

Supermarket Bulk Bin Project

NZQA Scholarship 2014

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<i>Introduction</i>	3
<i>Conceptual Ideas</i>	4
Brainstorming	4
Evaluating	4
<i>Farm Automation Conceptual Idea</i>	5
<i>Problem Identification</i>	5
Water Reticulation issue examples	5
<i>Initial Project Proposal</i>	6
Introduction	6
Applications	6
Existing Products	6
Farm Automation Idea Conclusion	7
<i>Supermarket Bulk Bin Conceptual Idea</i>	8
Background	8
Problem Identification	8
<i>Existing Systems - Bulk Bin Dispensers</i>	9
Scoop Bins	9
Gravity Dispensing Systems	9
<i>Background –Changes in Grocery Shopping Behaviour</i>	10
<i>Customer Survey needs Identification</i>	12
Survey Methodology	12
Survey Summary	12
<i>Proposal</i>	14
Introduction	14
Project Development Steps	15
Dispensing Process	16
Potential Advantages	17
<i>Supermarket Owners & Suppliers needs Identification</i>	18
Consultation	18
<i>Revised System Brief</i>	19
<i>Project Specifications</i>	20
<i>Worm Drive</i>	21
Design Specifications	21
Design Process	21
<i>Printing</i>	23

Bridget McKendry – MakerCrate.....	23
Bruce Sparks - CPIT engineering Department	24
<i>Driving the Worm Drive</i>	25
Stepper Motors and Driver Boards.....	25
Interfacing with Raspberry Pi.....	26
<i>Weight Calculation</i>	28
Design Specifications	28
Concepts.....	28
Long Term Developments and Considerations	29
<i>Scales</i>	30
Introduction	30
Obtaining Readings from the Scales.....	30
Short Term Developments and Considerations	32
<i>System Control</i>	33
Introduction	33
<i>Housing</i>	34
Design Specifications	34
Piping	35
<i>User Interface</i>	36
Design Specifications	36
Display	36
Customer Input.....	36
Customer Feedback	37
Future Developments	37
<i>Bibliography</i>	38
<i>Appendices</i>	39

Introduction

[See it on YouTube¹](#)

The Automated Supermarket Bulk Bin that I have worked on shows the progress of a project that started back in October last year with a brainstorm of ideas. The project has changed and developed throughout this past year to the point where I now have a successful working prototype.

I have really enjoyed working on the project and have learnt many things that I am sure to carry forward to future projects that I work on. Many problems have arisen throughout my project some of which I have been able to problem solve to work out a solution, others I have not been able to overcome myself and have had to turn to the help of others.

My mind was opened to many ideas along the way from a range of different people from industry which has really helped me to criticise my own ways of thinking as well as to open it up.

In particular I'd like to give a special mention to the following:

- *John Creighton – Teacher/Mentor*
- *Bridget McKendry – Maker Crate 3D Printing enthusiast*
- *Bruce Sparks – Learning Facilitator, CPIT Engineering department Christchurch Polytechnic*
- *Joe Colquitt – Electronics Enthusiast*
- *Andrew Hornblow – Electronics enthusiast from Brightsparks*
- *Ross James – Father Programming & Electronics enthusiast*

And also a big thank you to everyone else who has also assisted and helped me throughout my project

¹ <https://www.youtube.com/watch?v=cXSN-2Ap8Wo>

Conceptual Ideas

Brainstorming

Because that's where all good ideas come from... right?

I started off using a program called Mind 42 to get my ideas out so that I could then: organise them, think about them more easily and develop them even further. Figure 1: Brainstorm of Ideas. As I noted down an idea another idea spun off from it until eventually I ended up with a series of ideas that splayed off with applications, existing products and links to websites.

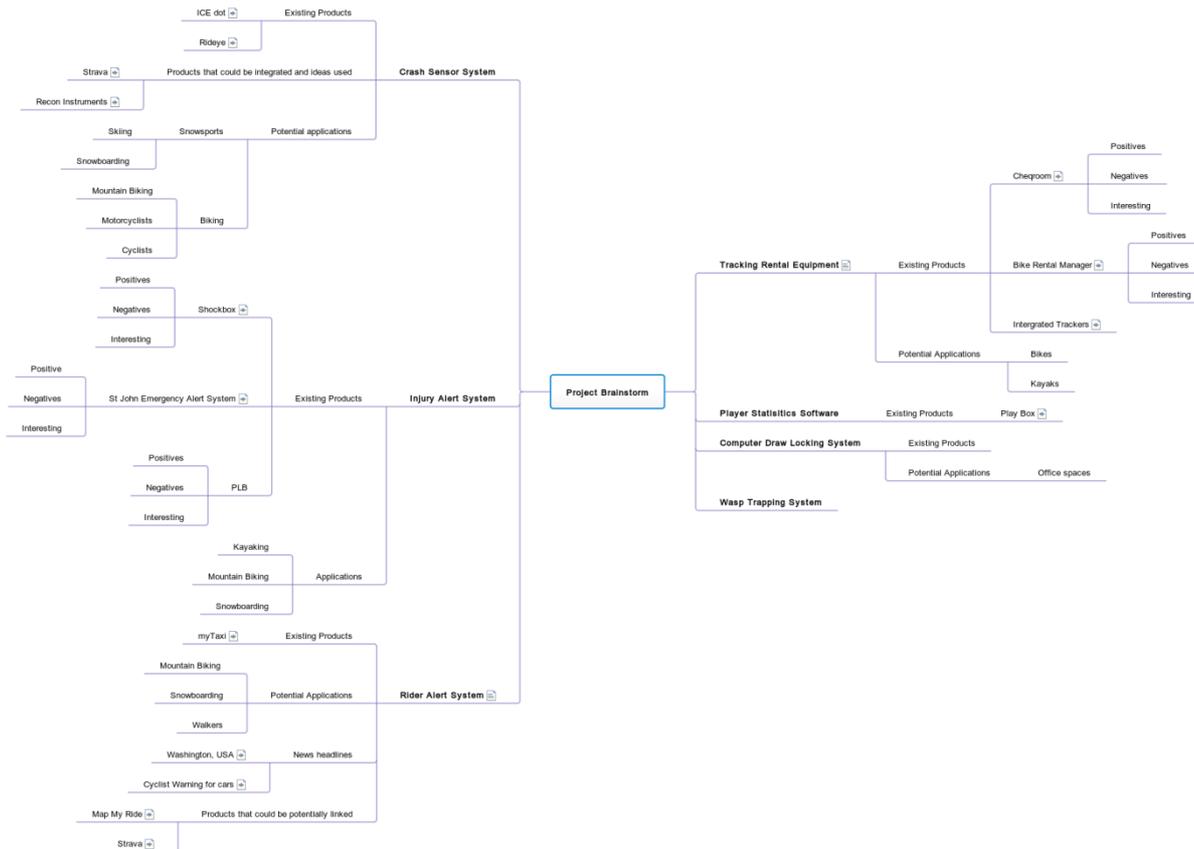


Figure 1: Brainstorm of Ideas

Evaluating

I did a quick evaluation of the ideas that I had been thinking about for the previous two months, however none of them really excited me. They were not going to be easily implemented and hadn't really caught the attention of people I had talked to.

I then narrowed the two best options down to a farm automation system and a supermarket bulk bin automation system to investigate further. Both appeared to have potential and caught the attention of people that I talked to. My Farm Automation Communication System was to develop an application to enable farmers to monitor specific parts of their farm irrigation system e.g. water flow, tank levels, trough levels etc. Bulk bin dispensing idea was a way to improve current systems in supermarkets.

Farm Automation Conceptual Idea

Problem Identification

There is a need for quick and timely identification of water reticulation problems which often result in water loss and equipment maintenance issues.

Water Reticulation issue examples

Issue 1

As the seals on my Grandfathers water pump failed, water seeped into the pump. As it seeped in the oil lubricating the pump seeped out resulting in the pump seizing and the farm water supply being compromised.

The pump was fixed (at a price) but requires monitoring to ensure the issue is identified before expensive repairs and water loss is incurred.

Even on Christmas Eve morning my grandfather felt compelled to check the pump out on the farm before we started our pre-Christmas family celebrations.

With a remote monitoring system he could rest easily and enjoy our family gathering without worrying about checking on water pumps.

Issue 2

Farm workers will often quickly round up stock with dogs for a milking not advancing into a paddock to check trough water levels. If a cow has knocked off the ballcock in a trough the trough may overflow for weeks wasting precious water before anyone notices.

If on the other hand a pipe supplying the trough has been broken the cows may well have drunk the trough dry leaving nothing for the next time the herd is put back into the paddock.

Meanwhile water will be leaking into an area where it's not needed creating nothing more than a bog.

A remote monitoring system on troughs would alleviate the issue of a missed cautionary glance when cows are being let into or taken out of a paddock. It would identify problems with water loss immediately so that they can be addressed before stock are without water and large quantities of water are wasted.

Initial Project Proposal

Introduction

My initial project proposal was to create a communication system which could transmit water level or flow information to and from a base unit from an input linked by a wireless RF or cellular connection.

Information would be sent via a communicator which would take input from a sensor and then send it back to the base. The Base would collate the information and notify the client/user of any warnings, updates etc.

The client/user could make adjustments, changes to the system by communicating with the base unit via internet or SMS.

Applications

Farming

The communication system could be used as part of a 'Smart Farm' concept whereby Farmers can monitor and control various applications from their desktop for example:

- i. **Water flow**
Alerts regarding broken pipes/ball cocks, pumps not functioning
- ii. **Electric Fences**
Alerts regarding functioning – control over operation
- iii. **Soil moisture or nutrient sensors**
data gathering - enabling adjustments to be made to effluent sprayers and irrigator patterns.

A farmer could have set up on his computer a program or a login to a website which would be able to show statistics that they have customised to suit their needs. Alerts or notifications could be text and/or emailed to the user, and shown on screen.

The system could allow the user to:

- Adjust water flows by closing valves to stop flows past a certain point.
- Adjust when and where an electric fence is on.

Existing Products

Gallagher wireless water monitoring system (htt)

Overview

The Gallagher wireless water monitoring system allows the user (farmer) to monitor their water tank and pump. The tank unit measures the water level and then sends the information to a 'display unit'; the Wireless pump controller allows the user to take remote control of the pump to ensure the tank level is maintained at their desired level.

Opportunities

The Gallagher system leaves open the opportunity to make communication between devices more versatile as it only allows the user to view data on a display unit. This leaves me with the opportunity to link data to the internet and display alerts on the user's mobile phone, providing peace of mind to users no matter where they are.

There are also many sensors which the Gallagher's product doesn't support which could be incorporated into this sort of system to increase the ability of farmers to monitor different aspects of their operations.

Harvest Electronics

Overview

Harvest electronics sell a wide range of systems for Hi-Tech New Zealand farmers. These include monitoring systems for: Pumps and water flow, effluent irrigation, milk vat levels, soil moisture levels and effluent pond levels (Figure 2).

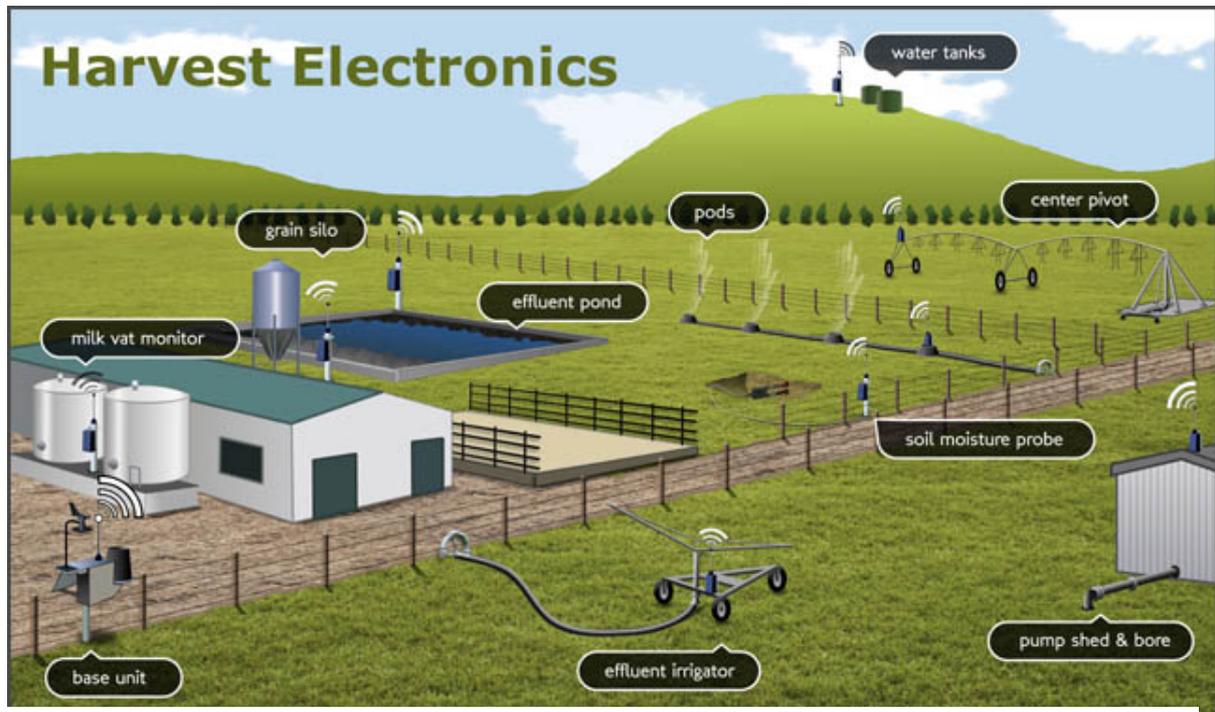


Figure 2 (har)

Their systems have communication capabilities via long range radio frequency, the GSM network and the Iridium satellite network. They have systems that will ensure data can be transferred in almost any farming environment.

Farm Automation Idea Conclusion

(Product already exists)

The Harvest Electronics System covered just about everything that I was proposing to do. I therefore decided to end my project on Farm Automation and resolved to think of a new idea that would be more unique. I decided to look outside of the farming area as there is clearly already a lot of automation in it.

Supermarket Bulk Bin Conceptual Idea

Background

The broadening of people's tastes in food, the increasing demand for organic foods and the desire to become more environmentally friendly has contributed to the advent of Bulk Bin shopping which some say "will be a mass movement" (Charter, 2014).

Problem Identification

My Experience with Bulk Bin shopping has however been frustrating:

Currently bulk bins

- Rely on customers to accurately code the contents of bags of product taken from bulk bins.
- Are open to the public to put in their un-gloved (unhygienic) hands and select the quantity and product make-up they desire.
- Rely on customers to be able to:
 - sight the amount they think equates to the quantity they desire
 - calculate the cost of their selected quantity based on a price per 100/g.
- Dispense with the flow of gravity (some items) making it difficult for customers to return unwanted product.

There is therefore an opportunity for improved bulk bin food dispensers that:

- Eliminate people putting their unhygienic hands into the food bins and contaminating product.
- Automatically dispense food based on a customer's pre-selection of quantity. Thereby eliminating the loss of food when the customer accidentally spills it or misjudges the quantity they require.
- Eliminate the unexpected cost (and potentially unwanted product) by notifying customers of the total cost of their selection before the food is taken from the bin.
- Help customers stop wastage of food in their household by enabling exact quantities required of a product to be purchased, a customer could for example choose to select and bag items in the exact quantities required for recipes.
- Eliminate time at the checkout and ensure accurate charging of product by printing a label containing the product's information (name, quantity) subsequent cost and possibly its own barcode.

