Biowall Development for the West Lafayette Public Library

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Introduction

A Biowall is a device that cleans indoor air using plants and growth media. The growth media contains a microbe community that captures and breaks down Volatile Organic Compounds (VOCs), and Particulate Matter (PM).

Air is pulled through trays filled with Coconut coir, activated carbon, and aerating chips. The roots of the plants in the growth media then absorbs the broken-down contaminants into the plants. This process is also identified as Phytoremediation

The building of the Biowall was led by four students from varying education levels and background, and with the assistance from two student organizations.

Figure 1 presents a rendering of the new generation of the Biowall that is designed to be installed in the Children's section of the West Lafayette Public Library. Consisting of 4 plant trays, it pulls contaminated air through the trays and exhausts clean air from the fan hole at the top.

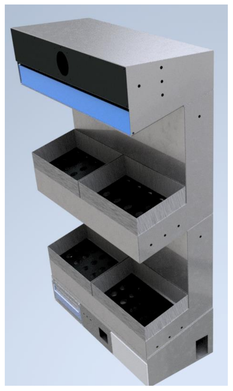

Figure 1. *Rendering of the new Biowall design*

Objectives

The Biowall needs to be able to:

- Fit in the space available in the West Lafayette Public Library
- Be engaging with children.
- Explain how it works and improve on the previous generation

To clean air effectively the airflow must be less than 0.1m/s (20ft/min) as presented on Figure 2. The Biowall was designed to operate at this configuration by multiplying the total velocity with the tray area to get a total air flow of 60 cubic feet per minute (cfm).

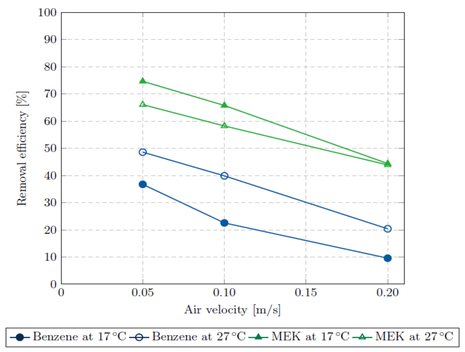

Figure 2. *Effect of airflow and biofiltration of MEK and benzene (Llewellyn et al., 2002)*

Methodology

Based on research done in 1970 by NASA and Bill Wolverton, certain plants have been identified to clean indoor air, presented in Figure 3 are a few of these options.

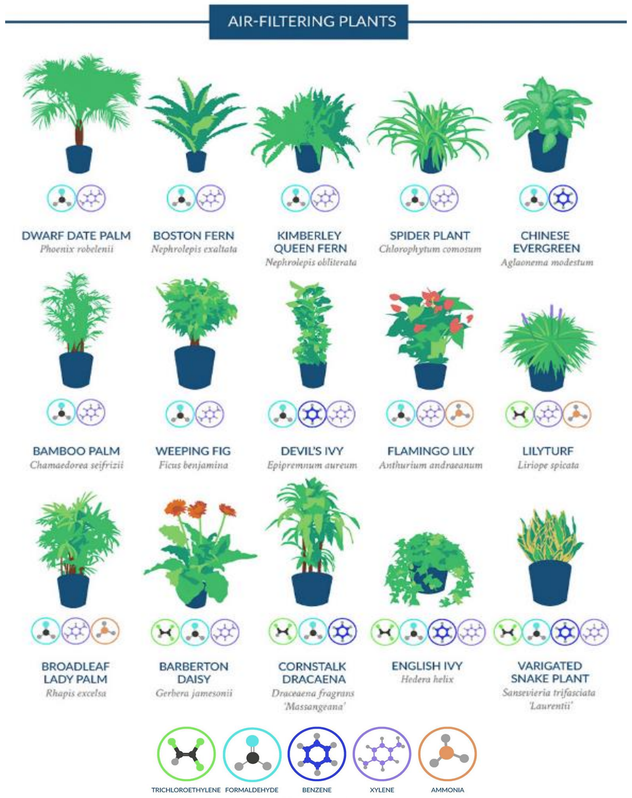

Figure 3. *NASA Guide to air-filtering houseplants (Love The Garden, n.d.)*

As air moves through the trays, the growth media becomes very dry. Thus, the plants picked out for the Biowall needed to be resistant to dry climates and need to be hardy plants.

