Group 3 Project Presentation

Cameron Carter
Ben Sedgwick
Hung Hoang
Jason Liu
Jean-Claude Khacho

Mill Street Brewery’s Needs

A solution that can:

-Measure the amount of dust in the silos

-Know if there’s too much dust for the filtration system

-Be accurate

-Communicate with HMI system

-Easy and cheap to install, maintain, and operate

“Mill Street Brewery needs a system that can measure dust levels in malt silos in order to provide warning of excessive dust conditions that can clog up the filtration system. The system needs to communicate with the existing computer system about dust levels, as well as be accurate and easy to maintain and operate”

Benchmarking:

-Either used a laser or ultrasonic sensor

-Detect dust as fine as 8 μg/m^3

-Had a ~5% accuracy range

-Provided constant data

-Gave a visual and audio alert

-Attached to the top or side of the silo

-Had a “simple installation”

-Cost up to $2000

Target Specifications

-Can detect dust as fine as 8 μg/m^3 with ~5% accuracy

-Can send data to the HMI system and can warn of high dust levels

-$2000 or less including installation and future maintenance

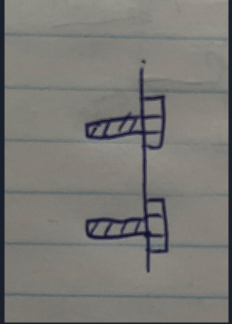
-Can be easily accessed for maintenance

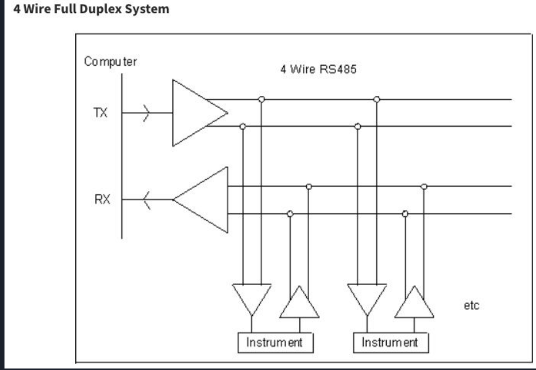
-Can withstand 600 kg/min of malt entering the silo

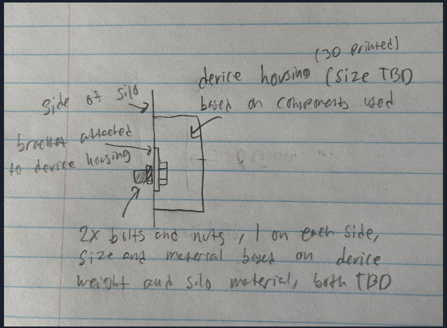
-Can operate between -20 to 80 °C

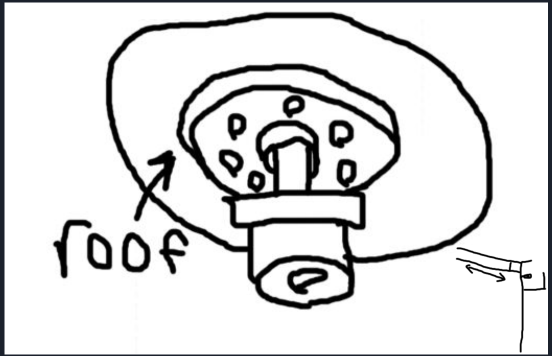
Concept Generation

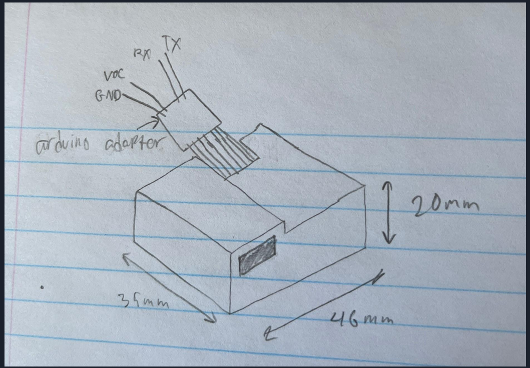
Dust sensing, device mounting, and HMI connection