Existing Systems - Bulk Bin Dispensers

Scoop Bins

These are the bins (Figure 3) that are the standard design used in just about all supermarkets, they allow the customer to select their own goods using the scoop provided (the scoop is in some instances attached to the container but is often is located in or near the bulk bin, enabling it unrestricted access to any of the bulk bins).



Figure 3

Positives

- Simple and easy to use for all customers
- Customers are able to self-select their desired product and quantity

Negatives

- There is potential for spillage to occur when product is taken out of the bulk bin and transferred into the plastic bags provided for product purchases.
- Hygiene can be compromised as food is open to un-sanitized hands and scoops which have been uninvitingly dropped on the floor.
- Cross contamination of product has the potential to occur when scoops are transferred between bulk bins to dispense different products.
- The product labelling system is open to abuse. The system relies on customer honesty and accuracy in correctly labelling their selected product.

Opportunities

Create a system that would:

- Reduce the potential for food spillage/wastage
- Reduce the potential for hygiene and cross contamination issues
- Label the selected product to avoid the potential for inaccuracy.

Gravity Dispensing Systems

These dispensing systems (Figure 4) are standard in most supermarket bulk bin areas, they feature a simple pull down bar which allows product to be gravity fed (fall down) into a plastic bag. They are usually found above the scoop bins and will usually contain 'non sticky' food that is hard and grainy in nature e.g. pumpkin seeds, coffee beans etc.



Figure 4

Positives

- Simple and easy to use
- Hygienic way of dispensing, the customer has no contact with the product in the bin.

Negatives

- It is very difficult to control the rate at which the product is dispensed and therefore the precise quantity selected.
- It is only suited to free flowing product
- The product labelling system is open to abuse. The system relies on customer honesty and accuracy in correctly labelling their selected product.

Opportunities

Create a system that would:

- Provide the customer with more control over the amount of product that is dispensed.
- Label the selected product to avoid the potential for inaccuracy.

Background –Changes in Grocery Shopping Behaviour

Technology has taken grocery shopping behaviour round a full circle. The future of grocery shopping is looking more and more akin to the shopping behaviour of customers 100 years ago.

Technology has changed the we do things however its influence over the way in which people shop has close similarities to the manner in which people shopped 100 years ago see Figure 5

1914

Supermarkets didn't exist 100 years ago, people bought their food from smaller specialist shops meats from the butcher, fresh produce from the fruit store and other grocery necessities from the local grocer. Without the modern transport conveniences, shopping was usually done on foot, limiting what people could buy to what they could carry.

Grocery stores would feature a set of scales at the counter as a lot of product was stored in bulk quantities, dispensed and sold according to the weight the customer requested, even cheese was cut from large blocks, weighed and then paid for. A clerk would select the food/goods a customer wished to purchase and then after payment was received pass the selected products to the customer to carry home.

1950's

After the war years and the great depression families were more price conscious in their food purchasing. Larger format grocery stores meet this need by keeping prices lower through bulk buying and lower staff to customer ratios, achieved by customers self-selecting their groceries. The invention of the supermarket trolley enabled customers to self-select large quantities of goods.

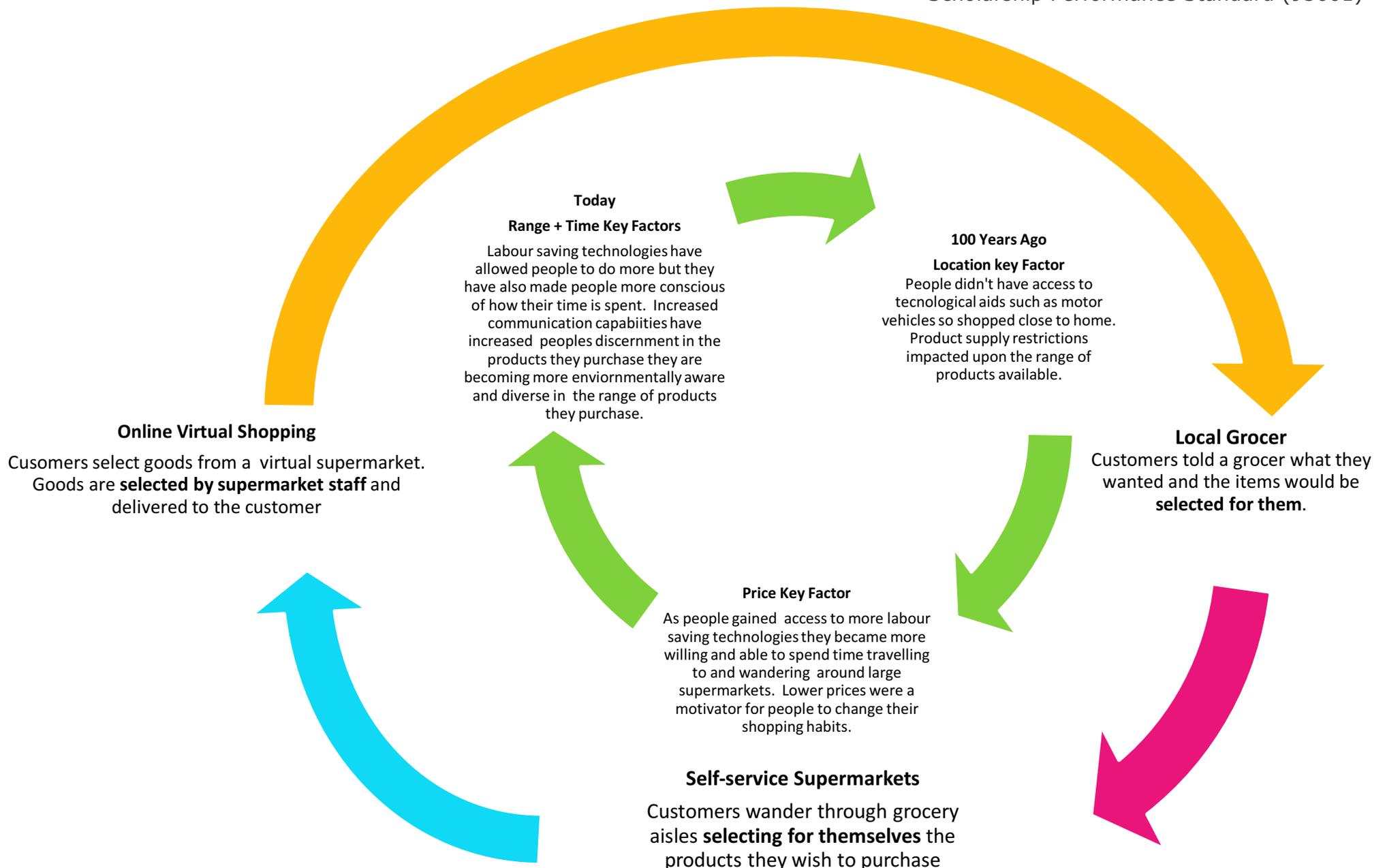
Technological advances in transport and refrigeration enabled customers to purchase in bulk. Daily trips to the supermarket were able to be changed to weekly trips.

Today

Aided by technology customers are now more time conscious. People are less willing to spend time physically shopping preferring to create a list and have someone else pick and deliver goods to their door. "Online grocery shopping already pretty popular is likely soon to sky rocket (Joel, 2013). The willingness to pass over the responsibility for selection of groceries today mirrors somewhat the grocery selection methods of 100 years ago.

People are becoming more environmentally aware, the enabling of mass communication of the damaging effects packaging materials are having on the environment is making people actively look at the part they can play in reducing landfill rubbish. Supermarkets are encouraging customers to bring their own bags to take their groceries home. The next step may be for customers to bring their own containers to dispense bulk produce into, a concept which has parallels to the dispensing of sugar and flour 100 years ago. If weight could be accurately determined at the point of dispensing as opposed to point of sale this could be a reality in the not too distant future.

Founders of a new German bulk bin style supermarket believe "consumers will get greater value by buying the exact portions they need" (Charter, 2014) 100 years ago Grocers would select and weigh the exact quantities customers demanded from bulk sacks of sugar, flour. Technology is bringing us back in a full circle.



Customer Survey needs Identification

Survey Methodology

An open ended survey was conducted to gather information on whether or not people choose to shop from supermarket bulk bins and to gauge people's reactions to the bulk bin shopping concept.

[View the Survey Form here](#)²

Survey Approach

The Burnside High School staff and the Merrin School staff mailing lists were chosen as the primary means of circulating the online link to the survey as they:

- I. Cover a reasonable age range that is appropriate to the survey
- II. Cover a selection of people from a variety of suburbs within Christchurch.

I also placed the survey on the Brightsparks forum to try and gain a wider geographical feedback.

Survey Summary

[Survey Results](#) (see Appendix pg. 50-51)

Consumer Behaviour

Of the 120 people I surveyed only 17% shopped online for groceries, while 78% owned a smart phone. Technology is being adopted by people; however it appears people still like to go into stores to select their own groceries.

91% of people surveyed had/used supermarket loyalty cards.

Bulk Bin Responses

Of the 120 people that I surveyed 87% had made purchases from Supermarket Bulk Bins. The key areas in which people identified improvements could be made in the bulk bin area were: 'perceived' hygiene, range of products, weight and price calculation and labelling. People were conscience of the price of bulk bin products and sited the relative price of bulk bin products to pre-packaged products as a key factor determining their usage of the area.

Non Users

The two key factors that discouraged people from using bulk bins were: perceived hygiene issues and the uncertainty associated with cost. The self-service design of bulk bins set off alarm bells for people concerned with what 'might be'. The perceived potential for hygiene issues (real or not real) put them off. People who chose not to purchase from the bulk bins, overwhelmingly did not due to perceived hygiene. People also indicated that they preferred pre-packaged goods as "you know the price". Some people acknowledged that the price of the items in bulk bins discouraged them from purchasing. They were not willing to pay for or did not perceive a higher quality of items in bulk bins. One person even questioned the quality and origins of bulk bin products as there was no information indicating where they were sourced from.

² <https://docs.google.com/forms/d/1Bj8aYc51xNf4iewh2B95PzbIT1Nlwq4MhEmMRJ9cXaw/viewform>

Users

54% of people who indicated that they had purchased items from supermarket bulk bins felt improvements could be made to them.

Customers felt strongly that the design of the bulk bin could be improved to:

- i. Eliminate hands, tongs, scoops potentially contaminating products
- ii. To enable control over quantity dispensed.

Some customers also noted that the freshness of the product was perceived to be questionable. Bins filled from the top and served from the top give the perception that the last product in is the first product selected – taken.

Another significant area customers noted for improvement was: a means of determining the cost of product selected. A means of eliminating the uncertainty over quantities taken and therefore cost of product taken would be welcomed by customers. One customer suggested dispensing product in fixed 50g amounts.

Customers also felt strongly that labelling of the bulk bin bags could be improved upon. They didn't like having to write on the plastic bags. Some even suggested that they would like the option of being able to bring and fill their own containers.

Customers were keen to see a greater variety of products available in bulk bins. They also suggested that more information about products regarding for example the source of product, whether or not it is Fairtrade/Organic/Gluten Free would be an improvement.

Conclusion

Only 17% of people surveyed purchased groceries online while 87% of people surveyed shopped from supermarket's bulk bins, indicating that customers like being able to select their desired products.

The value placed on 'self' selection is further proven by the fact that customers were keen to see more products being offered in bulk bins. If a product can entice a customer to the bulk bin area they will buy more from other bins simply because 'they are there'.

However people appeared to compare bulk bin offerings to pre-packed shelf alternatives, in doing so they identified:

- i. Potential hygiene issues with self-selected products: issues which they didn't perceive with pre-packaged foods as they were only aware of the product in its packaged form.
- ii. Pricing issues with self-selected products: people liked to know what the package they were putting in their trolley was costing them.
- iii. Ease of use: Customers found the system of writing on plastic bags difficult. They valued additional information provided on packaging identifying where the product was sourced.
- iv. Freshness: Some people questioned how long product had been in the bulk bins. Yet they did not question how long a sealed package had been on the shelf. Perceived high turnover appears to be the differentiating factor.

People are willing to adopt new technologies as evidenced by the fact that the majority of customers own smart phones (78%). They are also willing for supermarkets to hold their details as evidenced by the fact that 91% have or use supermarket loyalty cards.

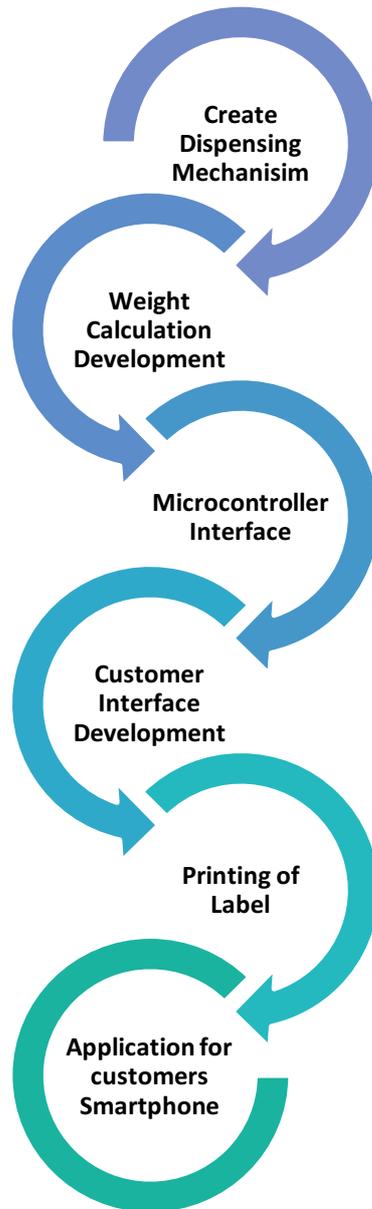
Proposal

Introduction

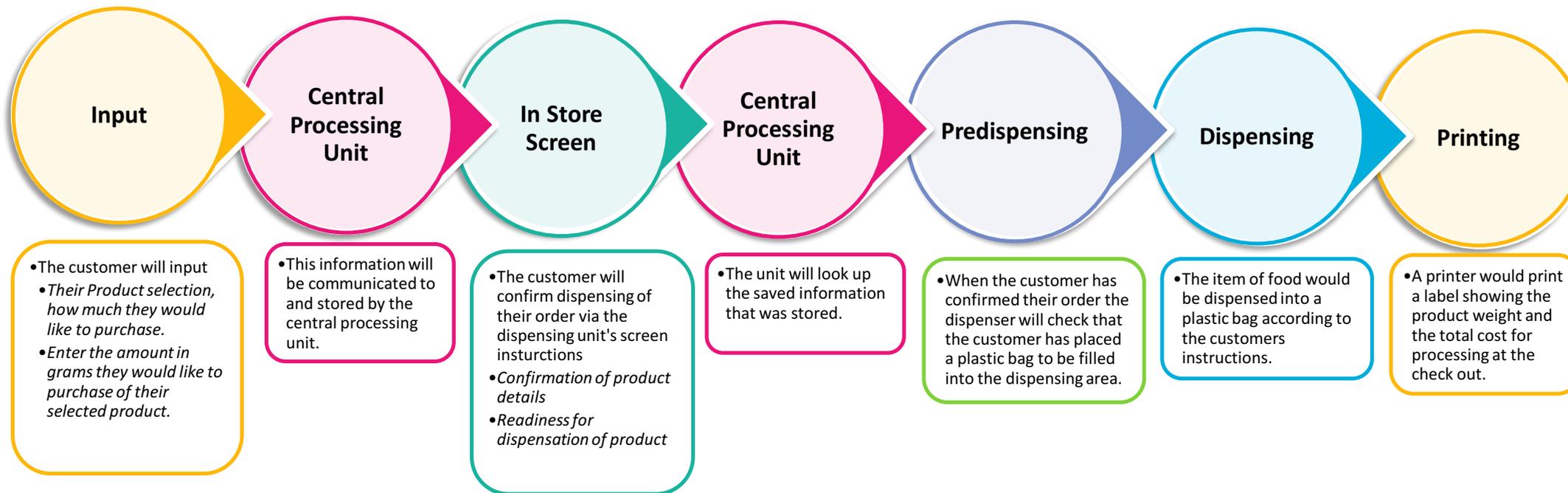
I propose to create an intelligent bulk bin dispensing system which will aid shoppers and supermarket managers. My system will be a hygienic, revolutionary way for people to shop in the bulk bin area of supermarkets.

