

# **Self-Service Lawn Bots**

## Project Definition Document

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# Customer Discovery

If anyone has ever done yard work, they know that lawn care is a complex job; it is one big job, that contains a lot of different tasks within it. If there is not a whole team of people working at it together, it can be a long and physically exhausting process. Lawn care has even proven to be a dangerous task as power mowers alone have been involved in 37,000 foot-related injuries to Americans every year (1). Automated robots would make lawn care easier for aging elders (2). Having robot drones perform the upkeep allows customers to have a nicely maintained lawn without putting in the manpower to do so. Ultimately, lawn care is a scenario where a robotic swarm working together to accomplish the task would be greatly beneficial. Enter the Self-Service Lawn Bots (SSLB).

In the lawn care industry, there's a blending of target customers and stakeholders that the robot swarm would lend itself to. In 2016, the lawn care industry saw a total revenue of \$77 billion with 50% coming from commercial landscaping services and another 30% coming from residential services (3). Another survey showed that 40% of Americans with yards hired a professional lawn service, spending up to \$600 a year to do so, with two of their motivations being to save time and to make their lawn look the best it can (4, 5). Consumers and professional services alike seek consistency and perfection in their lawn care and for their property to look well maintained and professional. Most successful companies know the importance of branding other positive company image-related experiences including a range of things like having an efficient working website to well-kept outdoor maintenance outside their business offices as a part of their ongoing image to their customers and employees. Places that strive for presentability to attract individuals are residential communities (apartment buildings and subdivisions), hospitality services (hotels and resorts), and commercial businesses (office buildings, retail centers, and restaurants) (6). Through the upkeep of their lawn, a company would be seen by a distributor as someone who takes care of their business. A well-maintained ground gives customers a positive impression of the business, whether they are aware of it or not. That's where commercial landscaping comes in, ensuring there's nothing that might give your customers a bad impression of your business before they even get to the front door (7).

Current solutions to lawn care are lacking multiple things that the SSLB hope to fulfill. One of which is consistency. Current lawn services are based around machines operated by individuals, subject to human error or even laziness. Consumers and professionals can accidentally miss areas when mowing or not pick up every stick. The robots hope to provide a solution to the lack of consistency, imperfection, and mistakes made by human-operated mowers. Another is safety. Since the bots are not human-operated, they minimize the possibility of operator or even bystander injuries. Also, we find that many customers lack time to do their lawn care consistently, but with autonomous robots, there is no time commitment for the individual at all.

Some earth-conscious, health-related, and technological advancements are also lacking in our current lawn care solutions. Over 2 billion gallons of fuel are used just for lawn care in the U.S. every year, and our bots will minimize fuel usage as well as the money spent on fuel while simultaneously minimizing gasoline emissions (8). Gasoline-powered lawn equipment contributes substantially to the emissions of benzene-1,3, butadiene, formaldehyde, carbon monoxide, and fine particulate matter, while Benzene-1,3 butadiene and formaldehyde are among the four top-ranking cancer-causing compounds (9). When this is compounded with increased legislation against small gas-powered engines, an expanded market starts to emerge. California's own ban will look to prevent the sale of such items in 2024, citing the lack of emissions regulations on the equipment, and the sheer quantity of the equipment within the state. The state board that passed the ban even provides rebates for consumers and

professionals to transition to zero emissions requirements, further driving the need for electric, automated services to fill the created gap (10).

Lastly, our world is facing our fourth industrial revolution era involving more AI-powered, machine learning robots, potentially increasing productivity, service efficiency, and customer satisfaction among a wide range of industries; including outdoor maintenance. A survey that was conducted on successful business leaders in the U.S. shows that 24% are already using AI-powered systems, and 60% are planning to use AI in the near future (11). Mowers and other lawn equipment have stayed predominantly gas-powered; with the technology revolution we are presently in, we have the opportunity to eliminate unnecessary fuel waste and carbon emissions. The SSLB will connect with emerging AI technologies to create a modern set of lawn tools, instead of trudging along with the same old lawn equipment designs.

# **Problem Definition**

Lawn-maintainers need a way to stay on top of lawncare in a way that improves their lawn quality and schedule management while also freeing them from the physical requirements to do so.

# **POV Statements**

Business owners need their lawns to look consistently well-maintained, professional, and attractive because it will lead people to trust them more and to have a better image in their eyes, possibly leading to an increase in customers.

Property owners and renters need to be able to take good care of their lawns without the time constraints of doing so because many people lead too busy of lives to put in an adequate amount of time for their lawn care.

Elderly property owners need to be able to do their lawn care while avoiding the physical requirements of lawn care because as people age physical limitations increase causing lawn care to be too physically straining or causing an inability to do it all together.

