Optimize Wait Times at VT Dining Halls

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ABOUT THE PROJECT

MISSION

The goal of our project is to 1) decrease wait times at dining halls on Virginia Tech's Campus 2) develop a system that will increase awareness of wait times in dining halls.

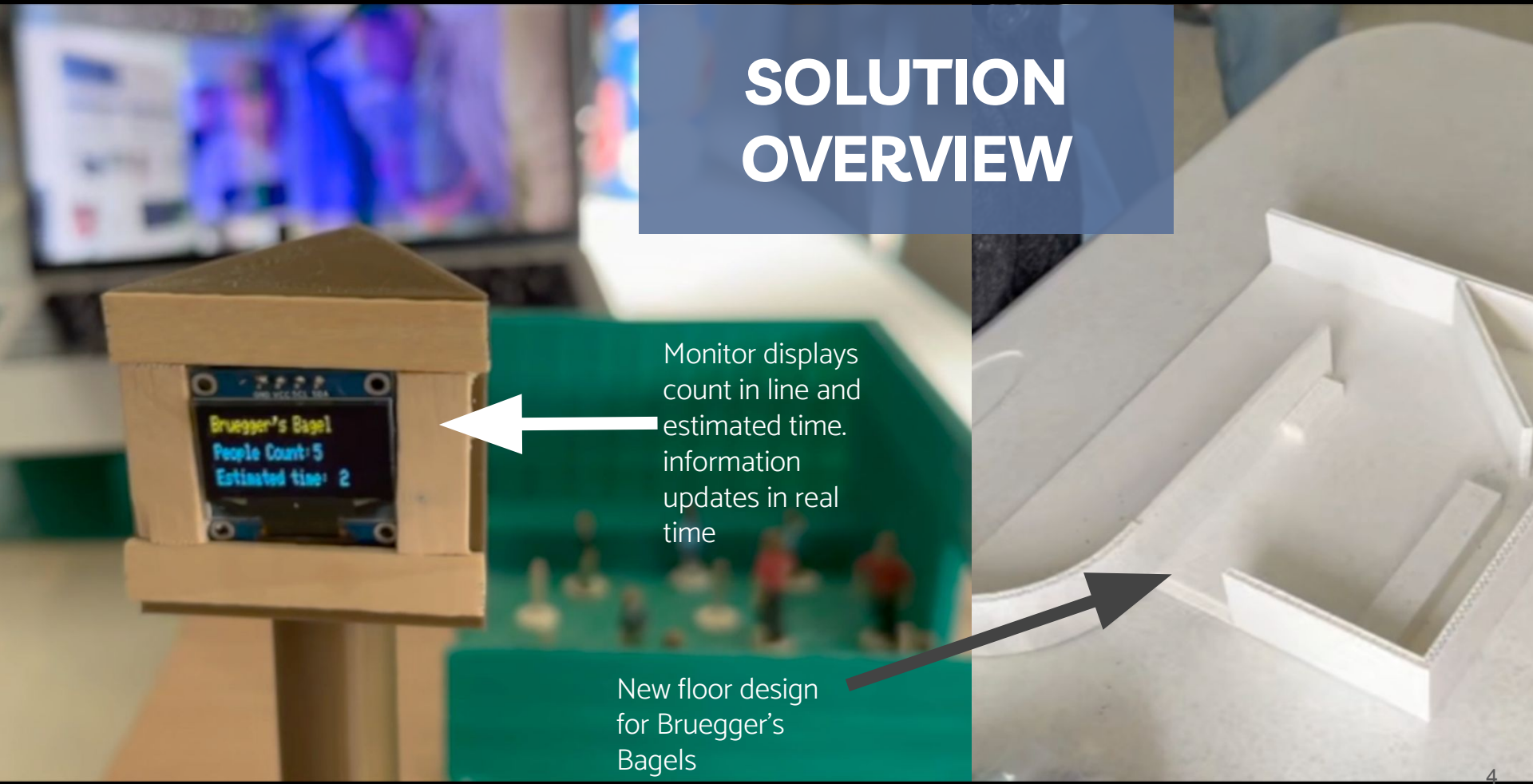
PROTOTYPE

Our project promotes an example of modifications that can be made to the current Bruegger's Bagels Shop for wait time optimization.

PROBLEM

Many Virginia Tech students have experienced crowded dining halls with long wait times. GrubHub users have experienced inaccurate wait time estimations. Dining hall staff are over strained from being understaffed.

SOLUTION OVERVIEW



Monitor displays count in line and estimated time. information updates in real time

New floor design for Bruegger's Bagels

Launch Screen of app

FEATURE HIGHLIGHTS

BRUEGGER'S BAGELS LAYOUT

The new and improved layout separates the in-person line (where staff builds your order made to order) with the grab and go line (pre-made bagels). This will encourage an atmosphere where the lines are not overflowing out of the shop.