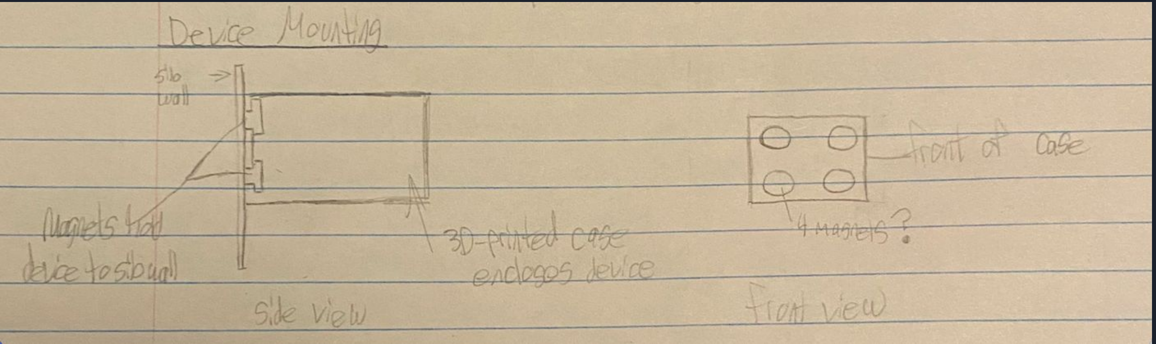


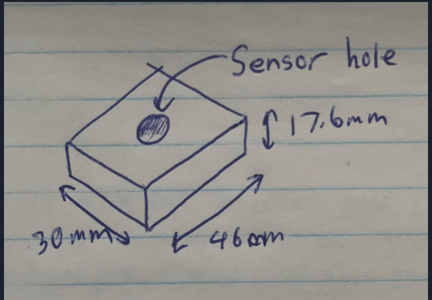












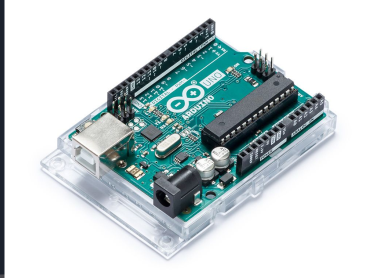
Idea Comparison

Dust detection	Cameron	Ben	Hung	Jason	JC
Concept:	DSM501A Laser Dust Sensor	PM2.5 Laser Dust Sensor	ZH07 PM2.5 Laser sensor	BinMaster NCR80	GP2Y1010AU0F light reflector
Accurately measures dust	>1 micron, but can detect particles under 2.5 µm	0.3-10 µm accuracy	0.3-10 µm accuracy	0.2 inch accuracy, 393 ft distance range	Detects particles larger than 0.8µm in diameter
Detects incoming dust in advance	Possible if installed in silo	Possible if installed in silo	Possible if Installed in silo	Possible	Possible if installed in silo
Make recommendations based on info	Arduino code can recommend things	Arduino code can recommend things	Unsure if it can connect to Arduino	Coding can calculate % of dust and recommend things	Arduino code can recommend things
Operate under different conditions	-10-65 °C	-20-50°C	-10-60°C	-30 to 120	-10 to 65°C
Cost	~$20	$46.90	13$ not included shipping	Not Sure (probable expensive as a quote is required)	Around $15 to $20

HMI communication	Cameron	Ben	Hung	Jason	JC
Concept:	RS485 connection	RS232 cable + Arduino adaptor	RJ45 cable	NCR80(Built in communication device)	USB Cable Type A to B connection
Can communicate with the HMI system	Yes (wired) Max Range: 1,200m	Yes via cable, 15m range	Yes, 328 ft range	Yes (Remote), can be integrated to the plant's PLC	Don't know
Make recommendations based on info	Yes via arduino code	Yes via arduino code	Yes via arduino code	Can send data remotely to existing desktop	Yes via arduino code
Cost	~$10 + adapter	~$3 adapter + ~$15 cable	~$10 + adapter	Not Sure (probable expensive as a quote is required)	~$5

Device mounting	Cameron	Ben	Hung	Jason	JC
Concept:	3D printed case enclosing the device with room for 2 25lb magnets to be embedded	2x steel bolts on side of silo attached to device housing	4x stainless steel bolts to device case	Rail/Pully System	Screw with zinc plated steel bolt and nut from the case
Easy to install	Yes; non-invasive	Requires drilling into silo, but fairly simple	Requires drilling into silo, but fairly simple	Somewhat complex installation(installing rails & chain)	Requires drilling into silo, but fairly simple
Size/Fits where it's meant to be installed	Variable size; likely fits in silo, holds up to 50 lbs	Variable size but should easily fit on the side of the silo	Side or top of the silo	Under the roof of Silo(should fit)	Yes
Accessibility	Could be removed from the inside	Can be unscrewed for maintenance	Can be unscrewed for maintenance	Can be easily accessed using a level & hatch	Can be unscrewed for maintenance
Operates under different conditions	Magnets could likely withstand the expected temperature range	Steel bolts work well under many temperatures, may rust if exposed to water	Stainless Steel bolts that are rust resistant	Completely protected by the silo	Steel is zinc plated for protection against rust.
Cost	$10-15	$0.77/bolt at Home Depot	$1.94/bolt at Home Depot	Home Depot ~$40 for 2 rails + ~$3 per foot for steel chain + ~$10 for pulley	$0.87/bolt at Home Depot

