Certus Engineering

October 19th, 2015

Dr. Andrew Rawicz

School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S5

Re: Functional Specification for Arca by Certus Engineering

Dear Dr. Rawicz,

Enclosed is the Functional Specification for our Automated ID Scanner named Arca. Our proposed design is aimed to be used for Identity verification and attendance tracking.

This Functional Specification is intended to give you an overview of our design. This document includes cost considerations, project schedule, and the technical aspects of our product. This document discusses the utilization of the design as well as forecasting perspective challenges we might face in the process of designing this product.

Our company consists of four engineering science students with backgrounds in software/hardware, electronics, real time embedded systems and mechanical design bringing their knowledge together to create Certus Engineering. We also have one consultant and two additional members with a background in business, graphic design and media relations.

Should you require any additional information regarding our product, please do not hesitate to contact via phone at (604)349-8182 or via email at ffa8@sfu.ca or farshad@certusengineering.com.

Sincerely,

Farshad Farshadi

Chief Executive Officer

Enclosure: Functional Specification for an Automated ID Scanner, the Certus Engineering.

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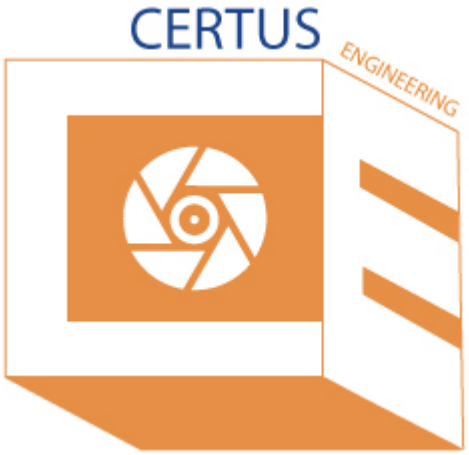
Certus Engineering



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Executive Summary

Most students at SFU or any other institution have experienced inefficient and lengthy process of taking attendance and distribution of parts required for lab. While many students accepted this bothersome situation as part of being a student along with their lengthy school projects, Certus engineers saw an opportunity.

Arca, an electronic authentication device, is an innovative, inexpensive and reliable solution to lengthy and boring process of taking attendance and part distribution that takes place many times in educational institutions. Arca is a multi-purpose identification device and provides its customers, freedom to choose one or combination of identification methods such as RFID, barcode, picture ID and ID number cards. It is currently in development phase by Certus Engineering and will be release in first quarter of 2016.

Arca can be easily adopted by other organizations such as libraries, community centres and pools and can be expended to use new technologies as they become available in the future.

Certus engineers are focused on delivering a high quality and reliable device along with an affordable price to serve the community.

Certus Engineering's core aim is to improve the efficiency and accuracy in the authentication process for organizations in a cost efficient way. Our tools not only provide a better means of verifying personnel documents but also capture and generate attendance information for data analysis.

This Functional Specification lays the foundation for our future documents and proposes a solution to this problem.

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List of Acronyms

ABS Acrylonitrile Butadiene Styrene

ANSI American National Standards Institute

ASCII American Standard Code for Information Interchange

CDF Cumulative Distribution Function

CMS Content Management System

CMOS Complementary Metal Oxide Semiconductor

CSA Canadian Standards Association

CPU Central Processing Unit

ENSC Engineering Science

GUI Graphical User Interface

ID Identification

ISO International Organization for Standardization

kHz Kilohertz

LED Light Emitting Diodes

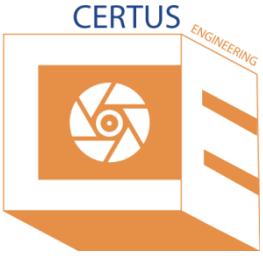
MHz Megahertz

OCR Optical Character Recognition

PC Personal Computer

PDF Probability Density Function

PHP Personal Home Page / Hypertext Preprocessor



RFID Radio Frequency Identification

SFU Simon Fraser University

SQL Structured Query Language

UI User Interface

UID User Identification

USB Universal Serial Bus

1. Introduction

Arca is an enclosed system, designed by Certus Engineering, used for personnel verification and attendance tracking for financial and educational institutions. Our goal is to improve accuracy in the authentication process for business enterprises in a cost effective way without compromising on efficiency. This device will read and authenticate a barcode, an identification number, and the RFID value. Depending on the user's specifications, the device can be set to read any combination of those three features.

1.1 Scope:

This document is designed to outline a detailed functional specification by Certus Engineering for the product, Arca. This will include specifications on software, electronic components, mechanical design, and any other design tools and parameters used to successfully manufacture this product.

1.2 Intended User:

The intended user of this product will range from students/professors/lab technicians at educational institutions to industry professionals operating a business enterprise. The target demographic will be young adults in the age group 18-25 and adults in the 35-50 age group. The first group will be defined as students and the latter would be the professors/business officials. This attendance tracking could potentially be used in elementary/secondary schools and therefore children and teens would also operate this device but are advised to do so with adult supervision.

1.3 Classification:

The classification of the specification will adhere to the following notation:

[Req A.B.C – XX]

Req is short for Requirement. The letters *A.B.C* are all numerical and *XX* will be letters. *A* will be the section head or requirement group. *B* denotes the sub-group within the requirement. *C* denotes an additional sub-group. *XX* will represent the priority in the following way:

PC – Proof of Concept: Requirements for the proof of concept system
PT – Prototype: Requirements for the prototype build of the product
FD – Final Design: Requirements for the final market ready product

2. System Overview

This device will read a barcode, an identification number, and the RFID value. Depending on the user's specifications, the device can be set to read any of those three features. This system has four main stages: Detection, Authentication, Distribution, and Collection.

Detection is where the user is given an ID card with an RFID tag embedded and the user would tap it against the RFID reader. In this section, the card is read properly the UID is pending authentication.When detection is being processed, the card is read and the UID pends authentication.

Authentication is where the UID and the ID numbers are cross referenced in the database and the system determines if the person's credentials are legitimate.

Distribution only occurs if the task is to dispense any parts/components/equipment. After the credentials have been verified, the user is permitted any equipment.

Collection is the last stage, and this is where all the data amassed is saved. This allows the administrator to keep track of all participating members and allows the operator to further examine this data.

The following figure describes Arca's actions on a technical level.

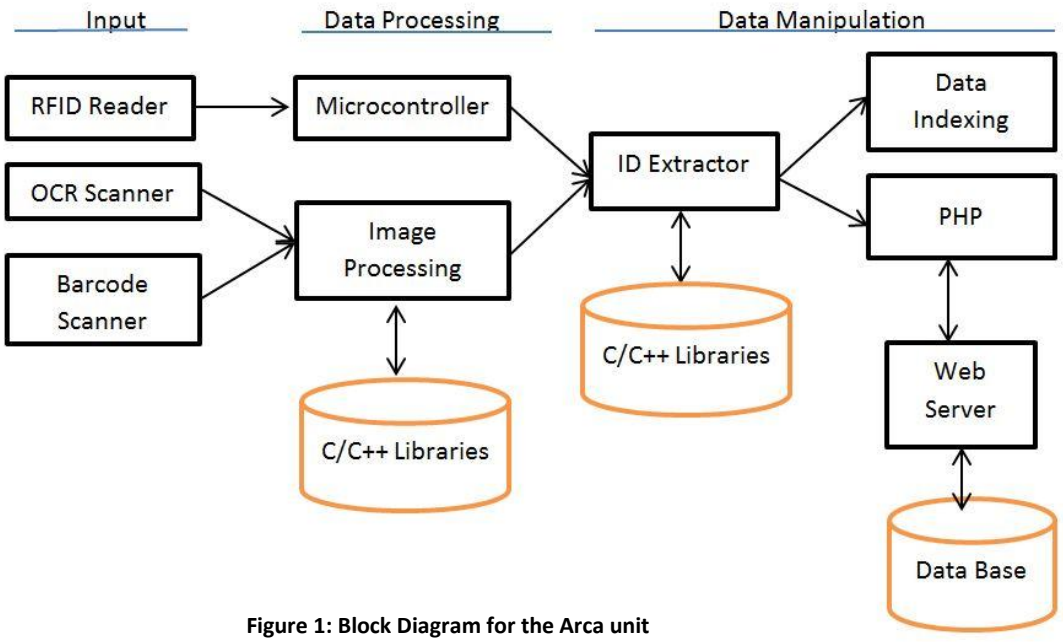


Figure 1: Block Diagram for the Arca unit

Extensive testing will be needed during this process and is broken down into three main sections:

Unit Testing:

Software/hardware test cases are planned and performed to ensure correctness of each module in the system. Test cases will check functionalityof each module in boundary conditions and validation of our functional requirements.

Integration Testing:

We will combine multiple unit tests to generate integration tests and observe how related components work together. As we add more components in later versions, these will be tested for proper integration. Integration tests are done after individual unit tests.

System Testing:

In this test phase, we focus on testing functionality of system as a whole. We will perform stress tests in this phase to ensure system can function properly under expected heavy use also to validate our functional and non-functional requirements.

3. System Requirements

Section 3 gives a detailed view into the specific requirements for this product. There are six main sections, each with various sub-sections to provide further requirements. General requirements provide an overview of the unit. Operations and set-up requirements are meant to show the initial conditions to start up the system.

3.1 General Requirements

[Req 3.1.0.1 – FD]	System must use Open source projects if available to reduce cost and copyright issues
[Req 3.1.0.2 – FD]	Application should not access personal data or excess system resource unethically
[Req 3.1.0.3 – FD]	Personal data (ID, Pictures, etc.) must not be used for any reason except identification purposes and must not be shared or accessed by unauthorized people

[Req 3.1.0.4 – FD] Software system should be advertisement free

[Req 3.0.1.5 – FD] Retail price should not exceed $10

[Req 3.0.1.6 – FD] Product must be light and weigh less than 1 pounds (455 grams)

3.1.1 Operation Requirement

[Req 3.1.1.1 – PT] Minimum CPU requirement for operation must be dual core CPU with speed of 1.7 GHz to perform at an optimum level

[Req3.1.1.2 – PT] System will require minimum of 2 GB of RAM and 120 MB of storage to operate

[Req3.1.1.3 – PT] System must be able to archive data offline to prevent loss of data due to internet disconnection

[Req3.1.1.4 – PT] The RFID reader only operates at a band of 13.56 MHz therefore the tags must have the same frequency in order to be read

[Req3.1.1.5 – PT] The system constantly needs a power supply of 5 volts via a USB connect

[Req3.1.1.6 – PT] A clear visual of the RFID reader position will be required (the desired place for ID to be swiped)

[Req3.1.1.7 – FD] System must provide a log history on recent logins and user activities for security purposes

[Req3.1.1.8 – FD] A differential backup will be in place in order to backup and preserve data, saving only the difference in the data since last backup.

[Req3.1.1.9 – FD] An incremental backup will be in place for disaster prevention. Backup will be collected a daily basis to an external location. The purpose of this backup is so if there is a physical damage to the server, the data can be restored

[Req3.1.1.10 – FD] Once the product is in production, Certus Engineering will have a technical support hotline and a technical ticket support system to assist user through any troubleshooting

3.1.2 Set-Up Requirement

[Req 3.1.2.1 – PT] Connect the USB to the computer and the device is ready for use (no installations necessary)

[Req 3.1.2.2 – FD] Depending on the type of application, instructions can be found in the user manual

[Req3.1.2.3 – FD] Setup must be achieved by running an executable application

[Req3.1.2.4 – FD] Set-up should not take more than 60seconds under ideal CPU conditions

3.1.3 Documentation Requirement

[Req 3.1.3.1 – PC] User manual & documentation will be released in French

[Req3.1.3.2 – PT] Application UI, manual, and other documents must be released in English

[Req3.1.3.3 – FD] A user manual must be created to assist anyone having difficulties with the product

[Req3.1.3.4 – FD] A website will be a part of the documentation to enhance user experience and to provide feedback on the product

[Req3.1.3.5 – FD] User manual should be easy to follow and should not include extensive technical contents

[Req3.1.3.6 – FD] Software portion of the system should be distributed on a CD-ROM (included in the package) and be available online for download by authorized users

3.2 Electrical Requirements

The section below summarizes the electrical requirements. The unit will require one USB cable to be connected to the PC where the data storing will occur.

[Req 3.2.0.1 – PT] The device should obtain its power via USB from the PC in which the data collection will take place

[Req 3.2.0.2 – PT] In order to store the data into the database, the PC in which the operation takes place must be connected to the internet at all time

[Req 3.2.0.3 – FD] Input devices must operate and powered using a USB connection

[Req 3.2.0.4 – FD] Microcontroller must operate using voltage level of 5.25 V and no less than 4.75 V (5 V ± 5%) between the positive and negative bus power lines (for USB 2.0) and 4.45–5.25 V (for USB 3.0)

[Req 3.2.0.5 – FD] The server which holds the database must be connected to the internet

3.3 Mechanical Requirement

In this section the mechanical requirements of the unit will be defined. We chose the ABS plastic because of its brittleness, thus making it easier to remould and reshape if necessary. This is what makes ABS a thermoplpastic and is outlined in the stress versus strain graph below. Unlike other plastics, ABS has a smaller strain hardening region yet offers higher tensile and yield strengths when compared to others.

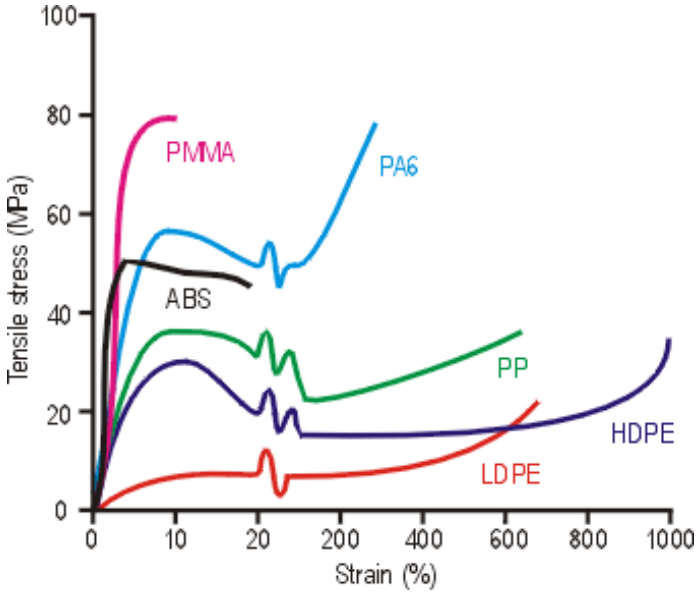


Figure 2: Stress vs Strain graphs of several popular plastics [6]

3.3.1 Mechanical Requirement

[Req 3.3.1.1 – PC] There will be two optical CMOS sensors and two lenses to capture images

[Req 3.3.1.2 – PC] All circuitry and wiring is integrated onto a single chip

[Req 3.3.1.3 – PT] Maximum size of the unit will be 200x100x70 mm (LxWxH)

[Req 3.3.1.4 – FD] The device is made of 3D printed ABS polymer plastic material

[Req 3.3.1.5 – FD] This housing will enclose all electrical components as a self-contained unit

[Req 3.3.1.6 – FD] The unit will have two image capturing cameras

[Req 3.3.1.7 – FD] One lens will capture the ID information;the other one will take a live picture of the user

3.3.2 User Interface Requirement

[Req 3.3.2.1 – PT] Time between user action & system feedback under normal CPU condition should not exceed more than 1 sec

[Req 3.3.2.2 – FD] User Interface must be easy to use by an amateur user UI user friendly/easy to use (learnability)

[Req 3.3.2.3 – FD] System must provide error/status message if user is waiting for an action more than 5 seconds

[Req 3.3.2.4 – FD] GUI must be easy-to-navigate and follow compliance standards under the platform which it's used

3.4 Software Requirement

This segment is devoted to the software requirements of the unit. The product must be compatible with different operating systems and on different machines. Any software created by Certus Engineering must run on various operating systems.

3.4.1 Software Requirement

[Req 3.4.1.1 – PC] Develop system for OSX & Linux

[Req 3.4.1.2 – PT] Software system must have only dependency on C++ libraries, Platform specific libraries, Python libraries, OpenCV, Tesseract)

[Req 3.4.1.3 – PT] Systems must not disrupt or disable accessibility features of software products or operating systems.

[Req 3.4.1.4 – PT] The unit should have the capability to store data in any text field,(separate requirement, needs identifier) however we will be storing the data in MySQL database.

The software should have capabilities to export the data into MS Excel via CMS

[Req 3.4.1.5 – PT] Application must be developed for Microsoft Windows platform

[Req 3.4.1.6 – PT] OCR software must be developed to read the SFU ID and its barcode values.

[Req 3.4.1.7 – PT] All software applications must be compatible with all Microsoft Windows operation systems later than Windows XP.

[Req 3.4.1.8 – FD] Application must not crash more than 10% of executions

[Req 3.4.1.9 – FD] User must be authenticated before using the system. Users will have different privileges depending on their clearance.

[Req 3.4.1.10 – FD] Software must automatically detect the appropriate serial port i.e. COM3, COM5, etc.

3.5 RFID

This section is dedicated to the RFID requirements of the unit. This is further dissected into three sub-sections: physical, electrical, and software. The frequency we are using is 13.56 megahertz since this frequency is very common in commercial/residential RFID locked door mechanism. The values read from the UID will be stored in a database via MySQL. There will also be a web-application which will assist the user with any distribution of components and allow the operator to view personnel records. For security reasons the latter must be password protected and stored on a secure server.

3.5.1 Physical &Environmental Requirement

[Req 3.5.1.1 – PT] The RFID should only get activated when the tag touches the box

[Req 3.5.1.2 – FD] Device must operate in humidity range of 5% to 45%

[Req 3.5.1.3 – FD] RFID reader and board containing microcontroller, each, should not exceed 55x80mm

3.5.2 Electrical Requirement

[Req 3.5.2.1 – PT] RFID tag used in card must operate with 13.56MHz clock

[Req 3.5.2.2 – FD] RFID reader must operate with regulated voltage level between 3.3 V and 5 V

3.5.3 Software Requirement

[Req 3.5.3.1 – PT] Inputs Data must be collected through RFID reader or Scanner

[Req 3.5.3.2 – PT] Output characters are stored using ASCII characters

[Req 3.5.3.3 – PT] System will archive data upon each new scan or RFID tap

[Req 3.5.3.4 – FD] Software must be designed to interact with Microcontroller and operating system on a desktop

[Req 3.5.3.5 – FD] Application must be designed to receive data from hardware. (Separate requirement)Once the data is received it will display results in any text field on the local machine

[Req 3.5.3.6 – FD] A script must be written to take values and copies them to the designated field in order to store the value in MySQL database.

[Req 3.5.3.7 – FD] A web based application along with the MySQL database must be residing on a server, in order to store the collected data

[Req 3.5.3.8 – FD] The Web based application (PHP) must have different functionalities such as attendance, part collections, exams and etc.

[Req 3.5.3.9 – FD] For educational institutions, the system will store the data on its local server

3.6 Reliability & Safety

This section is to outline any reliability and safety requirements. This is further divided into five sub-sections, with the main ones being standards, reliability, and responsibilities of an engineer. In order to make a reliable product, failure testing must be performed to ensure a safe and dependable unit. Load versus resistance will be analyzed to produce a unit that has less than 0.1 probability of failure. Reducing the purple shaded are in Figure3 is the key to creating a successful product with a very low probability of failure.

