

This entry received a **score of 3** independently from two expert raters based on the EDPPSR. In this entry, design requirements are listed and prioritized (indeed, the designers indicate in the introductory paragraph in this entry that, “the constraints are listed in order of importance”). The design requirements/constraints are generally clear and somewhat detailed (e.g., “The product must be able to withstand outdoor conditions because it will be used outside and kept in either a garage or an outdoor environment”). Sometimes information included under a given heading does not all support that topic. Thus, for example, under “Aesthetics,” the students note:

“Our product must be painted in a color that blends in or goes well with many/all existing lawn mowers. The majority of lawn mowers that are currently on the market are green, red, or black, or orange so one of those colors would be most pleasing to the eye. All of the lawnmowers on Lowes.com have some feature on it that is painted black, so our product would match the best when painted black. The surface of the product must be resistant to the elements.”

This last sentence has nothing to do with aesthetics, but is a sort of “stream of consciousness” detail that follows discussion about paint.

Nonetheless, taken as a group, the design requirements/constraints have the potential to lead to a viable solution to the problem of shoulder injury while pull starting a lawn mower motor. However, some of the design requirements are not objective, for example, “Our product must be able to withstand the vibrations of the mower. The vibrations will be quite drastic because ‘the average walk behind mower has a 5-7 horsepower motor’”. The lack of a reference to the source of quotes such as in this example also creates uncertainty about objectivity.

Evidence that the requirements represent the needs of, and have been validated by, at least a few primary stakeholders comes from the students’ mention of the use of a survey to help them “find the best solution to our problem.” While students never made clear who survey participants were and why they were chosen, it is likely that they were individuals who have used or intend to use a lawn mower. This evidence is minimal at best, and contributes to the assignment of a 3 rather than a higher score.

### Engineering Design Process Portfolio Scoring Rubric Component and Element Titles

#### Component I: Presenting and Justifying a Problem and Solution Requirements

- Element A: Presentation and justification of the problem
- Element B: Documentation and analysis of prior solution attempts
- **Element C. Presentation and justification of solution design requirements**

#### Component II: Generating and Defending an Original Solution

- Element D: Design concept generation, analysis, and selection
- Element E: Application of STEM principles and practices
- Element F: Consideration of design viability

#### Component III: Constructing and Testing a Prototype

- *Element G: Construction of a testable prototype*
- Element H: Prototype testing and data collection plan
- Element I: Testing, data collection and analysis

#### Component IV: Evaluation, Reflection, and Recommendations

- Element J: Documentation of external evaluation
- *Element K: Reflection on the design project*
- Element L: Presentation of designer’s recommendations

#### Component V: Documenting and Presenting the Project

- Element M: Presentation of the project portfolio
- Element N: Writing like an Engineer

**Please Note: Elements M and N require no submission from the portfolio author(s) and are intended to be scored based on the portfolio work as a whole from what has been submitted from Elements A through L**

## Element C - Presentation and justification of solution design requirements

- 5** Design requirements are listed and prioritized, and they are consistently clear and detailed; these design requirements presented are consistently objective, measurable, and they would be highly likely to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, many if not all primary stakeholder groups.
- 4** Design requirements are listed and prioritized, and they are generally clear and detailed; these design requirements presented are nearly always objective and measurable, and they would be likely to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, several primary stakeholder groups.
- 3** Design requirements are listed and prioritized, and they are generally clear and somewhat detailed; these design requirements presented are generally objective and measurable, and they have the potential to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, at least a few primary stakeholder groups.
- 2** Design requirements are listed and prioritized, but some/all of these may be incomplete and/or lack specificity; these design requirements may be only sometimes objective and/or measurable, and it is not clear that they will lead to a tangible and viable solution to the problem identified; there is evidence that the requirements represent the needs, of/and or have been validated by, only one primary stakeholder group.
- 1** An attempt is made to list, format, and prioritize requirements, but these may be partial and/or overly general, making them insufficiently measurable to support a viable solution to the problem identified; there is no evidence that the requirements represent the needs of, or have been validated by, any primary stakeholder groups.
- 0** Design requirements are either not presented or are too vague to be used to outline the measurable attributes of a possible design solution to the problem identified.

**Design Specifications**

**Introduction**

In order to find the best solution to our problem, we sent out a survey and looked at past solutions. These research options have given us concrete factual information that will help us narrow down the exact specifications. We will use this feedback to create our product constraints. This portion of the design process will require us to determine the precise details that will make our design most effective in solving our problem. The constraints are listed in order of importance.

**Constraints**

**Customer needs**

The people that completed our survey have given us certain feedback that will help us come up with specifications. First, 29 percent of the survey takers explicitly stated that a spring or gear system is a feature that is desirable. Likewise, the use of an anti-kickback feature and the implementation of the old crank shaft starting device were listed by the remaining survey takers. Overall, these possible features must be able to reduce the amount of trauma force on the customer's shoulder while using the device.

**Performance**

Based off of our survey, we have determined that our product must be able to start a recoil start motor by increasing mechanical advantage and by starting the motor within a shorter time period. Specifically, since the force required to pull start a recoil start motor is approximately 30 pounds, our product should attempt to decrease this required force by at least 50 percent. Furthermore, on average, it takes approximately 5 pulls for someone to start a motor. Therefore, to increase efficiency and decrease effort, our product should be able to start a recoil start motor within the first or second pull.

