EML 4501 –Fall 2020 – Group 12
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BioBox Autonomous Bioreactor

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Abstract

Increasing the capabilities of laboratories that use recombinant DNA is the main priority for the redesign of the existing microbioreactors. Improving upon existing designs, the BioBox autonomous microbioreactor can control two separate environmental chambers, liquid handling, and measuring solution properties such as optical density and fluorescent intensity. By improving upon existing microbioreactor technology, this system aims to bolster the speed and research capacity of such laboratories. The BioBox's driving concept is to provide the most user-friendly handling capabilities, minimizing costs associated with system errors and skewed experimental data.

Product Functionality

The autonomous microbioreactor was designed to culture cells in various environments including exposure to differing temperatures, gases, and levels of light emissions. The system is housed inside of an extruded metal frame design where the primary section houses cultures in poor atmospheric conditions, and the evolver houses the cultures in favorable conditions. The liquid handling movement system is controlled by a stepper motor on an x-y-z axial system. The system is heated and cooled by the same system, and the temperature is dispersed within the system by a fan. There are ten different gas dispensing hoses with five directed into the evolver for favorable conditions and five directed into the primary section for unfavorable conditions. There are exhaust pumps to rid the system of the gas previously used in between tests.

Gas Regulator Dual System

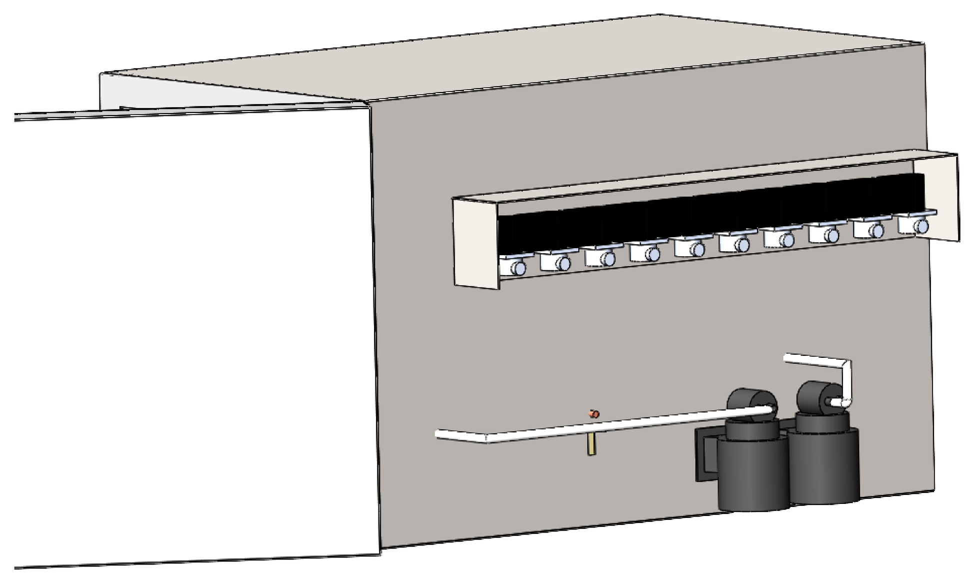


Figure 7. The gas regulation system features a dual control system for the evolver and the main chamber. This setup allows the cultures to be exposed to different gasses within the BioBox simultaneously. An exhaust pump is present in both chambers to relieve the potentially hazardous gasses

