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HygroSpores:

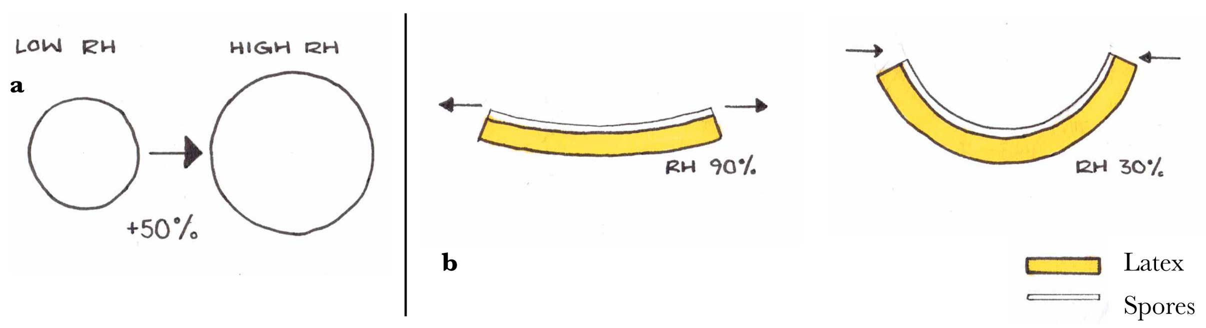
programming hygromorphic bacteria for architectural applications

1.0 | Introduction

This research looks use a deep understanding of natural processes to challenge traditional building operation systems, which currently account for over 36% of the UKs carbon emissions [1].

Understanding the sophisticated and efficient kinetic responses seen in nature to stimuli such as mositure and light provides opportunity to directly incorporate organic materials as a zero-carbon alternative to mechanical power in an architectural setting.

Bacterial spore hygromorphs, an active material with moisture-sensitive adaptive systems, rapidly respond to changes in humidity providing potential application in architectural settings where internal and external environmental conditions can change suddenly [2]. When bacterial spores are applied to the surface of latex, they create a hybrid material which flexes in different humidity levels. The hypothesised application for this material is as a membrane, which acts like pores of the skin, allowing buildings to sweat as humidity rises; maintaining a comfortable internal environment and without the use high energy consuming mechanical systems.



a) the expansion capability of a *B. subtilis* spore **b**) affect of *B. subtilis* spores on the passive layer

2.0 | Aims

My aims were to:

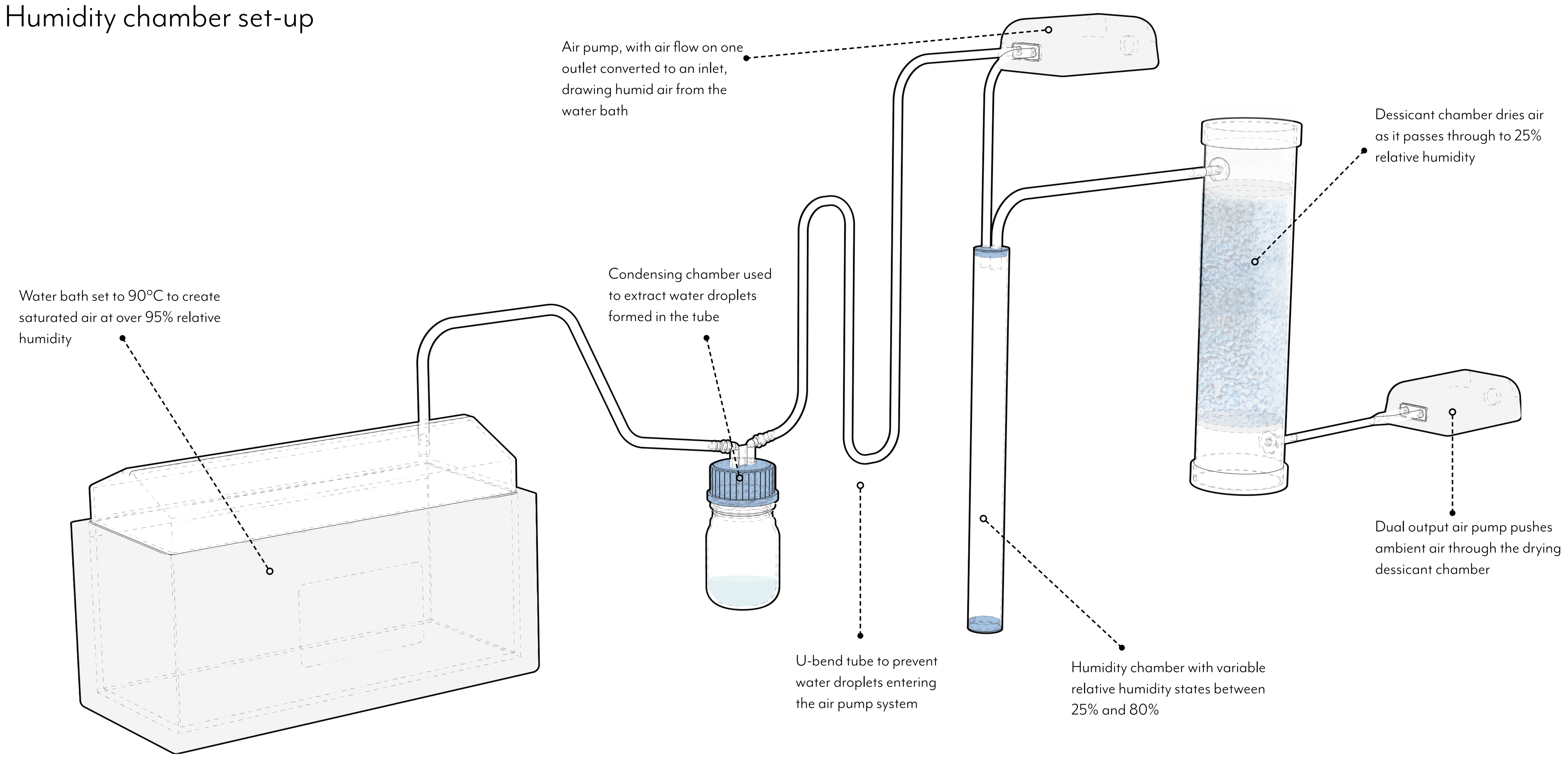
- Create a humidity chamber which ranges between 25-80% relative humidity for experimentation
- Refine methodology to increase deflection of latex
- Test the effectiveness of spores applied on latex strips in a concertina pattern

Whilst the primary motive for my the research was to improve understanding of the properties, characteristics and responses of bacteria spore hygromorphs, another research defining factor was the fabrication of a humidity chamber. Creating a bespoke chamber was integral to the research process: without it, experimentation on the bacterial spores was not possible, however, laboratory specific equipment costs in excess of £15k. This element of my research addresses the issues around funding limiting access to research.

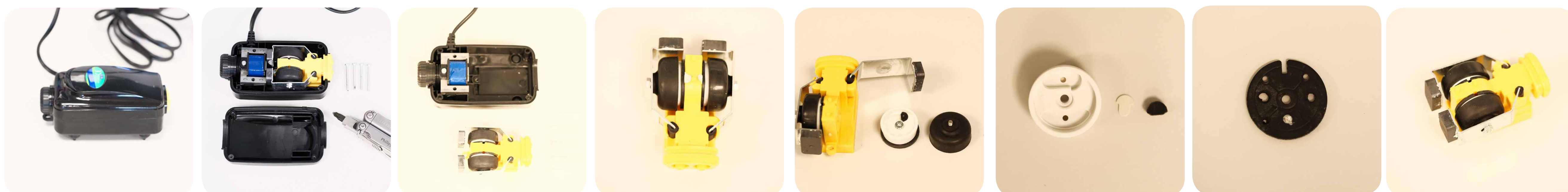
3.0 | Methods

The following images show the humidity chamber set-up along with images of other fabricated / altered equipment required to pursue the research project.

