

# Preliminary Design Review: Automated Mail Sorter

Team 14

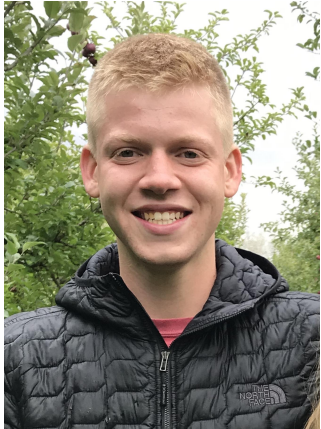
Dan Emerson, James Finn,  
Harrison Liu, Long Nguyen

Advisor: Professor Holcomb

October 10, 2019



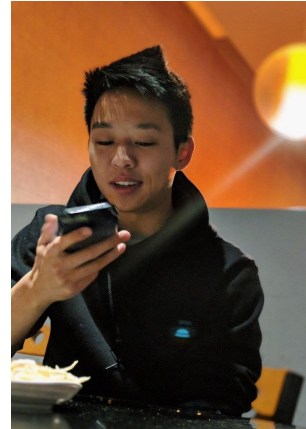
# Team 14



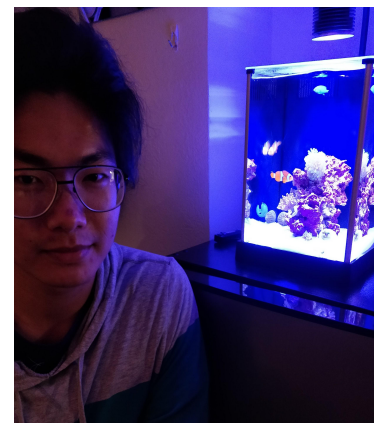
Dan Emerson  
ME



James Finn  
CSE



Harrison Liu  
CSE



Long Nguyen  
CSE

# Problem Statement

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Sorting mail is a mundane and routine task that can be significantly enhanced through automation. Automation would improve the cost efficiency compared to a traditional mail carrier.

Currently there are no automated last-mile delivery implementations available on the market. We plan to fulfill this gap by designing a small scale automatic mail sorter for individual office mailbox arrays.

# Design Alternatives - Human Mail Person

- Average wage of a mail person is \$17.71/hr
- Cost saving of at least \$1,341 per year compared to a traditional mail person