BioBox Bioreactor

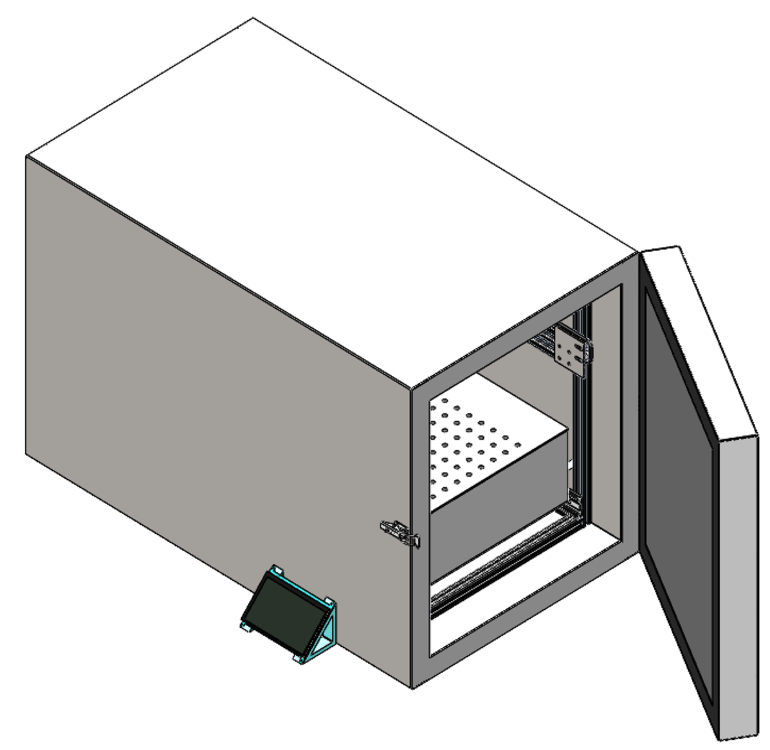


Figure 1. Full assembly of the BioBox Autonomous Bioreactor. This system meets the requirements of a BSL-2 lab space and is suitable for research and classroom use.

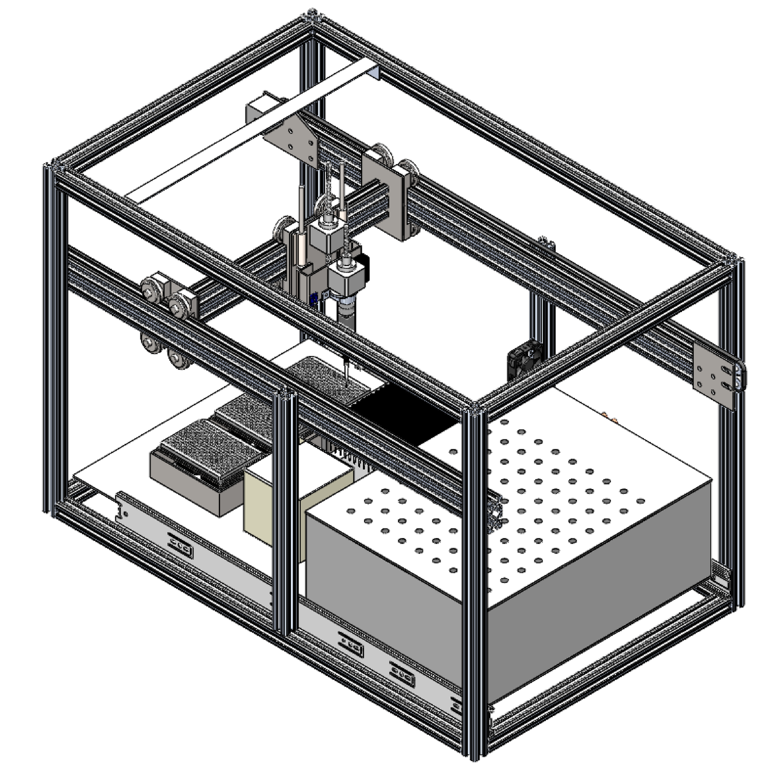


Figure 2. Assembly of the BioBox Autonomous Bioreactor without the external frame shown. This system is composed of the light emission monitor, temperature control, gas control, shaker, liquid handling, and liquid movement subsystems.

Syringe Movement System

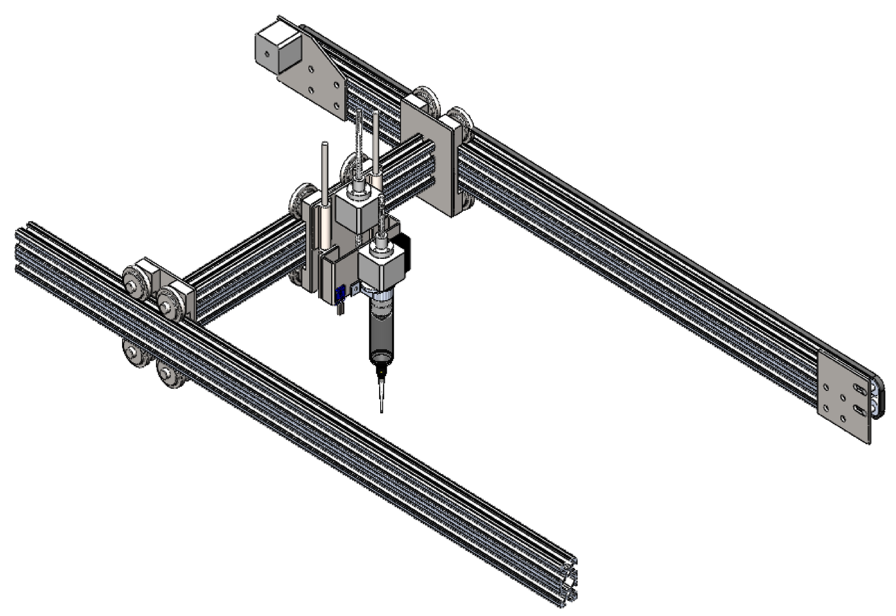


Figure 4. Full axial control over syringe movement throughout the system. This modular system can be placed within the main system enclosure easily and features X-Y-Z control..

Frame Accessibility

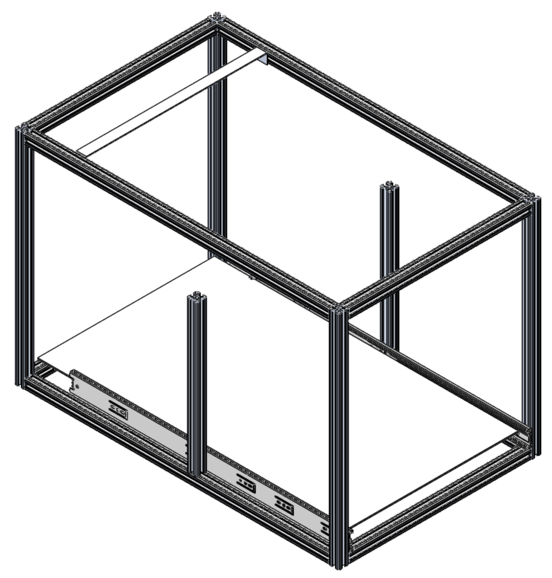


Figure 5. The internal components of the BioBox are easily accessible by the laboratory operator. The frame is modular, allowing for the installation of different subsystems.

Temperature Control

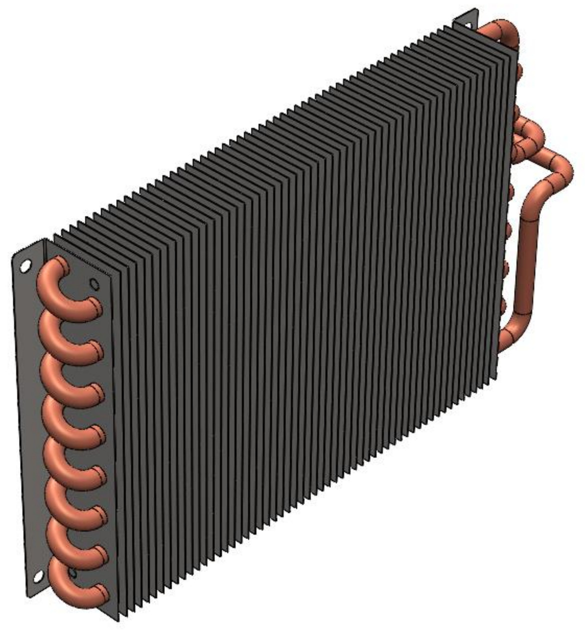


Figure 8. A fin coil heat exchanger will be used to regulate the temperature within the evolver and main chamber between 4-70 degrees Celsius. A fan is used in conjunction with the heat exchanger to create a forced convection environment which will improve heating/cooling speed. The heating/cooling element from a water cooler found in most office spaces will be used to vary the water temperature within the closed loop system.

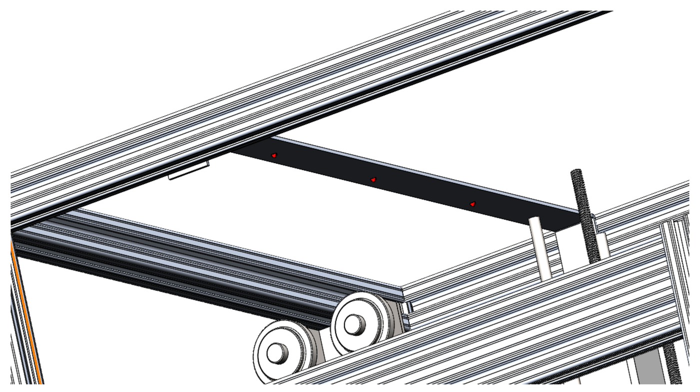
Cost Estimate

OTS Parts: $6,592.47
Raw Materials: $1,594.18
Manufacturing and Labor: $450
Energy Consumption: $0.1165/kWh
Assembly Labor: $49.75

Total Estimated Cost: $8,686.40

Light Emission Monitor

Figure 3. The light emission monitor's LEDs provide optimal wavelength for growth and sterilization of cultures. Additionally, the LEM measures the fluorescent intensity of the media for research analysis purposes.



Disposable Liquid Handling Syringes

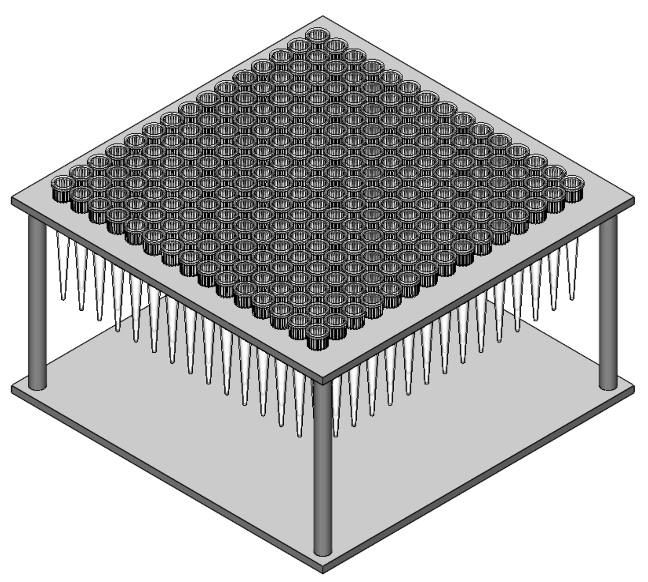
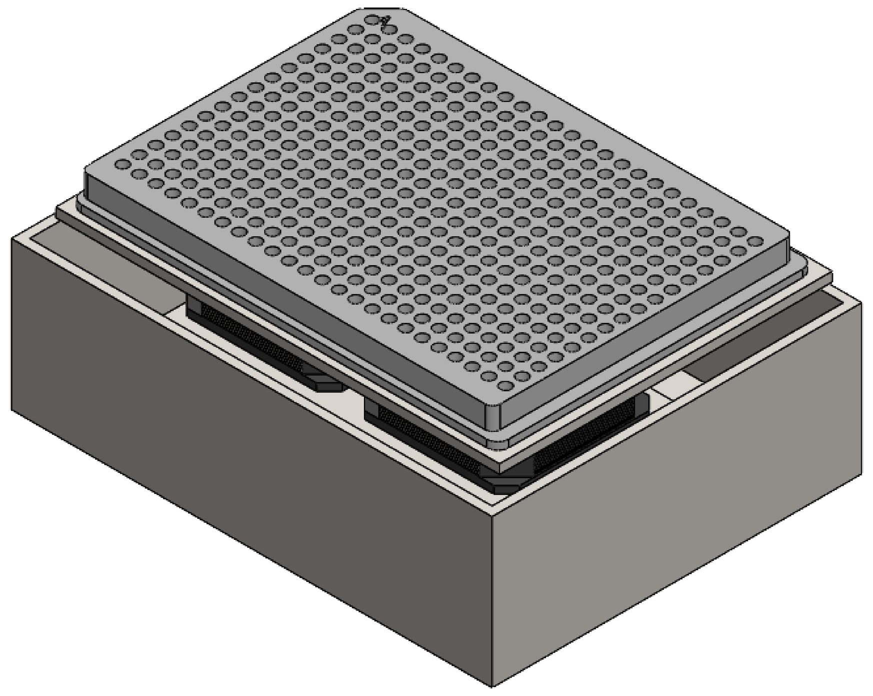


Figure 6. Disposable syringes attach to the liquid handling device. By using disposable syringes, there will be no cross contamination between cell cultures. These syringes can be replaced easily by the operator using a sliding door mechanism once all syringes have been used.

Shaker

Figure 9. Three shaking patterns provide optimal shaking for different strains of bacteria. Linear, orbital and double orbital motions shake the cell cultures.



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Customer Needs Map

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