

# Autonomous Lawn Care Unit

DESIGN DOCUMENT

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List of figures/tables/symbols/definitions (This should be the similar to the project plan)

NOTE: This template is a work in progress. When in doubt, please consult the project plan assignment document and associated grading rubric.

## 1 Introduction

### 1.1 ACKNOWLEDGEMENT

If a client, an organization, or an individual has contributed or will contribute significant assistance in the form of technical advice, equipment, financial aid, etc, an acknowledgement of this contribution shall be included in a separate section of the project plan.

### 1.2 PROBLEM AND PROJECT STATEMENT

The problem we intend to solve concerns the time and financial commitment required to upkeep a well-groomed lawn. There is a long list of reasons a certain individual may not be able to mow their own lawn, ranging from lack of time to physical incapacibilities. Someone who falls into this category does not have many options to get the job done, without hiring expensive, third-party help.

We intend to solve this problem by designing a safe, functional, and affordable autonomous lawn mower. This will give lawn-owners a relatively inexpensive, low-effort means of maintaining their lawn effectively. Our autonomous lawn mower will be able to safely mow any predefined area with maximum accuracy and efficiency.

– This is included so that the reader will have the correct conception of the problem and the solution approach upfront. Each shall be written in a non-technical manner that a lay person would understand.

– Consists of two components, each separated and clearly identified:

-General problem statement – defines the general problem area

-General solution approach – defines the proposed solution approach

-This section should also highlight the purpose of the project, what you are trying to do.

Explain what is driving this project. Why is it important?

Explain what the project is.

Explain what you hope to accomplish. What are the outputs of the project?

### 1.3 OPERATIONAL ENVIRONMENT

The general environment for our product will be a dry lawn. As with any lawnmower it, it would have trouble cutting wet grass. The wet lawn would also make it difficult for our lawnmower to retain traction and be able to travel up steeper terrain. Our mower will be spending most it's time outside, therefore, it must have some sort of water and dust resistance. The electrical components are very susceptible to water, and they must be kept dry. Lots of dust could cause static electricity to build up, which could kill the components. The next thing we would have to worry about is the

mower overheating. We will need to keep the electronic components out of direct sunlight. When we implement something to keep the components dry and dust free, it would also double as a shield from the sun.

#### 1.4 INTENDED USERS AND USES

Our intended users are anyone who need their lawn mowed. If you own a home, you most likely need to keep your lawn trimmed. There are many reasons why someone may not be able to do this.

For example, some people do not have the time and some people have physical incapacities. The uses for our product would be to mow a lawn. We picture it being used by residents and not corporations. The primary goal of our product will be to make the lives of the user's a little bit easier.

#### 1.5 ASSUMPTIONS AND LIMITATIONS

- Assumptions
  - Residential, non commercial use.
  - Battery Powered
  - ½ Acre Lawn
- Limitations
  - Steep Terrain
  - Dry Conditions
  - Grass must not be overgrown.
  - < 40lbs
  - Must be affordable <1500-2000\$

- Two separate lists, with a short justification as needed.
- Extremely important, as it can be one of the primary places where the client can go to determine if the end product will meet their needs.
- Examples of assumptions: The maximum number of simultaneous users/customers will be ten; Blue is the best background color and will be used; The end product will not be used outside the United States.
- Example of limitations: The end product shall be no larger than 5"x8"x3" (client requirement); The cost to produce the end product shall not exceed one hundred dollars (a market survey result); The system must operate at 120 or 220 volts and 50 or 60 Hertz (the most common household voltages worldwide).
- For limitations, include tests not performed, classes of users not included, budget/schedule limitations, geographical constraints, etc.

#### 1.6 EXPECTED END PRODUCT AND DELIVERABLES

- Safe and Affordable autonomous lawnmower.
  - Lawn mower can find and avoid hazards in lawn.
  - It is affordable compared to other mowers on the market.
- Android/iPhone App to control lawnmower.

- This will tell the lawnmower when and where to mow. As well as view mower stats.

These tie in with the goals. What deliverables are necessary to meet the goals outlined in the introduction?

List the end product and any other items, along with a brief description, that will be delivered to the client prior to the end of the project.

- If the end product is to be commercialized, the description shall be of the commercialized end product.
- It shall be in the form of a technical product announcement, as opposed to a product advertisement, and shall not include a list of technical specifications.
- Any other items that will be delivered to the client shall also be included and described unless their definition and description are obvious.
- Examples might include a household power supply to eliminate the need for batteries, a user's manual, or other project reports.
- There shall be at least a one-paragraph description for each item to be delivered.
- Delivery dates shall also be specified.

## 2. Specifications and Analysis

### 2.1 PROPOSED DESIGN

Our lawn mower design is have a RC chassis with a tank drivetrain to power the movement portion of the mower. We plan on using a microcontroller to control the sensors and movement. As for the blades we plan on using a Reel blade which will be attached to the front of the mower. To make this mower autonomous we will have boundary wire surrounding the portions of the lawn which need mowing. The mower will sense for the wire and cut within the designated perimeter.

