Exam Collector

DESIGN DOCUMENT

SDDEC22-04
Dr. Bigelow

Brandon Degeneffe- Hardware Team Lead
Nicholas Fahey- Software Team Lead
Maxim Hjelmstad- Software Testing
Connor Kazin- Hardware Testing / Components design
Dylan Kohlbeck- Client interaction and Hardware design
Camdyn Zook- Software Architect and Group secretary
sddec22-04@iastate.edu
sddec22-04.sd.ece.iastate.edu

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Executive Summary

Development Standards & Practices Used

- ISO/IEC/IEEE International Standard - Systems and software engineering--Requirements for managers of information for users of systems, software, and services.
- ISO/IEC/IEEE International Standard - Software engineering -- Guidelines for the application of ISO to computer software
- ISO/IEC/IEEE International Standard - Systems and software engineering -- Life cycle processes -- Risk management

Summary of Requirements

- Must heat paper to 70 degrees Celcius fully in order to fully sanitize the exams.
- Must have a contact free intake in order to limit the spread of disease.
- Must not set exams on fire or damage the contents on the paper

Applicable Courses from Iowa State University Curriculum

EE201 - was an introduction to circuit analysis. This class taught us fundamental circuit components and circuit analysis processes. These topics are necessary for us to construct our PCB and design the electrical circuits of the exam collector.

EE 230 - Electronic Circuits and Systems: Cont. of EE 201

EE 452 - Electrical Machine and Power Electronic Drives: We would use this class in a dc to ac and ac to dc.

CPRE 281 - Digital Logic: Assists in PCB design in how the layout and gates should be arranged in order to get the functionality we need at a base level

CPRE 288 - Embedded Systems I: Introduction: Taught the basics of using microcontrollers and setting up various GPIO ports, allowing us to use microcontrollers effectively in our project.

SE 339 - Software Architecture and Design. This class helped us with designing an architecture that covers all the expected deliverables.

SE 422X - Introduction to Cloud Computing. Our project uses a EpCE Ubuntu VM which acts as a cloud server so being able to use best cloud practices will be useful

COM S 228 - Introduction to Data Structures. Understanding object-oriented programming

COM S 311 - Introduction to the Design and Analysis of Algorithms. Extending off COM S 228 and helps us write better algorithms so that the Machine Learning algorithms can execute faster

COM S 319 - User Interfaces, Our project has 3 user interfaces that we can program

SE 309 - Software Development Practices. Learned Agile development practice and learned to code in a group.

New Skills/Knowledge acquired that was not taught in courses

AutoCAD, thermodynamics, construction, 3D printing.

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1 Team

1.1 Team Members

Brandon Degeneffe- a Senior in Electrical Engineering

Nicholas Fahey- a Senior in Computer Engineering

Maxim Hjelmstad- a Senior in Computer Engineering

Connor Kazin- a Senior in Electrical Engineering

Dylan Kohlbeck- a Senior in Electrical Engineering

Camdyn Zook - a Senior in Software Engineering

1.2 Required Skill Sets for Your Project

Coding (Image processing), Wiring, Thermodynamics, 3D modeling, Assembly

1.3 Skill Sets covered by the Team

Coding: Nicholas, Camdyn, Maxim

Wiring/Electrical: Dylan Kohlbeck, Connor, Brandon

Thermodynamics: Camdyn, Connor

3D modeling: Connor

Building/Assembly: Brandon, Dylan

1.4 Project Management Style Adopted by the team

Agile/Scrum style - Breaking down the project into smaller milestones while having weekly scrum-like meetings and updates with the team.

1.5 Initial Project Management Roles

Brandon Degeneffe- Hardware Team Lead
Nicholas Fahey- Software Team Lead
Maxim Hjelmstad- Software Testing
Connor Kazin- Hardware Testing / Components design
Dylan Kohlbeck- Client interaction and Hardware design
Camdyn Zook- Software Architect and Group secretary

2 Introduction

2.1 Problem Statement

The return to in-person classes and exams also brings with it the potential for disease transmission between students, TAs, and instructors. One possible means of transmission is through physical homework and exam submissions, as pathogens can remain on paper for days. Our project seeks to solve this problem by means of a hands-free sanitation device.

2.2 Requirements & Constraints

- Must heat paper to 70 degrees Celcius fully in order to fully sanitize the exams.
- Must have a contact free intake in order to limit the spread of disease.
- Must not set exams on fire or damage the contents on the paper (constraint)
- Materials should be cost effective (constraint)
- Should have some way to record when a student submits an exam, as a backup of those present for the exam
- Have a way to adjust temperature inside chamber (should be made such that it can not reach a point that would damage the paper)
- Should strive to be energy efficient with heating elements

2.3 Engineering Standards

- ISO/IEC/IEEE International Standard - Systems and software engineering--Requirements for managers of information for users of systems, software, and services.
    - This standard specifies requirements and procedures for managing information for users using the software. This relates to our group since we must collect the names and student IDs of each student who turns in a test.
- ISO/IEC/IEEE International Standard - Software engineering -- Guidelines for the application of ISO to computer software
    - This standard provides guidance for organizations in the application of ISO 9001:2015 to the acquisition, supply, development, operation and maintenance of computer software and related support services.

- ISO/IEC/IEEE International Standard - Systems and software engineering -- Life cycle processes -- Risk management
  - This standard provides risk management elaborations for the processes.
    - This impacts our project since we will be using high heat to sanitize.

2.4 Intended Users and Uses

The benefits of this project can be applied to anyone that handles papers that are also handled by others.

- Teachers
- TAs
- Office workers
- Students

The primary purpose is to sanitize papers. The use cases are by design relatively narrow, but could be adapted to heat other objects that cannot be washed and are not particularly damaged by heat.

- Exams / assignments
- Mail / deliveries
- Office memos

3 Project Plan

3.1 Project Management/Tracking Procedures

We are working with the project management style of agile. We are planning on working on separate parts of the project and iteratively updating the group to combine later in meetings.

We are using a combination of Gitlab Issues and Discord for task management and communication respectively, and plan to use Git for version control.

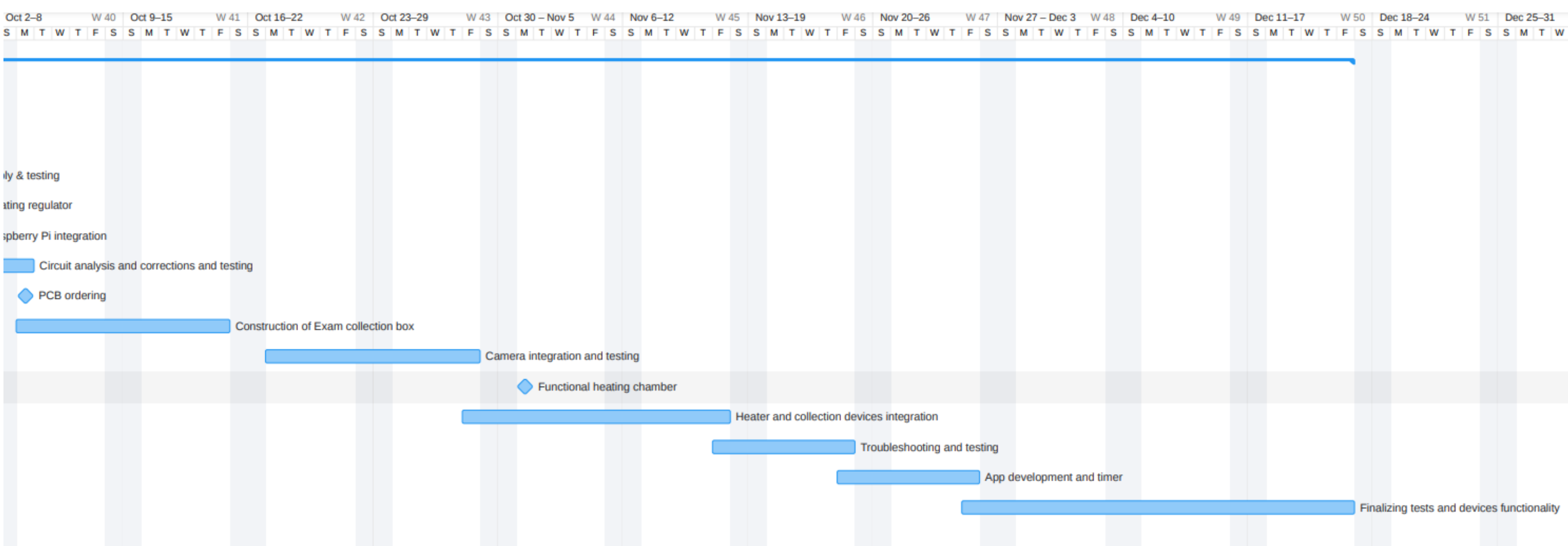
3.2 Task Decomposition

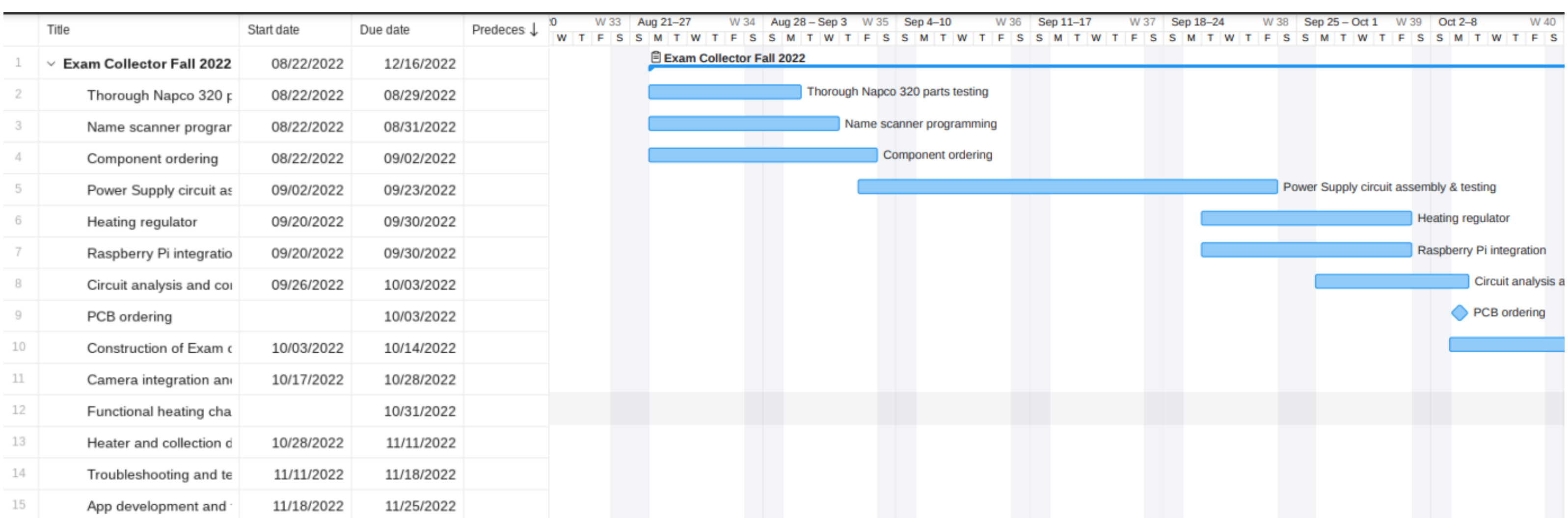
- Heater design
  - load/unload
  - Heater control software
  - Heater layout/power supply
- Collector design
  - Camera
  - ISU ID reader
  - Exam intake/unload
  - Writing software to record list of present students

3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

- Milestones
  - Full CAD Model of the exam collector w/ Components and Materials
  - Exam collector functionality
  - Exam oven functionality
- Metrics/Evaluation Criteria
  - Exam Collection ML algorithm should be 90% accurate compared to card reader data.
  - Less than 1% of submissions should be damaged in the oven in any way.
  - After all exams are completed scanning, they should be delivered to the professor through email.
  - Exam Collector must be able to last more than 4 hours on battery power
  - Exam oven must be labeled and designed in a way to prevent injuries throughout the whole process

3.4 Project Timeline/Schedule





	Title	Start date	Due date	Predeces
1	Exam Collector Fall 2022	08/22/2022	12/16/2022	
2	Thorough Napco 320 p	08/22/2022	08/29/2022	
3	Name scanner prograr	08/22/2022	08/31/2022	
4	Component ordering	08/22/2022	09/02/2022	
5	Power Supply circuit as	09/02/2022	09/23/2022	
6	Heating regulator	09/20/2022	09/30/2022	
7	Raspberry Pi integratio	09/20/2022	09/30/2022	
8	Circuit analysis and co	09/26/2022	10/03/2022	
9	PCB ordering		10/03/2022	
10	Construction of Exam c	10/03/2022	10/14/2022	
11	Camera integration an	10/17/2022	10/28/2022	
12	Functional heating cha		10/31/2022	
13	Heater and collection d	10/28/2022	11/11/2022	
14	Troubleshooting and te	11/11/2022	11/18/2022	
15	App development and	11/18/2022	11/25/2022	

3.5 Risks And Risk Management/Mitigation

- Camera fails to capture name / student number
  - 0.12
  - Picture backup regardless of recognized name / student number.
  - ID scanner backup for attendance.
- ID scanner fails
  - 0.02
  - Camera as backup
- Exam intake stuck
  - 0.03
  - We plan on making two collection boxes in case one fails
- Upload of student information to server/instructor fails
  - 0.08
  - USB flash drive backup.
- Heat too low
  - 0.1
  - Longer time spent in the oven can replicate higher temps for lower time.
- Heat too high
  - 0.05
  - Having an auto shut off if temperature reaches a certain point (well before burning point of paper at 200C.)
- Collector/Tests stuck in oven
  - 0.01
  - We plan on having a tray that easily slides in and out which won't get stuck

3.6 Personnel Effort Requirements

Task	Estimated Hours
Circuit Design/Research	60
Design/Construction of Collection Box	100
Software Implementation	80
Testing	60
Additional Features	Depending on time constraints and features added, anywhere from 80 -100 hours

These hours are more of an estimate than an actual concrete hours plan. It is very hard to judge the hours we will spend when we are unsure of how fast we will complete said portion.

3.7 Other Resource Requirements

Raspberry Pi, printing, Microcontroller simulation tools, Camera, Card Reader, AutoCAD, Python, Tesseract OCR, OpenCV, ETG Linux Server, Circuit Parts.

4 Design

4.1 Design Context

4.1.1 Broader Context

Our design problem is situated in the classroom. We are designing a safe, hands free way to collect, sanitize, and compartmentalize exams/homework. The two main communities affected by our design are the students and the faculty. Our design is attempting to increase public safety in schools by ensuring that Covid and other viruses do not spread.

Area	**Description**	**Examples**
Public health, safety, and welfare	With Covid appearing to be a mainstay in our society, it is important to find ways to be cleaner and safer in our everyday lives. Students/kids get sick very easily and can spread viruses to the faculty very quickly. Our product seeks to lower/eliminate that risk.	By sanitizing the papers we are able to decrease the risk of passing along a virus which will in turn allow students and faculty to be safer.

Global, cultural, and social	This product will realistically only be used at Iowa State where students and faculty come from all different cultural backgrounds. We understand that different cultures have different standards of cleanliness but we assume that no culture would be against the eradication of covid on exams.	We don't see our solution having a negative impact on the community because it does not change any of the norms. Our project is designed to not interrupt the flow of students turning in tests or homework.
Environmental	Our product will use electricity to heat the box which can come from various different types of energy. We would assume Iowa State used natural gas which has negative effects on the environment.	We don't have a ton of options because we don't get to choose where the heater is plugged in or what type of energy the University of Iowa State powers its campus with. We are designing the box to be as energy efficient as possible as a way to cut down on the total power used.
Economic	Our product will consist of two pcb's, a camera, and two boxes which will most likely be crafted from old printers. Our project will not be costly to create and at this time we do not see it being sold to consumers.	It is important to keep the costs low on this project because we were not given any money and instead will be relying on the resources Iowa State has. The only issue might occur when trying to create the PCB's because the world is in a global chip shortage.

4.1.2 User Needs

Faculty (Teachers, TA's, etc) : Faculty members want to stay safe while teaching during the pandemic because many faculty members are older which means they are a more at risk group.

Students : Students want to stay healthy while at school because getting sick means falling behind and that will be a detriment to their grades.

4.1.3 Prior Work/Solutions

When we were doing early research we could not find anything like our project on the market. The concepts behind our product are relatively simple as we only have a heating box to kill the virus and a collecting box to transfer the exams and record them in a database. Heaters exist and image capturing technology also exists but they have not been implemented in a way designed for the classroom.

When it comes to the circuitry in our project the circuits we will have to create and implement already exist. Many of these circuits can be used for inspiration but will not fit the heating requirements of our box. This gives us the challenge of choosing the correct parts and designing a circuit which will exclusively meet the needs of our heating box.

4.1.4 Technical Complexity

Our project is most certainly complex. For our project we will have two boxes. The collection box will include a camera that will take a picture of the paper when it is inserted. To do this we will need to create a circuit that forces the camera to take a picture anytime the button is pressed. From here the picture will go to a database of the teacher and transform the students name and id number from handwriting to text. The heating box will need to be properly heated using a circuit to control the temperature. To create the box we will need to use thermodynamics which is something new to everyone in our group.Given that we are not mechanical engineers the actual creation of these boxes will take time and lots of trial and error. Our project meets both the criteria involved and includes many different engineering principles such as embedded systems, coding, thermodynamics, circuit design, and 3d modeling.

4.2 Design Exploration

4.2.1 Design Decisions

1. Initially we were going to have the collection box and the heating box be one box. But due to size constraints and heating problems we decided to separate. The circuits and the camera on the collection box could possibly be damaged by the high temperature and the heating box will most likely be heavy which means it would not be easy to carry to a class.
2. Will have to plug in the heating box due to the power needs of the heating elements. Additionally, in order to adequately power the camera and other data collection parts of the collection box, that may also require a plug in or large battery to operate.
3. Overall, the collection box will be designed such that whoever is collecting the exams will never have to physically touch the exams before they are put into the heating box. This will, in theory, limit the odds of the grader from potentially contracting any diseases prior to the sterilization of the exams

4. For the exam sanitation box we have decided to use an old Napco 320 Incubator. This is because our areas of expertise are not in thermodynamics or physical designs. This allows us a solid base to start our project since we have the heating elements and insulation completed.
5. We will add features such as an app that takes data from the incubator and will let users know when the sanitation is complete. Possibly add a lock which would ensure no students could sneak in and impact tests. We have many features that we can look into adding once we have the requirements met.