The Biowall after installed in the West Lafayette Public Library will publicize the technology that Purdue has been working on since 2011. The new Biowall will be the third generation of Biowalls.

To complete the project, students from two student organizations were recruited, American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Purdue Student Branch and Boiler Green Initiative (BGI).

The students worked with Professor Hutzel (Advisor), Dhanurja De Silva (Team lead), Melissa Freed (West Lafayette Public Library) to design, build, assemble, and test the Biowall before it is moved to the Library.

Another group that benefitted from this project were the students from the MET 421 Spring class. The students from the class were given the opportunity to measure data directly from the Biowall to learn the commissioning process before the installation of the Biowall

Impacts

The designing of the Biowall allowed students to improve their Computer Aided Design (CAD) skills, Computational Fluid Dynamics (CFD), and problem-solving skills while working with a metal machine shop and non-metal laser cutter.

A CFD model was built to test the air flow and to ensure balanced airflow throughout the trays. A screenshot of this simulation is presented on Figure 4.

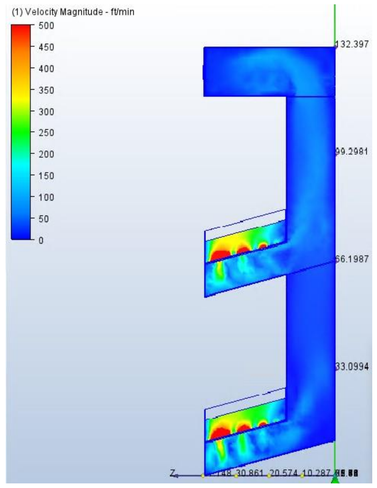

Figure 4. *Screenshot of results from Biowall simulation from Autodesk CFD*

The new Biowall is being built to fit in the space at the West Lafayette Public Library, presented in Figure 5. Located at 208W Columbia St, West Lafayette, a space in the Children's Section of the library is dedicated to the Biowall.

Figure 5. *Outside view of the West Lafayette Public Library*

Figure 6 presents a rendering of the Biowall in the space in the Children's Section of the Library. The space which is about 60 inches tall, 41 inches wide, and 18 inches deep, located 51 inches above the ground is used to store the Biowall.

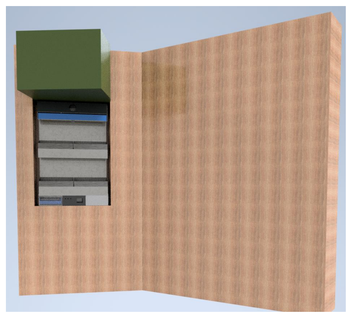

Figure 6. *Rendering of Biowall in the space*

Once installed, the Biowall and the information shared from the project will benefit the West Lafayette Community and everyone that visits the Children's section of the Library.

Reflection and Conclusion

The Biowall in its current state is presented in Figure 7. Plants, lights, and fan installed, the watering system is currently being completed.

Figure 7. Current status of the Biowall

Assembly of the Biowall is currently in progress while data collection will continue for few more weeks. Table 1 presents the planning and steps for the successful completion of the project in more detail.

Table 1. Steps for the completion of the Biowall

Task	Summer 22		Fall 22		Spring 23	
Design						
Fabrication						
Testing						
Installation						
Monitoring						
Training						
Outreach						
Analysis/Results						

One of the few the challenges that students came across was the lack of information on why some decisions were made in the past designs.

The students planned together to make a list of the potential solutions and discussed the engineering constraints and narrowed down solutions to finalized on the best solution.

In the future, explaining why a decision was made to the future readers will be beneficial such that they can further improve the technology

Acknowledgements

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