**Safety**

The product that we will develop to solve the problem of shoulder injury while pull starting a motor must eliminate the strain on the rotator cuff caused by the jerking motion from the pull cord. From our survey, sixty percent of the survey takers stated that pulling a start cord was a level difficulty of 5 or greater (10 being the most difficult and 1 being the least difficult). The more difficult the motion is, the more likely for someone to injure their shoulders. Furthermore, seventeen percent of the people specifically stated that they had injured their shoulders while pulling the start cord.

**Durability**

From our survey, a product developed to make pulling a start cord more efficient must be durable in several areas. First of all, the cord must be made of a material that will not break and will be capable of providing enough torque to start the motor. As previously stated, this force is around 30 pounds.

**Ergonomics**

The product should be comfortable to the hand or foot (depending on the final design), and must be fit to the size of the average hand (180mm by 80mm) or foot (size 8). (source 2)

**Service Life**

The service life of this product should be about 7 to 10 years, since a survey by J.D. Power and Associates determined that the life of a lawn mower without maintenance is about 7 to 10 years, and we'd like the product to last as long as the mower.

**Estimated Cost**

Based off of our survey, we have determined that the cost of the product should not exceed \$50, as it is a reasonable price that people would be willing to pay for the product.

**Material**

The ideal materials that should be used are steel and plastics. These are ideal because steel is weather resistant, and the plastics are cheap and can be very durable. Any part of the product making direct contact with the user should be plastic to be comfortable, and any parts receiving a lot of stress should be made of steel to that they hold their shape and last longer.

**Size/Weight**

The weight of the attachment should be no more than 10 percent of the weight of the average push lawn mower. According to the lawn mower comparison on Husqvarna.com, the average weight of a push lawn mower is 89.57 lbs, so the maximum weight of our attachment should be approximately 8.957 lbs. Although this product must be light, the materials must be durable and strong.

**Operating Environment**

Our product must be able to withstand the vibrations of the mower. The vibrations will be quite drastic because "the average walk behind mower has a 5-7 horsepower motor." The product must be able to withstand outdoor conditions because it will be used outside and kept in either a garage or an outdoor environment.

**Global Environment**

The product must not include any toxic chemicals because we don't want to injure or harm any people or animals. The product should be made with recyclable materials, because with an estimated product life of 7-10 years, the materials would normally be disposed of in a way that would contribute greenhouse gasses into the atmosphere. Recycling these materials would save money and preserve the environment.

### **Aesthetics**

Our product must be painted in a color that blends in or goes well with many/all existing lawn mowers. The majority of lawn mowers that are currently on the market are green, red, or black, or orange so one of those colors would be most pleasing to the eye. All of the lawnmowers on Lowes.com have some feature on it that is painted black, so our product would match the best when painted black. The surface of the product must be resistant to the elements.

### **Sources**

1. 12V 10AH 26058 6-DZM-10 CB10-12 CE5 CE6 MA 2.0 Lawn Mower Battery - 2 Pack. (n.d.). Com Electronics. Retrieved October 31, 2013, from <http://www.ecomelectronics.com>

2. Average Hand. (n.d.). Size. Retrieved November 1, 2013, from [http://www.theaveragebody.com/average\\_hand\\_size.php](http://www.theaveragebody.com/average_hand_size.php)

3. Life Expectancy of a Lawn Mower | eHow. (2011, October 24). eHow. Retrieved November 1, 2013, from [http://www.ehow.com/info\\_12158633\\_life-expectancy-lawn-mower.html#ixzz2jj4baWh7](http://www.ehow.com/info_12158633_life-expectancy-lawn-mower.html#ixzz2jj4baWh7)

4. 12V 10AH 26058 6-DZM-10 CB10-12 CE5 CE6 MA 2.0 Lawn Mower Battery - 2 Pack. (n.d.). Com Electronics. Retrieved October 31, 2013, from <http://www.ecomelectronics.com>

5. as Push Lawn Mowers. (n.d.). Lowe's. Retrieved November 5, 2013, from [http://www.lowes.com/Lawn-Mowers-Tractors/Push-Lawn-Mowers/Gas-Push-Lawn-Mowers/\\_/N-1z0zc5p/pl?cm\\_sp=OPE--OPE|PopularCat--Merch|PopularCat\\_OPE\\_Gas\\_push\\_mowers&cm\\_cr=Lawn+Mowers--Web+Activity--Lawn+Mowers+TF--SC\\_Lawn+Mowers\\_TopFlexible\\_Area--10711579\\_4\\_#!](http://www.lowes.com/Lawn-Mowers-Tractors/Push-Lawn-Mowers/Gas-Push-Lawn-Mowers/_/N-1z0zc5p/pl?cm_sp=OPE--OPE|PopularCat--Merch|PopularCat_OPE_Gas_push_mowers&cm_cr=Lawn+Mowers--Web+Activity--Lawn+Mowers+TF--SC_Lawn+Mowers_TopFlexible_Area--10711579_4_#!)

6. Compare Lawn mowers. (n.d.). Lawn Mowers. Retrieved November 5, 2013, from <http://www.husqvarna.com/us/products/lawn-mowers/compare-lawn-mowers/>