PUTR

UNIVERSITY OF
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Department of Engineering and Computer Science

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Group 16

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Table of Contents

List of Figures

List of Tables

1.0 Project Description

1.1 - Introduction

Golf is a very expensive sport for the average hobbyist. Paying for the driving range on a weekly basis and spending long hours driving to a practice facility every week is not sustainable for casual golfers. The average cost of a trip to the driving range is about $10, and if the golfer wants to practice more than once a week, this price starts to add up. Most avid golfers avoid this by purchasing a cheap putting mat so they can practice putting at home. The problem with these mats is often they are flat or have constant elevation in them to mimic the break of a real golf course green. Having a constant surface, the user will get used to reading the same put every time. And when the user goes out on a course to play golf, they will still not see improvement since they only practiced the same put on the same mat over and over. These mats also come with a very real price, being costly for almost no reason, advertising better traction or other features that don't really add up, with little technology involved into the process at all.

1.2 - Solution

Our solution is the PUTR. A fully automated, variable putting surface with built in tracking and projection. With built in controls, the surface elevation can be changed on the mat to mimic any putting break or slope the user wants to practice. The user can practice on their own or use a training mode where the PUTR will read the elevation of the green, and project possible paths for the ball to travel into the hole. We also would like to add a versus mode where you can challenge a friend to a full 18 hole putting match. With several modes and surface combinations, the user will never be putting on the same surface over and over again like traditional home putting mats.

Starting with the surface, the PUTR will have a traditional turf surface that will look and feel like a real golf green. We plan to create a play area around 10x10 or less to allow for ample space for practice. The surface fram will either be made of wood or a lightweight metal for support and strength. Under this grass surface, an array of actuators and sensors will be utilized to vary the playing surface. The actuators will function in a linear motion up and down at different points under the mat. This way we can create variable elevations and breaks in the putting surface. The actuators will ideally be able to support the weight of at least one player at a time standing on top of it. On one end of the surface, we will have a standard pga size 4.25 inch diameter cup as the target hole for the golf ball. Inside of this cup will be a sensor that will tell the microcontroller when a putt has been successfully made. If time allows, an automatic ball return under the surface would be a great feature to add to the PUTR as well.

Above the surface, the PUTR will feature a projector and cameras to allow for tracking and path planning to take place. The cameras will be used to sense the position of the ball as well as the elevation of the playing surface. This data will be used to project possible paths the golf ball can travel to the hole. And when the ball is hit, the current path of the ball will project onto the grass to show the user how close or far their putt was to the ideal path.

The whole system will be controlled by a main microcontroller for computing. This microcontroller will take in the data from the sensors and controls, and send it out to the actuators and projector to make the necessary changes. The unit will also have a control board with a screen to allow the user to change the settings of the play area. An alternate option to a control board would be bluetooth to allow the user to control it with their phones. Lastly, the whole system will be powered by the standard US ac wall outlets.

1.3 - Comparison

Putting mats are a very popular practice tool that are widely available online and at any sporting goods store. They can sell for anywhere from 20 to 200$ depending on the quality and features available. Most of which do not include an option for varying elevation/break. The ones that do are more expensive and require manual insertion of spacers and material to raise the grass mat. The only option for an electronically varying golf mat on the market has a starting price of over $70,000. A price like that is not meant for the average golfer who wants to practice at home. The other cheaper versions often are plain flat grass mats with a small hole cutout as the cup. They do not offer many features aside from an “automatic” ball return which is just a mat with an uphill slope that allows the ball to roll back down towards the user.

1.4 - Goals

Our goal is to create an easy to use and accessible practice tool for any average golfer with the necessary area in their home. Thus weight and portability will be prioritized along with price and functionality. We want to create a functional variable putting surface that will be enjoyable to use and fun for home settings. We aim to create a fully automatic surface that will cost around 400-500$ per unit, allowing the average golfer a better chance at having a high quality practice mat in their own home. We aim to keep the cost comparable to a few months of driving range fees which will be saved in the use of the PUTR. We separated our goals into two groups, main goals and stretch goals to reach for if time allows:

Main Goals	Stretch Goals
Variable Grass Surface	Automatic Ball Return
Projection	Audio Cues
Position Sensing	New Game Modes
Path planning	Real Course Presets
Practice and Play modes	Decorative Lighting
Under 100lbs	Putter Face Positioning Feedback
Under $400	Bluetooth
Able to support human weight	-

Table 1 : Project goals

2.0 - Project Specifications

Attributes	Descriptions
Dimensions	An estimated surface area of 10x10 or less is ideal depending on constraints
Cost	$400
Weight	Ideally this would be easy to install at home and able to be moved around, but sturdy enough to support someone standing on the surface. Estimated to be around or Under 100 lbs.