# **Design Requirements**

- 1) The devices shall have a safety to prevent it from turning on automatically.
- 2) The devices shall be able to be controlled via an app.
- 3) The devices shall provide an expected life of 5 years.
- 4) Devices shall be seismically qualified in accordance with requirements of IEEE 693.
- 5) Cellulose insulation barriers and spacers shall be high-density material. Low-density pressboards are acceptable for forming insulation parts.
- 6) No split or star-locked washers permitted.
- 7) Devices shall be able to withstand wet ground conditions (water resistant).
- 8) Devices shall withstand a maximum wind speed of 5 mph.
- 9) Each device cannot weigh over 30 pounds.
- 10) To prevent overheating, cooling shall be integrated into the design.
- 11) Devices shall have the ability to schedule weekly lawn maintenance.
- 12) Devices shall have the ability to launch and dock themselves.
- 13) The devices shall provide a safety guard to prevent injury.

# **Design Criteria and Evaluation**

## **Quality of Materials**

As a design team, nobody wants to be known for a cheaply-made product that doesn't live up to their customers' expectations with everyday use especially for outdoor equipment tools. As John Welch an executive for General Electric Company experienced, customers will not scientifically rate your product against another similar company's product and you can be placed better or worse," which can ruin a company's chances of success if their product is rated lowly (12). The customers want something that is built to last. Not only is the quality of materials important to the customer, but as formerly referenced, possibly detrimental to the success of the SSLB as well.

The design team will be using materials like carbon fiber for handles and materials like forged steel or stainless steel for blades to ensure the design has a lasting, high-quality design.

## **Battery Life**

When making a purchase, especially for a device that helps maintain the home, the battery life plays a huge role. A product will not be as enlightening to a consumer if it only lasts a few months to a year. Even though a robotic lawn mower can last up to ten years depending on how the consumer takes care of the product. The battery life itself can last anywhere from two to five years prior to replacement. A well-maintained battery can last up to three years on average (13). We believe that it is important to educate consumers on how to properly store and maintain the lawn mower so that the battery will be able to function to its full potential.

Three batteries we will test are the Li-Ion-Battery, Li-Iron phosphate Battery and NiMH-Battery. The evaluation of the batteries will be based on things like their durability at varying temperatures and the effects of different work-demand cycles on their longevity.

## **Cost**

Customers are willing to pay more for a product that better solves a problem they face. Forbes recently published results from a study that polled customers on their willingness to pay more for convenience and service and their results support our hypothesis. Customers responded by saying that 50% would pay more for better service and 70% would pay more for convenience (14). If better materials, smarter technology, and better execution offset a price increase, then a price increase is an acceptable counterbalance.

As a comparative value, we will use the average price consumers paid for lawn care services of \$600 and an average price between non-robotic lawn care kits from popular home improvement stores. With those values in mind, we will try to keep within the percentage values from the Forbes survey to justify an end price that would meet customer satisfaction, convenience, and overall service.

## **Weight**

The weight of a product is an important factor to customers in a few different ways. In one sense, a heavier weighted product can allude to greater quality and stability in the product. If a product is super light, especially if it is meant for more heavy-duty work like lawn care, customers may have a doubt in the quality of work it can accomplish and the long-term durability of the machine. On the other hand, if the product is too heavy, it will make managing the transportation of the product extremely difficult for customers.

When evaluating SSLB designs based on weight, the focus will be on creating a durable and top-notch product, even if that means the product has a greater weight. NIOSH establishes

51 lbs. as the safe lifting weight for products in a perfect world (assuming the consumer follows proper lifting techniques) but the line will be drawn at a max of 30 lbs. per device to air on the side of safety for consumers (15).

### Aesthetics

Regardless of function or price, value and satisfaction can be added simply by making the look and design of the SSLB system pleasing to the customer by adding design focus to its sensory properties and what the customer can experience. By adding visually appealing aesthetic to the system, we can increase the value in the experience the customer has with the SSLB that they purchase. This will, in turn, increase the satisfaction the customer has with their purchase (16).

The Design team will use the basic, subjective tenets of aesthetic analysis to determine how to maximize the appeal of the SSLB design by focusing on the noted sensory aspects of touch, color, and visual form (16).

## AHP Table

	Quality of Materials	Battery Life	Cost	Weight	Aesthetic	Total	Weight (Crit/Overall)
Quality of Materials	1	1	3	1/2	4	9.5	23.76%
Battery Life	1	1	3	3	5	13	32.51%
Cost	1/3	1/3	1	2	5	8.6666	21.68%
Weight	2	1/3	1/2	1	3	6.8333	17.09%
Aesthetic	1/4	1/5	1/5	1/3	1	1.9833	4.96%
Total	—	—	—	—	—	39.98	

### AHP Description:

Analysis of the Criteria above indicates that Battery Life will be the most important criterion to prioritize. The design team will then focus on decisions for Quality of Materials being used and total cost of the SSLB respectively. Since these top three criteria work very closely together to enhance the overall satisfaction in the SSLB system it makes sense that they rank highly. Weight and Aesthetic are at the bottom of the hierarchy. Weight will be strongly affected by the size of battery used and quality of materials. Aesthetic provides no true function other than appeal to the target users.

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