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Dr. Andrew Rawicz
School of Engineering Science
Applied Sciences Building
8888 University Drive
Burnaby, British Columbia
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October 19, 2015

Re: ENSC 440W Functional Specification for Alternative Parking Indicator

Dear Dr. Andrew Rawicz,

Attached is a document describing the functional specification for *Alternative Parking Indicator* (API). We at ParkoLite Ltd. aim to develop a market ready product that will simplify the concept of finding a street parking and also help the enforcers to nab parking rule violators.

This document outlines the various electrical, software and mechanical requirements that need to be met for a successful engineered product and these requirements will later be used as a guide in the development and design phase of the API system.

API is produced by ParkoLite, which consists of 5 talented and dedicated engineers: Raj Sidhu, Soudeh Mousavi, Mubaarak Sandhu, Oliver Krajci, and Azin Navah. If you have any questions regarding our Functional Specification or product, please feel free to contact us at gssidhu@sfu.ca or by phone at (778) 239-4676.

Sincerely,

Raj Sidhu

CEO
ParkoLite Ltd.

Enclosure: Functional Specification for Alternative Parking Indicator

ParkoLite Functional Specifications

Functional Specifications for Alternative Parking Indicator

ENSC305W/440W: Capstone Engineering Science Project

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Submitted to:

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Executive Summary

Finding a vacant parking spot in big malls or on a busy street can be really challenging and frustrating, especially when there are hundreds of parking spots on different parking levels. The situation is especially abysmal in localities full of townhouses. A very common term used in such parking zones is "Tandem Parking". This term describes a single lane situation where the outer car is always blocking the car parked further inside. Oftentimes, cars are parked on both sides of the road, restricting the road to a one-lane traffic zone and causing unnecessary issues for the law enforcers. In the best-case scenario even when the driver finds a vacant spot, bylaws can be really hard to decipher and this leads to immense confusion. The misinterpretation of bylaws is a major cause of cars getting towed. Additionally, patrolling officer's work to seek out parking violators can be easily overwhelmed if there are hundreds of cars in a parking lot, leading to a substantial increase in the chances of human error on officer's end.

We certainly need to find a solution to the by-laws misinterpretation issues, which can help both the city and general public. API by ParkoLite is simple solution to the parking issues, which visually informs both the general public and operating officers, about the parking rules and bylaws. API uses the concept of AMR sensors to detect the cars in a parking spot and LEDs are used to display the results. Based on the colour of the LED light, it becomes clear to both, the driver and the officer, whether a car is allowed to be parked in that spot or not. API's main priority is to help drivers locate parking spots, indicate whether the parking spot is available for parking or not and also assist parking inspectors to determine efficiently if car is parked illegally or not.

The development of this product will be split into the following stages:

- Vehicle detection circuit to be implemented with AMR sensors
- Programming the bylaws with help of microcontroller unit (MCU)
- Expected results will be displayed by LEDs
- Mechanical and materials will develop the casing for the components

Through the use of computer aided design software a prototype will be created house all of the electrical components. This includes the LEDs the batteries and processing electronics for the AMR sensor. The casing will be designed so that it meets basic structural support capabilities and allows for an adequate amount of light to pass through the structure all while maintaining a waterproof seal to the external environment.

Once these stages are finished and implemented, various test plans and debugging procedures will be carried out, to verify the reliability and functionality of the API system. Furthermore API will comply with safety standards and regulations and the final working prototype will be delivered by no later than December 22, 2015.

Detailed functional specifications of the API system and its subsystems are provided in the following document. Therefore, it is expected that this document will be regularly used by the developers, designers and testers of the product.

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Glossary

API	Alternative Parking Indicator
AMR	Anisotropic magneto-resistance
CSA	Canadian Standards Association
EPG	Engineering Policy Guide
LED	Light-emitting Diode
MCU	Microcontroller Unit
RGBY	Red, Green, Blue, Yellow

