Design and Development

Our device is split into 2 stations to optimize workflow: a manual filling station that undershoots the target weight, and an automated dispensing system for precise final adjustments. The first station is a standardized filling container. The automated dispensing system consists of four components as shown in Figure 1: the scale, the microprocessor, the motor drive, and the wax hopper. The client begins at the manual filling station, scooping wax into a standardized bin that undershoots the target weight by 0.5 – 1 lbs. Then, the client transfers the bag onto the scale at the automated dispensing system. The client presses a button to initiate processing and dispensing. The microprocessor reads the current weight from the scale, and enters a feedback loop that spins an auger within the hopper to dispense wax while monitoring weight. When the target weight is reached, the client understands that task is completed because motor stops and wax no longer falls through hopper.

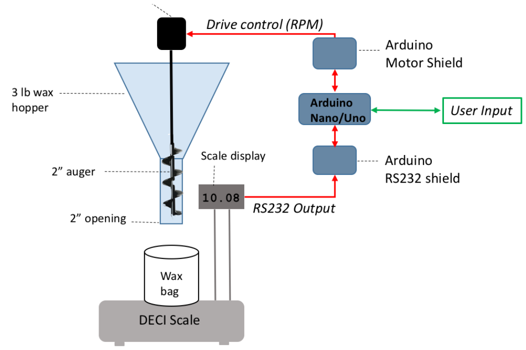

Figure 1 :Schematic of automated dispensing system.

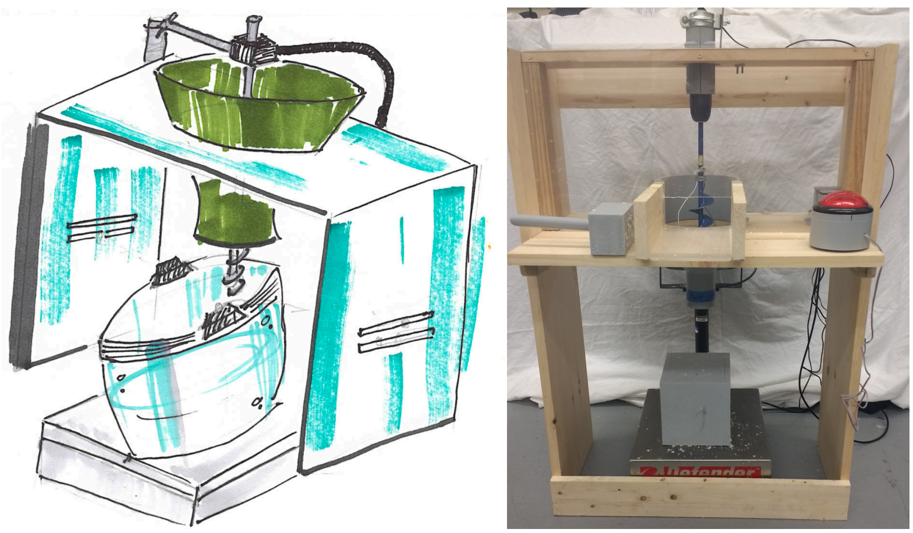

Figure 2. A conceptual drawing of the dispenser system (left). Final device (right).

I. Manual Filling Station

The first filling station preserves current procedure at DECI, with one added component. Clients place the empty bag into a standardized container of 9.25±0.25 lbs. Then, clients manually scoop wax to the top of the container, then transfer the bag to the scale. This purposely undershoots the target weight to avoid removing wax from the bag, but also leaves room for variability due to wax density. Thus, the automated dispensing system only serves as a precise top-off.

II. Automated Dispensing System

A. Scale and RS232 Output

To save cost, the automated dispensing system utilizes the scale currently used at DECI (Figure 2). It is an *Ohaus T31P*, precise to 0.02 lbs and capable of RS232 serial communication. The scale is configured to transmit its weight once per second. With these settings, the client simply places the bag on the scale and the weight is automatically sent to the microprocessor.

Figure 2:Ohaus T31P digital scale.

B. Arduino Microprocessor

The *Arduino Uno* is integral in interpreting the quantity of wax required to reach the precise target weight, and then driving a motor to dispense wax to that weight. The client initiates processing with a pushbutton, which then locks out the user until the task is complete. The *Uno* is equipped with a *LinkSprite RS232 Shield V2* that connects to the DB9 port of the scale. The *Uno* receives the scale's weight and calculates the difference between the current and target weights, dictating the speed at which wax dispensing will occur. An *Arduino Motor Shield* allows the Uno to drive a motor at high power. A continuous feedback loop ensures that the weight of the scale is checked while the motor is slowed as the target weight is approached. When the target weight is reached and stable, the motor is stopped and an LED is illuminated for the client.