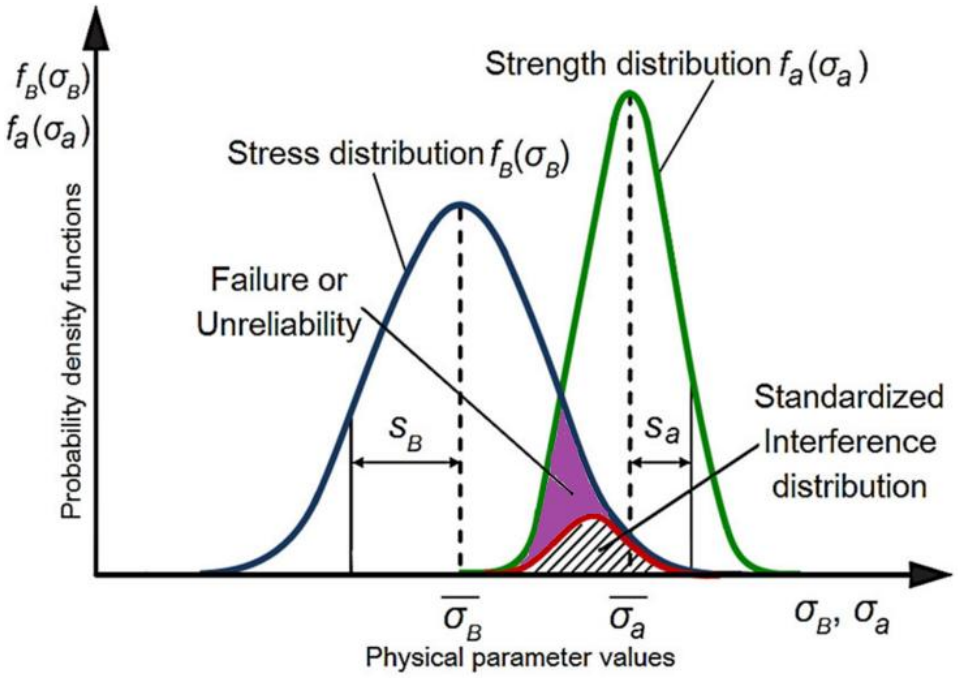


Figure 3: Graph of Stress & Strength outlining probability of failure [7]

3.6.1 Standards Requirement

[Req 3.6.1.1 – FD] The unit meets the ISO/IEC JTC1CO-RFID Ed. 1.0 standard for RFID applications [1]

[Req 3.6.1.2 – FD] The unit meets the ISO 2033:1983 standard for OCR information processing [2]

[Req 3.6.1.3 – FD] The ABS thermoplastic will comply with the following standard in terms of waste and recycling: ISO 7245:1984 [3]

[Req 3.6.1.4 – FD] The unit itself, including all electrical components, will adhere to the ISO/CSA/ANSI standards[4] [5]

3.6.2 Reliability &Sustainability Requirement

[Req 3.6.2.1 – PT] The unit must not overheat under continuous usage

[Req 3.6.2.2 – FD] Accelerated testing will be performed on physical, electrical and software aspects of the unit.

[Req 3.6.2.3 – FD] Redundancy will be designed into the system to minimize the rate of failure.

[Req 3.6.2.4 – FD] Loads (Stresses), capacities (Strengths) will be tested to minimize the failure probability.

[Req 3.6.2.5 – FD] Samples will be collected and CDF along with PDF will be calculated to ensure probability of failure to be less than 0.1 with 90% confidence.

[Req 3.6.2.6 – FD] The unit must be resistant to different physical forces such as dropping or getting hi t.

[Req 3.6.2.7 – FD] The device's performance should not degrade before end of its lifetime.