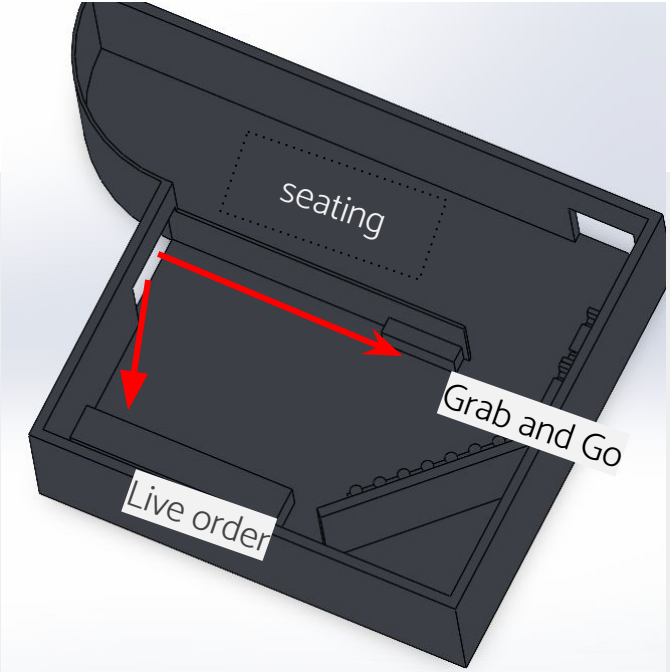
AI BASED DETECTION

The AI system captures footage that detects people frame by frame. It utilizes a deep model, which is trained on a substantial data set of reference images–this is the preferred method as it delivers more accurate, reliable results.

REAL-TIME CLOUD APP

Chow Time: The app broadcasts the wait time to users in real time from the cloud. It's designed with Virginia Tech's color traditions in mind and provides insightful data about the approximate wait times and the people currently in line.

FEATURED HIGHLIGHTS



Live order:
Line where customers personalize order in real time.

The **redesigned floor plan** will separate live order lines from the grab and go station. This allows better flow as there is less traffic in the small area.

LIMITATIONS

LONG WAIT TIMES FOR 3D PRINTING

Our team submitted 3D printing files 2.5 weeks before the deadline under the impression that it would be finished in one week. It took longer than expected because the parts we submitted used a large 3D printing plate. There is only one large plate in the Newman Library. Staff did not inform us there were multiple large projects in front of ours which caused our project to print later than expected..

WHY IS IT CHALLENGING?

Not having the 3D printed layout sooner was an issue since the other components like furniture relating to the layout had to be attached to it. Thus, it caused construction to take place later in the design process than anticipated cutting it close to the deadline.

OUR PLAN TO LOOK AHEAD

As the deadline was soon approaching, our team realized that immediate action needed to be taken to speed up the 3D printing process. A team member requested that the needed prints must receive printing priority due to academic purposes. The request was granted.

LACK OF DATA

There is no public information regarding which dining hall is most frequently visited based on time of day. Additionally, Virginia Tech does not disclose publicly how wait times are estimated on the GrubHub app.

WHY IS IT CHALLENGING?

Our team's lack of information with regards to crowd volume patterns at different times of day caused our team to refocus the project's scope to solely involve the Bruegger's Bagel shop.

To combat our inability to analyze Virginia Tech's GrubHub data and improve its objective, we collected data and utilized a static formula to come up with an estimation of wait time. Formula: [(2 * # ppl in line)/workers] derived from observation during data collection.

OUR PLAN TO LOOK AHEAD

Our solution includes collecting the number of people in the dining center and storing that data in the cloud. Once our data is stored, it can be further used to train new machine learning models for a more accurate and dynamic formulation in terms of wait times.

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PROJECT GOALS

PROJECT REACH

WHO

- Students - Modifications made to the system directly impacts Virginia Tech students positively since wait times will be reduced.
- Staff and workers - They will have a more efficient system to work with, which reduces work strain.

WHERE

Bruegger's Bagels Shop in Lavery Hall (Turner Place)

WHAT

The function of our design records the time it'll take for the consumer (mostly students) to get their food in line. This will help them make an independent and informed decision on when and where to eat. Our changes in B's Bagels floor plan ensures more efficient movement of foot traffic.

CONSTRAINTS & CRITERIA

WAIT TIME

Consists of the time it takes for a person to get to get their order and leave, after they get to an establishment. It is measured by the program calculating wait time respective to number of people in line defined by AI system. Our design ranks this criteria as top priority. It is based on diverting traffic from busier halls to less crowded ones by allowing people to see the wait time of every dining hall, which will allow them to go the dining halls with less wait time.

BUDGET

The amount of capital invested in the project. It is measured in American dollars. Our design ranks this criteria as its second most important.
Our prototype is build within a budget constraint of $60. We redesigned the current floorplan of one specific dining hall instead of creating a completely new structure to keep the design plan in control.

PRIVACY

People's privacy regarding the AI human detection system. It is measured by the program's ability (or inability rather) to save data from those being recorded. Our design ranks this criteria as its third most important.
Our programming team has made sure we don't collect and save any images when our sensor is working to detect people.

CONSTRAINTS & CRITERIA

REACH

Reach of the prototype. It is measured by the amount of people the prototype impacts. Any person can download the app and connect to dining wait time information. Also our monitor is played high above so that any person can see it from far. So our product is reached to everyone.

DURABILITY

General durability of the prototype. It is measured by the prototype's ability to be moved without affecting its structural integrity. Our design meet this criteria as the screen of the sign board is placed very high using a pole to avoid being tampered with the sensor or the monitor.

STAKEHOLDER PROFILE

WHO THEY ARE

Name: David Halston
Age: 24
Ethnicity: Asian/Caucasian
VT relation: Student
Hometown: Townsville, Queensland, Australia
Current residence: Blacksburg VA
Major: Aerospace Engineering

WHAT THEY NEED

- A reliable source of information broadcasting accurate wait times within dining halls.
- Shorter lines in dining halls
- Ability to move freely within dining halls without feeling too crowded
- Make it to class on time

HOW WE'RE HELPING

1) An easily seen sign displaying wait times will influence David to enter a line or go to a different shop to eat. Potentially shortening line length.
2) Redesigned Layout: Two seperate lines will divert traffic and encourage better flow of shop.

STAKEHOLDER PROFILE

WHO THEY ARE

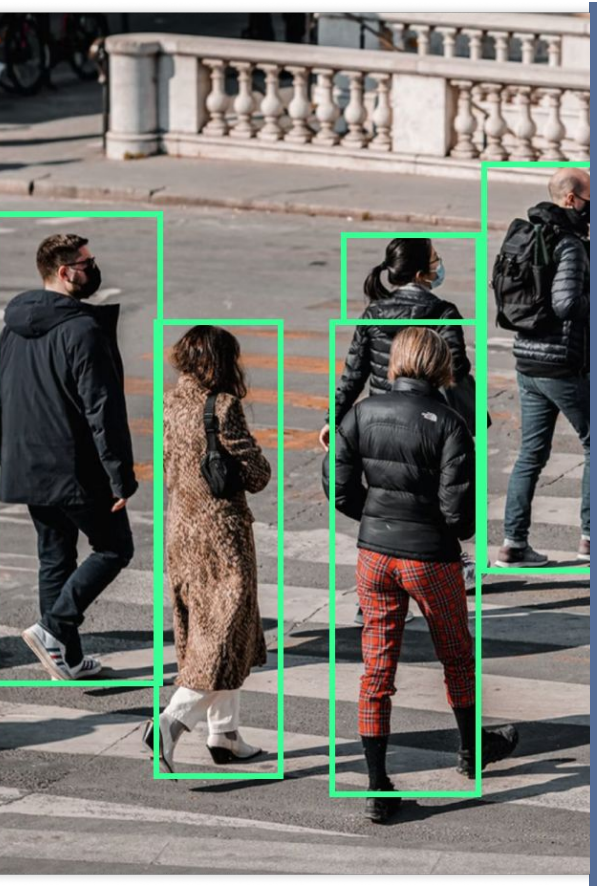
This worker from Bruegger's Bagels is a student at Virginia Tech. On average, they work shifts of 4-6 hours a week, similar to all other student workers at Bruegger's Bagels and other dining halls. They live in Blacksburg, VA. Their job is impacted by the modifications that may be made to the dining hall they work at.

WHAT THEY NEED

At Bruegger's Bagels, the overcrowding (especially during certain specific times of the day) causes stress for those who work there and puts them under conditions where they may need to overwork themselves. This results in additional pressure along with the stress of schoolwork.

HOW WE'RE HELPING

Our project explores a solution to the problem of wait times, which is caused by overcrowding caused by long queues at Bruegger's Bagels. Our solution includes a new floor plan which implements multiple elements that play a part in reducing issues that cause overcrowding - the floor plan that separates the in-person and grab-and-go queues, and the app and LED sign displaying wait times. This will reduce strain on workers to manage this large number of people.



OUR PRINCIPLES

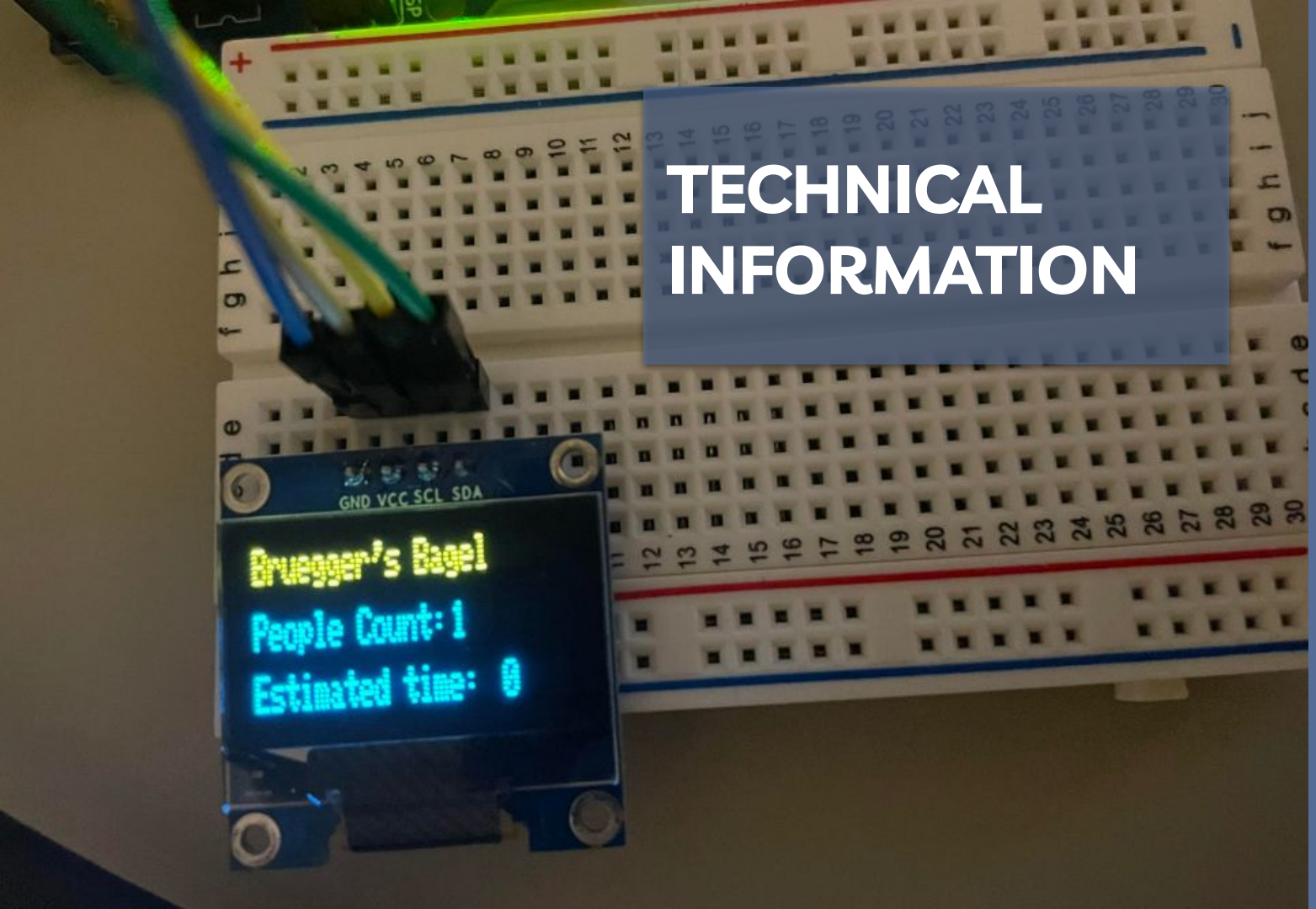
POTENTIAL CONCERNS

Since the application to determine the number of people in line includes a camera, privacy is one concern that we will evaluate the app by. Since those who choose to eat at Bruegger's Bagels will constantly be on a camera to determine the number of people waiting in line at any given time, it is an ethical concern if they are recorded or their identity is recognized in any way.

OUR ETHICAL STANDARDS

The first fundamental canon from the NSPE code of ethics states that "engineers shall hold paramount the safety, health, and welfare of the public"[3]. Within the project, we will be respecting the privacy of all individuals by not revealing or storing any data (regarding the app's camera) without the prior consent of all of those involved. This is consistent with the project as a whole having ethical motivations

TECHNICAL INFORMATION



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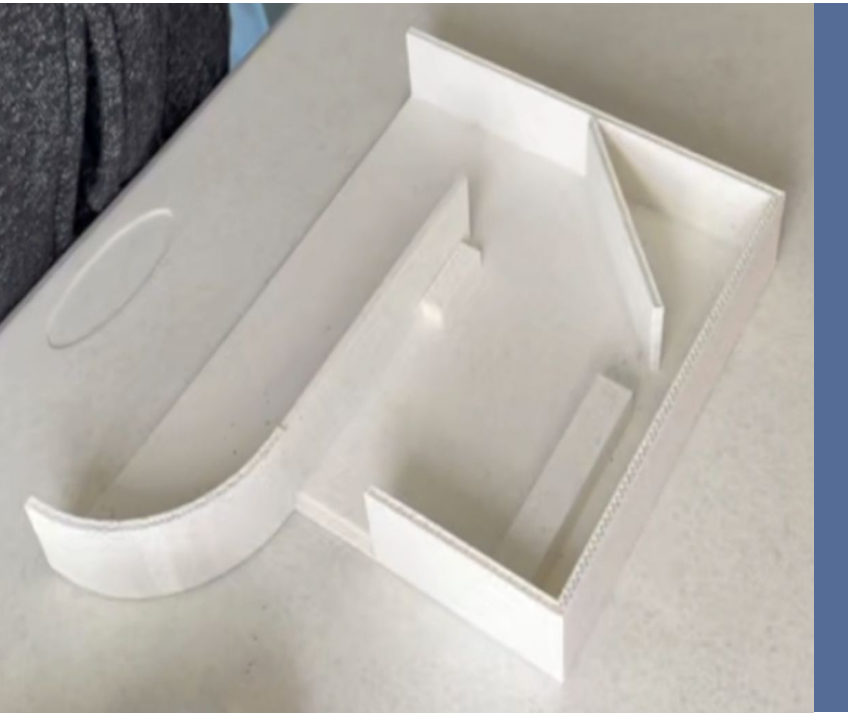
PROTOTYPE DETAILS



New floor plan of bruegger's Bagels

DESCRIPTION

The prototype includes a model of the floor plan, a 3-sided triangular model, an app 'Chow Time' programmed with an AI detection system, and an advertising sign. The physical components of this prototype have been made by 3D printing and using materials within the budget of $60.

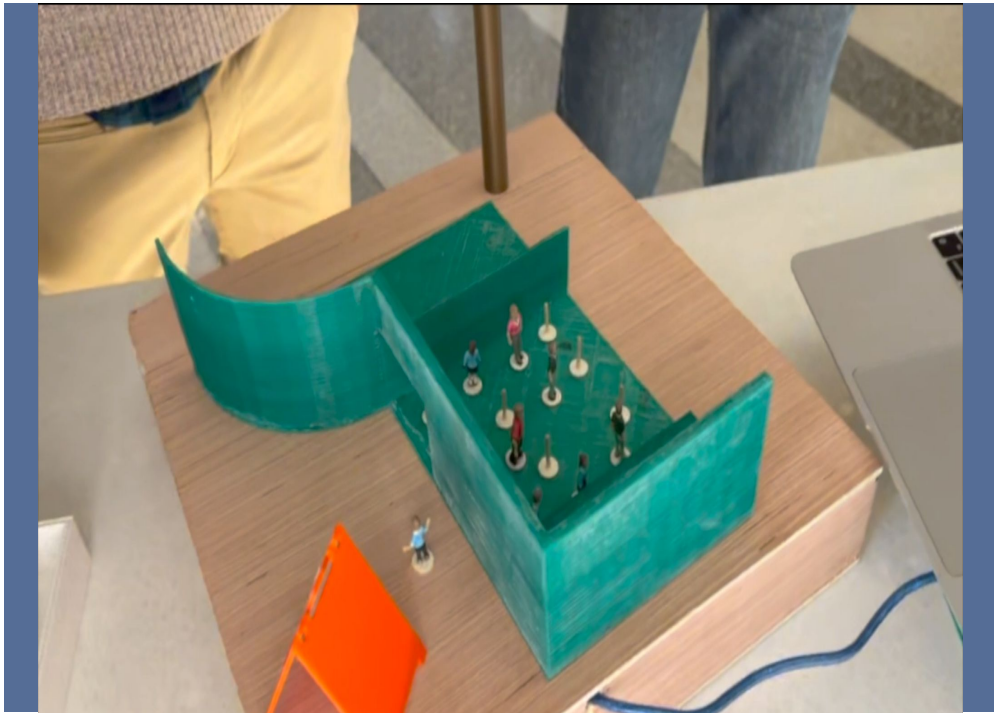
IMPORTANT DETAILS

Included in the final prototype is the following:

- Redesigned floor plan
- Triangular 3-sided monitor displaying wait times
- App displaying wait times
- Programmed AI detection system (aids in wait time estimation)
- Sign advertising dining services is hiring

DESCRIPTION

The prototype, as described earlier, is of a redesigned floor plan of the restaurant Bruegger's Bagels located in Lavery Hall at Virginia Tech. Our model varies from the current floor plan of B's Bagels as it separates the live order and grab-and-go lines. In the hall would be a 3-sided triangular LED sign displaying the current number of people in line and the approximate time of wait, which would be calculated using an AI human detection system. This is displayed to customers to show how long it'll take to get their food, and consequently, make a faster and more informed decision on whether the wait is worth their time. This means that the line will be tracked through a camera in the restaurant. The wait times will also be displayed on Chow Time (more on app/program later). The final component of the prototype is an A-frame sign that will be displayed outside the dining hall, encouraging people to scan the QR code and apply to dining services to help the issue of understaffing.



PROTOTYPE DETAILS

BILL OF MATERIALS

Description	Quantity/Units
Poly Lactic Acid (3D printing material	0.5 kg
OLED screen	1 unit
1/4 in Plywood	0.5 kg
Wood Glue	1 unit
Arduino Kit	1 unit
Mini Wooden Dowels	1pk (130 pc)
Mini Wooden Circles	1 pk
Mini People	2 pk (5 pieces)