C. DC Motor Drive and Auger Bit

A variable speed DC motor with external gearing is driven by the *Uno.* In turn, the motor spins an auger (Figure 3), which is a helical bit used to move material from one end to another.[6] The motor's external gearing allows it to churn through wax clumps without drawing too much power. A hex shank keyless chuck couples the motor shaft to the auger bit, but can be unscrewed by hand to remove the bit for cleaning. The motor drive and its housing are suspended above the wax hopper, secured with nuts and bolts that can be removed should maintenance be required.

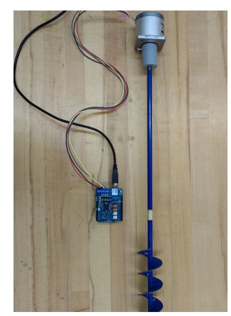

Figure 3: DC motor drive and auger.

D. Wax Hopper

The hopper-auger system is the basis of the dispensing system where wax input by the client will be transferred into the plastic bag. The hopper is a 3-D printed 6" diameter cone with a narrow pipe ending. The diameter of the auger is 2" and the narrow pipe of the hopper is also 2". This is to ensure that the ridges of the auger act as a barrier between the wax and the opening of the bag. The motor attached to the auger is controlled by the value of the weight coming from the scale. As the auger spins, wax is dispensed out of the last rung of the auger.

E. Wooden Case

The case is the main support for the hopper-auger. It is essentially a wooden table surrounding the scale with a circular opening for wax to fall into the hopper through. It is also equipped with a top shelf that will support the motor and the auger.

Figure 4. Sections in the case where the hopper will be attached and the motor suspended.

F. Pusher System

The pusher system was implemented for safety. Instead of attempting to pour over the hopper with an exposed auger, the client will push the wax with a 3-d printed block through an acrylic-lined runway. A plexi-glass shield forms a barrier between the auger and the runway except for a rectangular hole just large enough to slide the wax directly into the hopper. The runway is guarded in the back by a cylindrical wall that surrounds the auger protecting both wax from flying out the back and hands from reaching in through the back.

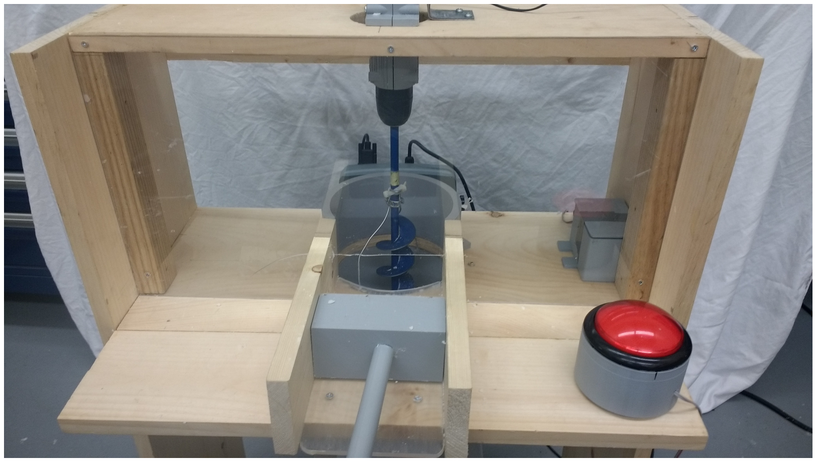

Figure 5. Close-up of the pusher system.

G. Casing for Arduino

To seal off all the electronic elements from the external environment, an Arduino case was designed to hold the Arduino and the two shields that control the motor and RS232 connection to the scale. Holes were created for all the ports in the boards. The box will be mounted on the shelf of the hopper as well.

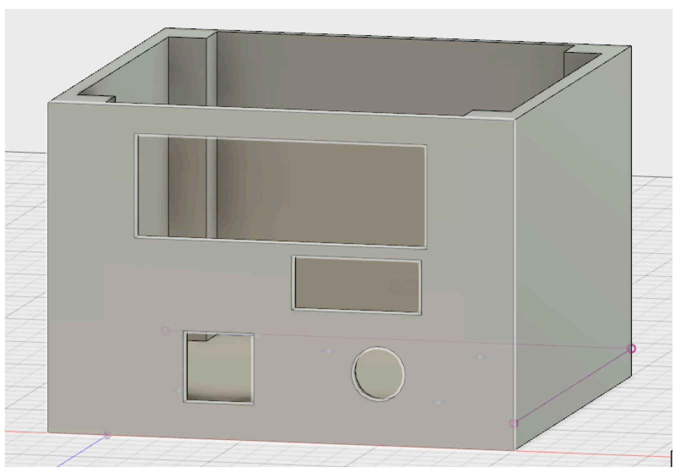

Figure 6. CAD file for the Arduino box.

III. Summary

Together, these components produce a device that meets design constraints and criteria. It fits into the current workspace at DECI and is comprised of durable materials that are resistant to wax buildup. The end device streamlines process workflow and is simple to use. It allows the clients to perform their job more independently by interpreting the exact quantity of wax required to reach the target weight, and dispenses wax to that amount.