February 7, 2019

Dr. Craig Scratchley
School of Engineering
Science Simon Fraser University
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Burnaby, BC, V5A 1S6

Re: ENSC 405W/440 Requirements Specifications for **Automatic Product Tracker** by **Pondus Tech**

Dear Dr. Scratchley,

The attached document contains the requirement specifications for implementing the Automatic Product Tracker. The goal is to reduce the amount of time spent doing inventory and accurately calculating how much ingredients to purchase for buffet or grab n' go style restaurants. This will be done by tracking product data and providing suggestions based on ingredient consumption.

This document will specify the requirements for the Proof of Concept, Prototype, and Final Product versions of the Automatic Product Tracker. The requirements are split into the following sections: General, Electrical, Website and Server, Arduino Data Processing, and Safety and Sustainability.

The group consists of five engineering students from various branches of engineering: Justin Aoki, Tahsin Alam, Paul Bologea, Kevin Corbett, and Mauricio Veloz. We believe the group as a whole has both the hardware and software experience to successfully implement the product.

Thank you for taking the time to review the requirement specifications. If you have any questions, please contact our Chief Communications Officer, Mauricio Veloz, by email at mveloz@sfu.ca.

Insert Kevin's Signature
Regards,
Kevin Corbett
Chief Executive Officer
Pondus Tech

Enclosed: Requirement Specification for Automatic Product Tracker

Pondus Tech

Requirements Specification

Automatic Product Tracker

Team 10

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Submitted to:
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Dr. Andrew Rawicz (ENSC 440)
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Abstract

The Automatic Product Tracker is a scale intended for use in keeping track of inventory in fast paced environments and restaurant in order to facilitate real-time inventory monitoring as well as using product usage statistics in order to formulate efficient and effective ordering schemes.

The Automatic Product Tracker can be broken down into its 3 main systems: the scale, which measures the weight of items in real time; the processor, which reads the weight information and packages it into readable information which is also capable of sending the information out via wi-fi; and the server, which receives the incoming product data and allows users to monitor their items over days, months, and years.

The requirement specifications for the product will be separated into several categories: General, Electrical, Website and Server, Arduino Data Processing, and Safety and Sustainability. The requirements given will cover the Proof of Concept, Prototype, and Finished Product. Requirements will also be given a priority level. All of the requirements presented in this document must be considered while the product is being developed.

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List of Figures and Tables

Glossary

These are a list of acronyms that will be used throughout the specification:

ATP: Automatic Product Tracker
PoC: Proof of Concept
WP: Working Prototype
FP: Finished Product

Introduction

With our growing population and climate change happening all over the globe, it is without a doubt that significant changes in our food production and consumption need to occur. Canada is one of the world's largest wasters of food. Over 50% of our food produced in Canada is either lost or wasted, which is a major concern at Pondus Tech.

For this reason, Pondus Tech is in the planning phase of a new product, the Automatic Product Tracker (APT). This product will be designed to keep track of inventory in fast paced environments where constant human monitoring would not otherwise be practical. A ‘Grab and Go’ kitchen would find this product useful as items are constantly being removed and refilled without taking inventory on a regular interval.

By using the APT device and software, we will be able to monitor usage of any particular item(s) over days, months, and years depending on use case. This will aid in day to day work if some item was being used more than usual, or over a longer term to track usage and to find the best time to restock and order more items. By doing this, we will be able to reduce shipping costs by reducing shipment sizes to be more precise as to what will be needed for that week. By having a more precise ordering system in place it will also reduce the amount of items expiring on shelves. By using our monitoring device and software it has the potential to save money for the owner and lower his/her ecological footprint.

The function and features of the APT device and software will be outlined in this document with respect to general requirements, technical requirements, and safety requirements.

Requirement Classification

The requirements for the APT have been sorted into multiple categories to detail which part of the system they correspond to. Additionally, they have been assigned to one specific product version depending on the complexity and usefulness of the specification. The general form for requirement classification is as follows:

RQ[(Requirement Section).(Product version).(Requirement Number).(Priority Level)**]**

Requirement Section	
G	General
E	Electrical
M	Microprocessor
WS	Website and Server
SS	Safety and Sustainability

Product Version	
PoC	Proof of Concept
WP	Working Prototype
FP	Finished Product

Priority Level	
H	High
M	Medium
L	Low

Table 1: Requirement Classification Table

General Requirements

The APT is a product tracking system which uses a scale with a wi-fi chip in order to relay real time statistics to a server. These statistics are easily accessible by the user via an online website, and will allow the user to keep track of products that may not be tracked by current systems. This device must be usable within a kitchen environment, as our main demographic will be a 'Grab and Go' kitchen, a kitchen where different products are used, but not necessarily kept track of every time they are used. Therefore the scale must comply with FOODSAFE BC requirements. Because this will mainly be used in kitchens, the device should also be capable of handling cold, hot and wet products. The APT scale should be able to weigh products of up to 15 kilograms, as this is around the maximum weight of a product that would be commonly used in a 'Grab and Go' kitchen.

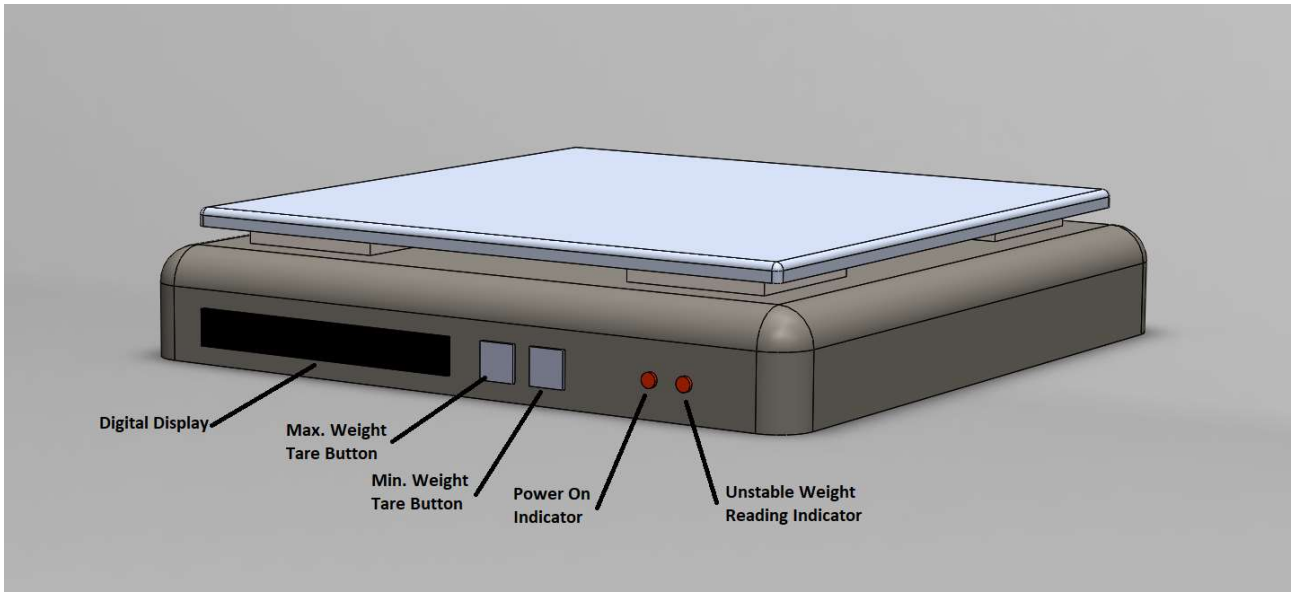

Figure 1: SolidWorks rendering of potential PoC prototype (front view)