3.6.3 Environmental Requirement

[Req 3.6.3.1 – PT] The material used for 3D printing must be a thermoplastic polymer type

[Req 3.6.3.2 – PT] System is free of any lead contamination or any other toxic chemicals of that kind

[Req 3.6.3.3 – FD] The device should operate in a range of -20^{o} – 50^{o} Celsius

[Req 3.6.3.4 – FD] The device should not produce any audible sounds other than the feedback after scanning the ID card i.e. a "ding" for accepted and a "buzz" for a rejected card san

3.6.4 Safety Requirement

[Req 3.6.4.1 – PT] The device should not have sharp edges

[Req 3.6.4.2 – PT] The device should not collect excessive electrostatic charge that is harmful to humans and electronic circuits inside the device

[Req 3.6.4.3 – PT] There will be no current/voltage present in the electrical components when then USB cable is unplugged

[Req 3.6.4.4 – FD] All electrical devices/components are properly placed inside the housing unit

3.6.5 Responsibilities of an Engineer

[Req 3.6.5.1 – FD] Device must be designed and implemented in a modular fashion for easier and faster delivery and maintenance

[Req 3.6.5.2 – FD] A version control scheme should be used for different versions of software, hardware parts and documents

[Req 3.6.5.3 – FD] Engineers must ensure functionality of the system and each module using stress testing

4. Sustainability & Safety

We have tried to design the Arca to be reliable and safe for all users and the environment. We focused heavily on cradle to cradle design to minimize any negative impact our product may have on the ecosystem. Environmental sustainability is an issue everyone at Certus Engineering takes very seriously and that is reflected in our design of the product.

We have decided to use a 3D printer to house all our electrical and hardware components. This will provide an enclosure made of ABS that is durable and vastly customizable. The thermoplastic polymer material used by the printer will ensure a pliable unit. Unlike thermosetting polymers, thermoplastics can be easily remolded after printing and recycled to print other items. All of electrical components will be lead free thus making it easier for it to decompose in the ecosystem. This paired with the thermoplastic enclosure truly make our design environmentally friendly.

5. Conclusion

These functional specifications will serve as an outline for Certus Engineering's execution of the Arca product. This document was meant to simplify the larger more daunting tasks into smaller subsections ultimately making it easier to analyze and execute them. The next document, design specifications, will shed light on how these tasks will be completed.

6. References

[1] Scc.ca, '| Standards Council of Canada - Conseil canadien des normes', 2015. [Online]. Available: https://www.scc.ca/en/standardsdb/iec/11381. [Accessed: 15- Oct- 2015].

[2] Scc.ca, '| Standards Council of Canada - Conseil canadien des normes', 2015. [Online]. Available: https://www.scc.ca/en/standardsdb/iso/101935. [Accessed: 15- Oct- 2015].

[3] Scc.ca, '| Standards Council of Canada - Conseil canadien des normes', 2015. [Online]. Available: https://www.scc.ca/en/standardsdb/iso/105867. [Accessed: 15- Oct- 2015].

[4] Iso.org, 'ISO - ISO Standards - ISO/TC 22/SC 3 - Electrical and electronic equipment', 2015. [Online]. Available: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=46752. [Accessed: 15- Oct- 2015].

[5] Webstore.ansi.org, 'ISO 14001:2015 Environmental management systems - Requirements guidance use', 2015. [Online]. Available: http://webstore.ansi.org/RecordDetail.aspx?sku=ISO+14001%3a2015&source=homepage. [Accessed: 15- Oct- 2015].

[6] C. Loughnane, 2015. [Online]. Available: http://www.pdnotebook.com/2011/07/when-to-use-nonlinear-finite-element-analysis/, 2015. [Accessed: 16- Oct- 2015].

[7] E. Aziz and C. Chassapis, 'Probabilistic Simulation Approach to Evaluate the Tooth-Root Strength of Spur Gears with FEM-Based Verification', *Engineering*, vol. 03, no. 12, pp. 1137-1148, 2011. [Accessed: 16- Oct- 2015].