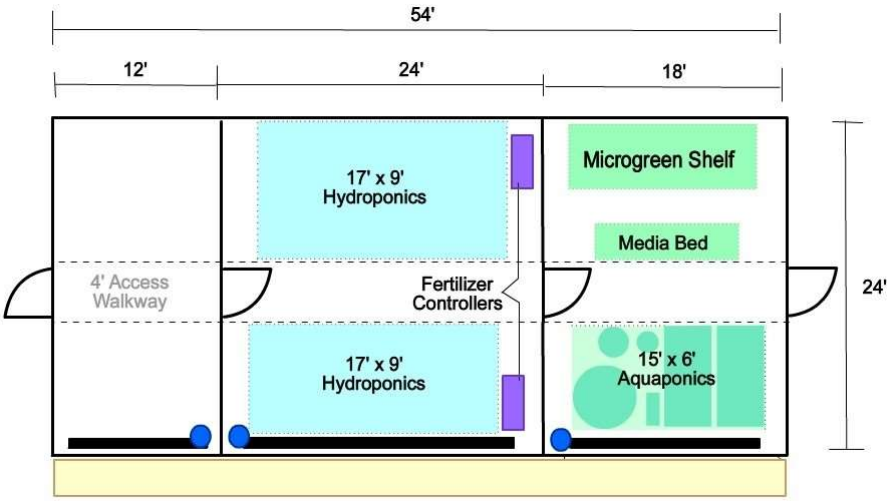
Hydroponic Greenhouse Automation

- **Problem:** The Hydroponic Greenhouse made over $29,000 last year from selling produce to Mason Dining. However, up to 30% of the produce in the greenhouse is lost due to root-rot diseases, over/under-watering and numerous other factors.
    - Currently, irrigation pumps are on timers and may cause over and under-watering as the timers don't account for changes in temperature, light levels, and humidity.
        - Additionally, the Hydroponic Greenhouse relies upon a significant amount of volunteer labor to complete tasks that could be automated.

- **Desired Outcome:** Reduce disease prevalence and reliance on manual labor to improve crop yield through automation and technological implementation.
    - Develop a detailed operational plan for the implementation of the following:
        - Design a system that allows for live-monitoring as well as the collection of data/information displayed in easy-to-read graphs/spreadsheets so Hydroponic Greenhouse staff can utilize data/information to maximize crop-yield.
            - Examples: dissolved oxygen sensors, existing pH and fertilizer concentration sensors, LED light sensors, CO2 meter, etc.
        - Equipment utilized should allow for remote and live-monitoring and adjustment of all environmental controls as well as crop status via smartphone. For example, the adjustment of water/feed levels, fan operation, turn on/off equipment, etc. Additionally, the system designed should send alerts/notifications when equipment fails, encounters an error, or detects an anomaly. This way, staff will be able to address the issue immediately and mitigate any potential impact to crops.
        - NOTE: there are systems that can be purchased and implemented (such as this one) for hydroponic automation. However, we don't want to purchase a pre-built system, but want one built "in-house." For various reasons including student/staff/faculty engagement/involvement and fiscal responsibility.
- **Resources:**
    - Suggested Components:
        - Moisture sensing modules/components of soilless root zones that will turn on the pump for irrigation. This will prevent overwatering, which causes fungal and insect diseases. Moisture sensors will be placed in each tomato media bed and each system of horizontal NFT (4 tables/racks) with channels and vertical zip-grow channels, which grow lettuce, herbs and microgreens.
            - Helpful Hack: many boats utilize automated sensors for pumps, monitoring, reporting, etc. These technologies are specifically designed to be used in high-humidity and moisture-rich environments. Pairing maritime technology with Raspberry Pi, Ardurino, and your knowledge/skills might be a great combination!
    - Existing sensors: Each tank has a "fertroller" or fertilizer controller that has pH sensors, fertilizer concentration meters, and water flow sensors. They are made by bluelab and Crop King. They contain wire connections that allow you to receive the data, but it has never been utilized. There are also Wadsworth environmental controllers in each room that turns on and off the heating and cooling systems automatically based on live temperature readings. These devices store a week's worth of temperature data, that has never been downloaded and saved because the USB drive to do so costs over $600.
    - Greenhouse and Hydroponics layout (Tomato Beds are in the Aquaponics area listed below as well as some of the Microgreen racks) - Ethernet connections are available:



Tomato Media Beds

Microgreen rack, top shelf

Nutrient Film Technique (NFT) Channels in middle room

- Light sensors should be used to detect when LED grow-lights are needed or not. Light sensors will ensure that maximum light is provided to increase plant growth without wasting electricity. The light sensors will monitor and report day-length (number of hours of light available for maximum plant growth) in real-time to ensure that LED grow-lights are turned on/off for plants to be exposed to 16 hours of light per-day, which is how much is needed for optimal growth.
- LED grow lights are in the middle room and over the tomato beds: