Context

Area	Description
Public health, safety, and welfare	We cannot think of any public health and safety risks with our wireless charger.
Global, cultural, and social	Our wireless charger will be in line with the IEEE Code of Ethics in every step of the design process.
Environmental	By designing a competitive wireless charger, we can diminish the improper disposal of old cables. Oftentimes it takes an extra step to dispose of electrical components, and most people may not take those additional steps.
Economic	Considering the additional technology we will implement inside our wireless charger, the price of it will be slightly higher than other wireless chargers on the market. Plus, considering that the wireless charger needs additional power to charge the phone and the motors inside the charger, overall energy consumption will increase and the energy bill of the household owner will increase slightly as a result. However, since the goal of the wireless charger is to charge the phone faster, it will need to be plugged in for less time, so we do not see this having a major impact on the overall energy consumption.

Prior Solutions

INIU Wireless Charger

https://www.amazon.com/INIU-Wireless-Qi-Certified-Sleep-Friendly-Compatible/dp/B08LVSFN4X

Description:
- 15W super fast charging saves 45 mins off your waiting time.
- Superior compatibility for all Qi-certified devices.
- The FOD system for detecting foreign objects supports wireless charging with phone cases less than 5mm thick.
- Dual SuperConductivity coils ensure both landscape & portrait charging with power flowing.
- Dominant Temp°Guard controls heat smartly and silently to protect your phone battery.
- Self adaptive LED Indicator allows the most user-friendly power prompt.

Shortcomings:
- The alignment needs to be very precise to allow the phone to begin charging.
- The charger is small which makes it hard for larger phones to be aligned properly.
- Phone will not charge if the case is too thick.

JOYROOM Wireless Car Charger with Smart Alignment Charging

https://www.amazon.com/Wireless-JOYROOM-Alignment-Charging-Clamping/dp/B0B127NH3N

Description:
- 15W car charger that charges cars efficiently from inside the car
- Automatically clamps the phone into the optimal charging position
- Can charge through thicker cases (<= 4mm)
- Compatibility for Android and Apple devices

Shortcomings:
- Can only be placed vertically

- Has more moving parts, making it prone to manufacturing errors
- Only intended to be used in vehicles

Yoobao Wireless Charging Station Power Bank Charge Dock

https://www.amazon.com/Yoobao-Wireless-Charging-Compatible-Restaurant/dp/B07F1N9FPY

Description:
- Easy to use
- Visually appealing
- Compatibility for Android and Apple devices
- Dual coil configuration to ensure both landscape & portrait charging with power flowing

Shortcomings:
- The phone & case cannot be too thick otherwise they won't fit
- The charger is small which makes it awkward for larger phones to be aligned properly.

Technical Complexity

Our project will consist of a microcontroller unit (MCU), two axes of movement in order for the charger to move around, and the charger itself. We'll also have a sensor to detect that a phone is on the wireless charger. The movement will be done using pulleys and a belt, as well as two motors.

Design Decisions

- Current Sensor
  - Can measure currents from coils and devices. We will use it in our wireless charger to determine whether or not the coil is in the proper position to charge the phone.
- Proximity Sensor
  - Detects if there is a phone on the device at all so it can start searching for an optimal charging position.
  - IR or ultrasonic sensors could be used.
- Sled-based Charger Coil
  - This is the most compact, efficient, and robust way to align the charger coil to the phone, has two axes of motion
- Arduino
  - Arduino is what we will be using to store our program to automatically move the sled based charger coil to the optimal charging position.

Ideation

Phone is secure in place	"Slider" alignment system	Easy to use	Easy to take with you on the go (flat)	High accuracy	Phone is elavated and safe from spills/tipping	User can choose level of accuracy needed	Low cost to manufacture after design	Easily Distributed
Very low possibiliy for user error	**Toaster**	Visually appealing	Most efficient charging	**Pad**	More internal room for movement	Easily updatable due to being software	**App**	Potentially usable with any wireless chargers
Charges multiple devices	Works with any Qi enabled device that is not too big	Partially automatic	Could charge multiple devices	Works with any Qi enabled device	Fully automatic	Works with any Qi enabled device that the software	Not automatic	
Phone is kept secure but still usable	Clip alignment system	Phone visible to driver	Toaster	Pad	App	Phone still usable while charging	Efficient use of space	Good ambient cooling due to surface area
Multi-purpose (car phone clip, charger)	**Car Clip**	Aligns phone quickly	Car Clip	Wireless Charger	Stand	More consistent phone placement	**Stand**	Easier view of phone while charging
Works with any Qi enabled device that is not too big	Fully automatic					Works with any Qi enabled device that is not too big	Partially automatic	

For the style of alignment, and ultimately the charger itself, we had five ideas, some of which were based on the products mentioned above, and others that were presented to us by our client. We used the above lotus blossom to identify the advantages of each style of charger.

Decision Making and Trade-Off

Criteria	Weight	App (no movement)		Stand (1-axis movement)		Pad (2-axis movement)		Toaster	
		Score	Total	Score	Total	Score	Total	Score	Total
Alignment Accuracy	0.3	2	0.6	3	0.9	5	1.5	3	0.9
Autonomy	0.3	1	0.3	4	1.2	5	1.5	3	0.9
Cost	0.1	5	0.5	4	0.4	3	0.3	2	0.2
Size	0.1	5	0.5	4	0.4	3	0.4	1	0.1
Complexity	0.2	1	0.2	3	0.6	2	1.2	2	0.4
Total	1		2.1		3.5		4.9		2.5

We chose to use the go with the Pad (2-axis movement) design. Due to being able to move along two axes, the pad can align itself precisely with the phone's charging coil. This design is also completely autonomous; a phone would be placed upon it, and it would find the phone with no user interference. It is one of the more complex and costly designs, but the other criteria were deemed more important in this case. This would be somewhat large, but not nearly as large as the Toaster style. The car clip style was not considered at all, since it can only be mounted in a car.