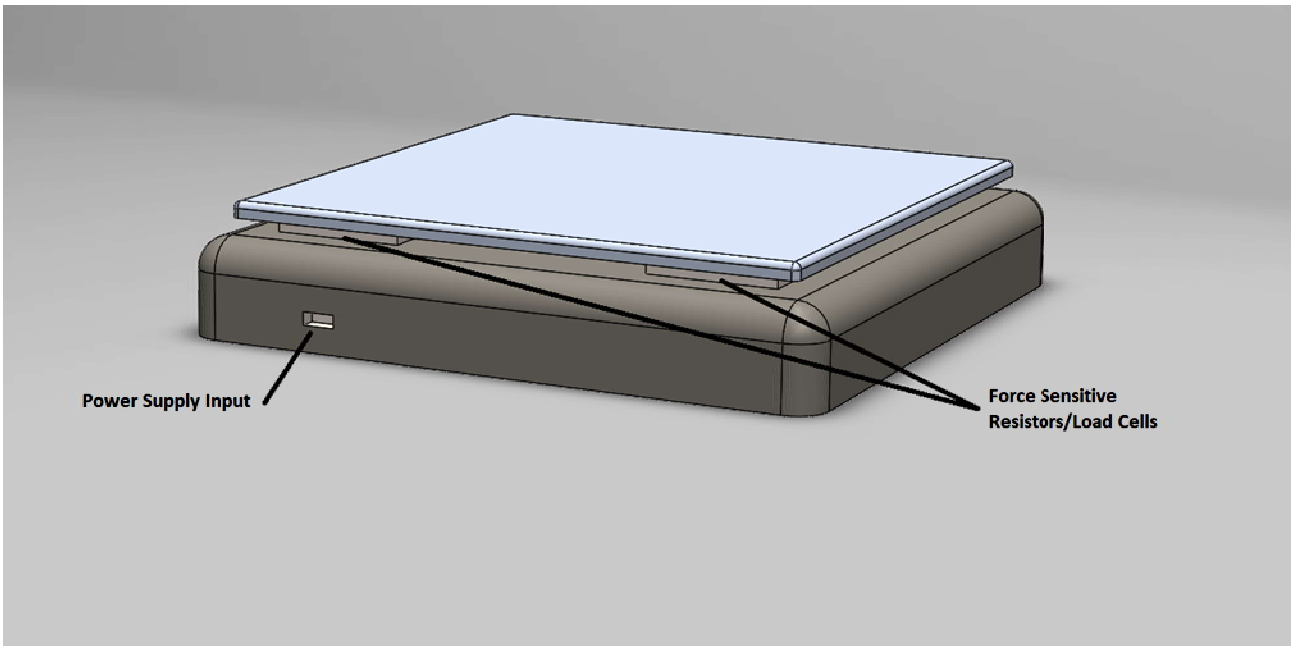

Figure 2: SolidWorks rendering of potential PoC prototype (back view)

The APT is also designed to not be incredibly complex for the user to master. It is designed in order to be easily configurable by any employee, as well as be simple to view and track product statistics. The user manual will define how to set the unit up, as well as creating a website account in order to monitor the statistics. The PoC model will allow the user to configure one scale, whereas later models will allow users to configure multiple scales.