The system will be created so that customers are able to download an App to their smartphone (ideally it would be linked to the stores existing shopping App), then select the products and the related quantities that they would like to purchase from the bulk bin area. This information would be sent to a server so that when the customer enters the bulk bin ('you-select' quantity section) of the store and activates the appropriate product dispensers their preselected quantities would be dispensed, packaged and labelled. Dispensers could be activated via the customer's mobile phone (if the phone has NFC) or their customer card.

Project Development Steps



Dispensing Process



Potential Advantages

Supermarket Owners

The intelligent quantity dispensing system would:

- Preprint product labels with prices, enabling quick and accurate scanning of products at checkouts.
- Automatically dispense the product according to the customer's selection enabling store pickers to more accurately pick a customer's online bulk bin order.
- Notify staff when stock levels are low and need to be reordered.
- Help to reduce product wastage by providing customers with:
 - notification of the cost of their selection before the product is dispensed
 - a means of dispensing the exact quantity that they desire
- Maintain a hygienic means of customers self-selecting the quantities of products they desire.
- Reduce the different quantity packaging options for products enabling a greater variety of products to be stocked.
- Enable products to be sourced in bulk at more competitive pricing margins..

Customers

The intelligent quantity dispensing system would provide customers with:

- An accurate means of selecting the quantity of a product they wish to purchase.
- An ability to determine the cost of their selected purchase quantity before it is dispensed.
- An assurance that the product they are selecting (whilst not pre-packaged) hasn't been contaminated by other shoppers.
- An ability to preselect, store and recall past quantities of a product that they wish to purchase..
- Save time and stress by taking the 'guess work' out of the bulk bin ('you-select' quantity) section of the supermarket..

Supermarket Owners & Suppliers needs Identification

Consultation

I sought feedback on my proposal from a supermarket bulk food supplier³ and managers⁴ of two different styles of supermarket to help develop a set of specifications for my project

Reactions and Requirements

"Providing customers with what they want is a good service to strive for, pre-printed labels are a good idea " (Turner, 2014)

The following requirements were identified as being important considerations in an automated bulk bin system:

Cost

Bulk foods is a small department in supermarkets and as such generates only a small proportion of a supermarkets revenues. The cost of installing automated dispensing systems would therefore have to be weighed closely by the benefits they would bestow.

The server and associated software requirements for an automated system to interact with a smartphone App would further add to the cost of installation of a system. Not all Supermarket brands have a smart phone App either, New World & Pak'nSave currently don't.

Product Containment/Hardware

The space consumed by an automated system will directly impact upon a stores ability to adopt it.

Systems that deliver well-presented and fresh product that the customer can see are critical to the success of the bulk bin area.

Ease of cleaning is an important consideration, bulk bins are required to be cleaned somewhere between once a week and once every 3 weeks (depending on the type of food in the bins). Currently it takes an average of about 12 minutes clean a bulk bin.

Reliability

An automated system needs to be reliable and easy to maintain.

Hygiene

"Improved hygiene is always something to strive for". However those people who do find hygiene a problem won't usually shop in the bulk bin food area. (Jackson, 2014)

Due to food safety regulations the concept of bringing 'your own' container into a supermarket has not been widely adopted. The concept of 'bringing your own container has an element of risk associated with it as the store has no control over the hygiene of the container

³ Jeremy Seed, General Manager –Self Selection, Profile Foods
Ian Jackson, Regional Manager South Island, Profile Foods

⁴ James Turner Manager Fendalton New World (a specialty style supermarket)
Sue Lee Manager Hornby Pak'nSave (a larger warehouse style supermarket)

Revised System Brief

Customers must be able to determine the cost of their selection before the amount is dispensed.

This would be achieved by:

- Incorporating a user interface which will display the total cost of a preselected quantity the customer will have knowledge of and be able to confirm the cost of an item before it is dispensed.
- Incorporating a worm drive I will be able to automatically drive product out of a food containment area in response to a customer's instructions.

The system must be food safe, easily cleaned and meet customer's hygiene requirements.

This would be achieved by:

- Using food safe materials in the food containment and dispensing areas which are able to be quickly and effectively cleaned.
- Ensuring that the system can be easily accessed for cleaning by a supermarket worker.
- Ensuring the food containment area is transparent and dispenses on a first in first out basis to ensure the customer's perceptions of freshness are meet.
- Incorporating a worm drive to automatically drive product out of a food containment area, enabling the food containment area to be sealed to customers.

The system must be easy to use.

This would be achieved by:

- Incorporating a user interface with simple, clear, instructions.
- Gaining feedback on the design of the system from supermarket customers.

The system must be economical for supermarkets to implement

This would be achieved by:

- Simplifying the system so that it only includes components necessary to achieve the main objectives of hygiene and automatic dispensing of a preselected quantity, I will be able to keep costs down. Additional features that I proposed to link the system to a smart phone App would unnecessarily add to the cost of the system and would be better implemented when supermarkets have systems in place to complement them.

The system must be reliable

This would be achieved by:

- Installing systems to help prevent problems such as product jamming.
- Designing the system so that it is able to be easily dismantled for maintenance.

Project Specifications

User interface:

- Easy to use
- Enable the customer to input a desired amount
- Provide the customer with sufficient information to enable them to confirm the dispensing of an item before it is dispensed.

Dispensing Mechanism:

- Food safe
- Easily cleaned
- Strong enough to drive a full load of product out of a food containment area
- Easily maintained
- reliable

Housing:

- Transparent
- Fit easily into the bulk foods section of a supermarket.
- The food containment area needs to be food safe, easily and effectively cleaned and have the ability to be sealed to customers.
- The electronics need to be easily accessible for maintenance.

System Control

- Economically priced
- Able to control a number of electronic components
- Reliable

Worm Drive

The worm drive is an important element in my design as its function is to ensure the desired amount of a product is dispensed. The worm drive is designed to work like an Archimedes' screw to transfer food items from a 'bin' to a customer's container.

Design Specifications

The worm drive is part of a larger 'bin' dispensing system; as such it has to:

- fit neatly and seamlessly with the other parts of the system
- be strong enough to transfer a full load of product (when every turn of the helix contains product)
- enable quick, and thorough cleaning with ease

Design Process

Design Tool Research

The first step in creating my worm drive was to find and learn how to use a CAD software package that would enable me to create a model of my worm drive in a file format that could be exported in a .stl format to a 3D printer.

As I didn't have any experience in 3D design software design I relied heavily on Google to find information.

OpenScad

After discussing my project idea and lack of CAD experience with Bridget McKendry from Fabriko (MakerCrate), she suggested I start by finding something like I was hoping to design on the Thingiverse website (a place where inventors and hobbyists can share their designs with the world) and then modify it to suit my specifications.

After some extensive searching I was able to find a worm drive file that could potentially be modified to meet my specifications.

The developers on the Thingiverse website use a popular free program called OpenScad to design their 3D models, I however found it difficult to isolate within the code the key specifications that I needed to change to get an accurate fit for my purpose. Despite OpenScad being popular I found it very hard to visualise what I was altering as I was learning and modifying the code. I had to therefore look at using a different program to create my worm drive.

Tinker CAD

I went back to Bridget to ask if she had any further suggestions. She showed me her favourite online program called Tinker CAD. It is very simplistic, easy to use, perfect for me, except that the tools available on the program, are not really designed for creating projects like mine.

AutoCAD

Scouring the internet again I found AutoCAD a design program by Autodesk. The sheer size of the program (3.65 gigabytes of bandwidth) wasn't the only problem I encountered trying to install it. I had to also update my operating system to windows 8.1 and download and update internet explorer so that it could verify the installation.

Eventually I was able to create a worm drive with the specifications required for my project in AutoCAD and export the file in a .stl format for test printing. [Worm Drive AutoCAD](#) (see *Appendix* pg. 40)

Inventor

After playing around with AutoCAD and creating my worm drive I then decide that I would need to create some gears for my project to help slow the motor down and give it more torque. I looked around on the internet for a tutorial to create the gears that I required.

Scouring the internet again I found a program called Inventor that I would be able to use to create my gears. Inventor looked to be simplistic and easy to use. I had to once again download the program, (this time 8.83 = gigabytes big) and master the skills required to use it. Peter Crawley from CAD Pro Systems kindly agreed to help me with the finer points of creating a worm drive in Inventor, the program that I was going to use for my gears. After a month of overcoming hurdles in design I completed this stage of my project. [Worm Drive Design Drawing Inventor](#) (see *Appendix* pg. 41-44)

Printing

Bridget McKendry – MakerCrate

I took my worm drive design to Bridget at the MakerCrate to test a variety of 3D printing methods to produce a worm drive to meet my design specifications. Bridget is a 3D printing enthusiast, she runs sessions with primary school children in the 'used to be' Pallet Pavilion

UP Mini Printer

Overview

The first print that Bridget tried was on an UP mini printer that she had at the MakerCrate, its printing range is quite small so we were only able to print a small section of the worm drive as a test. The result is pictured in Figure 6.

Conclusion

As you can see from the picture (Figure 6) the helix needed to be filed down to create a smooth hygienic finish.

Makerbot Replicator Printer

Overview with scaffolding

After trying to print worm drive on the Up Mini printer with scaffolding and not having a huge amount of success with the finish we decided to try printing it on a Makerbot printer with scaffolding. The Makerbot printer is the printer which Bridget uses more frequently and has more experience with.

Conclusion with scaffolding

The worm drive (Figure 7) came out with scaffolding which was very tough and rigid and difficult to remove. It did not leave me with a finish that met my specification of being hygienic and easy to clean. The worm drive printing therefore needed to be improved to make it feasible as a device to drive the product out of the bin.

Overview cut in half

After thinking about our options again Bridget came up with the idea of printing the worm drive in two halves (Figure 8) thereby eliminating the need for scaffolding (On a flat based 3D printer any angle greater than 45 degrees needs scaffolding to provide support for the layers to be printed on). I cut the worm drive design in half (horizontally) so that it wouldn't need scaffolding to support the structure while it was printing using Tinker CAD. . We printed the prototype on the Makerbot as it enabled me to print the drive at the full scale required for my final worm drive.

Conclusion cut in half

The printer printed the drive really nicely however the edges lifted a little. When I came to glue the drive together the edges that had lifted didn't quite fit together, small gaps were left where product could get stuck and go stale. This had been my best print so far, the finish had turned out successfully however the prototype still did not meet my design objective of being hygienic and easy to clean.



Figure 6



Figure 7



Figure 8

Bruce Sparks - CPIT engineering Department

I was able to make contact Bruce Sparks from the CPIT Engineering department⁵ for some feedback and advice on my design and the mechanics of how it would work.

His first suggestion was to increase the angle of and the radius between the blades of my worm drive so that product wouldn't get stuck and go stale and horrible. This would also help ensure the worm drive could be thoroughly cleaned. [WormDriveV3](#) (see *Appendix* pg. 45-46)

UP printer

Overview with scaffolding

I decided after printing my worm drive on the Makerbot and talking to Bruce Sparks at CPIT that I would try printing my revised worm drive file in two short parts on an UP printer with scaffolding to avoid having to cut the drive in half horizontally. Bruce believed that an UP Printer would be able to provide the finish that I needed. I tested his hypothesis on the school printer (Figure 9).



Figure 9

Technical Difficulties

I found that with all technology there are faults and it doesn't always work 100% perfectly well. As 3D printers are a developing technology and are establishing themselves they haven't quite been perfected to their best for user feasibility. I found there were a few flaws with the printer.

The confinement of the height

This was a real problem as it meant I would not be able to print the whole model as one component, I would have to make a break in it. However this was always going to be a restriction to printing my worm drive unless I spent a lot of money to get it printed on an industrial 3D printer.

Print Time

Print times were always a real hassle especially since the printers that were available for me to use would take about 9 – 16 hours to print my model. If I didn't quite get the design right or the printer faulted during the print then it would mean that I would once again have to reprint the whole model again. If you are unable to watch for faults like a break in the plastic during the print, the whole print time is wasted.

Conclusion with scaffolding

The first print that I did on the UP printer came out really well, the scaffolding came off easily (Figure 10) leaving a nice smooth finish. I was really happy with the outcome. I still had to print the worm drive in two parts, but no matter what sort of printer I decided to use, I would still have to cut the drive in half to enable it to be printed to the scale I needed. [Worm Drive Evolution](#) (see *Appendix* pg. 47-49)



Figure 10

Future improvements

Cast Metal

To fully meet hygiene and strength requirements the worm drive would ideally be cast in stainless steel. Casting would enable the drive to be moulded as a single unit maximising its strength and trueness. Casting a worm drive in stainless steel would however add a significant but essential cost to the cost of the dispensing system.

⁵ Bruce Sparks, Learning Facilitator, CPIT Engineering department

Driving the Worm Drive

Stepper Motors and Driver Boards

Introduction

I needed to use a stepper motor to drive the worm drive, however this was going to be a real challenge for me as I had no experience with stepper motors and no knowledge of how to wire them.

Research/Learning

I found it pretty easy for a start finding forums and topics that had information on stepper motors and how to wire them however I find it really hard to find a way of working out which stepper motor would be best suited to my project.

I decided that I would talk to a few people that might have a bit of expertise with Stepper Motors

Bridget McKendry - 3D expert @ The Maker Crate

I talked to Bridget McKendry from the Maker Crate as I knew that stepper motors were a prominent part of 3D printers (they are needed to drive the move the nozzle of the 3D printer in along the X and Y plane and also move the base plate along the Z lane).

Bridget recommended that I use the NEMA motors that are used in 3D printers because of their reliability and strength.

Conclusion

Bridget was only able to advise me on a suitable type of motor. As her experience of using the NEMA motor outside of 3D printing was limited I decided to delve deeper into the community of electronics experts that I knew before making a decision.

Andrew Hornblow - Electronics Enthusiast, Brightsparks Mentor

I knew that Andrew would have some sort of expertise in this field of electronic technology and that he would be able to provide me with some guidance in this area.

Andrew recommended using a kit as it would be the easiest option for a first timer in this area of electronics.

A browse of the internet revealed very few kit sets and none for NEMA stepper motors.

Joe Colquitt - Electronics Enthusiast

In response to my post on the Brightsparks website Joe offered to send me two electrical circuit boards he had designed and two stepper motors (which were fortunately NEMA stepper motors).

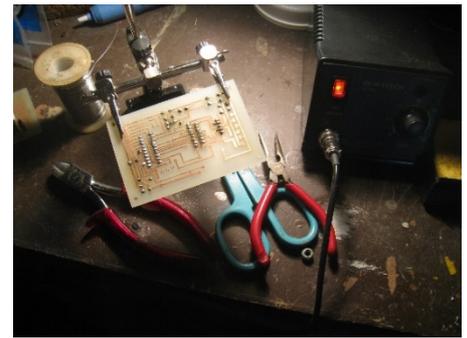
Driver Board Construction

The boards Joe provided me with still required components to be added.

This was my first real go at soldering up a board from scratch and I therefore made many mistakes which had to be identified and fixed.

Driver Board Testing

Testing a homemade electronics board always leaves you with the doubt that it may not work which can be really frustrating. Joe had provided me with a board diagram which showed the board's circuitry but it didn't show how to interface the board to a microcontroller. I found some circuitry for an easy driver board on the internet (JoelEB, 2013) and replicated the circuitry and copied the code to test the driver board with an Arduino board.