PROGRAMMING SUMMARY

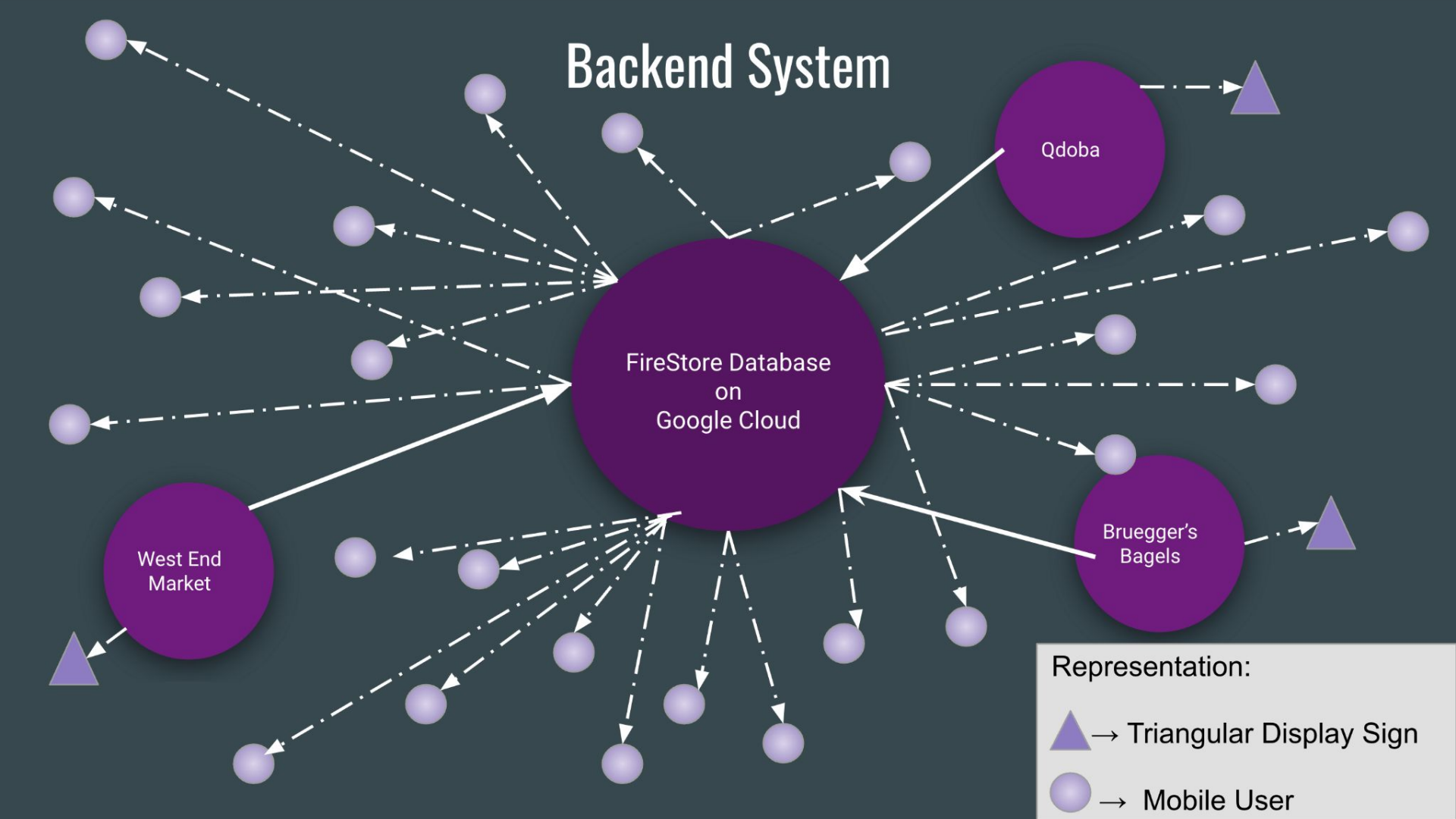
```
override func viewDidLoad() {
    super.viewDidLoad()

    self.tableView.dataSource = self
    self.tableView.delegate = self

    self.tableView.rowHeight = 320.0

    //Rotate the view
      CGAffineTransform transform  =
    self.tableView.transform = CGAffineTransformMakeRotation
    self.tableView.frame = CGRect(x: 10, y: 180 + 60, width:
    self.registerTableViewCells()
    // Do any additional setup after loading the view.

    let settings = FirestoreSettings()
    Firestore.firestore().settings = settings
    db = Firestore.firestore()
    tableView.backgroundColor = UIColor.clear

}

private func registerTableViewCells() {
    let textFieldCell = UINib(nibName: "DiningHallViewCell",
                              bundle: nil)
```

DESCRIPTION

We implemented a deep learning model the amount of people at the dining halls. The count, along with an estimated wait time, is displayed on an OLED screen attached to a triangular sign that allows people to easily view it from wherever they stand. Simultaneously, a cloud-based app will also allow people to see the wait time from anywhere. Thus, letting people decide if they want to go or not. In addition, this will improve traffic management.

IMPORTANT DETAILS

- An AI based camera sensor detects people in dining halls.
- An OLED screen that displays an estimated wait time and the number of people at the dining hall.
- A cloud-based app that allows people to see the wait time from wherever they are.