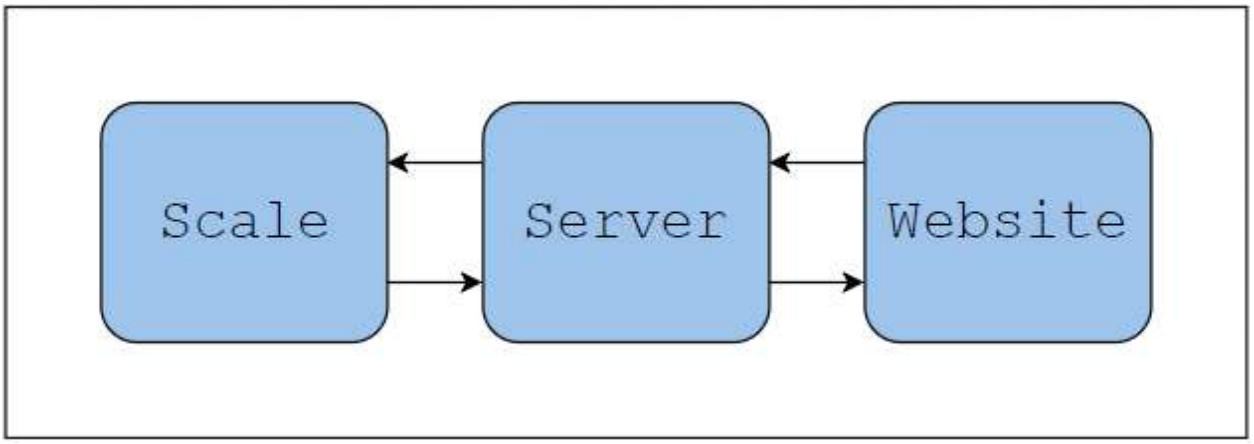

Figure 3: Flow chart describing the communication between different aspects of the system

RQ[G.PoC.1.H]	The ATP will consist of a weight sensor, microprocessor and visual display.
RQ[G.PoC .2.H]	The ATP must be able to work indoors.
RQ[G.PoC .3.H]	The ATP must be operable while handling hot, cold, and/or wet objects.
RQ[G.PoC .4.H]	The ATP must be able to withstand holding a weight up to 15kg.
RQ[G.PoC .5.H]	The ATP must be compliant with any and all food safe requirements.
RQ[G.PoC .6.H]	The ATP must be simple to use/understand for the user.
RQ[G.PoC .7.M]	The ATP must not interfere with any other wireless devices in its proximity.
RQ[G.PoC .8.M]	The ATP must be under 100* dollars to manufacture.
RQ[G.PoC.9.M]	The ATP must come with an instruction manual.
RQ[G.PoC .10.L]	The ATP must be operable without any weight tare configurations.
RQ[G.PoC .11.L]	The ATP must have Tare Max and Tare Min values to do percentage real-time tracking.
RQ[G.PoC .12.L]	The ATP must have a start-up time of 10 seconds or less.

Table 2: List of General Requirements
***Value subject to change**

Electrical Requirements

We will be using a power supply that can be plugged into an outlet for all of our prototypes, from our proof of concept to our finished product. This functionality is important for its application; during the testing phase, it is an easy and accessible method to power it, but for its application in a 'Grab and Go' kitchen, it would most likely be used in a setting where there is accessibility to power outlets. For the PoC prototype, the power supply would be connected directly to our microprocessor, where the microprocessor has a 5V bus that would be used to provide power to the rest of the hardware.

To accurately measure the weight of the product, we will use a load cell, which consists of multiple strain gauges that are in the configuration of a Wheatstone bridge [Justin Reference #]. A strain gauge is essentially a resistor whose resistance value changes as strain is added to it. This mechanism had previously been used by members in our group, and can be applied to get an accurate measurement for objects of different masses. In our application, the weight should never exceed more than 15 kg. The signal that comes from the output of the Wheatstone bridge is often so small, or differs so little that it is difficult to get an accurate reading, therefore we require a signal amplifier that can get improve the difference in voltage from the output. The output of this signal amplifier should be enough to accurately measure the weight of the object to the gram.

The data that we receive from the output of the load cell amplifier can be converted into a weight measurement through the microprocessor. This microprocessor will also be in charge of handling the outputs of the power indicator LED for the PoC prototype, as well as to the digital display as

outlined in [Kevin Ref]. For the working prototype, the processor should also be able to handle the minimum tare weight input as well as the maximum tare weight input. These inputs will be simple normally-open digital push-button inputs, and will be connected to the microprocessor directly. The working prototype will also have an additional indicator LED that will be used to show the user when the current data is not being used by the scale. The microprocessor will be able to connect to wi-fi, and will connect to a server which will accept all of the data from the scale.