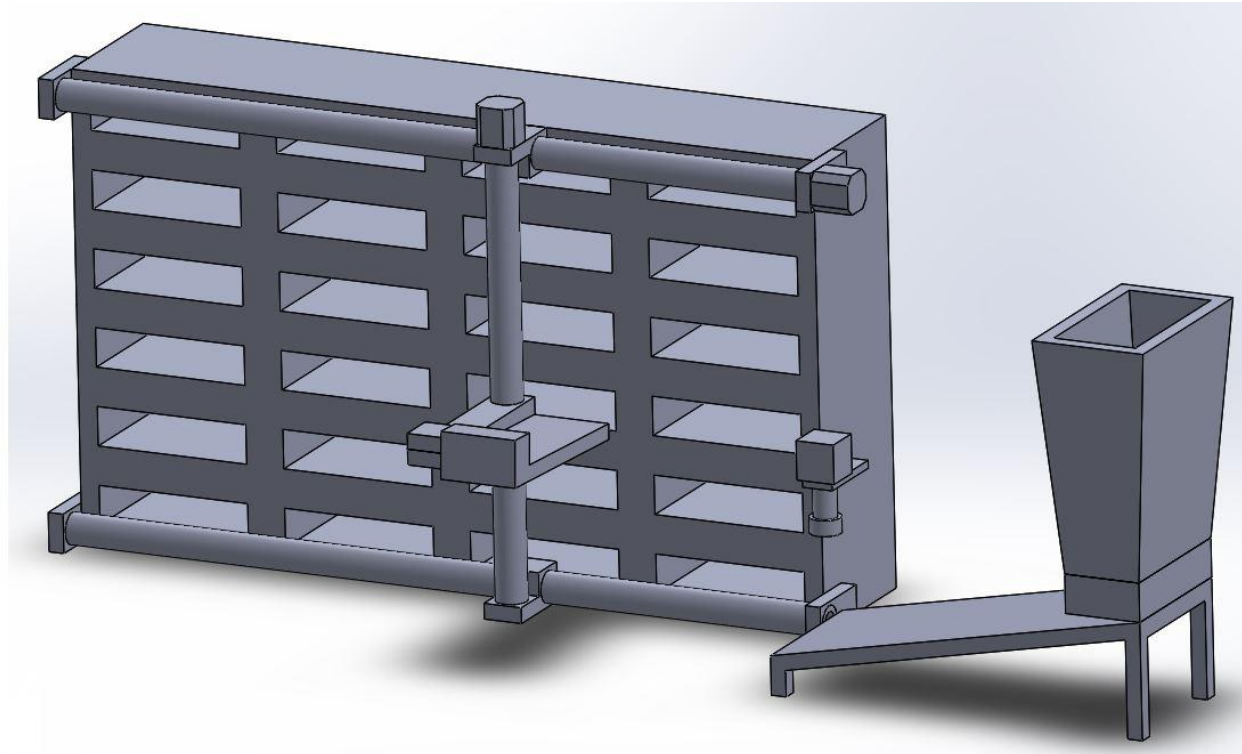


# Design Alternatives - OPEX Mail Matrix

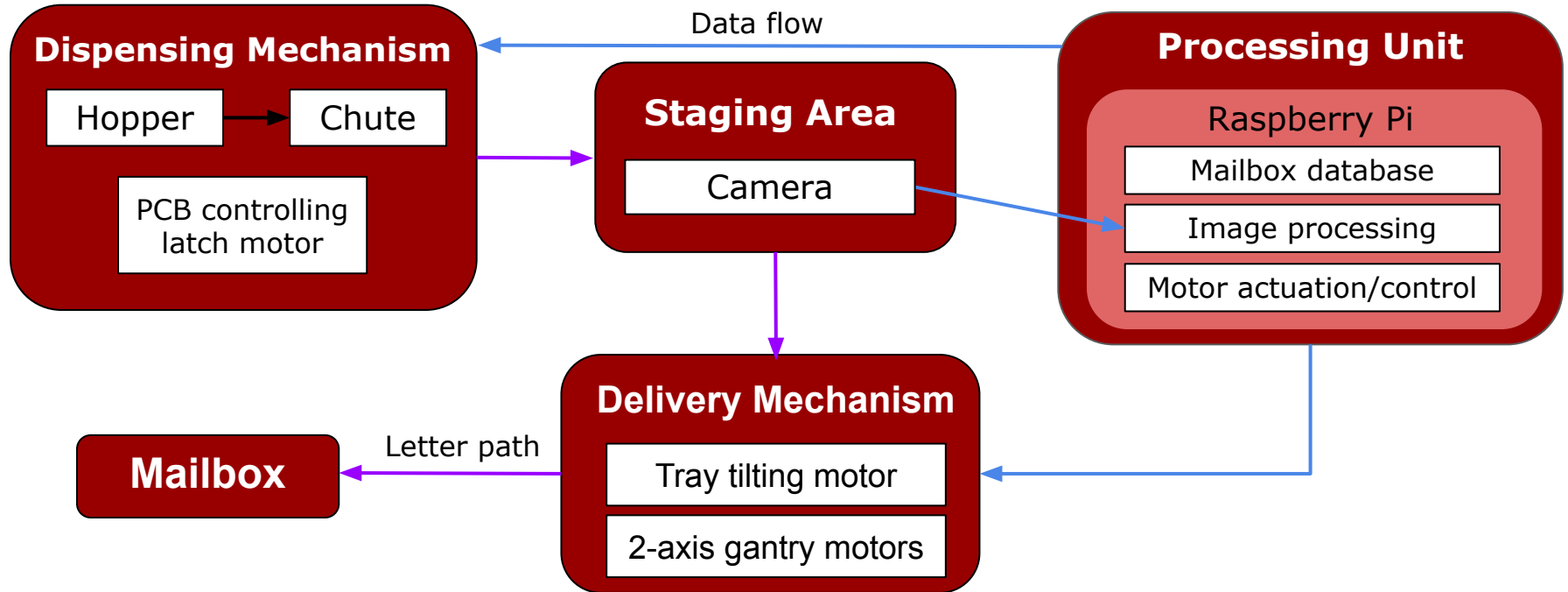
- \$180,000 for smallest model
- Use case: large mail center sorting (e.g. university wide mail center)
- Sorts mail into clusters (by college, department, etc.)