1] Introduction

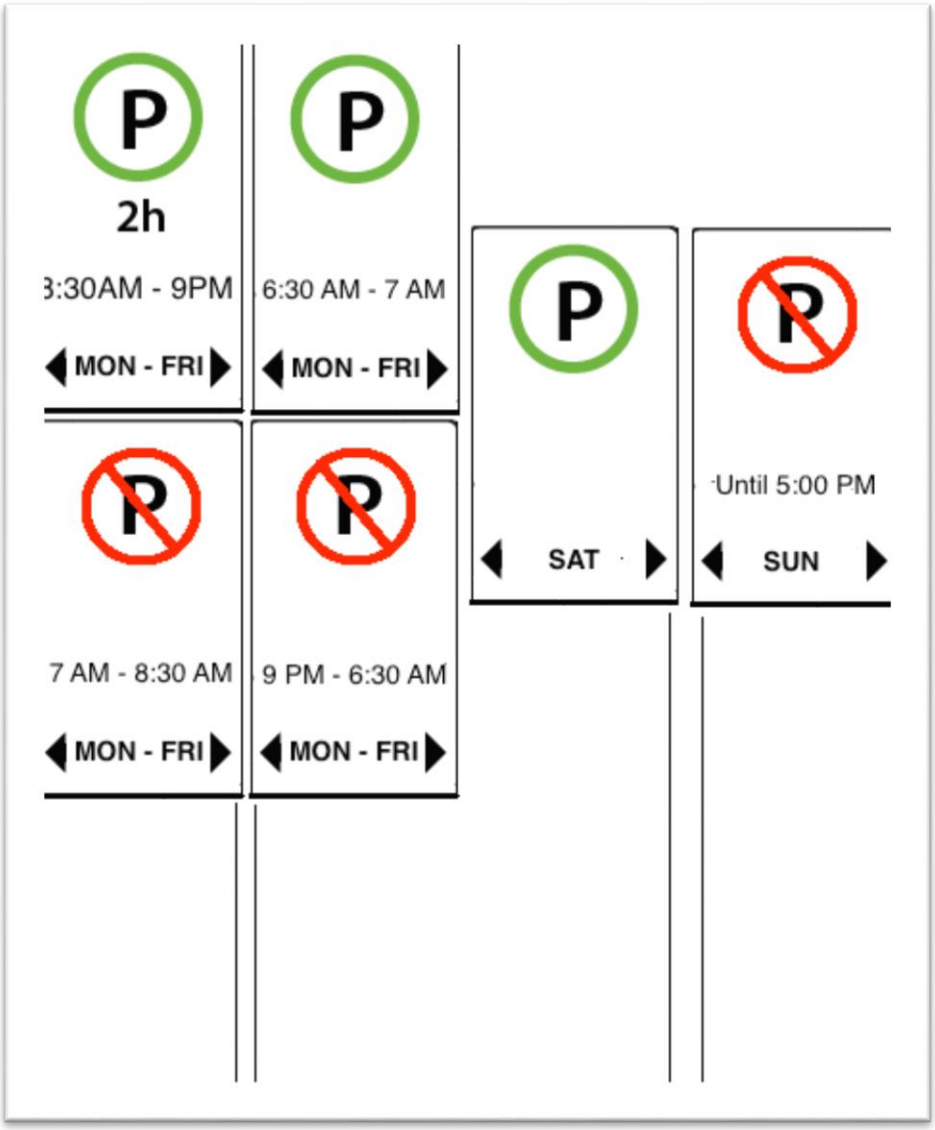

Figure 1: Universal Bylaws Scenario

Above table is an example of universal bylaw scenario and one of these are found in Calgary where raj used to live. This kind of bylaws gets really confusing and can easily be misread by drivers, which results in their car being towed. ParkoLite believes that similar complex bylaws will greatly benefit from the creation of API. To address these problems, API will feature an RGBY LEDs in their design which will provide visual information to the drivers and warn them if the spot is available to park or not. Making bylaws less complex and easy to interpret to help drivers is the ultimate goal at ParkoLite.

1.1 Scope

The scope of this document is to outline the functional requirements of the API system developed by ParkoLite Ltd. This document describes the functionality of electrical, software and mechanical parts of system and its overall functionality. Hence the requirements listed in this document will describe the proof - of - concept model and this document will also be used as a reference in designing, developing and testing phases of the product. However this requirements and design is not final as the specifications and design of some components may change during the designing or testing phase of the product.

1.2 Intended Audience

This Functional specification document is intended to be used by all the team members of the ParkoLite. Our engineering team will refer to this document throughout all designing and testing processes to ensure that the final product meets the pre-defined functional requirements and works according to the requirements listed in this document. Furthermore, this document will also be used by our team for the advertisement of the final product.