Combined Conceptual Design



-PM2.5 laser sensor connected to an Arduino

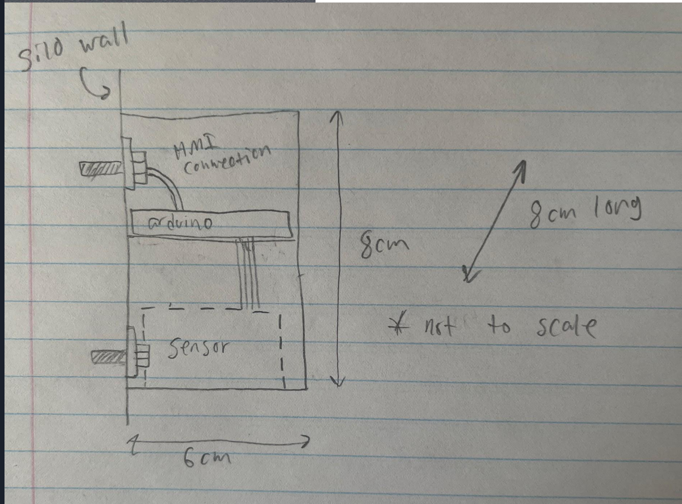
- Most accurate, designed to connect to an Arduino

-RS485 cable to connect to the HMI system

-Reliable, long range, cheap

-3D printed housing with 4 bolts

-Cheap, easy to install, easy access for maintenance



Client Feedback

-HMI connection cable was a bit overkill, only need to run a 4-20 mA current

-Installation process should work as intended

-Environment inside the silo can be very harsh at times, the device has to withstand it

-Have to ensure that the device is foodsafe, can't have pieces breaking off

Detailed Design

-3D printed housing, 250x76x60 mm

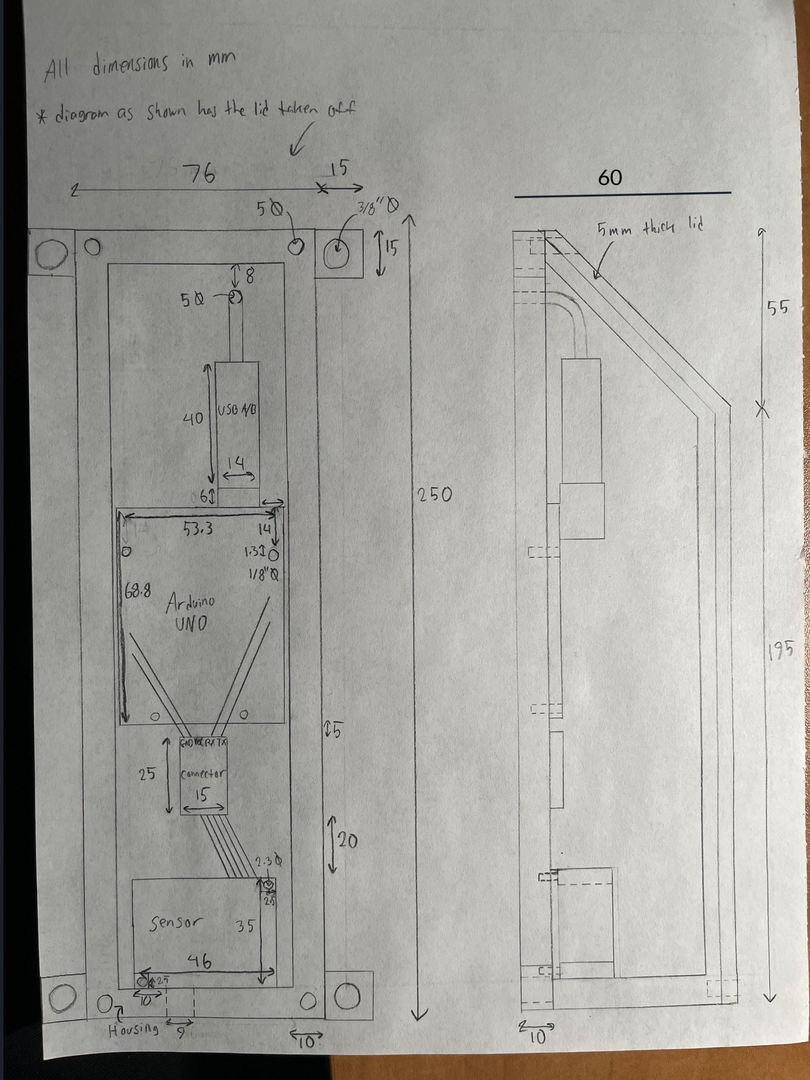
-Slanted top to reduce impact, removable lid for maintenance