4.2.2 Ideation

For the physical characteristics of the device, the following options were considered in our design process:

1. Fit both the collection functionality and the heating chamber into a single connected device. This would reduce some of the physical complexity of the design.
2. Separate the two previously mentioned functionalities into two parts: a smaller device for collecting and scanning the exams which could be brought to classrooms and exam locations, and the heating device which would receive the exams from the collector by connecting to the exam output of the collector.
3. Inclusion of an ID scanner, which wouldn't greatly increase the size or complexity of the collection device and could be a useful backup in the case that the other scanner is unsuccessful.
4. Material for the chassis of the heating device: many plastics would not react well to the heat, so metal would likely work better. Aluminum was identified as a potential match due to its light weight and low cost.
5. The weight of a battery would be detrimental to the purpose of the collection device, so a power supply and plugin were identified as necessary components.

4.2.3 Decision-Making and Trade-Off

1. Combine the heater and collector vs separate the components: Combining the two could reduce the physical complexity of the device, but would prevent the portability of the collection aspect and could introduce issues with electronic components being located near heating elements. We chose to separate the two aspects of the device to properly utilize the collection feature and prevent issues with overheating electronics.
2. ID Scanner Inclusion: The only potential drawback of including this feature is a slight increase in the work required by the MCU, but this drawback is minimal compared to the benefit of having a viable backup to the camera-based scanner and possibly increased efficiency of swiping ID cards as opposed to positioning an exam for an accurate camera scan.

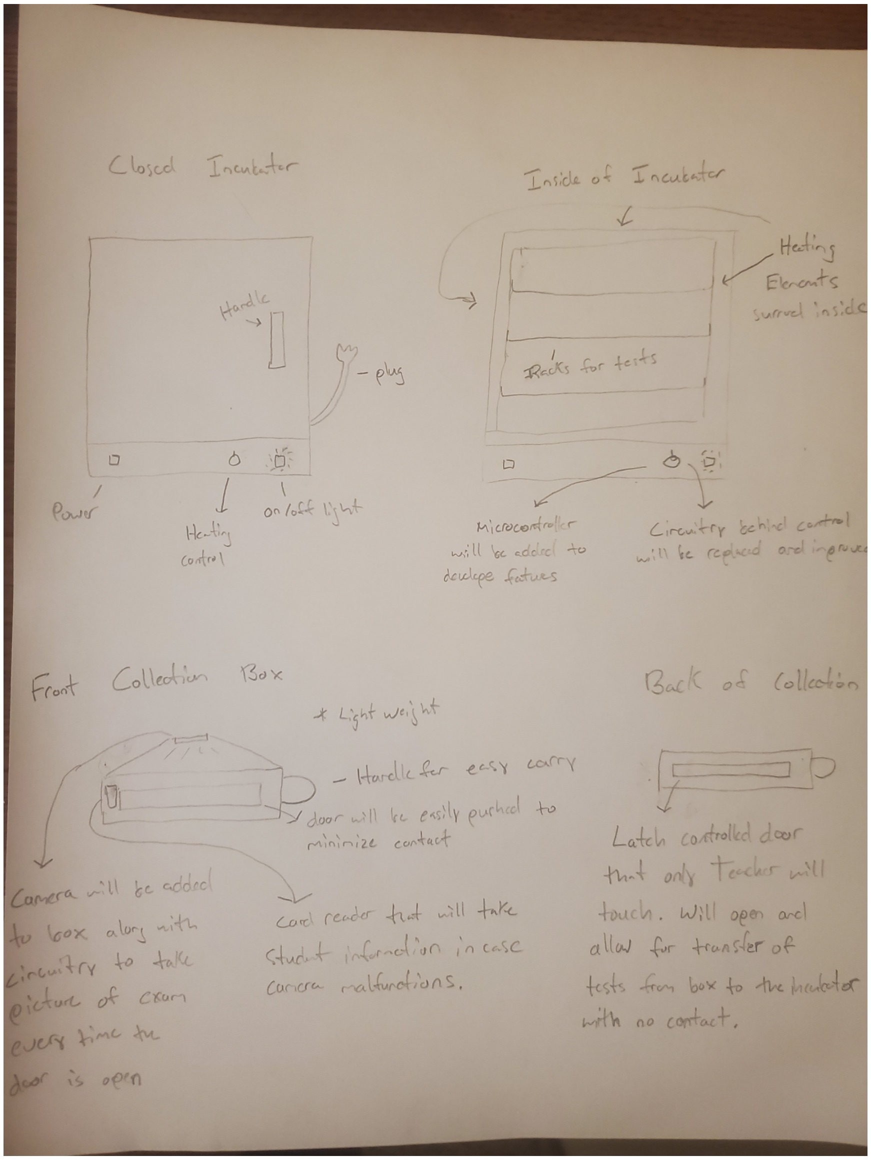
3. Having a tray that slots into both boxes: This decision was made as we discussed how best to limit the potential spread of diseases. In order to accomplish this, we needed a way to transfer the exams from the collection box to the heating box without physically

4.3 Proposed Design

So far, our designs have been focused on finding the best way to construct a prototype that we can build and show off the core idea of the project with. To that end, we have tested how paper heats in a chamber, in order to figure out how long we will need to fully sanitize the exams. In addition, we have tested how writing on paper is affected when heat is applied, making sure that students' answers do not become illegible as a result of being used in the chamber.

