

# **Engineering Requirements Document (ERD)**

## **Autonomous Coffee Machine**

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# **1. Introduction**

## **1.1 Scope**

The Autonomous Coffee Machine makes brewing coffee hassle free and hands free. The machine is Wi-Fi enabled, and should be able to be controlled anywhere the user has a network connection and the machine has a network connection. The machine is autonomous in the sense that it is completely hands free with the exception that the filters need to be cleaned out manually every few brews. With this machine the user will have full remote control of when and how they want their coffee brewed, eliminating the headache of setting up and waiting for your coffee.

## **1.2 Identification**

Scott's Autonomous Coffee Machine (SACM for short)

## **1.3 Project Overview**

The physical coffee machine will come from a cheap preexisting Mr. Coffee machine. The body will then be modified to have a carousel to spin filters for multiple brews. Hardware will be added to control the carousel, reservoirs, and additional sensing that will need to be done. Then a raspberry pi will host a website as the user interface and will also be the host for controlling all the hardware on the machine.

## **1.4 Limitations**

Requires Wi-Fi network connection on both Client and Server. The size of machine must be compact, and this is going to be hard to accomplish due to the addition of a three-filter carousel.

## **1.5 User Characteristics**

This product should be easy enough for any and all users to be able to control. The only requirement is to know how to access a webpage with a web browser, and how to clean coffee filters occasionally. Installation and setup might be a little more involved, but I am not worrying about that at this time.

## **1.6 General Constraints**

The machine is going to be very expensive to produce. The size of machine must be compact, and this is going to be hard to accomplish due to the addition of a three-filter carousel.

## **1.7 Assumptions and Dependencies**

The raspberry pi is going to be able to simultaneously host a webpage for the user interface and database, as well as control the coffee machine.

# **2. Product Requirements**

## **2.1 Features and Functions**

- Wi-Fi Enabled for remote control
- Multi-Cup Brewing as a user option
- Brew strength as a user option
- Allows multiple brews to occur before needing to be cleaned
- Senses and prevents brewing when filters are dirty
- Keeps coffee warm for the perfect amount of time.
- Database to store use information

## **2.2 User Interface**

The user interface will be a webpage, with a designated page to start brews, and a designated page to view database contents. The brew page will have a beautiful HTML form for the user to select parameters and start brews.

## **2.3 External Interface Requirements**

There are no external interface requirements as of right now.

## **2.4 Installation Requirements**

There will be setup and installation requirements, but until I finish the design I wont be able to list all of them.

## **2.5 Design Constraints**

Design constraints are already listed in the above constraints.

## **2.6 Test Requirements**

Testing of the final product is documented in the Test Plan Document. All tests required in the Test Plan are to be performed before the release of the product.

## **2.7 Packaging**

The final product would need to be packaged with instructions and everything pre-configured to make the users life easy. However this machine will probably never be shipped so I shouldn't have to worry about that.

## **2.8 Environmental Requirements**

The plastic I use to fabricate my parts must be able to withstand heat and not cause health hazards if consumed. 3D printers are the cheapest way to fabricate parts but I would have to use ABS plastic as opposed to PLA plastic, to be able to withstand the necessary heat to brew coffee. However, I would be much better off with a metal like aluminum because ABS can leach toxins that can cause health problems.

## **2.9 Power Supply Requirements**

The machine is going to use 120V AC power from the wall. I might need to step down to 12V DC with a transformer to power the solenoid valves and then use voltage regulators to power the microcontroller and stepper motor.

## **3. References, Standards, and Procedures**

These are some of the websites I have read from to learn about fabricating and 3D printing:

<https://www.3dhubs.com>

[https://en.wikipedia.org/wiki/Acrylonitrile\\_butadiene\\_styrene](https://en.wikipedia.org/wiki/Acrylonitrile_butadiene_styrene)

<http://filamentguide.net/>

## 4. Glossary

Glass Transition Temperature – The reversible transition in amorphous materials from a hard and relatively brittle state into a viscous or rubbery state as the temperature is increased.

Polylactic Acid – PLA is a biodegradable thermoplastic derived from renewable resources such as cornstarch or sugarcane. It is one of the most popular bioplastics.

Acrylonitrile Butadiene Styrene – ABS is a common thermoplastic well known in the injection molding industry.

## 5. Notes

1	PLA glass transition temperature = 140-150 degrees Fahrenheit
2	PLA glass transition temperature = 220 degrees Fahrenheit
3	Coffee brewing temperature = 195-205 degrees Fahrenheit (closer to 205 the better)
4	

## 6. Estimate Project Costs

<b>Purchase Invoice</b>		
<b>Component</b>	<b>Description</b>	<b>Cost</b>
Raspberry Pi 3	Microcontroller that controls coffee machine and hosts website with the user interface	\$34.72
Micro SD Card	Hard Drive for the controller	\$10.00
Mainstays 12-Cup Coffee Maker	Base Machine with functional components	\$10.84
E-flite 5mm Prop Adapter	Prop Adapter to Connect the stepper motors shaft to something threaded	\$3.21
Nema 17 Bipolar Stepper Motor (84 oz.in)	Stepper motor to precisely spin the carousel	\$13.99
(2) Reusable Coffee Filters	Reusable coffee filters to hold the grounds and sit in the carousel	\$8.00
6MM x 130MM all thread rod	My way of extending the motor shaft to connect to the carousel.	\$2.19
(2) 6MM Coupling nut	How I am connecting the all thread rod to the prop adaptor on the motor	\$1.98
6MM Wing nut	The wing nut is acting as the lower nut holding the carousel to the all thread shaft.	\$1.73
6MM Acorn cap nut	The upper nut holding securing the carousel to the all thread	\$1.67
	<b>Total Price</b>	> \$60

## 7. Appendixes