Putting Surface	The surface will be elevated by a platform made of wood or a lightweight metal. There will be actuators/air bladders underneath a grass putting mat around 10x10 ft or less. It will have the standard 4.25 inch golf cups and ideally be strong enough to stand on.
Projection	Any standard media projector will work for our project. We need the projector to project images and paths onto the grass surface from above.
Sensors	Our project will utilize several sensors.First we need a camera for imaging the playing surface and tracking the golf ball. Next we would need a type of motion or pressure sensor to fit inside the cups to sense when the user has successfully made a putt.
Computing	Our project will be controlled by a microcontroller to process the data input of the sensors and output data to the projector and actuators.
Controls	We need a system of controls to allow the user to input various settings into the device. On/off switch, elevation settings, player settings etc. Depending on budget constraints, this could be a touchscreen or just simple switches/buttons with some sort of display to show the settings chosen.Bluetooth is another possibility for the controls section.
Power	The whole unit will be powered through the standard North American ac wall plugs (120v 60hz). Which will then be converted to dc to power the various electronics in our device.

Table 2 : Project Specifications

3.0 - Project Constraints

Constraint	Description
Price	Grass golf mats are expensive and so will the electronics and materials needed to complete this project. An ideal goal of $400 will be aimed for.
Size	Ideally we would want a large putting area to mimic the large greens of a golf course. However, we want this to be available to the average hobbyist who only has a small area of a garage or room. And since mats are sold by the area, a small surface area would be beneficial for the budget as well.
Time	Time is a big factor as we only have two semesters to make this project happen.
Tracking/Projection	A big constraint will be the tracking and projecting functionality of this project. Tracking a small golf ball,projecting its path, and projecting possible paths to the hole will be difficult to implement.
Power	Power will be another constraint, Ideally this should all work with the North American standard wall outlets and thus will be constrained by this standard 120v AC.
Variability	Creating unique playing surfaces will be a challenge. We may need to start out with just a handful of options but ideally a fully customizable play area is our goal. An 18 hole game would be a good start.
Part Availability	Due to supply issues, some materials may be hard to come by. We will have to be flexible and work with what is available to be purchased in the timeframe of SD1 and SD2. Some

	parts may be backordered or out of stock.

Table 3: Project Constraints

4.0 Design & Illustration

4.1 - Block Diagram

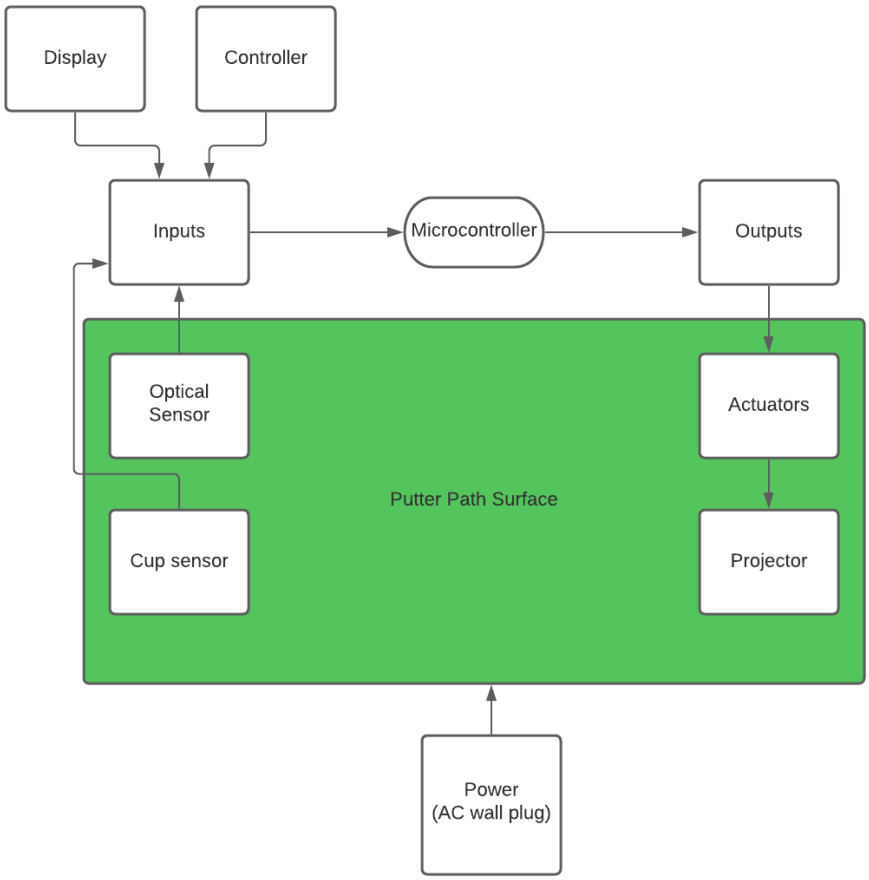

Figure 1: Block Diagram of the PUTR system

4.2 - Block Descriptions

(Team member responsible for each block is in bold below)

PUTR surface: The turf grass playing surface that the user will putt on. **Dominic.**

Power: The power will be from a standard AC wall outlet which will then be converted into DC for the various electronics. **Dominic**

Microcontroller: The microcontroller will be used to process the input data and output it to the necessary components in our project. **Dylan**

Display: Used to display the current settings and menu for setting changes. **Ryan**

Controller: Used to make the setting changes shown on the display. Either physical controls or bluetooth. **Dylan**

Optical Sensor: A system of two cameras used for imaging and tracking the ball on the playing surface. **Ryan**

Cup Sensor: A motion or pressure sensor will be inserted into the cup to track when the putt was successfully made. **Dominic**

Actuators: Linear actuators or air bladders of some sort will be used to vary the elevation and slopes of the playing surface. **Dominic**

Projector: The projector will display the paths to the hole and the current path the ball is heading based on the data from the optical sensors. **Ryan**