Result

With the added uncertainty that the code wasn't right or wasn't going to work with the board I had, it was a huge relief to see the motor actually revolving and to be able to control the amount of steps that the motor would make.

Stepper Motor Testing

I set-up a test (Figure 11) to determine whether or not the stepper motor would be able to drive a weight equivalent to that which I was hoping to drive in my bulk bin dispenser prototype.

The test consisted of a long threaded cylinder like screw attached to the end of my motor. I held a bolt on the thread of the screw so that as the screw tightened the motor and screw head moved forward pushing on household objects of an equivalent weight to my test weight.

The test was successful.

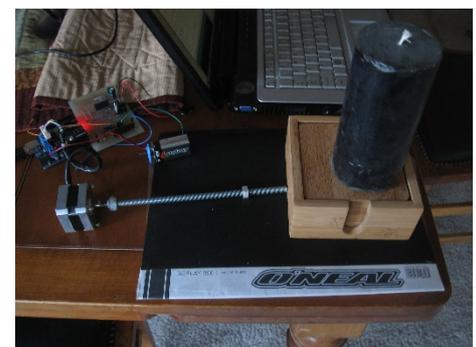


Figure 11

Interfacing with Raspberry Pi

Interfacing the stepper motor driver board with a Raspberry Pi gave me the ability to control the direction of the motor as well as the speed that it spins at. These were the basic functions that I required of the motor, however this could be expanded by using some of the other functions that the board has in the future.

Wiring

It took me a while to figure out how to wire up the stepper motors to the Raspberry Pi as there is little documentation on how to do this online.

I managed to find the datasheet for the two main stepper motor ICs and from this and information about a similar driver board was able to determine the data lines required to connect the stepper motor driver to the Raspberry Pi.

Detecting Stalls

I needed to find a way that would allow me to detect when the motor had stalled to enable me to reverse the motor to clear a jam.

Voltage Reading

By carrying out some research on the internet I found that a common way of detecting the stall of a motor was to read the change in voltage drawn across 2 pins, in the circuit of the motor driver board.

Unfortunately the stepper motor board that I was using didn't have an appropriate line for me to be able to do this. Joe Colquitt (the stepper motor board designer) recommended I test to see if when the motor stalled there was an increase in voltage on the driver IC.

Unfortunately this didn't work, there was no detectable change in voltage.

Fly Wheel & Photo interrupter

Through further research on the internet I found a spoked wheel on the end of a motor will break the connection in a photo interrupter while the motor is turning.

3D Printing

To get an evenly spaced spoked wheel that would fit on the end of the motor I was using I had to design and print one. [Fly Wheel Design](#) (see *Appendix* pg.58)

Assembling Photo interrupter

I found it quite difficult to solder up the photo interrupter without having the leads touching.

I tried using a blank kiwi patch board designed by Andrew Hornblow to solder the photo interrupter terminals into. Unfortunately in implementing it the photo interrupter shorted and blew up.

I then went with the safest option and bought a breakout board for the photo interrupter.

Testing

In my first test the spokes didn't interrupt the photo interrupter.

My solution was to redesign the fly wheel and increase the width of the spokes as that seemed like the most obvious reason why the photo interrupter connection wasn't being broken.

After my second test with the redesigned spoked wheel didn't work, I realised that as I had printed the fly wheel in a white plastic which was reflecting the light, not blocking it out. The problem was easily solved by colouring the wheel in with a black marker.

Coding

I modified my python code to detect whether or not after a 100 steps of the stepper motors operation a change in the photo interrupter had occurred. If no change was detected the motor was considered stalled and was reversed twenty steps before continuing. [Stall Detection Code](#) (see *Appendix* pg.55)

Weight Calculation

I needed to find a way that I would be able to calculate the weight of product dispensed

Design Specifications

The weight calculation is part of the electronics that control the 'bin' dispensing system; as such it has to:

- be compatible with the other electronic components used incorporated into the system:
- be reliable

Concepts

Weight of Bag Calculation

The weight dispensed would be calculated by measuring the weight of the bag as the product is being dispensed into it.

Positives

- If outside interference is not factored in it would be easy to set-up and maintain.

Negatives

- The weight reading could easily be interfered with by the customer if it is not designed right.
- Designing a way that customers cannot influence the weight would likely compromise the ability to maintain the system.

Evaluation

Although this would probably be the most accurate way of calculating how much the product had been dispensed. I couldn't be sure I would be able to design a way of maintaining ease of access to the scales for maintenance purposes while restricting customers from distorting the weight measurement.

This is an area that could be researched further in the future.

Dispensing Unit Calculation

Weight that has been dispensed would be calculated by taking a reading of the initial weight of the bin and then subtracting from it a reading taken of the bin periodically through the dispensing. Dispensing would stop when the weight and the initial weight - the current weight of the bin was equal to the quantity to be dispensed.

Positives

- It will enable the scales to be easily maintained
- The risk of outside interference is minimised

Negatives

- Measuring a small change of weight may be difficult
- The vibration of the motor may distort the readings of the scales

Evaluation

The weight may not be as accurate as you are only measuring a very small change over a much bigger weight

e.g. *If the weight of the bin is 8kg and the customer inputs into the dispensing system that they want 75g the system has to try and detect when the total weight of the bin is 7.925kg*

This is obviously a flaw in this concept of my design unless the scales that I use are accurate enough to measure small changes in weight.

Final Decision

In the end I implemented my second weight calculation concept as it would enable me to develop a system that I knew could be easily maintained and had the potential to provide an accurate reading if I could get scales which were able to measure small changes in weight accurately. The scales did now however become a limiting factor in the accuracy of my system.

Long Term Developments and Considerations

Design

I would really like to think of an improved means of calculating weight. Presently the scales sit under the bin which works for this prototype however it means weight is a limiting factor for the dispensing system. I.e. larger product weights could move the total weight of the system beyond the capabilities of the scales.

The load cells that I have used are also not certified for their accuracy, certified load cells are expensive to obtain, but would be necessary for a commercial product.

Scales

Introduction

I sourced my load cells from a simple set of kitchen scales purchased from a local electronics retailer.

Obtaining Readings from the Scales

I needed to somehow get the values measured by the scales outputted in a digital form so that I could use them in my code and calculations.

Hacking

I started by opening up the scales to determine which of the components on the board were accessible (one of the IC's had been covered with silicon). After doing some research on the internet I found that the IC's that were open weren't involved in the amplification of the weight but were rather for the buttons and LCD on the scales.

Mentor Consultation

I went and saw two engineers from AIO Tech, Bluewater systems⁶ and talked to them about how I could proceed with obtaining voltage readings from the scales that I had obtained. They suggested that I should start by creating a Wheatstone bridge with one load cell adding a variable resistor and 3 resistors around the circuit to get readings from the scales.

However after doing a little research on the topic, I found that it would be more accurate to take readings from the four load cells in parallel as set up in the scales. I therefore discounted the idea of only using one load cell and continued with the idea of using a full Wheatstone bridge.

Wheatstone bridge

I wired the load cells myself into a Wheatstone bridge (Figure 12) formation and then took the Sense+, Sense- and Excite+ and Excite- lines and wired them into my breadboard. I was then able to take a measurement of the voltage from the load cell.

Testing

Thankfully this was successful, and I was able to detect the small changes in the voltage through the multi metre which was a really encouraging start and a really good step in the right direction.

Amplification of the voltage

I needed to find a way in which I could amplify the voltage being given off by the scales, as a result of resistance generated from weight applied to the scales.

LM741 Op-Amp

I first looked at using this amplifier as Andrew Hornblow had told me that they were a standard amplifier commonly used. After doing some research I found that they weren't going to provide me with the accuracy that I needed. I needed to use an Instrumental Amplifier.

INA126 Instrumental Amplifier

I used a research document from San Jose State University (Furman) to wire the Amplifier (INA126) into the Wheatstone bridge.

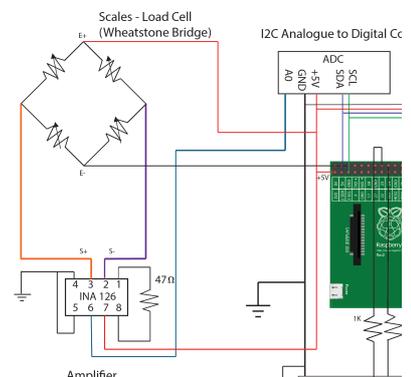


Figure 12

⁶ Russell Hocken and Andre Renaud

Weight v Voltage Relationship

I put a series of different weights on the scales and recorded the voltages. From this I was able to determine that a linear relationship exists between weight and voltage. This meant that as the weight increased by 1 gram the voltage increased by 0.8406 millivolts. Figure 13.

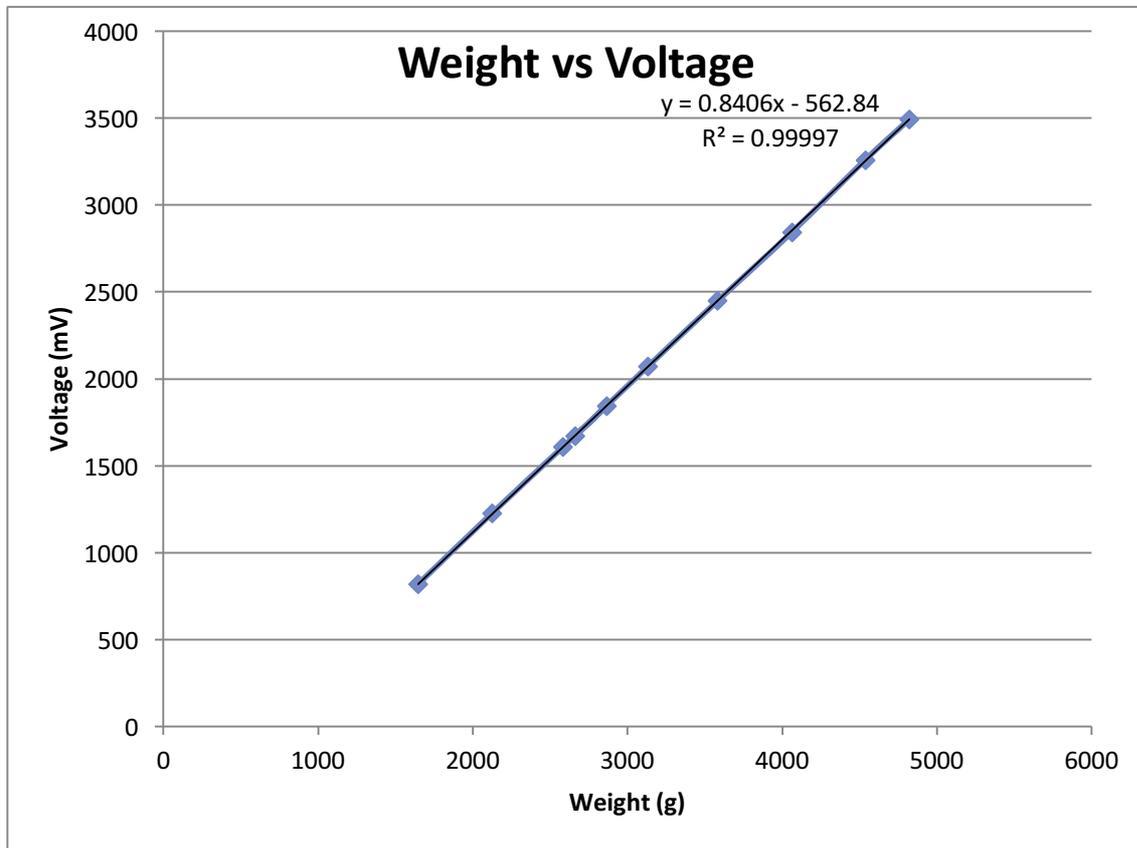


Figure 13

Problems & Solutions

Unfortunately there is a bit of noise in the voltage which means erroneous values can be sent to the Raspberry Pi, potentially interfering with the weight readings. To try and get an improved result I coded the Raspberry Pi to take five weight readings and then average them.

Unfortunately errors still appeared in the weight readings however the result was an improvement. (Figure 14)

		Actual Weight	i Dispense Weight	Weight Differential
Weight of Container	235	235	235	0
Entered weight	100	335	370	35
	100	435	465	30
	100	535	555	20
	100	635	655	20
	100	735	750	15
	100	835	910	75
	100	935	1005	70
	100	1035	1100	65
	100	1135	1200	65
	100	1235	1290	55
	100	1335	1380	45
	100	1435	1485	50
		Maximum Difference		75
		Minimum Difference		15
		Average Difference		45.42

Figure 14

Short Term Developments and Considerations

Electrical Circuit

I would like to try adding some capacitors to the Wheatstone bridge to test whether they aid in filtering out the noise that comes through the scales.

As yet I haven't been able to find any information which I can follow to do this.

System Control

Introduction

I needed to find a microcontroller that was available at an economical price and capable of controlling my network of electronic components.

Arduino Platform

Positives

- I had previous experience with using Arduino boards and am therefore quite proficient at using them.
- There is also a lot of support for this platform of microcontroller as they are very widely used for hobbyist electronics projects.
- I had the microcontroller available to use.

Negatives

- It doesn't have the necessary capability to allow me to expand my project in the future.

Raspberry Pi – Linux Platform

My first thought was to use the Raspberry pi to control the Arduino board

Arduino in Conjunction with the Raspberry Pi

Raspberry Pi Positives

- Gave me the ability to code the microcontroller directly by bypassing the need for a computer.
- Offers opportunities for expansion in the future.

Raspberry Pi Negatives

- Doesn't have as many hardware interfaces as the Arduino board.

Raspberry Pi in conjunction with the Arduino Negatives

- Two lots of code would need to be developed (one for each platform).

GPIO Breakout and I2C Analogue to Digital converter on the Raspberry Pi

To enable just one platform to be used I purchased a GPIO Breakout and an I2C Analogue to Digital converter to use in conjunction with the Raspberry Pi

[Circuit Diagram](#) (see Appendix pg. 57)

Positives

- These additions enabled the Raspberry Pi pins to be put it into a solderless breadboard giving easy access to all the input output lines I required.
- Both additions used standard libraries.

Housing

Design Specifications

- The housing for the dispensing system needs to contain both the food containment area and the associated electronics to enable it to fit easily into the bulk foods section of a supermarket.
- The food needs to be contained in a food safe manner with the ability to be funnelled down into a central hole to enable a steady flow to the worm drive for dispensing.
- The food containment area needs to be able to be easily and effectively cleaned and have the ability to be sealed to customers.
- The electronics need to be easily accessible for maintenance.

[See it on YouTube⁷](#)

Containment Options

I needed to find a reasonably priced container that would be able to fit the criteria of being reasonably tall with a rectangular base, wide and transparent.

- **Transparent** – to enable customers to view the product
- **Tall with a rectangular base** –to enable the complete system to be housed within the one area.
- **Available at a reasonable price** – to enable the system to meet the economical affordability objective.

Click Clack 4.4L Container

The Click Clack container (Figure 15) was the first container that I looked at modifying to suit my project, it was tall, a good size, transparent and affordable. The big advantage that it over all of the other containers that I looked at was that it did not have any sort of handle moulded into the back of it and the plastic was strong.



Figure 15

Testing

While the Click Clack container met the transparent, price and rectangular base criteria, it didn't allow product to be funnelled effectively down to the worm drive.

The flow of product from the containment area through the dispensing funnel was too narrow. The peanuts I used as a test jammed in the funnel blocking the flow through to the worm drive. The twin container design incorporating the worm drive didn't allow for easy maintenance and may have hindered cleaning.