# Our Design



# Block Diagram



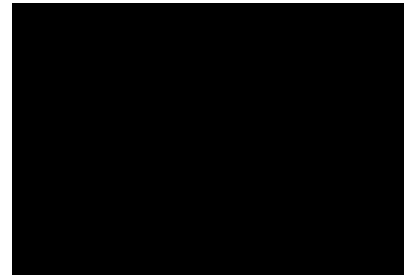
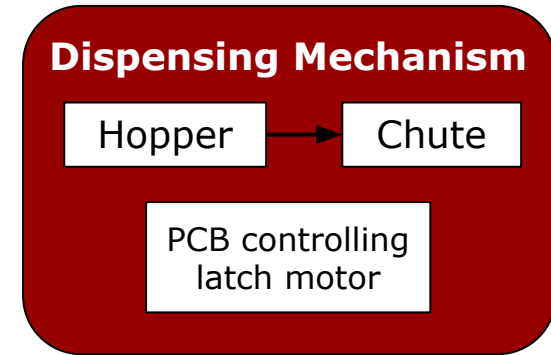
# System Specifications

1. Support standard envelope size of 4 $\frac{1}{8}$  in x 9 $\frac{1}{2}$  in
2. Hopper dispenses exactly 1 letter to be processed with 95% accuracy
3. Identify correct letter destination by reading with 99% accuracy (QR/typed/handwritten)
4. Capable of sorting 1,000 letters per day

# Subsystem 1: Dispensing Mechanism

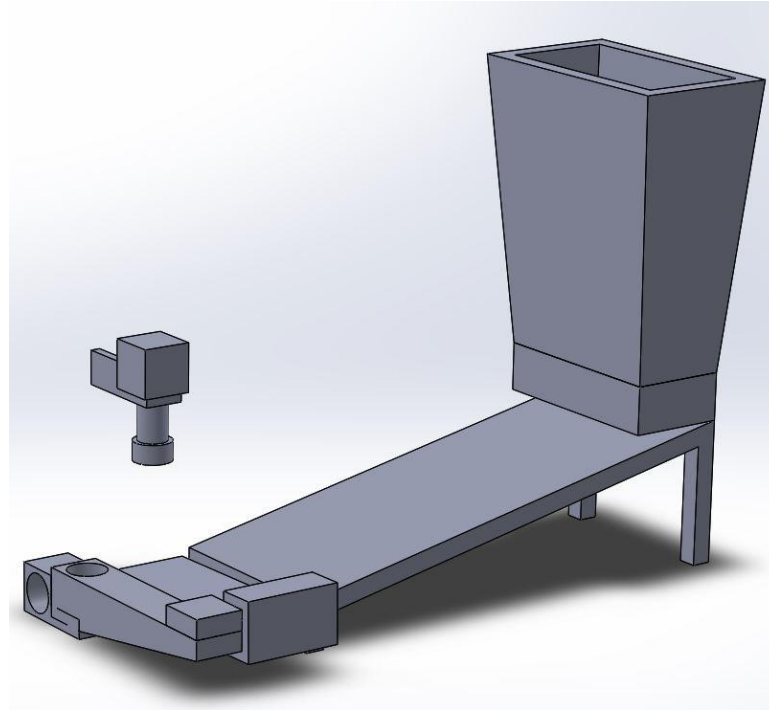
## Hopper and Latch

- Hopper loaded with properly aligned letters
- When delivery tray is in position, latch releases and drops 1 letter into chute
- Chute leads directly to delivery tray/staging area to process envelope name



Example of latch mechanism in cutlery dispenser

# Subsystem 1: CAD Model



# Dispensing Mechanism Alternatives

## Suction

- Good at picking up exactly one letter
- Less reliable at transporting letter

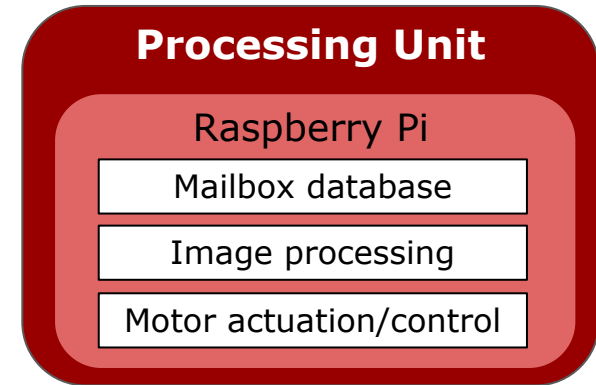
## Rolling

- Works similar to a printer by sliding one letter out from top of stack
- Letters are not a standard size like printer paper
- May result in grabbing two letters at once

# Subsystem 2: Processing Unit

## Raspberry Pi

- Houses mailbox database on MicroSD
- Performs image processing on envelope
- Communicates with dispensing and delivery systems