For the FP, the scale will have access to a backup power unit, which would activate upon loss of power to the scale unit. The scale would also be able to store data upon loss of connection to the server, and be able to transmit that data to the server once it regains connections. With this functionality, even when there is a loss of communication, the product would still be able to run and maintain the real-time statistics. This contingency mode is something that would be necessary for a finished product but would be time consuming and require extra resources for a PoC or WP.

RQ[E.PoC.1.H]	The ATP must be able to receive accurate measurements from the Strain Gauge/Load Cells via signal cleaning/enhancing (accurate to the gram).
RQ[E.PoC.2.H]	The ATP must be able to communicate data to the server.
RQ[E.PoC.3.M]	The ATP's power supply must be able to be plugged into a 120V wall outlet.
RQ[E.PoC.4.M]	The ATP must be able to visually display when the scale is on/running.
RQ[E.PoC.5.M]	The ATP must be able to be powered on/off externally.
RQ[E.PoC.6.M]	The ATP's controller should be able to power all other electrical components.
RQ[E.PoC.7.M]	The ATP's scale and all electrical components should be able to fit into 8" x 8" x 2" physical structure.
RQ[E.PoC.8.L]	The ATP must be able to visually display the current weight of the object on the digital display or serial port.
RQ[E.PoC.9.L]	The ATP must have a power on/off indicator LED.

Table 3: List of Electrical Requirements for Proof of Concept

RQ[E.WP.1.H]	The ATP must be compatible with multiple scales.
RQ[E.WP.2.M]	The ATP must be able to tare the minimum weight of a product (The empty container that the product is kept in).
RQ[E.WP.3.M]	The ATP must be able to tare the maximum weight of a product (When the container is 100 percent full of the product).
RQ[E.WP.4.M]	The ATP must be able to run for extended periods of time without error.
RQ[E.WP.5.M]	The ATP's Power Supply should be able to power wi-fi chip/other electrical components directly.
RQ[E.WP.6.M]	The ATP must weigh the product accurately to one tenth of a gram.
RQ[E.WP.7.L]	The ATP must be able to visually display when there is an unstable weight reading (weight data not being used towards average over current time period).

Table 4: List of Electrical Requirements for Working Prototype

RQ[E.FP.1.M]	The ATP's scale must have backup power supply that can run the device for 24* hours in case of loss of power.
RQ[E.FP.2.M]	The ATP's scale must have internal memory that can store 48* hours worth of data in case of loss of connection to server.

Table 5: List of Electrical Requirements for Finished Product
*Value subject to change

Microprocessor Requirements

For the proof of concept and working prototype, an Arduino Uno with a wi-fi module will be used. This will be the main processing unit where all peripherals are connected to before the data gets sent to the server for further processing. By using an Arduino, we are able to prototype and troubleshoot our product quickly thanks to the large amount of resources available for the Arduino and its peripherals.

The microprocessor will need to be able to convert analog inputs from the load cell sensors, into usable information that the website will be able to use. The data processing code will need to be able to discard invalid or unstable weight measurements in order for the website to have an accurate display. The code will also need to make sure that when the information packets are sent, they send out a stable value for the current time interval, as well as to make sure that there is a timestamp on the packet of information being sent.