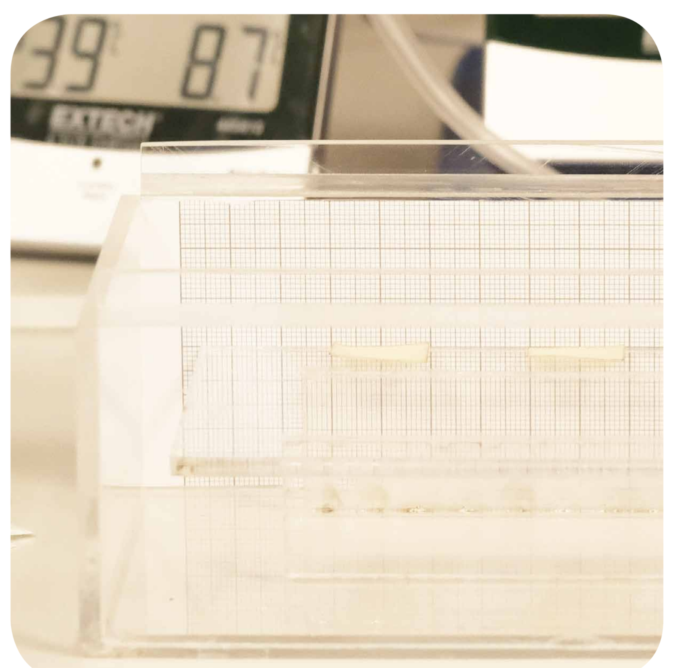
3.1 | Humidity chamber set-up



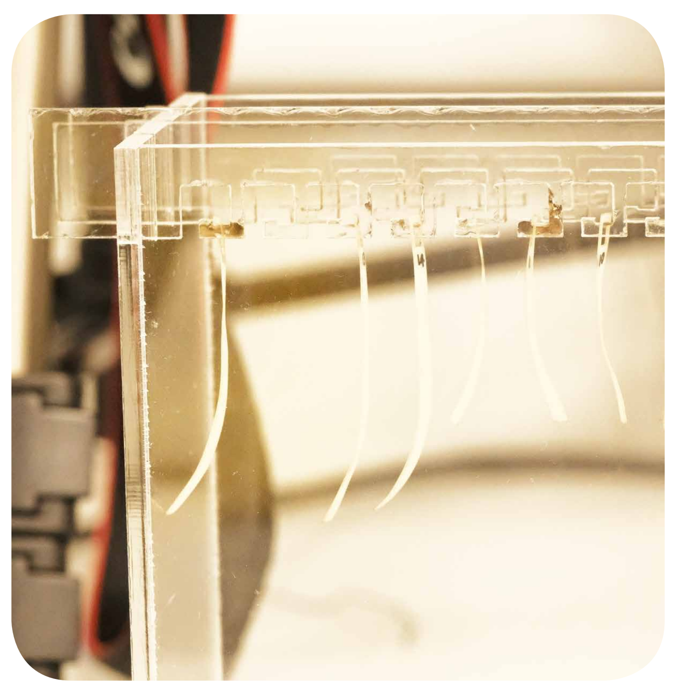
3.2 | Air pump outlet flow reversal to inlet