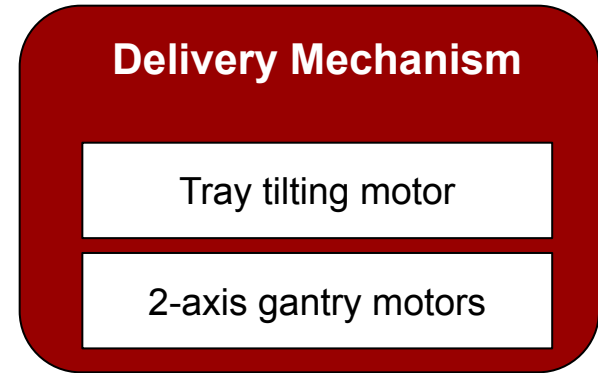
# Processing Unit Alternatives

	<b>CPU</b>	<b>Clock</b>	<b>Memory</b>	<b>Price</b>	<b>Comments</b>
<b>Raspberry Pi 4</b>	Quad core Cortex-A72	1.5GHz	1-4GB SDRAM	\$35-\$50	Strong CPU, cost-effective, ease of use
<b>BeagleBone Black</b>	AM335x ARM Cortex-A8	1GHz	512MB DDR3 RAM	\$50-\$65	Good for a lot of GPIO
<b>Arduino Uno</b>	ATmega328P	16MHz	2KB SRAM	\$22	Simply not powerful enough

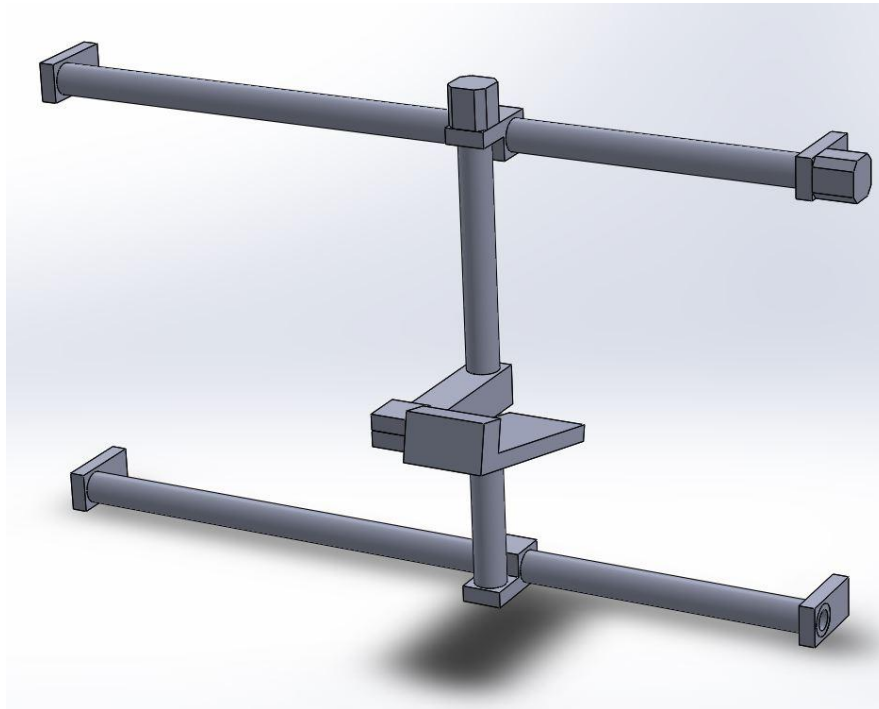
## Subsystem 3: Delivery Mechanism

### Tilt tray and 2-axis gantry

- Receives letter delivery information from Raspberry Pi
- Tray moves to the corresponding mailbox
- Tray tips to load letter into mailbox

