other important components, and programming the microcontrollers. Initially, the team's main concern was about the programming of the robot since few members have any programming expertise. However, we have since been assigned a graduate student to handle the various programming challenges ahead. Our customer is helpful both in design considerations as well as providing any supplies/materials needed. We are currently in the brainstorming and concept design stage, and are on track with our project timeline. We are optimistic that we can complete this project by our deadline.

Appendix 1 – Gantt Chart

Here is the project timeline for the robot.