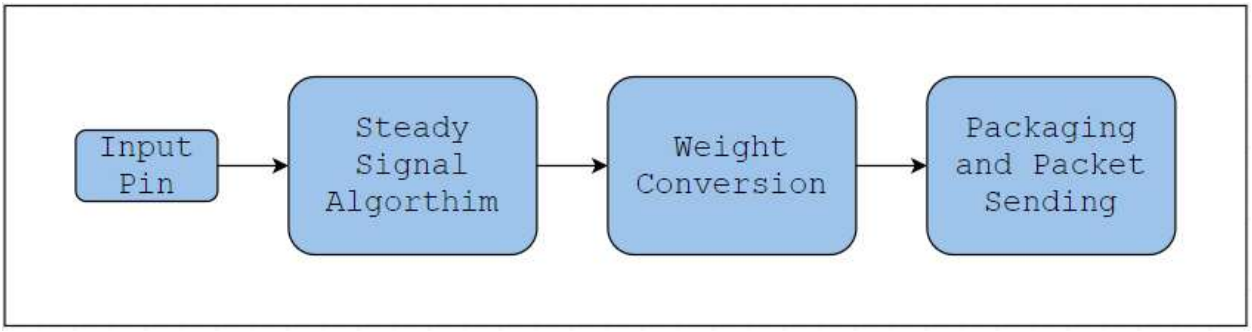

Figure 4: Flow chart describing the process of relaying information from the scale to the server

The WP prototype should also be able to interact with multiple other scales. These scales should be stand-alone from the microprocessor, in the sense that the user should be able to add more scales by simply adding more scale components of the ATP (and not buying another ATP). The user should be able to configure these devices, in the same way that one can associate an arbitrary remote control to a television set.

After completing a prototype, we can begin the process of designing an IC that will perform the tasks that it is required to do. This will reduce mass production costs and can improve reliability and effectiveness due to it being designed to perform our tasks perfectly.

RQ[M.PoC.1.H]	The microprocessor must convert load cell information into a weight within 5% error.
RQ[M.PoC.2.H]	The microprocessor must pack data into readable packets for pushing to server.
RQ[M.PoC.3.H]	The microprocessor timestamp sent packets.
RQ[M.PoC.4.M]	The microprocessor must be able to tare an empty tray.
RQ[M.PoC.5.M]	The microprocessor must discard unstable weight values.
RQ[M.PoC.6.L]	The microprocessor must use an intelligent waiting algorithm to find a stable weight.
RQ[M.PoC.7.L]	The microprocessor must push data to the server in 30 second intervals.

Table 6: List of Microprocessor Requirements for Proof of Concept

RQ[M.WP.1.H]	The microprocessor must have temperature load cell compensation.
RQ[M.WP.2.H]	The microprocessor must show information on a segmented display.
RQ[M.WP.3.H]	The microprocessor must be able to configure and track multiple weight trays.
RQ[M.WP.4.H]	The microprocessor must track multiple items.
RQ[M.WP.5.L]	The microprocessor must allow user to adjust frequency of data being pushed to the server.
RQ[M.WP.6.L]	The microprocessor must push error messages to the server.

Table 7: List of Microprocessor Requirements for Working Prototype

RQ[M.FP.1.H]	The microprocessor must be a custom chip (not an Arduino).
RQ[M.FP.2.H]	The microprocessor must be able to detect connection loss to server.
RQ[M.FP.3.H]	The microprocessor must be able store data locally during connection loss.

Table 8: List of Microprocessor Requirements for Finished Product

Website and Server Requirements

To display the data we will set up a local server that will receive the information. For the proof of concept design there will be a single APT scale sending data, and the website will be a simple page where all the user can do is download a .csv file containing the data. For the Working Prototype and Final Product the focus will shift more to how the data is presented and what the user can do. For the Prototype and Final Product users will also be able to create accounts and register multiple APTs. Line graphs will be used to present data for shorter ranges of time and bar graphs will be used for weekly and monthly statistics in order to make it simpler for the user to interpret the data. It should be possible for the user to change the product being tracked on the website and still keep the information from the previous setting. Browser compatibility is

intended to be Firefox, Chrome, and Edge, which can be checked manually or also through the use of tools [insert reference number here, website added in references section].

RQ[WS.PoC.1.H]	The server must be able to accurately receive data from local device.
RQ[WS.PoC.2.H]	The website must have a downloadable .csv file containing the data collected.
RQ[WS.PoC.3.H]	The website must support Edge, Firefox, and Chrome.