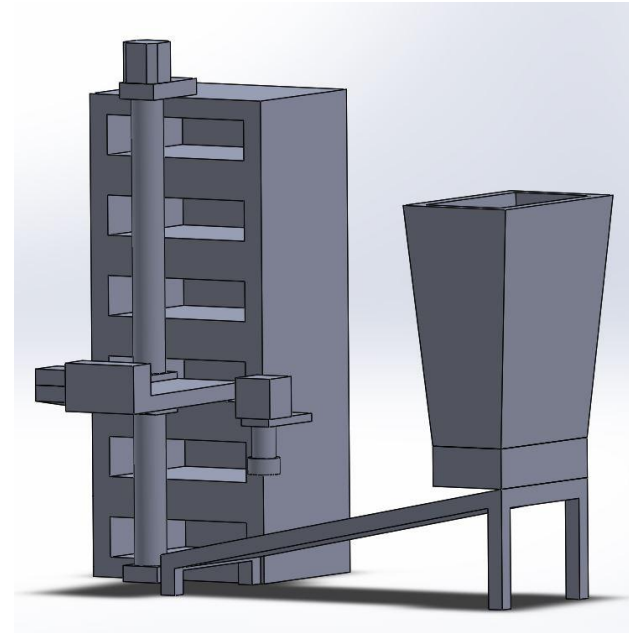


# Subsystem 3: CAD Model



# MDR Deliverables

- Design and implement mechanism to dispense one letter at a time with 75% accuracy
- Identify letter destination by QR code with 90% accuracy
- References database to locate coordinates of correct mailbox
- Transport letters along one axis
- Design is scalable to two axes for FPR



# Significant Hardware Component

- Will be used to control the motor for the letter release latch in the dispensing mechanism subsystem
- Use discrete logic devices
- For MDR: Circuit on solderless breadboard
- For FPR: Custom PCB

# Budget

<b>Raspberry Pi 4</b>	\$35-\$50	<b>Hopper</b>	\$40
<b>MicroSD</b>	\$10	<b>Chute</b>	\$20
<b>Camera</b>	\$25	<b>Delivery Tray</b>	\$20
<b>Stepper Motor (x2)</b>	\$60	<b>Mailbox Array</b>	\$0-\$20
<b>Servo Motor (x2)</b>	\$30	<b>Power Shield</b>	\$25
<b>Lead Screw &amp; Bearing (x2)</b>	\$150	<b>PCB Components</b>	\$15

**Total: \$430-465**

# Team Roles

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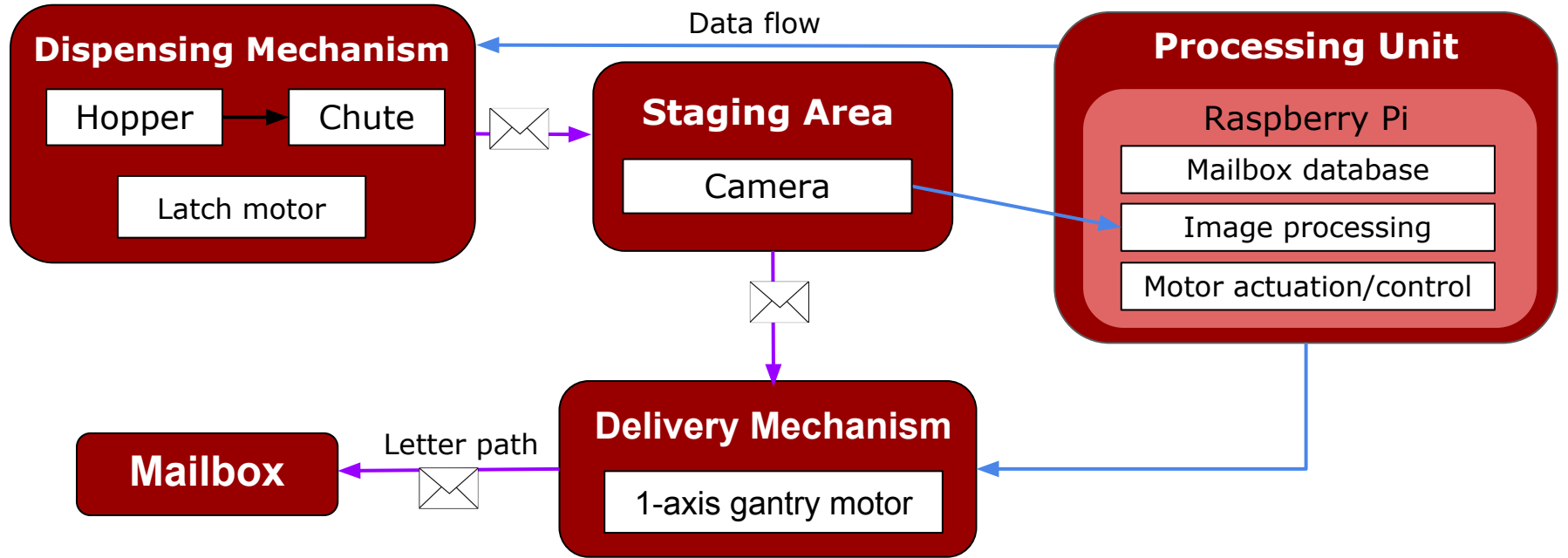
**Team Manager:** James

**PCB Lead:** Long

**Component Integration & Controls:** James & Long

**Image Processing:** Harrison

**Mechanical Systems:** Dan



# Questions?