We have also begun work on repurposing an incubator to serve as the main sanitization unit, as its design is close to what we need and allows us to focus on other functionality more related to our field of study.

4.3.1 Design Visual and Description



4.3.2 Functionality

The user of this device will carry the inner cube to the testing environment along with the testing materials needed for the exam. After students complete their exam, they will insert their exams into the carrying cube to be scanned and safely contained. After the exam, the user will carry the cube back to the heating external cube. After inserting their carried cube into the heating unit, the user will select a temperature and turn it on. After the necessary heating time, the heating elements will turn off and can be removed for grading after a safe amount of time has passed in order to touch the papers.

4.3.3 Areas of Concern and Development

Current concerns include how long it may take to fully heat a stack of paper, as final exams need to be graded in a timely manner before grades are required to be posted. Power requirements are also a concern, as we want our design to be environmentally conscious, and as such, should strive to use as little power as possible.

For potentially lengthy heating times, our immediate solution is to have multiple collection boxes per heating box, allowing for multiple graders to collect and have their exams ready to be sanitized as soon as the current batch is completed. For power usage concerns, we plan to run a number of simulations to decide the best way to heat the inside of the heating chamber, and potentially consult our peers in mechanical engineering who's knowledge would lend itself greatly to our project.

4.4 Technology Considerations

A strength in our design is the modular nature. Separate units for the collector unit and the heater allow for easier development, testing, and repair. A weakness is reliance on battery power on the test collector unit. We have discussed including a power supply on this unit as well to plug into the wall, but that would increase the weight and cost of the unit .

4.5 Design Analysis

Our 3.3 design still needs to be tested, but with the current information, it should still work.

4.6 Design Plan

In the use-case of an exam, we designed our product such that a lightweight collection box will be carried into the exam room, allowing students to drop off their exams once finished and, if desired, log their name as attendance at the exam. The collection box will then be taken to where the sanitization unit is kept, where a try in the collection box will slide out to transfer the exams into the sanitization box for heating. As it is likely that TAs and professors will be busy with other tasks during exams, we have designed a way to send a notification to the user's smartphone, alerting them to when the sanitization cycle is completed so they do not need to wait around for a potentially lengthy heating time.

In the use case of multiple instructors needing to use the heating box, our design accounts for this requirement by allowing multiple trays of exams to be sanitized concurrently. In this use case, the heating box could be located in a space shared by multiple instructors so that it is accessible to a greater number of faculty.

5 Testing

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, power system, or software.

The testing plan should connect the requirements and the design to the adopting test strategy and instruments. In this overarching introduction, given an overview of the testing strategy. Emphasize any unique challenges to testing for your system/design.

5.1 Unit Testing

Testing the functionality of our two circuits. For our heating control circuit we will need to ensure the circuit will be able to function at high heats. We also need to ensure our circuit actually works. To do this we will use online software to make sure our circuit design is correct, and then we will order the parts and build the circuit on breadboards. We will do this for the two circuit boards we have to create.

We will also need to test our collection box which will take a picture of the test as it is inserted and then sends that picture to a database for the teacher to have. To do this we will need to have the completed PCB back so this will be a second semester test.

We will also have to test if our box properly heats the paper. This will also be a second semester test which will require us to have the completed PCB.

5.2 Interface Testing

The two most important interfaces in our design are the heating controls and the camera controls. The testing of the heating controls will involve measuring the internal temperature of the heating device and comparing this value to that of the input. This interface will also likely have a digital timer, this will be tested by making sure that the timer is started once a specific temperature is reached within the device. Testing this interface will require a thermometer which can be placed within the device and read from the outside. The camera control testing will involve making sure that a document is scanned when it is placed inside the device. We will have to compare the storage location of the scans to the test submission to ensure the scan was made properly.

5.3 Integration Testing

Using a modular design process we plan on testing each component we implement individually and after it is connected to the entire project design. We plan on testing the power supplied to the circuits and the temperature control circuit by using a multimeter. This will allow us to use these values in calculations to predict the potential outcomes. We also plan on testing our calculated values to see if the designs have any conflicting components. For the software end the first test is getting the code to compile and upload to the microcontroller. Supplying the correct amount of power to the microcontroller will be tested as well as the code functionality.

5.4 System Testing

System testing will be done by building a prototype and testing various inputs, with expected results. For the sanitization box, we will use a thermometer to monitor the temperature at various points in a stack of paper, to observe how long it takes to fully heat the stack, and adjust the temperature as needed to ensure the stack of paper is quickly, and safely, heated.

5.5 Regression Testing

Through modular design, we can ensure that every implemented part does not affect the functionality of another part, such as the Collection box being more or less a separate "sub-project" of the overall design. Critical features that need to not break are the heating elements in the sanitization box, as a critical failure there could lead to the box not heating or worse, overheating. To ensure this part does not break, we will design multiple safety features that all work together to ensure the operation of the sanitization box goes as safely and as smoothly as possible. This is driven by the requirements of the project as there are many ways to improve the design of the box but those will not be added if they conflict with the requirements.

5.6 Acceptance Testing

We will demonstrate that our product is meeting its requirements through live demos, showing off each component's functionality as we complete them, and showing our data of the heating box to show all exams inserted are being sterilized to the recommendation of the CDC. Given that our client is our faculty advisor, they will be involved with testing at every step of the project, receiving weekly updates and providing us with advice on how best to move forward as we continue to work on our project.

5.7 Results

- Have heated paper in lab over and measured temperature to see how long it would take for stack to reach 70 degrees C
  - Found that the initial requirements of heating a paper in 15 minutes (this was changed following tests) would not be feasible.
- Have plugged in 320 Napco Incubator to see if the heating elements still work.
  - Have heated paper in lab over and measured temperature to see how long it would take for stack to reach 70 degrees C
  - Found that the heating elements work but the control system does not work well, temperature fluctuates and the heat is lower temp than specified by control.
- A collection of py-tests to test expected results from the Optical Character Recognition Algorithm.

6 Implementation

Our plan for next semester is to implement the circuits we have created and install them into the Napco 320 Incubator/Collection box. We must also complete the construction of the collection box. Once we have completed the construction of the collection box and have updated the incubator we will begin testing to ensure everything works properly. From here we will add features (microcontroller in the heater to let users know when done) to improve the project.

7 Professionalism

This discussion is with respect to the paper titled " Contextualizing Professionalism in Capstone Projects Using the IDEALS Professional Responsibility Assessment", *International Journal of Engineering Education* Vol. 28, No. 2, pp. 416–424, 2012

7.1 Areas of Responsibility

Area of responsibility	Definition	NSPE Canon	IEEE Canon
Work Competence	Perform work of high quality, integrity, timeliness, and professional competence.	Perform services only in areas of their competence; Avoid deceptive acts.	To improve the understanding of technology; its appropriate application, and potential consequences;
Financial Responsibility	Deliver products and services of realizable value and at reasonable costs.	Act for each employer or client as faithful agents or trustees.	To reject bribery in all its forms;
Communication Honesty	Report work truthfully, without deception, and understandable to stakeholders.	Issue public statements only in an objective and truthful manner; Avoid deceptive acts.	To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others
Health, Safety, Well-Being	Minimize risks to safety, health, and well-being of stakeholders.	Hold paramount the safety, health, and welfare of the public.	Accept responsibility in making decisions consistent with the safety, health, and welfare of the public
Property Ownership	Respect property, ideas, and information of clients and others.	Act for each employer or client as faithful agents or trustees.	To avoid injuring others, their property, reputation, or employment by false or malicious action;
Sustainability	Protect environment and natural resources locally and globally.	N/A	Disclose promptly factors that might endanger the public or the environment.
Social Responsibility	Produce products and services that benefit society and communities	Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor,reputation, and usefulness of the profession.	To treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

7.2 Project Specific Professional Responsibility Areas

Work Competence: This applies to our project since we all have to improve our knowledge of technology in order to complete the task at hand. As a team we have done a good job at researching things that

Financial Responsibility: This applies to our team members in deciding the various components needed and expect everyone to find a cost-effective solution for the task provided. We are to ensure that this project does not exceed the provided budget.

Communication Honesty: This applies to our team since we will all be working together to complete the same task we will have to be honest with each other if certain things are not up to par. I think our team is performing very well with this.

Health, Safety, Well being: This applies highly to our project, as the entire basis of its design is based in limiting the spread and transmission of diseases by sanitizing exams in between handing them to graders and back to students.

Property Ownership: This applies to our project because it involves interaction with exams done by many students. Since our device involves a camera interacting with these exams, we have to keep in mind that the content of these exams should remain confidential. Our project must also avoid damaging the exams.

Sustainability: This applies at a low level for our project, where we want to make sure our heating element is energy efficient, but otherwise, our product does not produce much waste.

Social Responsibility: We have a responsibility to treat all members of our group fairly, as well as a responsibility to create a device that benefits both the teachers and students of Iowa State University.

7.3 Most Applicable Professional Responsibility Area

Health, Safety, and Well-Being would have to be the responsibility that our team is working on currently with our project. This is key for our exam collectors because one of its goals is to limit the transmission of viruses and bacteria from test to grader. In the design of this exam collector, we made sure from the time the student turns in their test to after the heating process is done there is no contact to make sure there is no contamination.