1.3 Classification

To denote the functional requirement the following standard shall be utilized

[Rn-Px] A function

Where **R** is the **R**equirement, n would be the functional requirement number, **P** the **P**riority of the functional requirement, and **x**-which will be in roman numbers – is described into the following categories:

I Proof-of-concept for System

II Must be implemented into the prototype and the marketable product

III Final product stage

2] System Overview

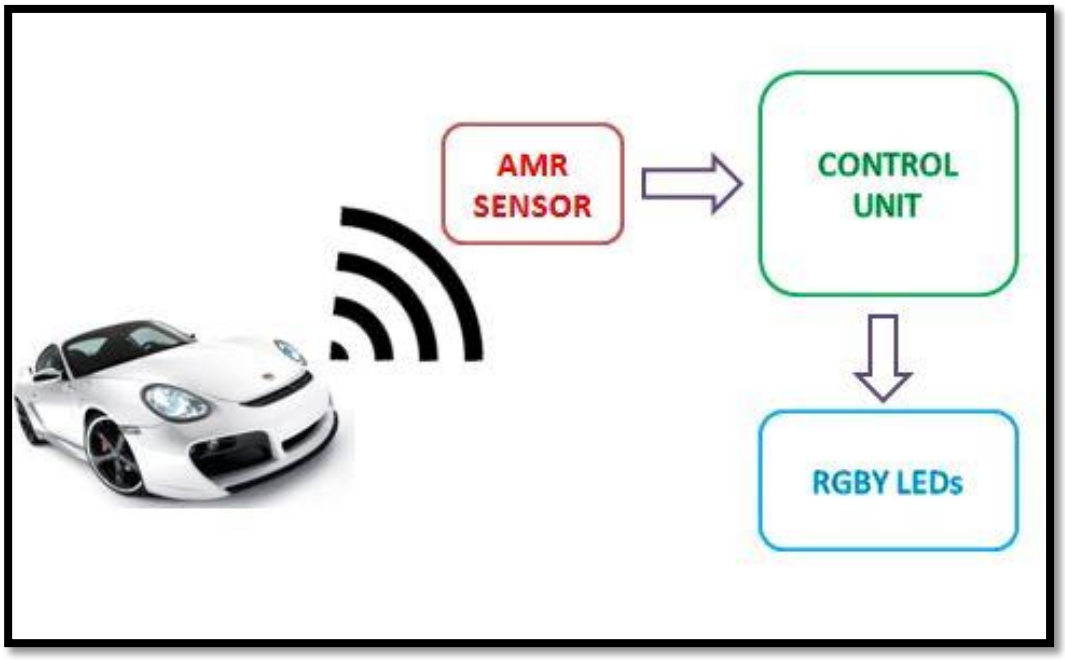

Figure 2: API System Overview

API's main component consists of AMR sensor, Control Unit and LEDs, Figure 2. AMR sensor will detect a vehicle - as it gets closer to the street curb- within its detection proximity; depending on the data it is receiving from the control unit, the colour of LEDs will be changed. API's control unit consists of microcontroller, Figure 3. There is a continuous communication between circuitry and microcontroller.