Currently we have

Include any/all possible methods of approach to solving the problem:

- Discuss what you have done so far – what have you tried/implemented/tested, etc?
- We want to know what you have done
- Approach methods should be inclusive of **functional and non-functional requirements** of the project, which can be repeated or just referred to in this section

If your project is relevant to any **standards** (e.g. IEEE standards, NIST standards) discuss the applicability of those standards here

## 2.2 DESIGN ANALYSIS

Our proposed design utilizes a customizable RC-style chassis and a reel mower blade. We have the ability to 3D print or acrylic cut any other pieces that we might need, such as the microcontroller housing. From our calculations, this design will be light enough to be easily maneuverable, yet robust enough to handle mid-grade inclines and keep traction even on wet ground. So far we have started creating the mobile application which allows users to check the weather and schedule a mowing time. We have determined the majority of the parts we need for the mower as well as their costs.

- Discuss what you did so far
- Did it work? Why or why not?
- What are your observations, thoughts, and ideas to modify or continue?
- If you have key results they may be included here or in the separate “Results” section
- Highlight the **strengths, weakness**, and your observations made on the proposed solution.

## 3 Testing and Implementation

Testing types:

Software:

1. Make sure that there is a solid connection between the microcontrollers and the motors of the mower
2. Make sure that the mower is moving in the correct direction
3. The Lawn mower should only be mowing within the specified radius
4. The lawn mower should be moving automatically w/o human interaction

Hardware:

1. All parts of the mower are connected securely and safely
2. All the sensors are receiving accurate data
3. The mower is operating at the correct speeds
4. Battery is charging correctly
5. The mower should be able to withstand certain conditions

Mobile:

1. The app should be connected to the mower correctly
2. Data from the mower should be shown to the user
3. Server for logging in should be working correctly

Software Test:

2. We will be testing the software on a pvc drivetrain before we purchase a metal chassis to make sure our software works.

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, or a software library

Although the tooling is usually significantly different, the testing process is typically quite similar regardless of CprE, EE, or SE themed project:

1. Define the needed types of tests
2. Define the individual items to be tested
3. Define, design, and develop the actual test cases
4. Determine the anticipated test results for each test case
5. Perform the actual tests
6. Evaluate the actual test results
7. Make the necessary changes to the product being tested
8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you've determined.

### 3.1 INTERFACE SPECIFICATIONS

- Discuss any hardware/software interfacing that you are working on for testing your project

### 3.2 HARDWARE AND SOFTWARE

- Indicate any hardware and/or software used in the testing phase

Below is the list of hardware for the drivetrain of the mower

Great States 204-14 Hand Reel 14 Inch Push Lawn Mower
PG71 Gearmotor
30" C Channel
8" Plaction Wheel with Wedgetop Tread (am-0514)
PG Series Mounting Bracket (am-2197)
500 Hex Hub (am-0096a)
3/8" diameter external retaining ring (am-1253)
M4-0.7 x 10mm SHCS [Qty-10] (am-1269)
10-24x1/2 Thread Forming Screw [Qty-25] (am-1361)
1/4-20 x 2" SHCS - Bulk Qty (am-1012)



1/4-20 Nylock Nut - Bulk Qty (am-1015)
Cheap and Dirty Radio Control System (am-2520)
8 Ganged ATC Fuse Block for Snap Action Breakers with Ground Terminal (am-3136)
5 ft of bonded red/black wire (buy 25 ft)
30 Amp Snap Action Breakers (am-0290)
12V 17Ah Battery
Connector, Female, 12-10 AWG, Tab .032"x.250", Yellow, Qty 10
Powerpole Kit
Talon SRX Speed Controller (am-2854)
Power Converter 12/24VDC to 5VDC
3-wire PWM cable
6 gauge Robot Side Power Cable Kit
6 Gauge Battery Cable
Battery Charger
Houseables Caster Wheels

Mobile Testing:

1. Android studio will be used to test the mobile app
  - a. We can run simple unit tests to make sure the app is working as intended
  - b. This software allows the developer to emulate the application on a phone.

### 3.3 TESTING

#### Hardware

For hardware testing we will put the mower through a variety of tests to make sure that it can mow to our desired specifications. We will create environments like the ones below

- Wet similar to just having rained
- Hill climb, making sure that it can go up our desired grade
- Rocky terrain as if it has to go through a garden or on gravel
- Thicker grass

Software:

Mobile:

Testing for performance, security, usability, compatibility

### 3.4 PROCESS

- Explain how each method indicated in Section 2 was tested
- Flow diagram of the process if applicable (should be for most projects)

### 3.5 RESULTS

Our funding has just been authorized so at this point in time, we have not been able to test because we have not had the hardware to do so.

- List and explain any and all results obtained so far during the testing phase
  - - Include failures and successes
  - - Explain what you learned and how you are planning to change it as you progress with your project
  - - If you are including figures, please include captions and cite it in the text
    - This part will likely need to be refined in your 492 semester where the majority of the implementation and testing work will take place

-**Modeling and Simulation:** This could be logic analyzation, waveform outputs, block testing. 3D model renders, modeling graphs.

-List the **implementation Issues and Challenges.**

## 4 Closing Material

### 4.1 CONCLUSION

Mowing the lawn is something the majority of homeowners need to do on a semi-weekly basis. Sometimes they may not have the time or ability to mow it. With our project we aim to solve this problem in a affordable and effective way. We think that with our approach we should be able to make a device that is much cheaper than what the current market has to offer. Our mower will also have extra features such as a mobile app, weed killers, and auto charging which should make it even more helpful to the consumer. Our end goal is to create a product that the every-day homeowner can

### 4.2 REFERENCES

This will likely be different than in project plan, since these will be technical references versus related work / market survey references. Do professional citation style(ex. IEEE).

### 4.3 APPENDICES

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc. PCB testing issues etc. Software bugs etc.