-4 bolts, one on each corner to mount it

-Sensor mounted at the bottom, pointing downwards

-USB-A/B cable attached to the Arduino, adapted to I2C to the HMI system

-Arduino and sensor screwed in, adapter glued in



Cost and Equipment

-Planned cost to date: $275.61

-Required equipment:

-Arduino IDE (programming)

-Fusion360 (designing housing)

-3D printer

-Phillips screwdriver (assembly)

Adjustable wrench (assembly)

Components:

-PM2.5 laser sensor

-Arduino connector

-Connector cable

-Superglue

-2x 2 mm screws (M2-0.4 x 6 mm)

-Arduino Uno Rev3

-Arduino wiring

-4.8 m USB-A/B cable

-4x ⅛" screws (M3-0.5 x 10 mm)

-3D printed sensor housing

-3D printed sensor lid

-4x 5 mm screws (M5 x 10 mm)

-4x ⅜" bolts (⅜" x 2")

-4x ⅜" nuts

-4x ⅜" washers

Main Associated Risks

-Sensor doesn’t work/doesn’t work correctly

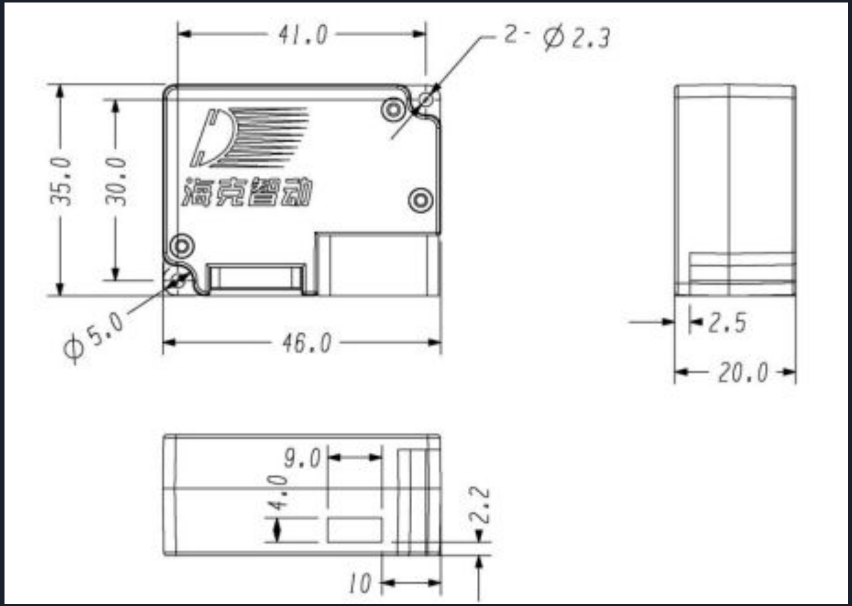
-Adapt code or order a different sensor that we identified earlier