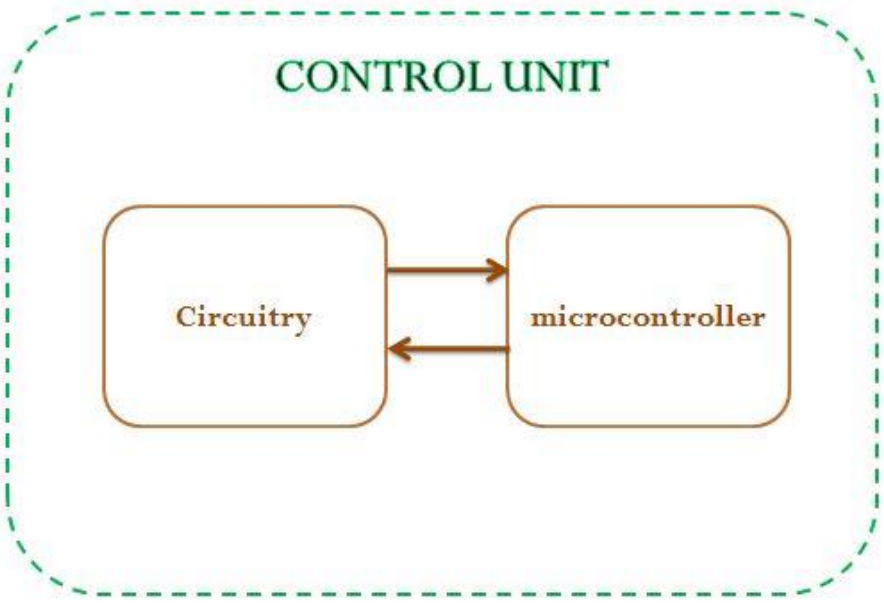

Figure 3 : Control Unit Overview

3] Algorithm Overview

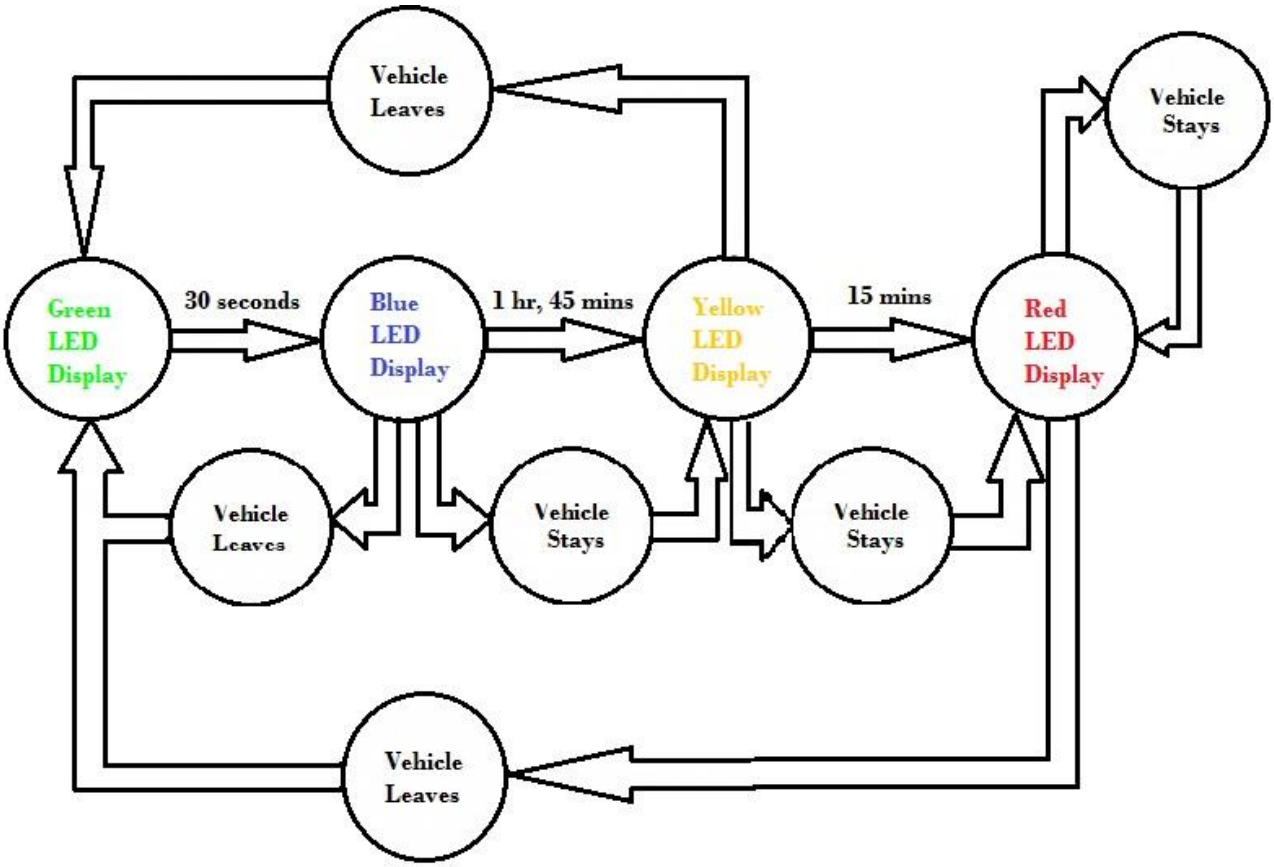

Figure 4: Algorithm Overview of the API System

Above figure shows the algorithm of our product and what our system will do. This is the concept that our team is adapting and expects to deliver as the part of the system; this algorithm is implemented for 2 hour free parking bylaws. When a driver will see or get the visual information from the LEDs, all the confusion and complexity related with bylaws are minimized to nothing. Initially the LED will be green which means that parking spot is available and once the driver parks the vehicle, our sensors will detect it and colour of the LED will change from green to blue after 30 seconds. We picked the Blue colour to indicate that the spot has been taken, now there can be two scenarios, driver leaves and in this case LED will go back to green colour or driver stays, which will the change the colour of LED from blue to yellow after 1 h and 45 minutes. Our team decided to go with yellow colour as a 15 minute warning to the owner indicating that parking time is about to expire. Again there will be two cases, if driver leaves colour will go back to green or if driver stays LED colour will jump to red after 15 minutes. Red colour means that the parking time has been expired and vehicle is no longer supposed to be parked at that spot.

This is highly efficient even for parking lot officers looking for violators. Once they see that the colour is red and there is a car at that spot, they can fine the owner of vehicle. Hence it will reduce the time it takes for an officer to check every individual car, now they just need to see if the colour is red or not instead of checking hundreds of car in big or busy parking lots.

3] System Requirements

The system requirements for API are mentioned in this section along with its algorithm that will explain what our system will do.

3.1 General Requirements

[R1-PII] API shall operate in any weather condition

[R2-PIII] Easily installed - the base will be bolted to the side walk

3.1.1 LED

[R3-PII] Colours of LEDs shall be similar to standard traffic pattern, so it does not confuse the driver or traffic officers

[R4-PII] The luminosity of the LED should be efficient to be viewed under foggy and rainy conditions

[R5-PIII] Dimensions – Overall height 100 cm (39.37 inches), base dimension 35cm x 35cm, and the top – where circuitry and LEDs are stored – about 15 – 20 cm (5.9 -7.87 inches) in diameter