3.3 | Pipetting chamber

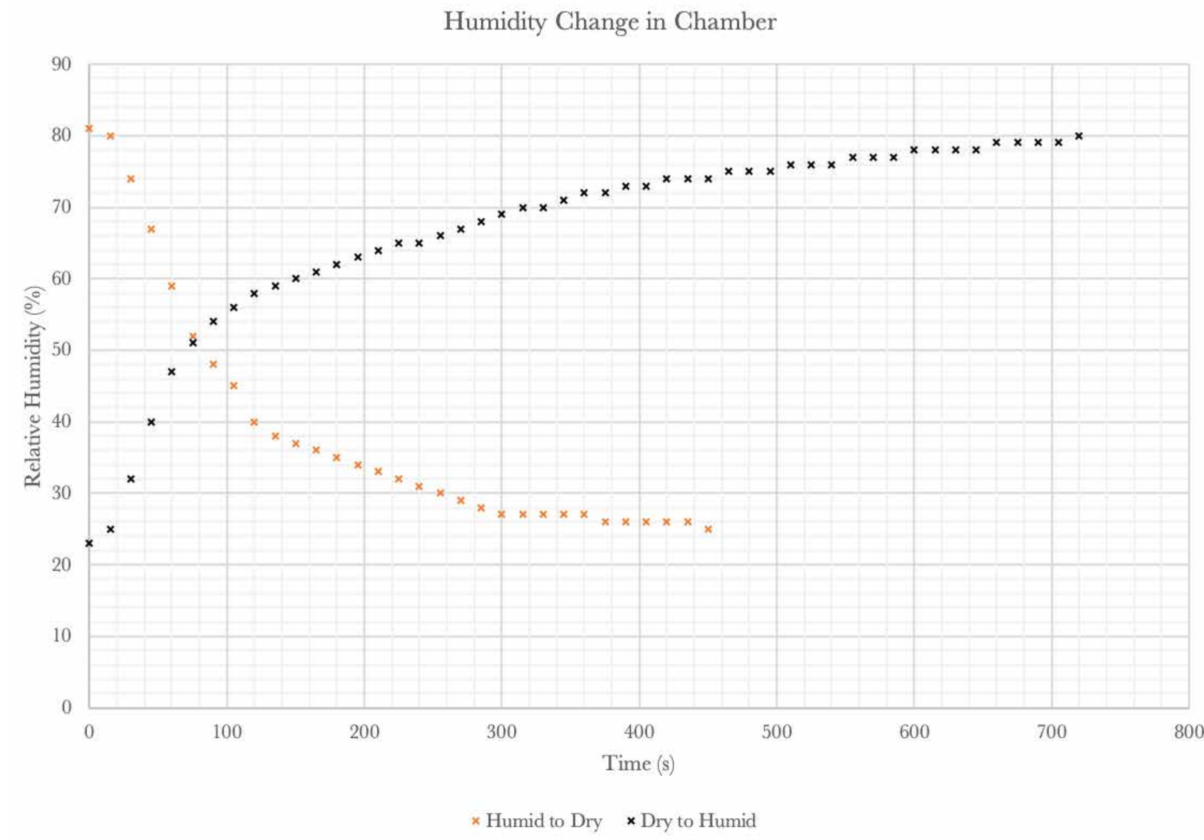


3.4 | Spore-coated latex strip holder



3.5 | Humidity tube fabrication

4.0 | Results



The graph plotted above shows the rate of air change in the humidity tube when changing between high to low relative humidity (80% to 25%) and low to high (25%-80%). The results show that the air within the humidity tube can go through a cycle of high/low/high humidity in just under 20 minutes. It also shows that it takes longer to saturate the air in the chamber than it does to desaturate it.

5.0 | Conclusion

I was able to produce a humidity chamber using bespoke equipment that was successfully able to change the relative humidity of air in the humidity tube between 25%-80%. The total cost of the chamber, including the retail price of the water bath and dessicant chamber, was £375 making it 97.5% cheaper than the specialist equipment available from typical laboratory equipment suppliers. Whilst the equipment is somewhat crude in comparison to its retail counterpart, it does show that, with first hand experience and specialist crafting skills, cheaper equipment can be fabricated to make research more accessible. As an architecture student, I was able to approach the humidity chamber issue as a design challenge that required careful consideration and craftmanship to resolve. This was fabricated in a matter of weeks in order to continue with the main objective of the research, however, the design could easily be refined for a faster, more accurate and programmable system. This process has shown that a cross collaboration between crafting industries and research could result in the fabrication of more affordable equipment, making research more accessible.

6.0 | References

[1] Department for Business, Innovation and Skills. Estimating the Amount of CO2 Emissions That the Construction Industry Can Influence. [Online]. 2010. [Accessed 27 May 2019]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/31737/10-1316-estimating-co2-emissions-supporting-lowcarbon-igt-report.pdf
[2] Holstov, A., Bridgens, B. and Farmer, G. Hygromorphic Materials for Sustainable Responsive Architecture. Construction and Building Materials, 2015, 98 (November) pp. 570-82. https://doi.org/10.1016/j.conbuildmat.2015.08.136