8 Closing Material

8.1 Discussion

Our project is well on track, with experiments for various components giving promising results and the materials coming together as we continue to push into the second semester of the project. Some experiments we performed include testing how a stack of paper heats in a chamber, and verifying that various forms of writing are unaffected after being exposed to high temperatures.

8.2 Conclusion

Our goal for this project is to build and test a way to sanitize a large number of exams at once, using heat as a way to ensure any transmissible diseases are sufficiently cleaned from the exams. Given the materials and work we have completed, our best way forward is to continue as planned, modifying the incubator to better suit our needs. Given our experiments with a heating chamber show promise, the incubator proves to be the easiest, most cost effective way for our group to succeed in our project.

8.3 References

List technical references and related work / market survey references. Do professional citation style (ex. IEEE).

Wißmann, J. E., Kirchhoff, L., Brüggemann, Y., Todt, D., Steinmann, J., & Steinmann, E. (2021). Persistence of pathogens on inanimate surfaces: A narrative review. Microorganisms, 9(2), 343. doi:10.3390/microorganisms9020343

N.-O. Hübner, C. Hübner, A. Kramer, and O. Assadian, “Original research: Survival of bacterial pathogens on paper and bacterial retrieval from paper to hands: Preliminary results,” AJN, American Journal of Nursing, vol. 111, no. 12, pp. 30–34, 2011.

8.4 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar data that does not directly pertain to the problem but helps support it, include it here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc,. PCB testing issues etc., Software bugs etc.

8.4.1 Team Contract

Team Members:

Nicholas Fahey

Brandon Degeneffe

Maxim Hjelmstad

Connor Kazin

Dylan Kohlbeck

Camdyn Zook

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team

meetings: Thursday @ 3:00 pm (In-Person) and Sunday 6:00 (virtual)

2. Preferred method of communication updates, reminders, issues, and

scheduling (e.g., e-mail, phone, app, face-to-face): Discord

3. Decision-making policy (e.g., consensus, majority vote): Majority Vote

4. Procedures for record keeping (i.e., who will keep meeting minutes, how

will minutes be shared/archived): Camdyn Zook

Participation Expectations

1. Expected individual attendance, punctuality, and participation at all team

meetings: Expected to be at all meetings, unless the individual has

communicated 6-8 hrs before the meeting (Obviously emergencies are

emergencies). Punctuality - at most 10 minutes after the meeting's start

time (Time in between classes). Participation - have each team member

report what they did for the week and try to contribute to conversation.

2. Expected level of responsibility for fulfilling team assignments, timelines, and deadlines: Team assignments should be finished each week as a group. If a team cannot finish a timeline or deadline, explain why and brainstorm how to fix this potential problem.

3. Expected level of communication with other team members:

Team members are expected to communicate any meeting conflicts or delay on project progression within 24-48 hours in advance. Each member should document essential data to be shared with the group. Team members are expected to reach out for assistance with designs or calculations in which the individual is unsure of the results or complications it may create. Overall letting the group be aware of your progress or scheduling conflicts.

4. Expected level of commitment to team decisions and tasks:

Minimum of 2 hrs a week (Both meetings) and maximum of 8-10 hrs a week.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):

Software Team Lead:Nicholas Fahey

Software Testing: Maxim Hjelmstad

Software Component design: Camdyn Zook

Hardware Team Lead: Brandon Degeneffe

Hardware Testing: Connor

Hardware Components design: Connor

Group minutes taker: Camdyn Zook

Client interaction: Dylan

2. Strategies for supporting and guiding the work of all team members:

Smaller meetings between Software and Hardware team members and constant support and communication on discord

3. Strategies for recognizing the contributions of all team members:

Keep track of individual contributions throughout the course of the project.

Goal-Setting, Planning, and Execution

1. Team goals for this semester:

Finalize a design and have a start on a semi working prototype.

2. Strategies for planning and assigning individual and team work:

There will be two teams, one focused on hardware, and the other focused on software. Each team will set goals for the week to complete.

3. Strategies for keeping on task:

Two meetings a week where we collaborate and share data/progress.

Consequences for Not Adhering to Team Contract

1. How will you handle infractions of any of the obligations of this team contract?

Infractions will be ignored as long as the member indicates he will not be able to complete the task for that week in a timely manner.

2. What will your team do if the infractions continue?

If infractions are constant, we will first meet with the individual and discuss these infractions. If they continue to occur we will meet the sponsor of the project and the class professor to discuss how to deal with the infractions moving forward.

****

a) I participated in formulating the standards, roles, and procedures as stated in this contract.

b) I understand that I am obligated to abide by these terms and conditions.

c) I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.

1) Dylan Kohlbeck	DATE 4/24/2022
2) Connor Kazin	DATE 4/24/2022
3) Brandon Degeneffe	DATE 4/24/2022
4) Nicholas Fahey	DATE 4/24/2022
5) Maxim Hjelmstad	DATE 4/24/2022
6) Camdyn Zook	DATE 4/24/2022