3.1.2 MCU

[R6-PII] MCU shall receive signals from the electronic circuitry

[R7-PII] MCU shall pass the desired and required results to the LEDs

3.1.1 Sensors

[R8-PI] Ferromagnetic objects shall trigger AMR sensor

[R9-PII] Distance between the parked vehicle and the sensor should be in the correct range in order for ARM sensor to send correct data

3.2 Standard Requirements

[R10-PIII] Comply with CSA's Canadian Electrical (CE) Code

[R11-PIII] Comply with EPG

[R12-PIII] API operators shall be given a strict written set of safety rules to follow

3.3 Environmental Requirements

3.3.1 LED

[R13-PII] LED Strip – Operating temperature is between -30° C to 85° C

3.3.2 MCU

[R14-PII] Arduino– Operating Temperature is between -40° C to 85° C

3.3.3 Sensors

[R15-PII] AMR Sensor – Operating Temperature is between -40° C to 150° C

[R16-PII] Surface mount sensor – Operating Temperature is between -55° C to 150° C

3.4 Electrical Requirements

[R17-PII] Current, Power, and Frequency monitoring circuitry

[R18-PII] All power electronic equipment will include appropriate electromagnetic shielding of critical components

3.4.1 LED

[R19-PII] SMD 5050 LEDs shall be sourced with a constant current for the same brightness at all time

[R20-PII] SMD 5050 LED strip runs on 12V

[R21-PI] Batteries will power SMD 5050 LEDs

3.4.2 MCU

[R22-PII] Arduino Board runs on 5 volts

3.4.3 Sensors

[R23-PII] Sensor shall detect a vehicle from multiple feet away

[R24-PII] Sensor shall work with supporting circuitry to inform the MCU when a car has been detected

[R25-PII] Sensor shall remain activated as long as a car is present

3.5 Software Requirements

[R26-PI] C- Programming language is most compatible with Arduino

[R27-PII] The software must be able to re-evaluate and correct the desired voltage

[R28-PII] The Arduino must be programmed to output the expected result in form of LED light

3.6 Mechanical Requirements

[R29-PII] Overall mechanical prototype will be a static pillar with a foggy translucent plastic that scatters the internal lighting with capability to operate in conditions from -20°C to 60°C with minimal thermal expansion and contraction and limited absorption capabilities

[R30 - PIII] A metal base that will be coated with black paint which protects the housing from corrosion and environmental factors like salting in the winter and acid rain