-Mounting/casing isn’t strong enough

-Redesign or change materials

-Inaccurate measurements online

-Redesign or change to other parts that we identified earlier



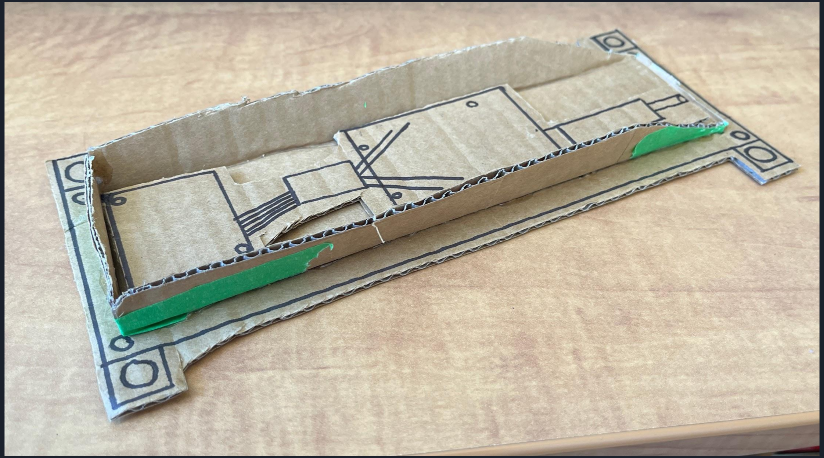
Prototype I

-Cardboard model of the casing and components

-Used to get a physical model to help us with understanding the design

-Allows us to foresee any potential design problems

-Cheap and easy to construct



Results

-Lateral size seems to be appropriate

-Might need to increase the height to fit in the wiring

-Might need to decrease the length at the top to eliminate excess space

-Actual components were inserted at a later date to verify the initial results

Prototype II

-Testing the ability of the sensor to detect dust

-Load the default sensor code into the Arduino IDE

-Attach the sensor and Arduino to the laptop

-Pour grain malt through a funnel into a bag to simulate malt being added to the silo

-Observe and record if the dust concentrations increase when malt is added

Results

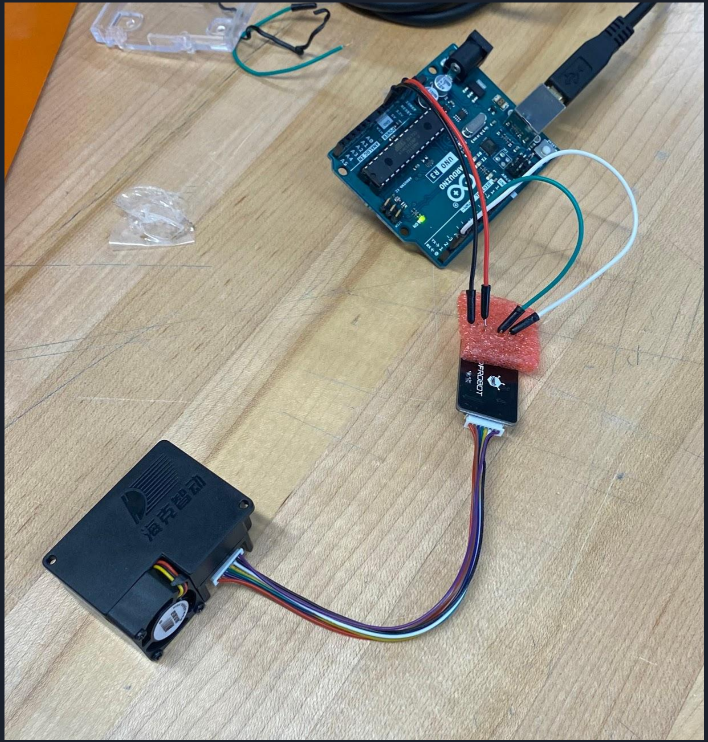
-Ordered the wrong type of jumper wires (M-M instead of M-F) due to misleading image on the product site

-Had to manually hold the wires together, which was difficult

-Sensor needed a stable connection for 30 seconds to transmit data, we couldn't do that

-Code functioned and the sensor briefly activated

-Correct wires have been ordered, the test will be repeated with them



Future Intermediate Prototypes

-3D printed scaled-down model of the casing and lid to test the fit

-3D printed to-scale connection points (holes) to test the fit and if the screws/bolts will insert properly