Backend System
Qdoba
FireStore Database
on
Google Cloud
West End
Market
Bruegger's
Bagels
Representation:
→ Triangular Display Sign
→ Mobile User

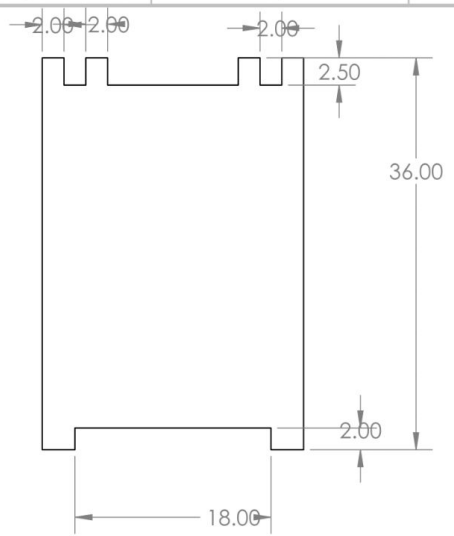
Highlights

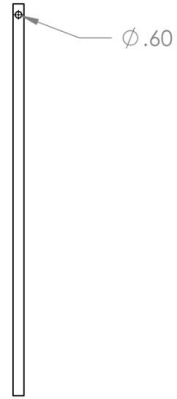
Oled screen connected via Arduino which display wait time and people count.

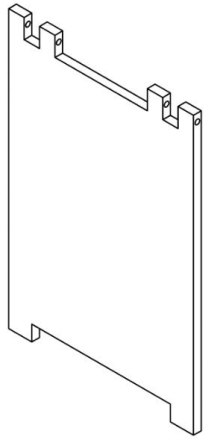
Human detection AI model, detecting human prototypes.

A cell of the app showing all the dining hall with people count and wait time.