Evaluation

A container with a larger rectangular base would be required to enable a steady flow of product through to the worm drive. A single container with sufficient height to house the worm drive would improve access to the different parts of the system.

⁷ <https://www.youtube.com/watch?v=ZuCo-6ckYYM>

Sterilite Gasket box 19L

The 19L Sterilite container (Figure 16) is rectangular with sufficient height to house the entire dispensing system and sufficient length to accommodate a gradual flow of product to funnel down to the worm drive. It is transparent and affordable.

Evaluation

This turned out to be my best option for housing the entire dispensing system as it enabled a consistent uninterrupted delivery of product to the worm drive. Ideally though the dispensing shoot would be moulded as one unit eliminating any joins and risks of compromised hygiene.



Figure 16

Piping

Introduction

I needed to find some sort of pipe to house the worm drive to enable the product to be contained until it reaches the dispensing area.

Design Specifications

I required the pipe to be:

- Made of a food safe material.
- Not too big to enable the bulk bin system to fit easily into the bulk foods section of a supermarket.
- If possible clear to enable customers to see the housing is clean.

Practical Specifications

- I required the pipe to be easy to cut and modify to suit the purposes of my project

Marley 65mm down piping (Figure 17)

Evaluation

This turned out to be my best option for piping although it wasn't clear it did come in a hygienic looking colour (white). It is made from a tough smooth plastic which means it can be hygienically cleaned. While strong it was also malleable enough for me to shape it to a form in which I could use. Its diameter was sufficient to house a worm drive with the strength to dispense product without impinging on the requirement of the system to fit easily into the bulk foods section of a supermarket.

Future Improvements

Ideally the pipe housing the worm drive would be transparent to enable customers to see it is clean. In the future I would look at increasing the size of my pipe, to enable the size of my worm drive helix to be increased. This would help to prevent jamming from occurring when product is flowing into the worm drive as well as enabling larger products to flow through the dispenser.



Figure 17

User Interface

Design Specifications

The system must:

- be easy to use
- enable the customer to input a desired amount to be dispensed
- provide the customer with sufficient information to enable them to confirm the dispensing of an item before it is dispensed.

Display

I needed a way of allowing the customer to be able to visually interact with the dispensing system so that they could input into it.

16x2 LCD Display

I chose to use a 16x2 LCD display (Figure 18) as a starting point to develop and test the system.

I purchased the LCD screens off eBay as they were really inexpensive and they came with an I2C backpack on them which converted the huge 16 pins into a much more compact 4 pins (Positive, Ground and SDA, SCL). Wiring therefore wasn't too hard at all, all I needed to do was to wire the SCA and SCL into the right pins and then I wire the Positive and Negative lines into +5V and GND and after that it was ready to go for programming

Finding code for the LCD display however was a little different, as I had brought it from eBay which meant that there wasn't quite as much support as I had hoped there would be for the I2C module. I eventually came across a library (Kar) [website](#) that had been written for interfacing I2C LCD modules with the Raspberry Pi and after that it was a simple matter of coding the LCD screen.



Figure 18

Customer Input

4x3 membrane keyboard

My first thoughts on allowing the customer to interface with the Pi was by way of a 4x3 membrane keyboard (Figure 19) as it had the ability to link straight into the electronic components that I was already using in my project.

Hard wiring

The disadvantage of it however was that it used 7 digital pins which was really too much for the Raspberry Pi if I was ever going to consider looking at controlling more than one bin from one Raspberry Pi.

Analogue detection

This option required me to use resistors of different resistances to link the voltage from a key depression to a key stroke. Rows were connected to an assortment of varying resistors and the 3 columns were connected to three analogue inputs.



Figure 19

Testing

I tested this concept using an Arduino board as it had the advantage of having on board Analogue lines. Unfortunately the resistance that was given wasn't very clear and was difficult to detect.

3 Button Input

This was one of the most simplistic input options, it required me to have 3 different buttons. One being Increase, another being decrease and the final being confirm. This would have been a really simple concept however it would not be as user friendly for customers.

USB Numeric keypad Input

The USB numeric keypad (Figure 20) has a few more input options on it e.g. '/', '+', '-' etc. which allow more flexibility in customer selection options and therefore increased ease of use.

This turned out to be my best option, with the additional '+' and '-' keys I was able to add a manual dispensing function.

Coding the USB Numeric keypad meant learning how to recognise the strokes of the keyboard. I used a library named curses mode (15.11. curses) which switched the terminal in to a different mode so that it could detect when a keystroke was being pressed. This was a bit of an issue when I was prototyping and found that it wasn't going to let me exit out of the loop without exiting out of the Curses screen however once I had it working this wasn't such a problem at all. I also changed the ending of the curses window to being after all the data had been confirmed by the customer.



Figure 20

Customer Feedback

I sought feedback on my dispensing system prototype from supermarket customers at Burnside High School.

Price Input Option

As a result of customer feedback I expanded my input options to include 'price'. Customers can now enter their desired total cost for their Bulk Bin selection. A price input is converted to grams and is dispensed accordingly.

Future Developments

Things that I would really like to see in my project if it was developed further

Graphical User Interface

A touch screen interface that would provide customers with the option of selecting their desired quantity based on a graphical image of the product dispensed into a zip lock bag (as provided by the supermarkets).

Application Interface

An App that would allow customers to use their smartphones to interface with the bulk bin dispensing system.

Labelling System

A printer that would print product labels detailing the total cost and quantity dispensed from a bulk bin. This would increase the user friendly nature of the dispensing system and enable quick and accurate scanning of bulk bin selections at checkouts.

Bag Detection System

Another important feature to develop in the future will be a bag detection sensor. This feature would ensure that a bag was present before dispensing was actioned by the system. This would help to ensure product was not wasted.

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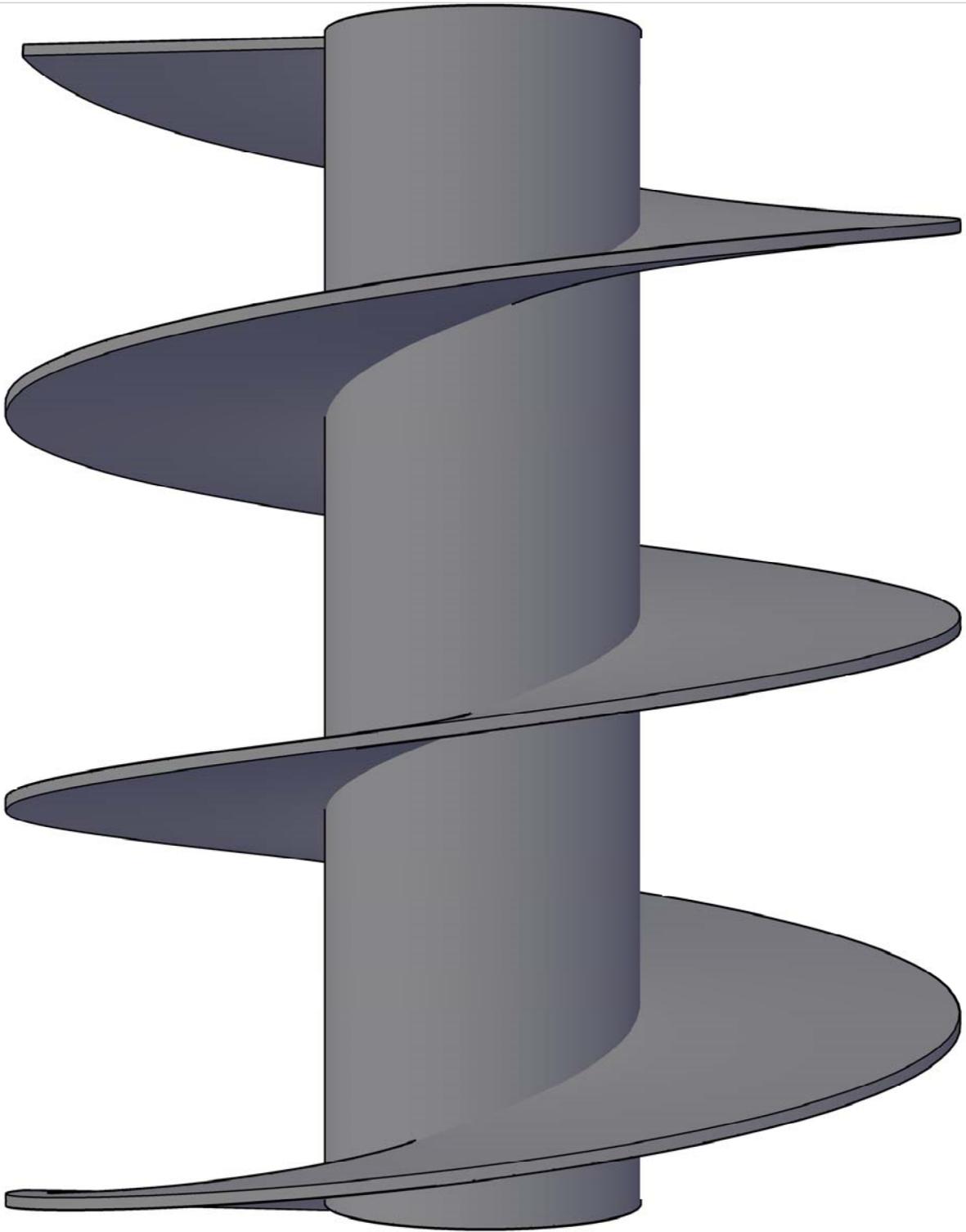
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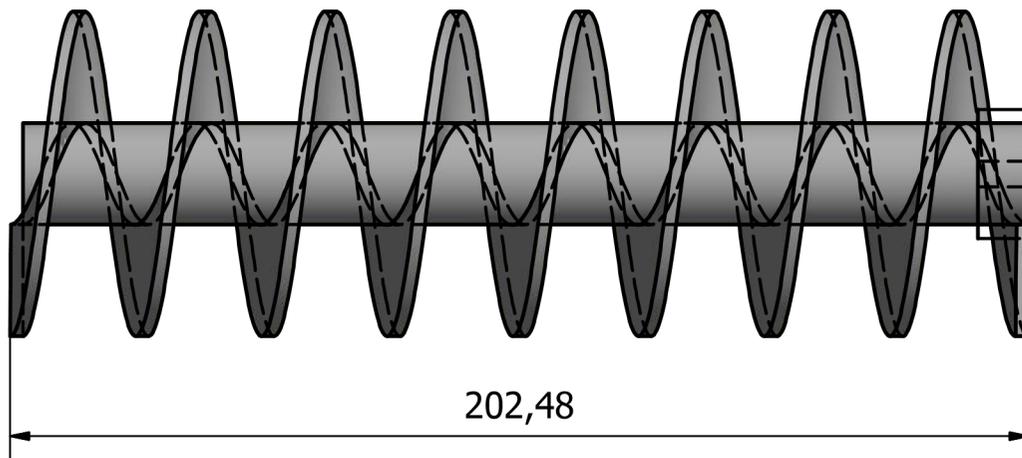
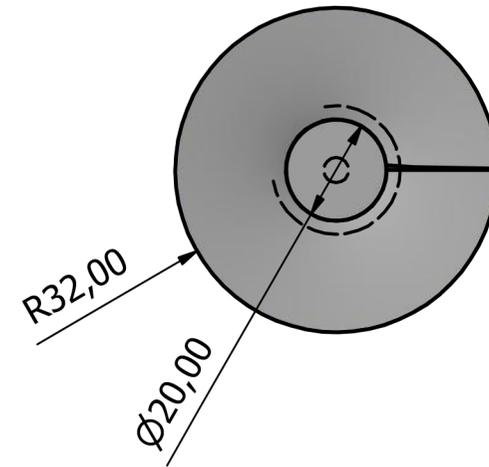
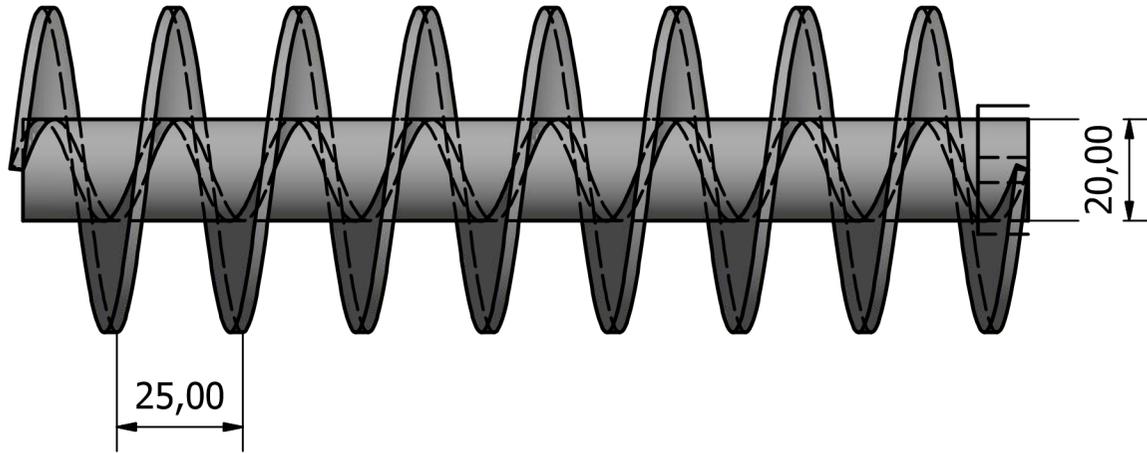
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Appendices