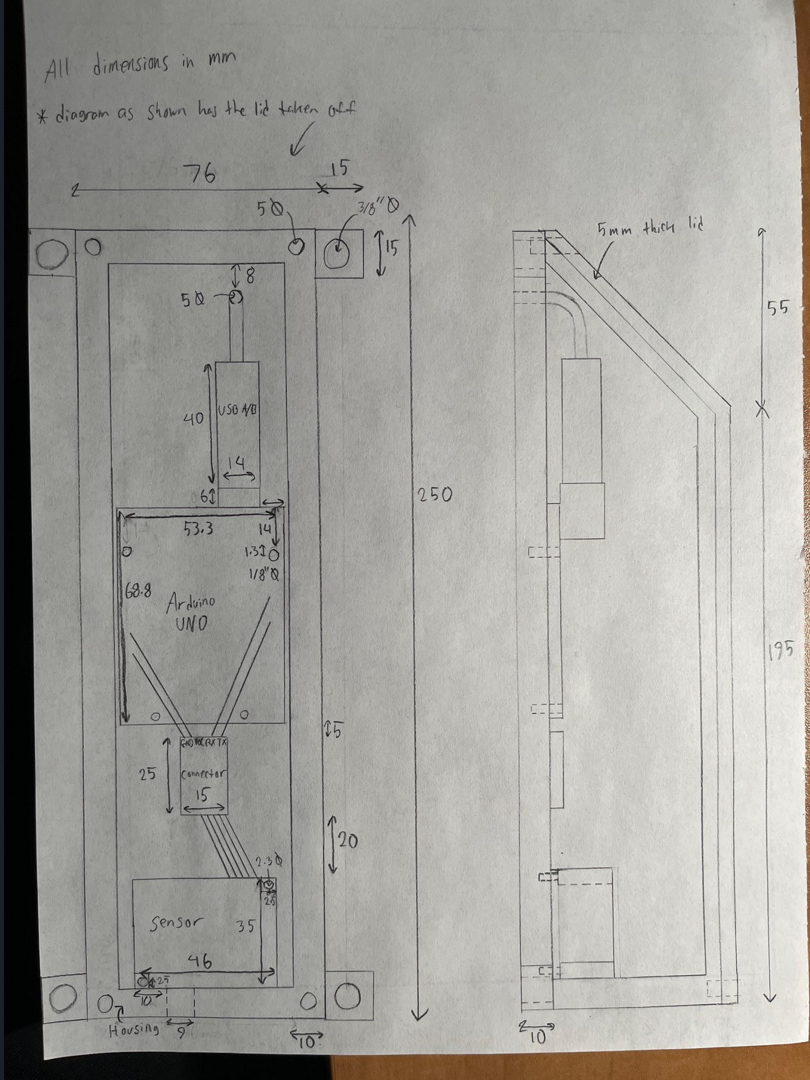
-Repeating the test from prototype II with our final code

Future Prototype III

-Fully constructed, functional prototype as outlined in the detailed design (with modifications based on previous prototypes)

-Repeat the prototype II test yet again to ensure that the sensor works inside the casing

-Get ordinary people to look at our code output to determine if it's understandable



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What's Next?

-Testing the system when connected to the actual HMI system

-Testing the durability and performance of the device in an actual silo environment

-Defining a proper manufacturing process once the design has been finalized

What We've Learned

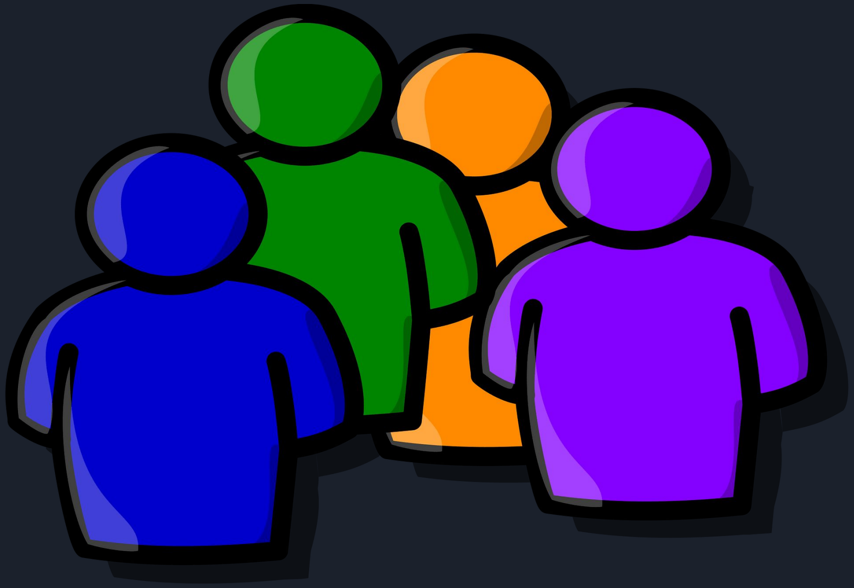
-Things can and will go wrong! But there's nothing wrong with that

-Learning from mistakes is the best way of learning

-An open mind is the best solution to problems

-Collaboration is everything

-Planning and scheduling works



Thank You!

Questions?