Table 9: List of Website and Server Requirements for Proof of Concept

RQ[WS.WP.1.H]	The website must display data for each device in a line graph and bar graph.
RQ[WS.WP.2.H]	The server must be able to distinguish between particular instances of a device.
RQ[WS.WP.3.H]	The server must be able to permanently store data.
RQ[WS.WP.4.M]	The server must have user accounts with password.
RQ[WS.WP.5.M]	The website must be able to register device(s) to an account.
RQ[WS.WP.6.L]	The website must be able to display data for different time intervals.
RQ[WS.WP.7.L]	The website must be able to remotely configure the devices.

Table 10: List of Website and Server Requirements for Working Prototype

RQ[WS.FP.1.H]	The website must be intuitive to use.
RQ[WS.FP.2.H]	The website must be able to organize individual devices into sub categories (restaurants, ingredients, etc.)
RQ[WS.FP.3.M]	The website must provide a recommendation of how much product to buy.

Table 11: List of Website and Server Requirements for Finished Product

Safety and Sustainability Requirements

The safety and sustainability is also an important portion the APT. Since it will be handled with food in varying environments, it is important that the product to be safe for all parties involved.

The materials chosen for this product should be safe for contact with food; therefore grades of stainless steel/aluminum/plastic will be chosen to best fit the needs of a restaurant. Considerations for wires, solder, and PCB will also be taken into account.

An ergonomic design will also be a part of the APT. By having a product that is easy to use, without any dangerous protrusions will ensure the safety of users of the product.

Lastly, the APT will be designed with the environment in mind as well. The materials chosen will be recyclable wherever possible without compromise to other safety concerns.

With careful considerations of the following requirements, the APT will be safe for foods, users, and the environment.

RQ[SS.PoC.1.H]	The ATP must run at safe, stable voltages.
RQ[SS.PoC.2.M]	The ATP must not use toxic or otherwise harmful materials.

Table 12: List of Safety and Sustainability Requirements for Proof of Concept

RQ[SS.WP.1.H]	The ATP must use food-safe materials.
RQ[SS.WP.2.H]	The ATP must be safe at low temperatures (refrigerated temperatures)**.**
RQ[SS.WP.3.H]	The ATP must be splash-proof.
RQ[SS.WP.4.M]	The ATP must have no sharp edges, and its cables must be protected/shielded.

Table 13: List of Safety and Sustainability Requirements for Working Prototype

RQ[SS.FP.1.H]	The ATP must be dishwasher safe.
RQ[SS.FP.2.M]	The ATP must be able to be recycled.

Table 14: List of Safety and Sustainability Requirements for Finished Product

Conclusion

The APT provides a simple and easy to use solution, for improper product tracking and for the over-ordering of certain products. This product will allow users to easily keep an updated and accurate inventory count of product, and see exactly how much product is used by the hour, day, week, month and year, in order to calculate product trends and create precise order spreadsheets.

The requirements that are presented and discussed in this document will be used in order to create a proof of concept prototype, which will have the capacity to do the most basic functionality required as listed in the document, as well a working prototype which will have more advanced functionality, and be in a state that would be much closer to our ideal vision of a finished product. The requirements are sorted into five categories: General, Electrical, Microprocessor, Website and Server, and Safety and Sustainability. The General requirements entail the specifications regarding the entirety of the product. The Electrical requirements refer to the physical hardware needed for the scale and processing/data transmitting unit. The microcontroller requirements go into detail as to what the microcontroller will do with the inputs and outputs that are getting received, and what information will actually get sent to the server. The Website and Server requirements discuss the needs for the online user interface, which will contain data based off of the information received by the server. The Safety and Sustainability requirements discuss the importance of what is being done for user/consumer safety, as well as how the product is being designed in order to accommodate easy and ecological disposal.

Sources and References

[Justin Reference #] www.pcb.com. (n.d.). *Load Cell Handbook: A Technical Overview and Selection Guide*. [online] Available at: http://www.pcb.com/contentstore/MktgContent/LinkedDocuments/Load_Torque/LT-LoadCellHandbook_LowRes.pdf [Accessed 6 Feb. 2019].

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Appendix I – Presentation Demo

Appendix II – Engineering Standards