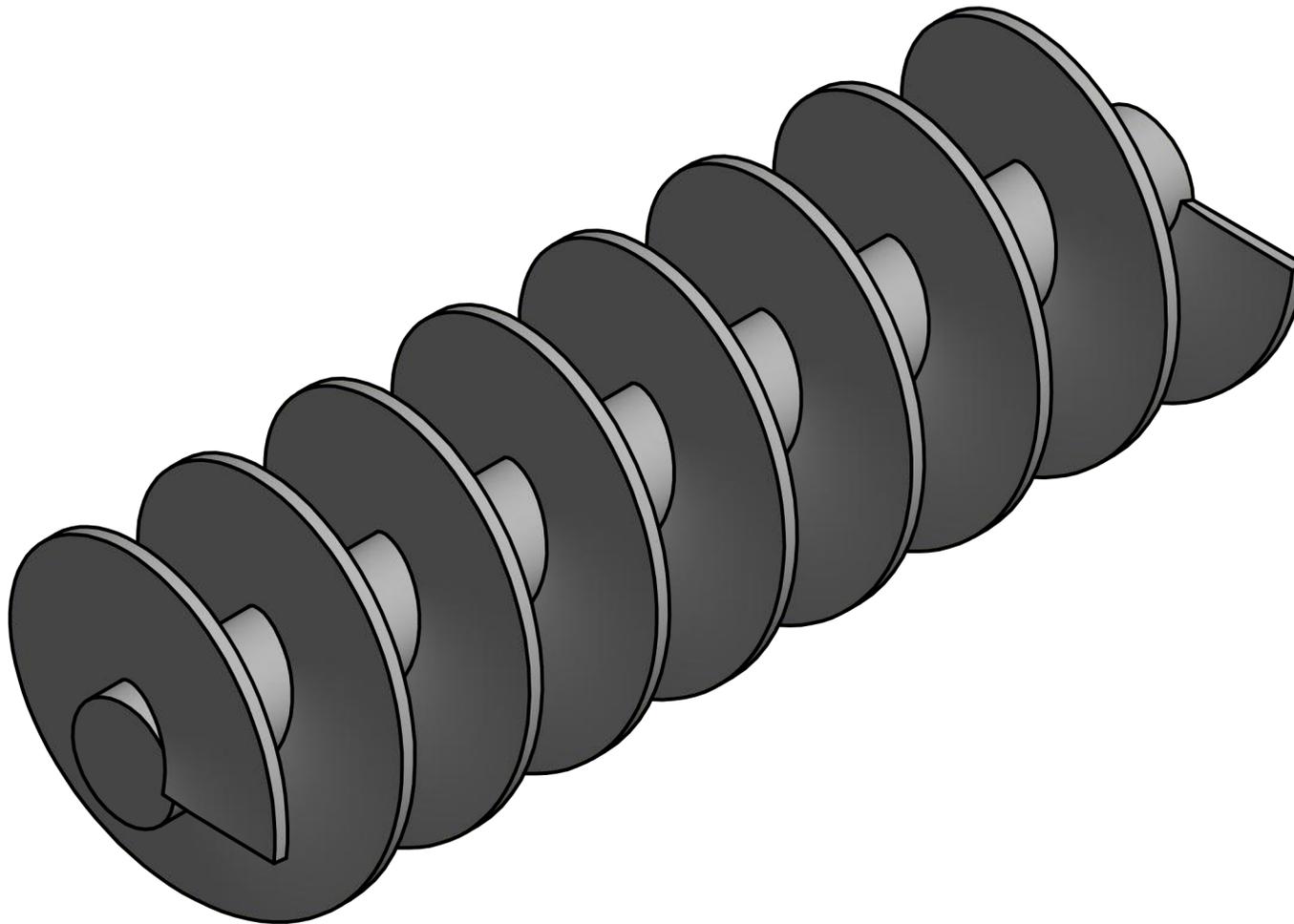




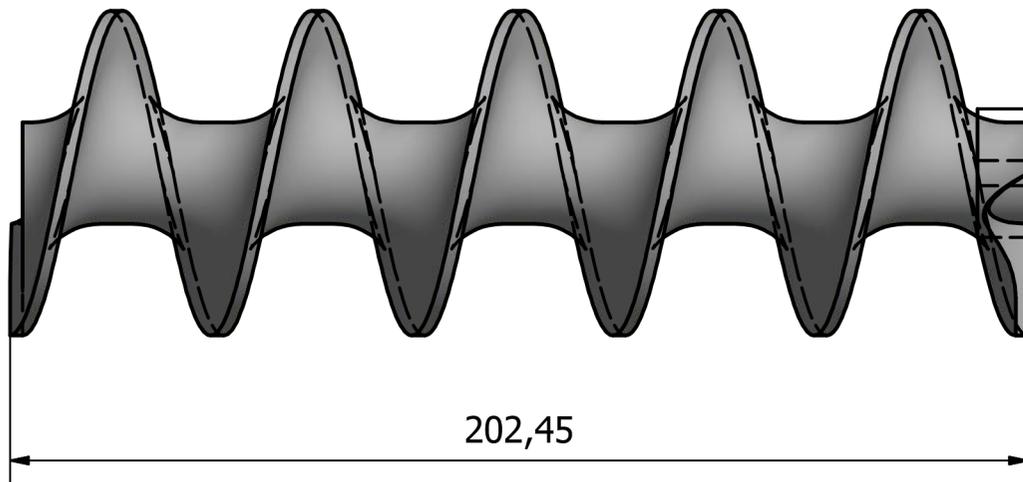
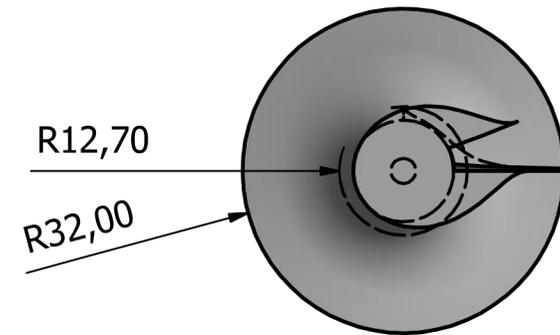
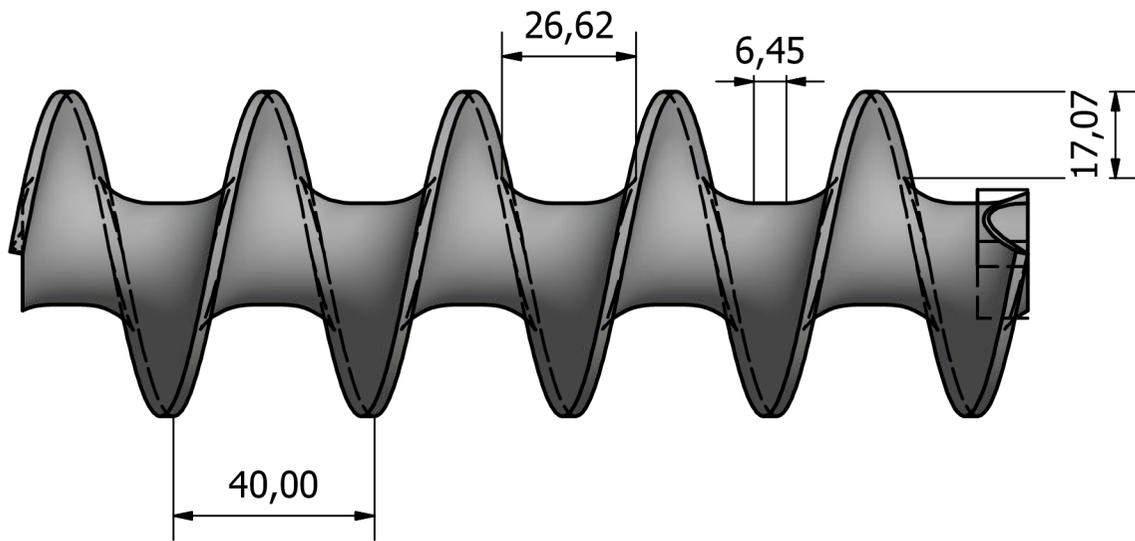
Designed by Nathan James	Date 6th June 2014
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Supermarket Bulk Bin Project Worm drive

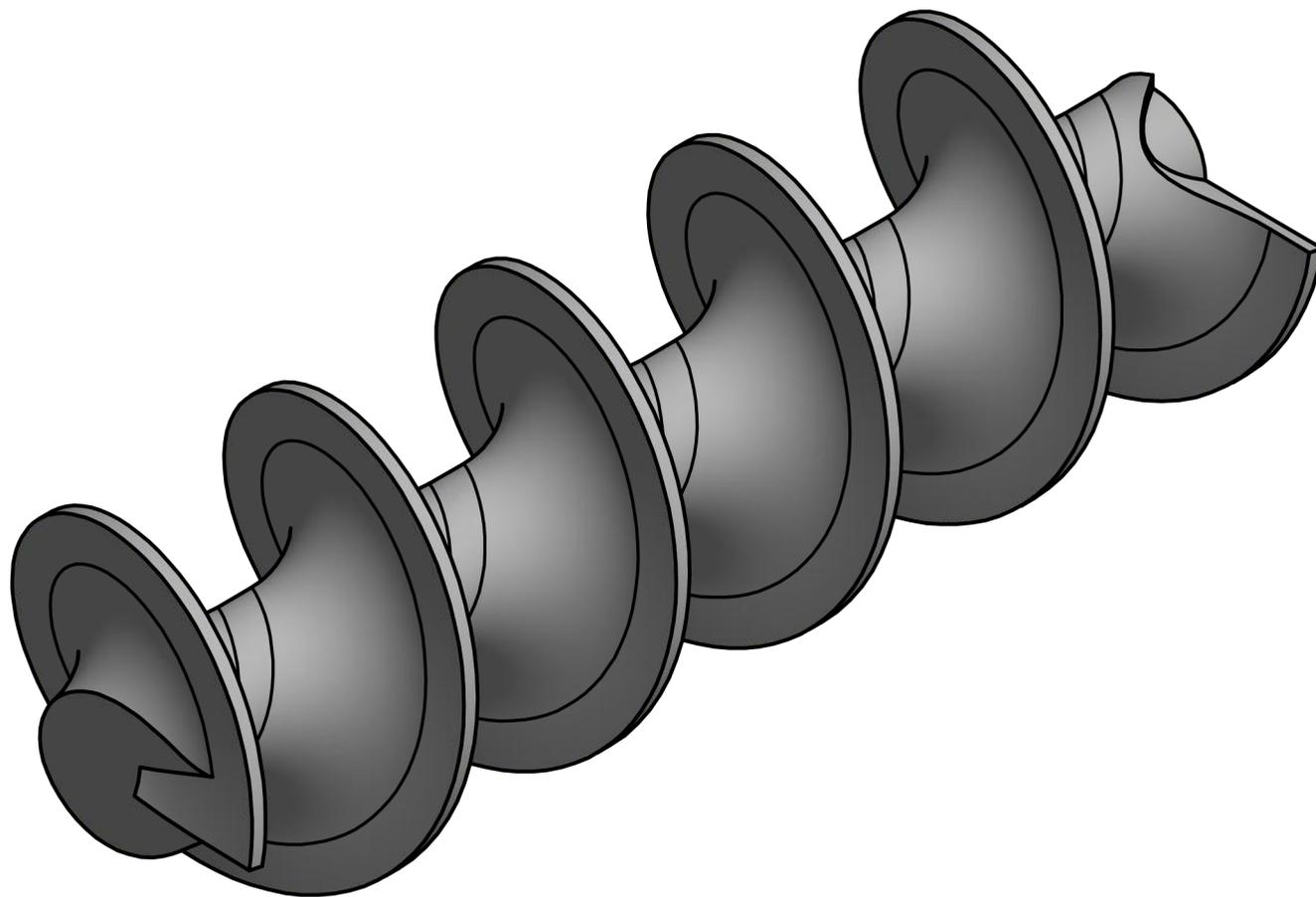
Burnside High School	Revision 1	Sheet 1/2
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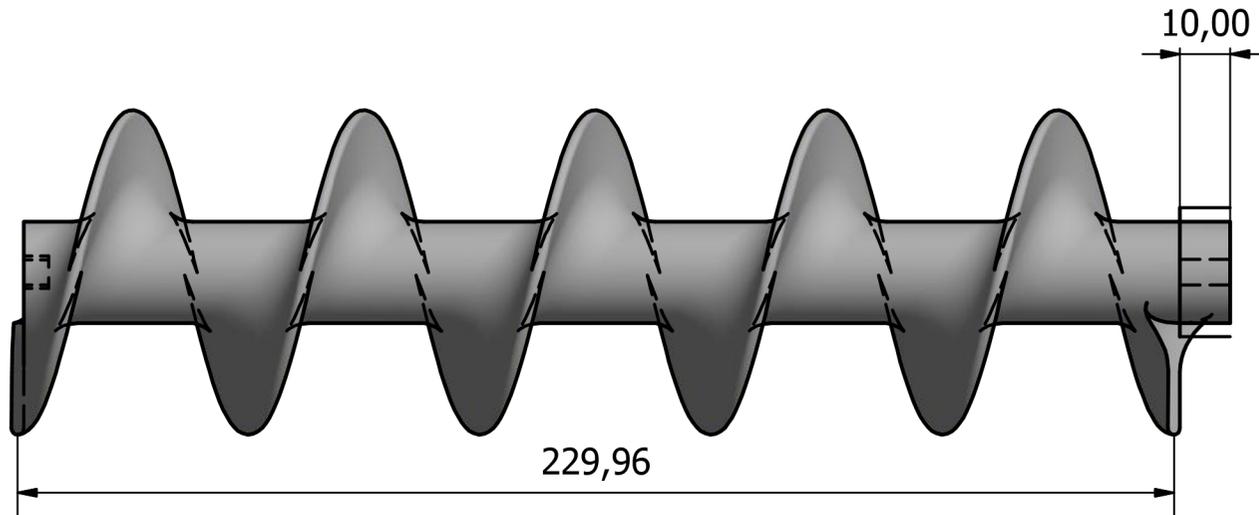
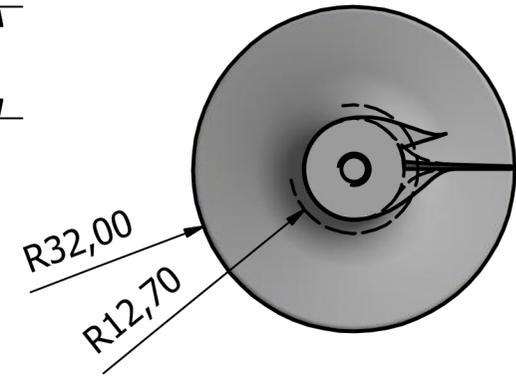
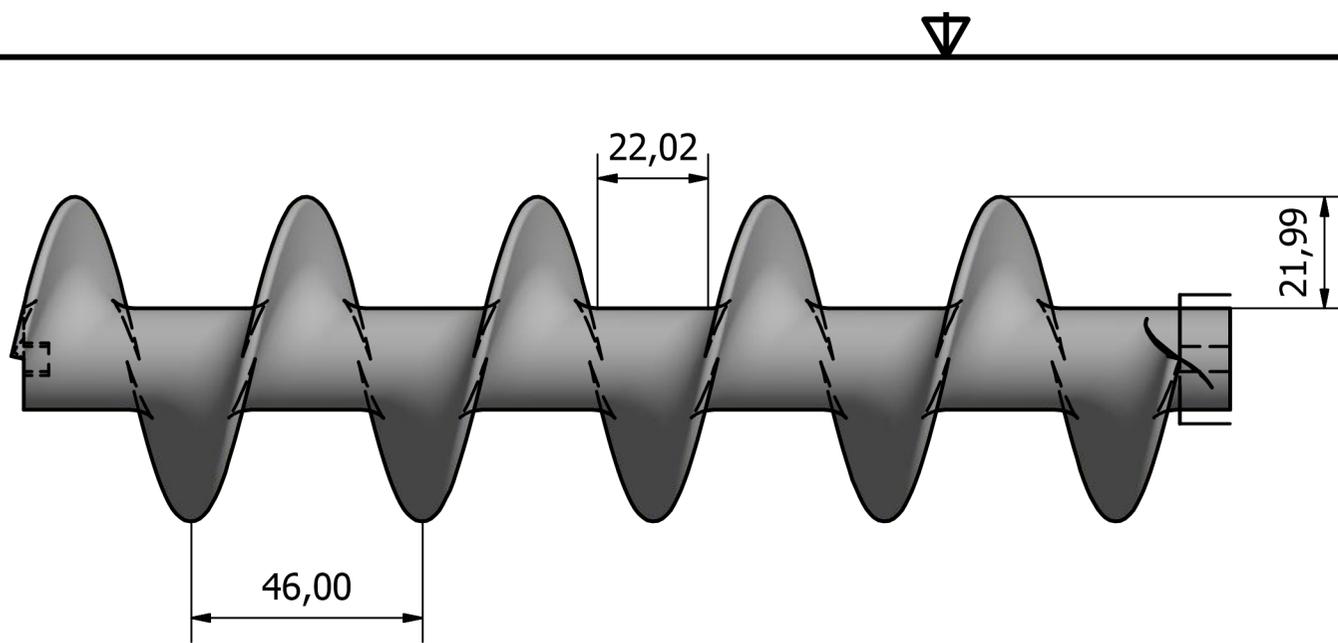
Designed by Nathan James	Date 6th June 2014	
Supermarket Bulk Bin Project Worm drive		
Burnside High School	Revision 1	Sheet 2/2