4.3 - Illustration of Project

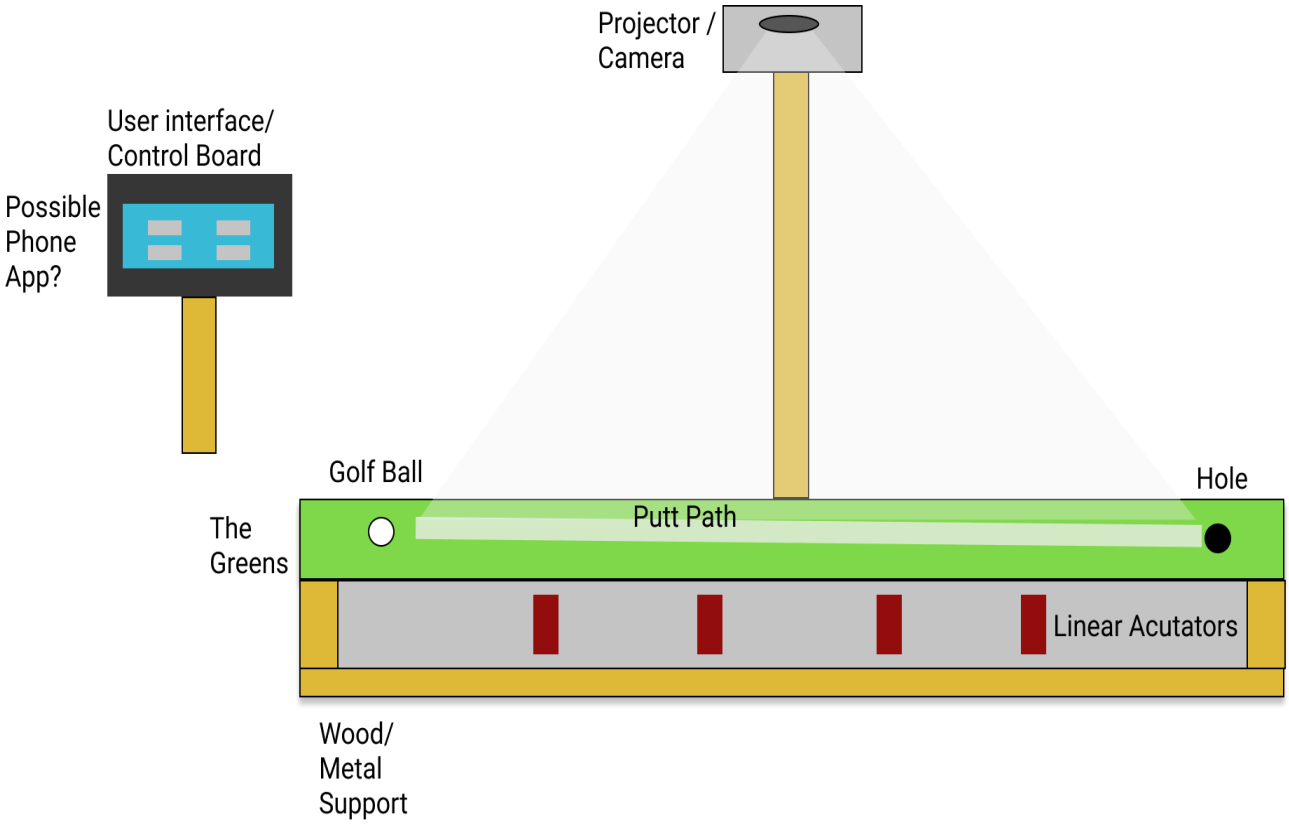

Figure 2: Project Design

5.0 - Decision Matrix

Our team decided to go ahead and pursue “PUTR”. There are multiple reasons why we chose this project, including learning a wide array of technology and the opportunities it could bring to us in the future for careers and other prospects.

First off, the technology used in the “PUTR” would allow us to gain experience in multiple fields. From computer vision and object detection to real electrical engineering skills using linear actuators and custom made PCB. Even building our own putting path will take a lot of hard work, but will be very fulfilling in the end with the amount of knowledge gained.

Another reason our team decided to go for this project was because it was very unique and in the market, there really is not a place for a consumer-friendly putting mat with this much technology embedded. The feeling that we are making

something unique and that has a use is great and has influenced our decision heavily.

All in all, our decision was influenced from a variety of factors. We do believe that this project will assist us greatly in future careers due to its technological variety and uniqueness in the market.

6.0 - Estimated Project Budget

The goal for this project is to stay around $400 which will be divided evenly between each group member. This goal is likely to fluctuate as more research and design decisions are made as the semester progresses.

Item	Quantity	Price Per Unit	Total Cost
Grass Mat	<10x10	$2 per sq foot	<$200
Linear Actuators	4?	~$30	120?
Projector	1	$70-100	$70-100
Camera module	2	$20-30	$40-60
Microcontroller	1	$10	$20
Display	1	$10	$10
Golf Cup	1	$5	$5
Projector Mount	1	$15	$15
Camera Mount	1-2	$10	$20
PCB	1-5	$15	$75
…			

Table 4: Project Budget

7.0 - Project Milestone

Number	Task	Start	End	Status	Responsible
Senior Design 1					
1	**Ideas**	01/20/2022	01/28/2022	Completed	Group 16
2	**Project Selection and Role Assignments**	1/28/2022	02/10/2022	In Progress	Group 16
	Project Report				
3	Initial D&C	02/01/2022	02/04/2022	Completed	Group 16
4	Final D&C	02/12/2022	02/18/2022	In Progress	Group 16
5	60 page Draft	02/14/2022	03/25/2022	In Progress	Group 16
6	100 page Draft	02/28/2022	04/08/2022	In Progress	Group 16
7	Final Document	02/01/2022	04/26/2022	In Progress	Group 16
	Research, Documentation, and Design				
8	How Terrain affects Trajectory	02/12/2022	02/22/2022	Researching	TBD
9	Golf Grass mat	02/20/2022	03/2/2022	Researching	TBD
10	Actuator	02/27/2022	03/9/2022	Researching	TBD
11	Display	03/06/2022	03/16/2022	Researching	TBD
12	Controller	03/13/2022	03/23/2022	Researching	TBD
13	Microcontroller	03/20/2022	03/30/2022	Researching	TBD
14	Projector	03/27/2022	04/09/2022	Researching	TBD
15	Optical Sensor	04/03/2022	04/13/2022	Researching	TBD
16	Cup Sensor	04/10/2022	04/20/2022	Researching	TBD
17	Power Supply	04/17/2022	04/24/2022	Researching	TBD
Senior Design 2					