DRAWINGS







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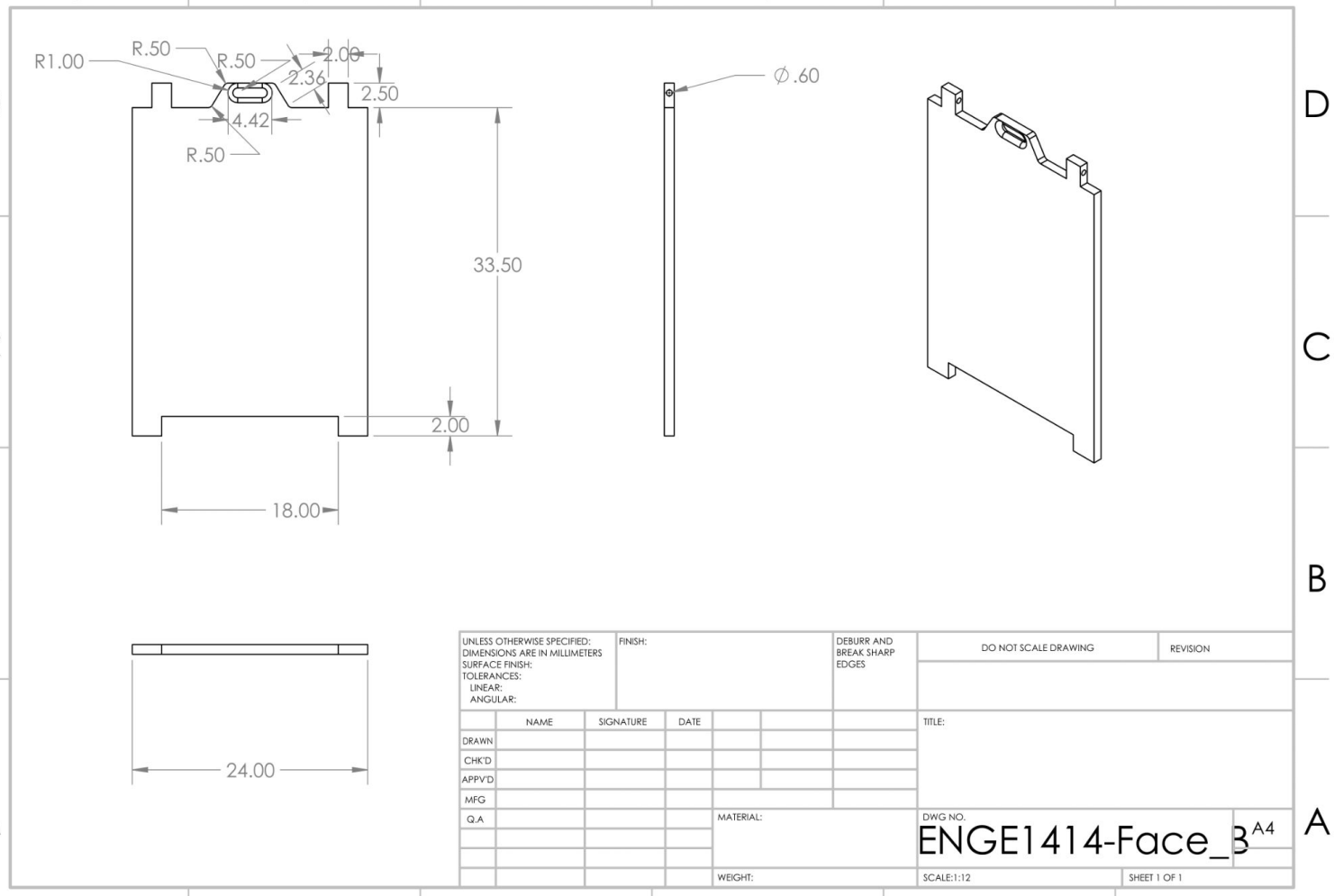
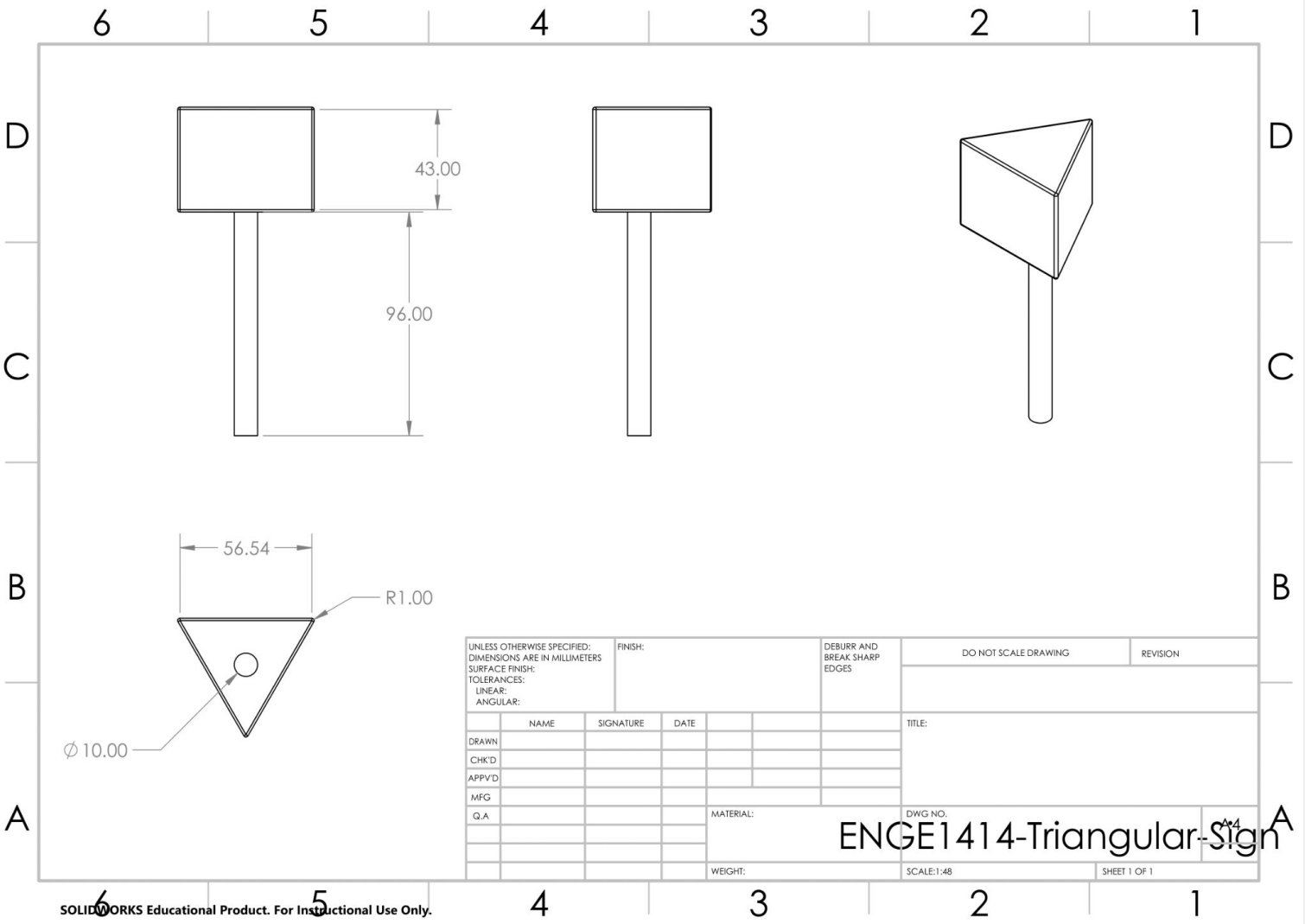
Drawings



Drawings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SHEET 1 OF 1
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REFERENCES

Project source code: https://gitfront.io/r/user-6756476/dc3ppDf8ZU2R/ENGE-1414/
CAD files:
https://drive.google.com/drive/folders/1UtHN3pvc_cbPvkrbFvtl4-iSOoQA--nq?usp=sharing

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[6]"Queue",https://pixabay.com/illustrations/food-distribution-refugees-queue-1013666/ (accessed Dec. 02, 2022)