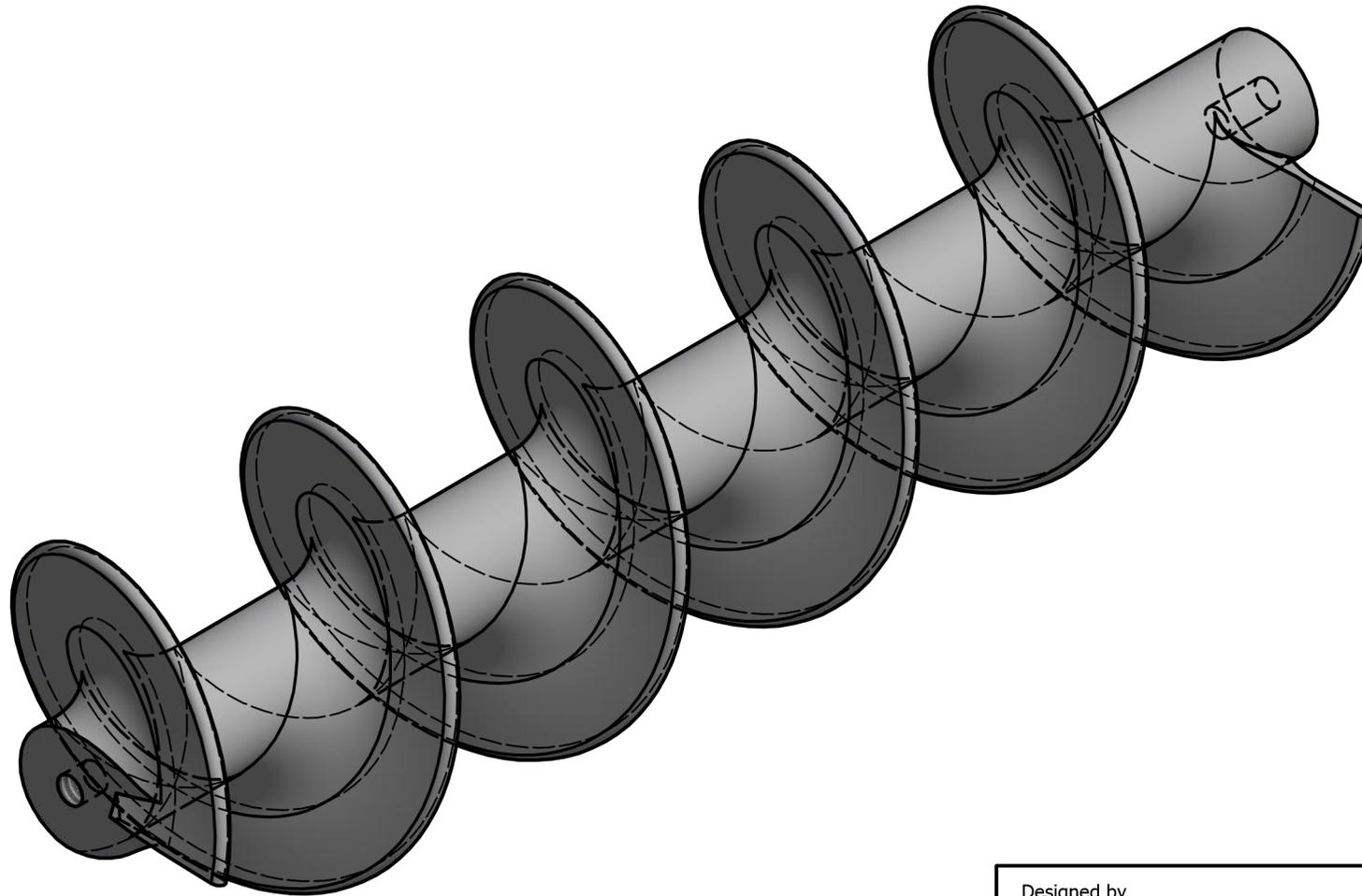
Designed by Nathan James	Date 7th June 2014
Supermarket Bulk Bin Project Worm drive	
Burnside High School	Revision 2
	Sheet 1/2



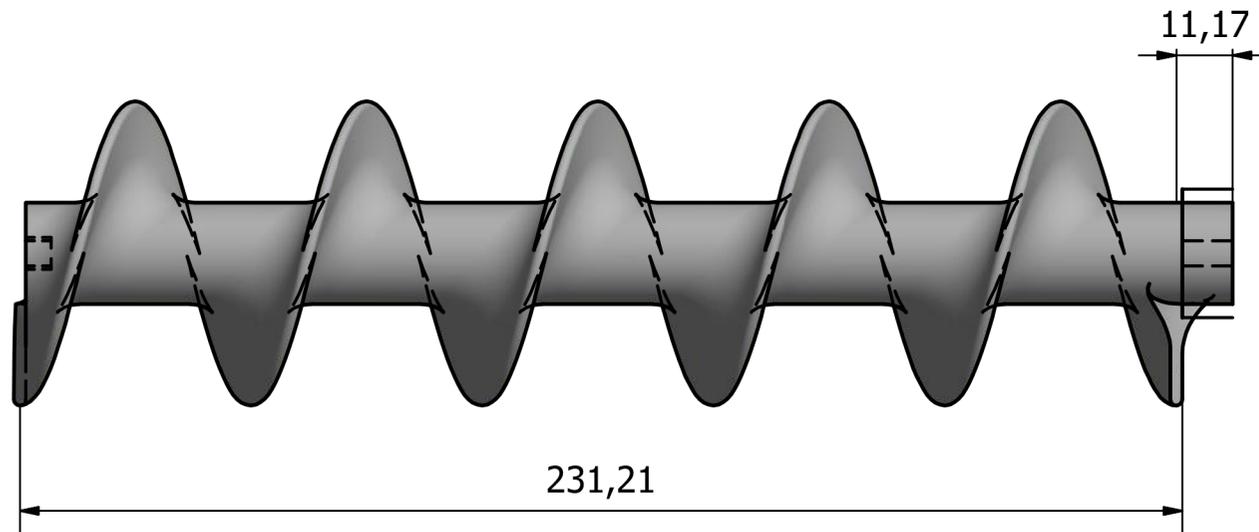
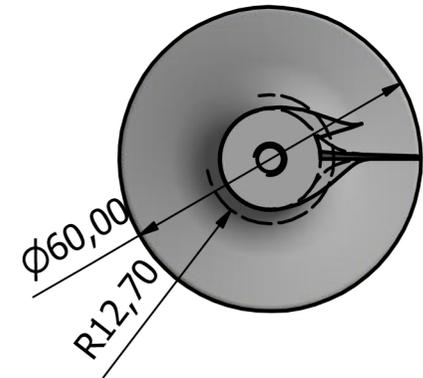
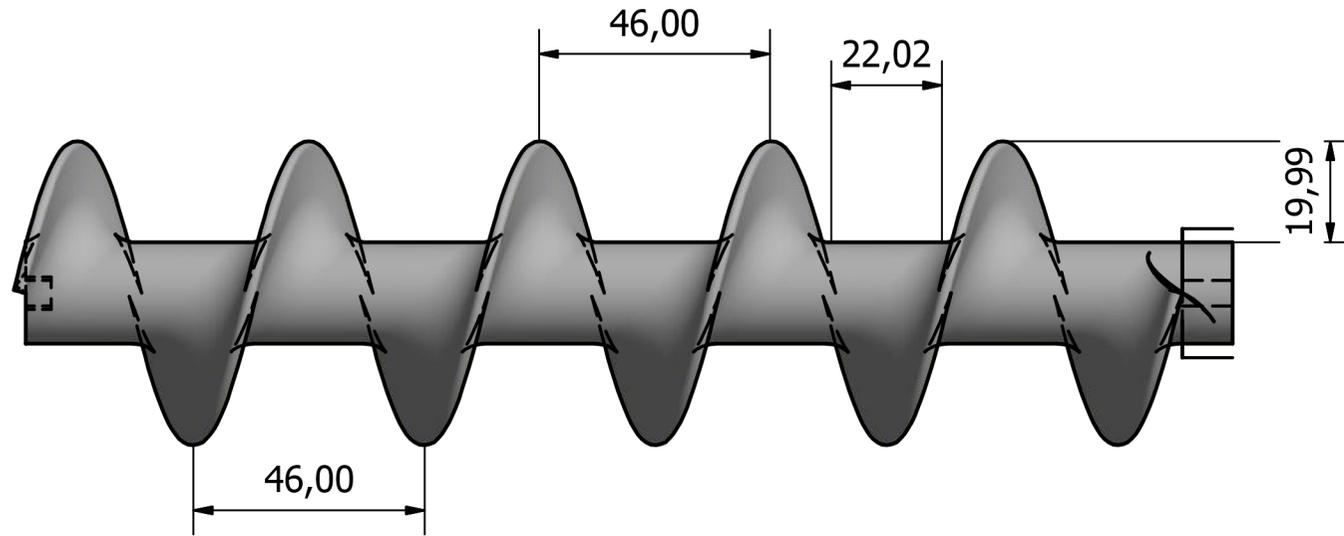
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Burnside High School	Revision 2	Sheet 2/2



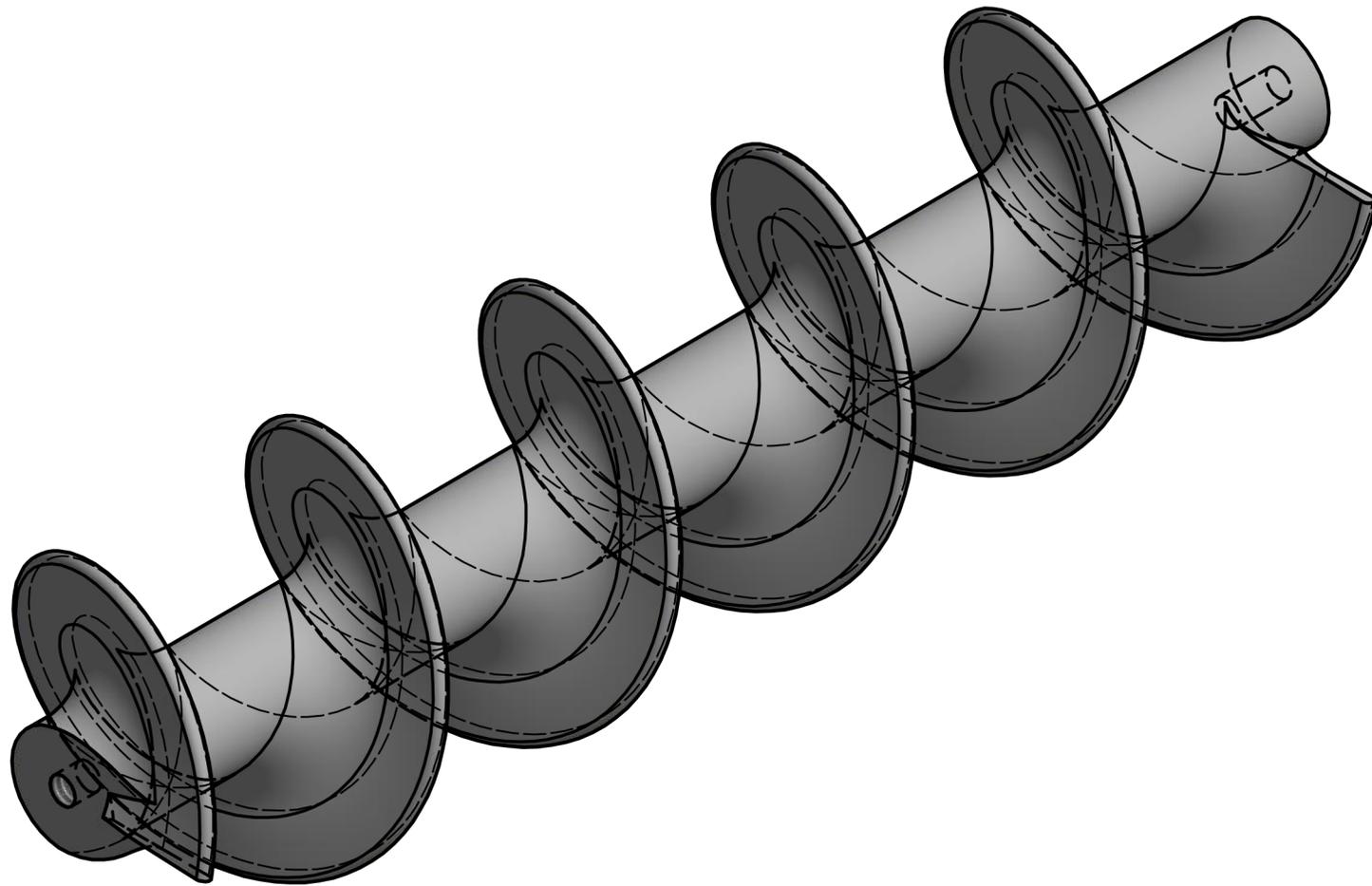
Designed by Nathan James	Date 16 June 2014
Supermarket Bulk Bin Project Worm drive	
Burnside High School	Revision 3
	Sheet 1/2



Designed by Nathan James	Date 16 June 2014	
Supermarket Bulk Bin Project Worm drive		
Burnside High School	Revision 3	Sheet 2/2

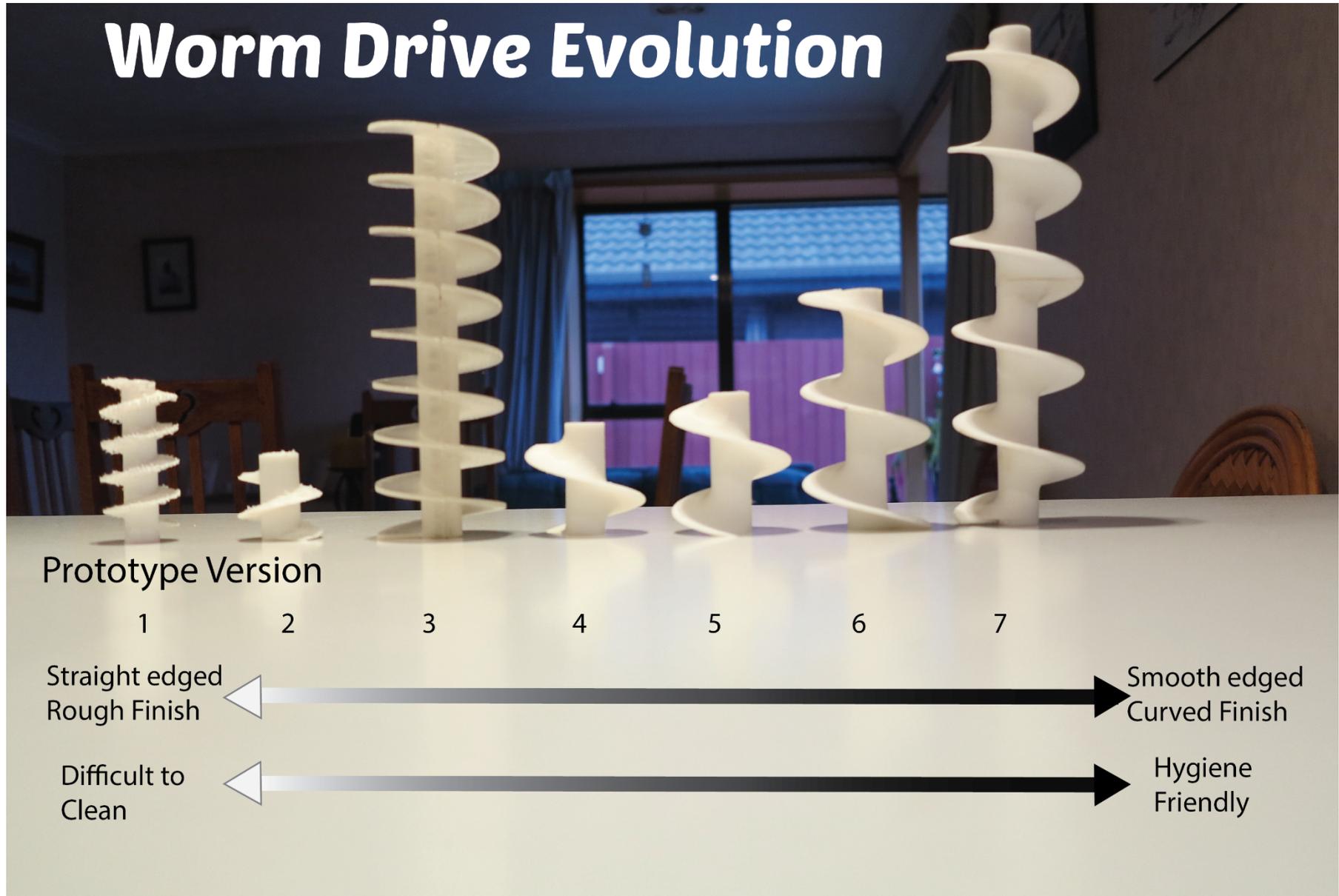


Designed by Nathan James	Date 04 August 2014
Supermarket Bulk Bin Project Worm drive	
Burnside High School	Revision 4
	Sheet 1/2