[R31 - PIII] A metal cap that will be coated with black paint which protects the housing from corrosion and environmental factors like salting in the winter and acid rain

[R32 - PII] Central threaded rod (bottom 5 cm) that extends from base to cap approximately a meter in height that provides internal structural support

[R33 - PII] Four smaller threaded rods (bottom 5 cm) at the ends that are oriented at 90° separation from one another with a radius of 7cm will provide extra mechanical support

[R34 - PII] Two circular disks that will provide the top and bottom of the internal housing for electrical components inside the API

[R35 - PII] Eight heavy duty bolts that will fasten the frame of the prototype to the ground

[R36 - PIII] Eight heavy duty bolt covers painted with corrosion resistance

[R37 - PIII] Two rubber gaskets to prevent water from entering the internal structure further creating a refined water tight mechanical seal

[R38 - PIII] Five screws that fasten into the rods on the cap end to hold the entire structure in place via compressive force

[R39 - PII] Internal module where electrical equipment shall be housed by the API between the two 1cm thick circular disks these modules shall be replaceable

3.7 Safety and Sustainability Requirements

[R40-PII] API operators shall be familiar with appropriate handling procedures of selected power source.

[R41-PIII] Translucent plastic shall be made up of recycled plastic for production ready product

3.8 Reliability and Durability Requirements

[R42-PII] The sensor shall detect any ferromagnetic material at all time for as long as the circuitry is powered

[R43-PII] The product shall last for more than 2 hours without charging internal batteries

[R44-PIII] The product shall have a long term supply of energy to power internal electronics

[R45-PIII] API shall be able to withstand significant physical impact without sustaining serious structural deformation

[R46-PIII] Internal circuitry shall be refined to differentiate between a car and other ferromagnetic material

[R47-PIII] API shall have a 0.1% Error in detecting vehicles to make it a viable solution to the problem

3.9 Physical Requirements

[R48-PIII] The base of the product will be made of cement and will bolted to side walk

[R49-PIII] The closest edge of the product should be at least 15.24 cm- 6 inches – away from the edge of the curb

[R50-PIII] The height of the product – 100 cm (39.37 inches) - shall not exceed the height of an existing park meters – 134.6 cm (53 inches)

3.9.1 LED

[R51-PI] LEDs shall be clearly visible through the structure

3.9.2 MCU

[R52-PI] Arduino shall fit in a waterproof casing for its small size

[R53-PI] Arduino uno shall be used because of its compatibility with LEDs

[R54-PI] Arduino shall be operating with 5V power

4] Concluding Remarks

ParkoLite is designing a small, low cost luminance pole on the sidewalk -where on street parking available- to indicate availability of a parking spot according to street parking bylaws. The Functional Specifications for ParkoLite Alternative Parking Indicator outlines all critical and optional functionality required to develop a sophisticated product.

At the proof of concept stage Parkolite ltd. would like to create a product that can show the merits of such an indicator. The basic signalling system uses fundamental human usability factors like allocating certain thought patterns to particular colours. Parkolite Ltd. has used human psychology to create a proof of concept product that gives complete feedback via visual aids. Moving forward in the protyping phase Parkolite has considered the mechanical and structural needs for such a product in the environment. As it can be seen in the functional specs a tremendous amount of thought has gone into making a prototype that is not only weather resistant but also electronically sound. The prototype will be created to cater to various different weathers and climates. Not only will it be reliable in low temperatures, it will also be reliable in warmer and more humid climates by providing a water tight seal via the mechanical design. Furthermore by making the design modular, Parkolite ltd. will have the capability to replace electronics and parts with minimal downtown. Based on investor interest and feedback the design will be further refined before entering the product stage for further production.

Lastly, the document above goes through the current function of the product and some future expansions to the current functions. As the product develops there will be several other things to consider. When investors start to weigh in and a focus group or a short study with the end user is conducted the functions may change depending on preferences and cost. For prototyping purposes Parkolite Ltd has pushed to create a product that is close to a refined completed product with room to change the design and functions where necessary. This product is extremely malleable and open to design and some function changes, since the fundamental functions do not require a significant learning curve for any user. In essence, the API is another source of direct unimpeded information for the end user to base their decision off of.

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Note: ParkoLite members created all figures and tables and they are property of ParkoLite Ltd.