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Team B8

MICROGREENS...?



The Good:

- + **Low overhead costs**
 - + Seeds, water, light, soil/grow medium, 1020 trays
- + **Fast growing**
 - + 1-2 weeks from seed to harvest
- + **Incredibly healthy!**
 - + 4-40 times the nutrition of adult version (depending on species)
- + **Rapidly growing market**

The Bad:

- **EXPENSIVE!**
 - Up to \$80/lb. or more
- **Very labor-intensive**
 - 5-6 hours per 1020 tray
- **Very detail-oriented**
 - Humidity, temperature, water, air flow, soil quality, etc.
- **Marketability requires consistency!**

USE CASES

- Reduce labor costs
 - Reduce seeding time
 - Entirely remove need to care for crops while growing
- Simplify complex cultivation details
 - Automatically optimise growth conditions to specific plant climate preferences
- Maintain rigorous food safety standards
 - Comply with all recommendations and guidelines in the FDA FSMA Produce Safety Rule (80 FR 74353)



Project Area Coverage: Hardware, Software, Signals

REQUIREMENTS: FEATURES

- Grow at least one “1020” tray of microgreens per cycle
 - Dimensions of internal chamber are able to fit a 10” x 20” x 2” bin with enough head room for plants to grow and tool equipment
- Automatically seed new trays
 - Capable of accurately dispensing 1-2 oz. of seeds
- Maintain optimal growing conditions over the course of a grow cycle
 - Judged as a yield ratio (seed weight:harvest weight)
 - Compared to manually grown control via wage equation (next slide)
- WiFi connection to a custom website interface
 - Latency <1s

REQUIREMENTS: LABOR COSTS

- Target sale price will depend on plant
 - Roughly \$35/lb target sale price
- Compared against manually grown controls
 - Control set at same sale price regardless
 - Aim to roughly double the wage via MiGroBox
- Wage equation will quantify benefits of automation



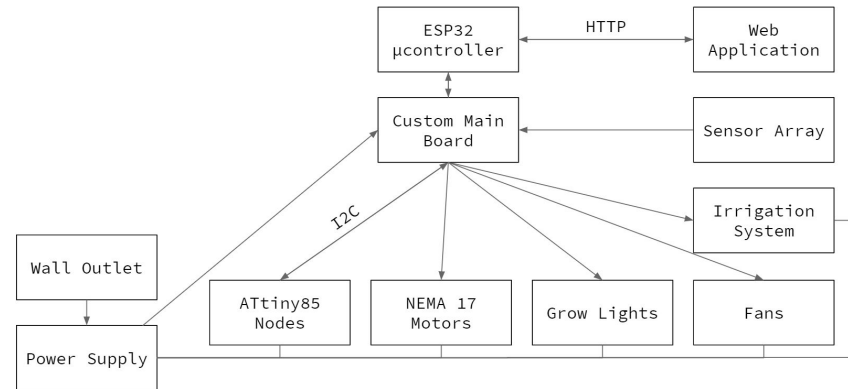
	MVP	Target	Target+
Hourly Wage	\$7.25/hr. (minimum wage)	\$14/hr. (<u>average hourly farm wage in USA</u>)	\$37/hr. (<u>average USA farmer salary</u>)

TECHNICAL CHALLENGES

- Coordinating massive number of inputs and outputs
 - Multiple sensor inputs and actuator outputs of varying types need to be made sense of
 - Custom circuitry to handle various specifications
- Environmental safety of electronics (integrity)
- Plant unpredictability
 - MiGroBox is supposed to run unattended - what if something goes...grows...wrong?
- Maintaining cleanliness
 - Could create significant additional maintenance labor
 - Design must minimise dirt collection and be easy to clean
- Increasing efficiency to the point where it's worth owning and using a device to farm microgreens
 - To what degree do you have to build it for them to come?

SOLUTION APPROACH: HARDWARE

- Create custom main board to house stepper motor drivers, peripheral electronics, and central microcontroller
- Central microcontroller: ESP32
- I2C communication between slave ATtiny85 nodes
- UV LED and RGB LED grow light strips
- 2 axis CNC using Nema 17 stepper motors
- Frame made from 80/20 aluminum extrusion



SOLUTION APPROACH: SOFTWARE



- ESP32 running RTOS with ported GRBL
 - Likely FreeRTOS but still undecided
 - Programs over top either written in C or CircuitPython
- Website interface built in Django
 - Simple GET and POST HTTP requests
 - Read sensor data and control machine manually for testing
 - Set device to automatic grow mode for final product
 - Store and display information about crops

TESTING, VERIFICATION & METRICS

- Constantly growing microgreens each week
- Compare automated microgreens quality vs. manually grown
 - Yield ratio
 - Shelf life
 - Flavor
 - Color



TESTING, VERIFICATION & METRICS

$$\frac{(Sale\ Price)(Yield) - (Seed\ Price)(Seed\ Weight) - (Other\ Overhead\ Costs)}{(Labor\ Hours)} = Hourly\ Wage$$

- Wage is the core metric driving the project
 - Central goal is to increase value of time spent growing microgreens by reducing hours
- Sale price set to be equal to manually grown control group
 - We will attempt to package and sell locally
 - Price will potentially shift to reflect quality

TASK DIVISION

Greg:

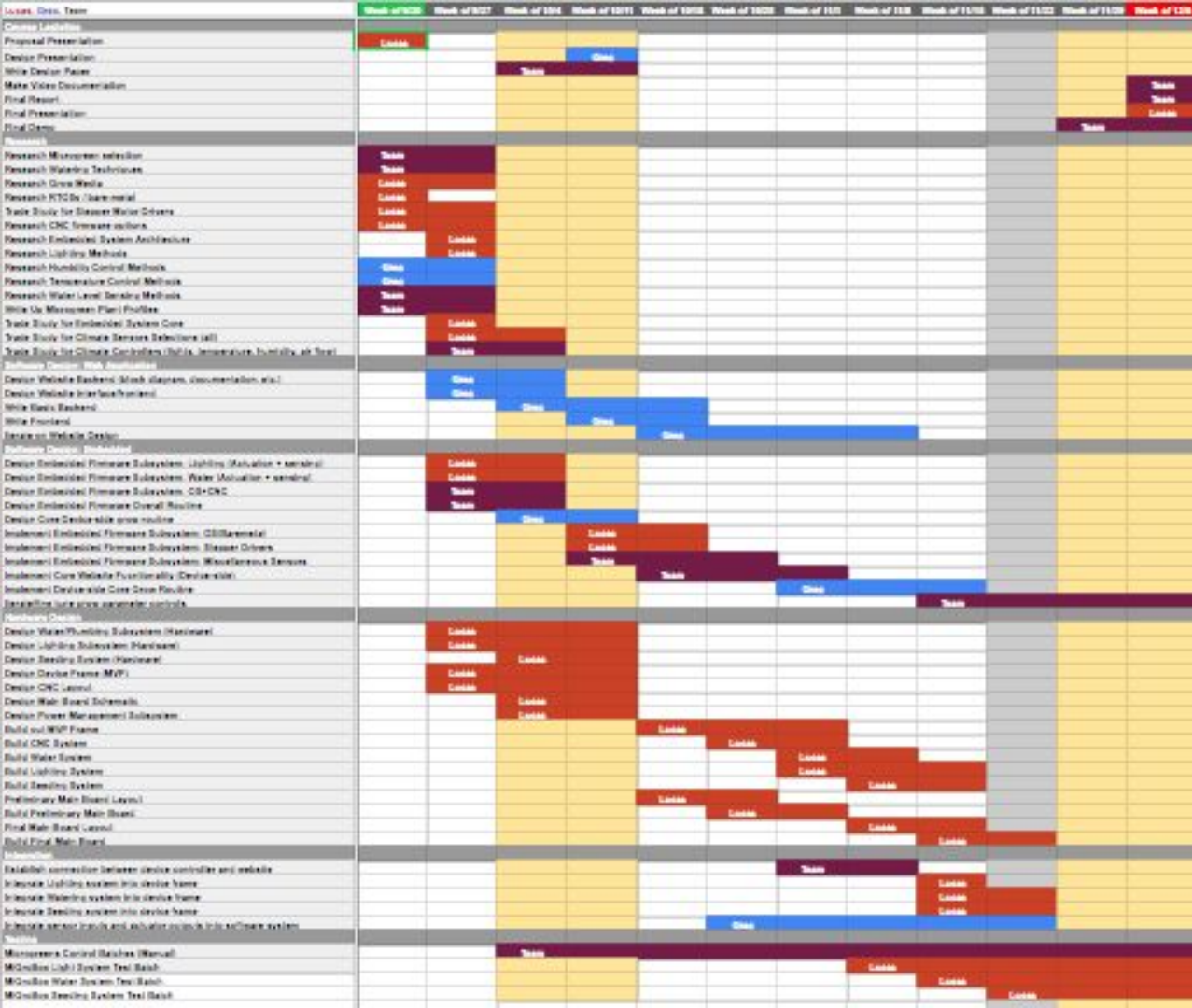
- Website backend
- Website front end
- MiGroBox grow routine software
- Embedded software
- Manual microgreens cultivation
- Access to on-campus facilities

Lucas:

- Hardware design and implementation (mechanical and physical)
- Embedded software
- Microgreens research
- MiGroBox live testing vs. manually grown microgreens



Guess I'm a farmer now



SCHEDULE

- Core hardware will take a lot of work
- Limited by remote location
- Tight schedule but ample slack time built into tasks