Designed by Nathan James	Date 04 August 2014	
Supermarket Bulk Bin Project Worm drive		
Burnside High School	Revision 4	Sheet 2/2

Worm Drive Evolution



Ages	Responses		Total
	Yes	No	
Under 30			0
31 - 49			0
50 - 65			0
66+			0
Total	0	0	0

Ages	Responses		Total
	Yes	No	
Under 30			0
31 - 49			0
50 - 65			0
66+			0
Total	0	0	0

**What could be improved in the bulk bin area of Supermarkets?
Is there anything you think could be done to encourage you to use this area?**

		Improvements										
<i>Question</i>		Layout	Range	Labelling	Freshness	Accessibility	Expense	Hygiene	Price	Ease of Use	Information	Weight
users	Non Usage		3				3	7	1		1	3
	Improvements	7	11	11	8	3	8	16	11	6	6	11
	Encouragement		2		1		0	4	2		1	1
	Total	7	16	11	9	3	11	27	14	6	8	15

Survey Results Summary 1



Survey Results Summary 2

```

#importing the libraries that I require
from __future__ import print_function
import pylcdlibv2
import Adafruit_ADS1x15
import easydriver
import curses
import sys
import RPi.GPIO as GPIO
from time import *

adc_sps = 200

#Setting the photointerrupter to GPIO pin 18
GPIO.setmode(GPIO.BCM)
GPIO.setup(18,GPIO.IN)

adc = Adafruit_ADS1x15.ADS1x15()

#setting the pins that the stepper motor is on
ed = easydriver.easydriver(23,.004,24)

#defining clockwise as being the true direction
cw = True

#defining the counterclockwise as being false
ccw = False

lcd1 = pylcdlibv2.lcd(0x27,1)
lcd1.lcd_write(0x01)
mv_g = 0.8406
price_100g = 0.8
adc.startContinuousConversion(0)
ed.set_direction(cw)
stopLoop = False
sampleSize= 5

#Will continually loop the iDispense unless a 0 is entered
#as a quantity
while stopLoop == False:

    #setting the weight string to being empty
    weightStr = ""

    #Making sure that the voltage coming through the scales is equal to 0
    #Printing the total weight in Volts on the screen
    totalv = 0.0
    for i in range(0,sampleSize):
        totalv = totalv + adc.getLastConversionResults()
    print(totalv)
    voltageStart = totalv/sampleSize

    #
    print(voltageStart)
    voltage = voltageStart
    weightDispensed = (voltageStart - voltage)/mv_g
    pulse = 0

    #Starts the keyboard entering code that allows
    #me to track what the customer is entering for
    #their desired weight
    stdscr = curses.initscr()
    stdscr.clear()
    stdscr.addstr(0,0,"Welcome to iDispense")
    stdscr.refresh()

    #Displaying the start up Screen on the LCD
    lcd1.lcd_puts("Welcome to",1)
    lcd1.lcd_puts("iDispense",2)
    sleep(5)

    #clears the LCD screen
    lcd1.lcd_clear()

```

```

#Entering a weight screen for the customer to
#enter their desired weight
stdscr.addstr(1,0,"Enter a weight")
stdscr.refresh()
lcd1.lcd_puts("Enter a weight",1)
weightStr = input('Enter a Weight:')

stdscr.move(2,0)
curses.cbreak()
curses.noecho()

entered = False
proceed = False
p = 0

#starts the loop running that will allow the wormdrive
#to start dispensing product
while proceed == False:

    #Starts the loop that will allow the customer to enter their
    #desired weight
    while entered == False:
        cr = stdscr.getch()
        c = curses.keyname(cr)

        #Decides whether the keystrokes entered are digits or not
        #If they are then ass themto the weight string
        if c >= '0' and c <= '9':
            weightStr = weightStr + c
            print(c, end='')
            sys.stdout.flush()

        else:
            #if the keystroke is a - then rotate the wormdrive
            #in a counter clockwise direction for 20 steps
            if c == '-':
                ed.set_direction(ccw)
                for i in range(0,20):
                    ed.step()
                ed.set_direction(cw)

            #if the keystroke is a + then rotate the wormdrive
            #in a clockwise direction for 20 steps
            if c == '+':
                ed.set_direction(cw)
                for i in range(0,20):
                    ed.step()

            #incrementing the times that the + or - so that the
            #weight string can be displayed on the screen
            if c=='-' or c=='+' :
                weightStr=" "
                pulse = pulse + 1

            #Setting the total weight to 0 and then getting the latest
            #update from the scales
            totalv = 0.0
            for i in range(0,sampleSize):
                totalv = totalv + adc.getLastConversionResults()
            voltage = totalv/sampleSize

            #Asks whether or not the + or - key has been pressed 5
            #times, if so then it will display the current weight
            #that has been dispensed
            if pulse == 5:
                weightDispensed = (voltageStart - voltage)/mv_g
                lcd1.lcd_clear()
                stdscr.addstr(3,0,"Weight %3.3f" % weightDispensed)
                lcd1.lcd_puts("Weight %3.3f" % weightDispensed,1)
                pulse = 0

            #Asks whether the key stroke was a /, if so then clear the weight
            #string and alternate between the 'Enter a Price' screen and the
            #'Enter a weight screen'
            if c == '/':
                weightStr = ""

```

```

        if p == 0:
            lcd1.lcd_clear()
            lcd1.lcd_puts("Enter a price ",1)
            p = 1
        else:
            lcd1.lcd_clear()
            lcd1.lcd_puts("Enter a weight",1)
            p = 0

#Asks if the enter key has been pressed or not, if so it
#terminates the 'entered' loop
if cr == 10:
    entered = True

#clears the weight string
if c == '*':
    weightStr=""

#Asks whether the backspace key has been pressed or not, so then
#remove the last character for the weight string
if cr == 127:
    weightStr = weightStr[:-1]
    stdscr.addstr(2,0,weightStr)
    stdscr.refresh()
    sys.stdout.flush()

#Changes the display screen if the number that is being entered is in $ or
#grams this is determined if the '/' key is pressed
if p == 1:
    weightDisp = float("0"+weightStr)/100
    lcd1.lcd_puts("%$3.2f          " % weightDisp,2)
else:
    lcd1.lcd_puts(weightStr+" grams          ",2)

#sets the weight screen to beign equal to 0 if the weight string is blank
if weightStr == "":
    weightStr = "0"

weight = int(weightStr)

#Determines the type of number that is being entered (float - decimal; int - integer)
if p == 1:
    price = int(weightStr)
    weight = (float(price))/price_100g

#Asks on the computer screen if this is the correct weight and price that the
#consumer is willing to pay
stdscr.addstr(2,0,"Weight %4.0f" % weight)
price = (float(weight)/100)*price_100g
lcd1.lcd_clear()
stdscr.addstr(" Price %4.2f - Ok?" % price)
stdscr.refresh()

#Asks on the customer input screen if this is the correct weight and price that the
#consumer is willing to pay
lcd1.lcd_puts("%4.0f grams" % weight,1)
lcd1.lcd_puts("Price %2.2f  Ok?" % price,2)

#starts the curses service once again
cr = stdscr.getch()
c = curses.keyname(cr)

#If the enter key has been pressed then proceed with dispensing
#this terminates the proceed loop
if cr == 10:
    proceed = True
else:
    #If the * key is pressed then don't proceed and clear the weight string
    if c == '*':
        weightStr = ""
        entered = False

#determines which screen the customer was entering their desired
#quantity into before
if p == 1:
    lcd1.lcd_clear()

```

```

        lcd1.lcd_puts("Enter a price",1)
    else:
        lcd1.lcd_clear()
        lcd1.lcd_puts("Enter a weight",1)

#This will stop the loop and exit back to the pi's main screen and stop the
#program from running any longer
if weight == 0:
    stopLoop = True

#Setting the total weight to 0 and then getting the latest
#update from the scales
totalv = 0.0
for i in range(0,sampleSize):
    totalv = totalv + adc.getLastConversionResults()
voltageStart = totalv/sampleSize

#Determines the target that the scales are trying to get to which is the amount that the
#customer desires
targetVoltage = voltageStart - weight*mv_g

voltage = voltageStart
count = 1
time = 0.1
pulseDispense = 0
targetWeight = targetVoltage/mv_g

lastIntrpt = 0
stallCount = 0
curses.echo()

#While the customers desired weight has not been dispensed loop
while voltage > targetVoltage:

    statusChange = False
    lastStatus = GPIO.input(18)

    #Start moving the worm drive in a clockwise direction allowing product
    #to be dispensed
    for i in range(0,20):
        ed.step()
        #Determines if the stepper detection wheel has changed since the
        #last 20 steps
        status = GPIO.input(18)
        if status != lastStatus:
            statusChange = True
            lastStatus = status
    sleep(time)
    count = count+1

    #If the status hasn't changed, increase the stall count by 1
    if statusChange == False:
        stallCount = stallCount + 1
    else:
        stallCount = 0

    #If the stall count has reached 5 then reverse the worm drive back 20 steps
    #and reset the stall count back to 0
    if stallCount > 4:
        stdscr.addstr(8,0,"Stall %i "% stallCount)
        ed.set_direction(ccw)
        for i in range(0,20):
            ed.step()
        sleep(time)
        ed.set_direction(cw)
        count = 1
        stallCount = 0

    #Setting the total weight to 0 and then getting the latest
    #update from the scales
    totalv = 0.0
    for i in range(0,sampleSize):
        totalv = totalv + adc.getLastConversionResults()
    voltage = totalv/sampleSize

    #Defining the values to be displayed

```

```

weightDispensed = (voltageStart - voltage)/mv_g
targetWeight = targetVoltage/mv_g
weightPercentage = (weightDispensed/weight)*100

#Printing the weight string to the computers screen
stdscr.addstr(4,0,"Voltage %3.3f " % voltage)
stdscr.addstr(5,0,"Weight %3.3f" % weightDispensed)
stdscr.addstr(6,0,"Percentage %3.0f" % weightPercentage)

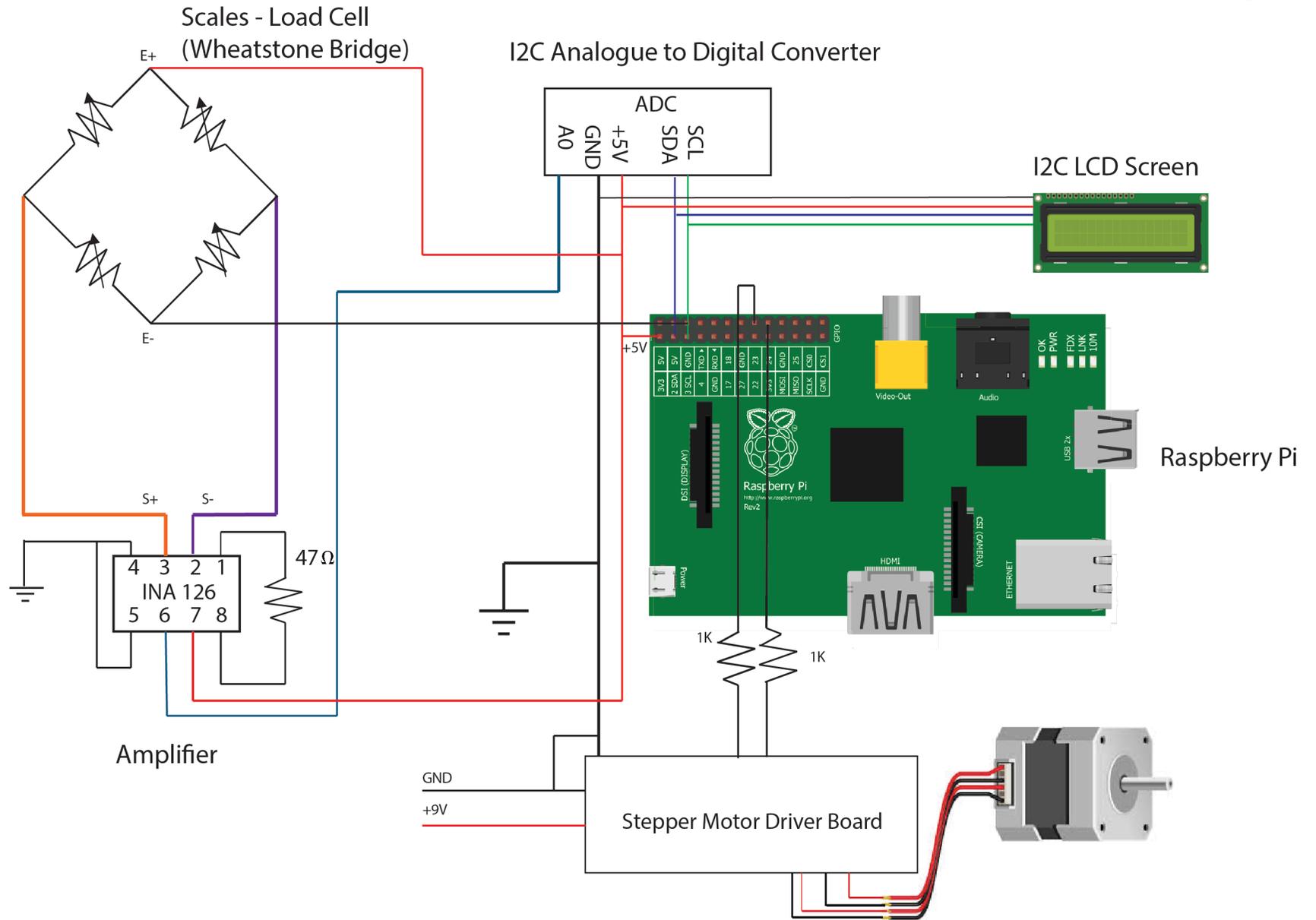
stdscr.refresh()

pulseDispense = pulseDispense + 1
#Updates the screen every 5 readings taken from the scales
#Lets the LCD screen refresh itself
if pulseDispense % 5 == 1:
    weightStr=""
    voltage = adc.getLastConversionResults()
    weightDispensed = (voltageStart - voltage)/mv_g
    lcd1.lcd_clear()
    lcd1.lcd_puts("Weight %3.3f" % weightDispensed,1)
    pulseDispense = 2

#Ends the Customers order displaying a confirmation screen with
#The weight being dispensed
lcd1.lcd_clear()
lcd1.lcd_puts("Weight %3.3f" % weightDispensed,1)
lcd1.lcd_puts("Complete",2)
sleep(5)
lcd1.lcd_clear()

#Ending the program
lcd1.lcd_clear()
ed.finish()
adc.stopContinuousConversion()
curses.endwin()
lcd1.lcd_clear()
lcd1.lcd_backlight(1)

```



Dispense Circuit Diagram