	Build Prototype	05/16/2022	06/16/2022		Group 16
	Testing and Redesign	TBD	TBD		Group 16
	Finalize Prototype	TBD	TBD		Group 16
	Peer Presentation	TBD	TBD		Group 16
	Final Report	TBD	TBD		Group 16
	Final Presentation	TBD	TBD		Group 16

Table 5: Project Milestones

8.0 House of Quality

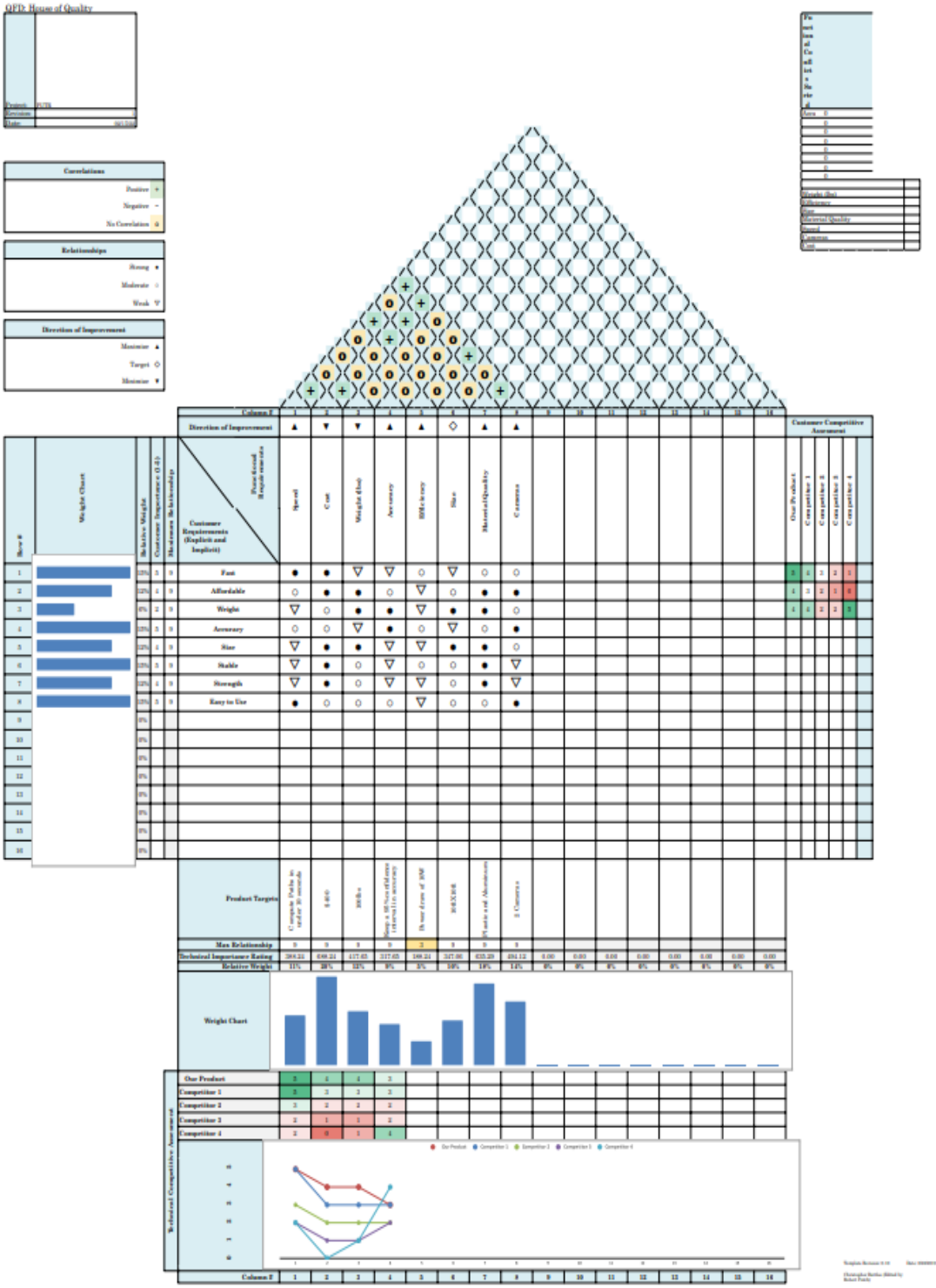

Figure 8.0: House of Quality 1

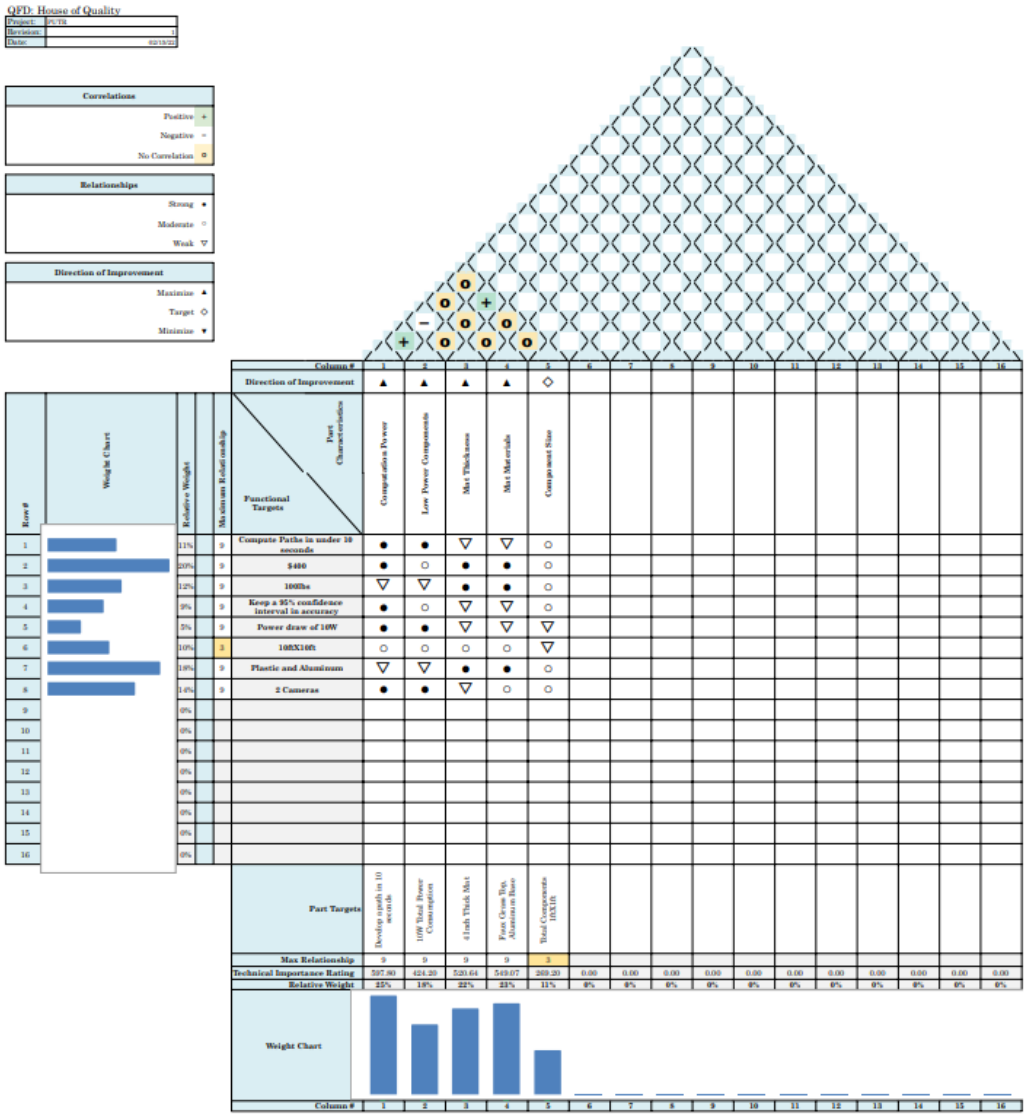

Figure 8.1: House of Quality 2