Master’s Project Selection

# Kh-01 (Kamyar) A Swarm Robotics Approach to Habitat Reconstruction

## Project Brief

55% of the world’s GDP, an estimated US$58 trillion, is dependent on nature or its services, and yet over the last 50 years we have seen a 73% decline in wildlife populations, mainly due to habitat destruction led by climate change, and the agriculture industry. One biome most heavily affected is the rainforests: 17% of Amazon rainforests have been lost, and a further 17% damaged since 1988. These rainforests are often inaccessible due to ecological complexity, and habitat protection/reconstruction measures by local labour forces and are certainly incapable of meeting the rate of habitat destruction. As a result, we must turn to technological intervention. This project aims to first evaluate existing measures for habitat protection/reconstruction in rainforest environments, identifying key drawbacks. We would then hope to evaluate the utility of swarm robotics in addressing these problem areas, taking practical, technical, environmental and ecological, economic and human (ethical) factors to build a specification and inform a final design.

## Problem Areas

* Manufacturing wildlife corridors in areas largely fragmented by logging and cattle pasteurising
* Repurposing/reconstructing damaged environments following natural disasters to inhabit and preserve local wildlife populations
* Multi-story cattle pasture redesign to prevent/reduce illegal deforestation efforts
* Data collection on biodiversity loss to inform better management of restoration efforts
* Infrastructure design to better facilitate further technological intervention
* Unblocking waterways by removing debris
* Restoration of decommissioned logging or mining sites

## Why Am I Suited?

This project is socially driven with the aim of leveraging the skills as a design engineer in a domain that is desperately in need of intervention. My experience outside the course has been varied, but my interests mostly lie in sustainability. This project will allow me to take the practical skills in robotics and design an intervention that doesn’t just map future problems but addresses them from a bottom-up approach. It will require a vast amount of research into the space, and access to stakeholders may be difficult, but I can build model environments and test on local terrain. The problems here are well established and policy change is too slow to effect: this project offers a large scope to pivot and many opportunities.

# Afp-01(Freddie) On Morphogenetic Modelling and Simulation in Ecological Architecture

## Project Brief

If we stopped all emissions today, the climate would continue to warm the planet for decades to come: it is vital we implement measures for carbon sequestration. Architectural regenerative design allows us to leverage the natural carbon sequestration properties of plant life, along with structural security and biodiversity gains. Until recently, we have struggled to model the seemingly random nature of biological growth, but advances in AI and morphogenetic programming have allowed us to identify the governing equations to accurately model these growth patterns. Functional Structural Plant Modelling (FSPM) models have not yet widely been applied to architectural or civil contexts: this project aims to assess the utility of regenerative measures in various construction and retrofit applications, modelling these structures and simulating their responses over time considering these environmental factors.

## Problem Areas

* Identify scenarios in which biological design in architectural or civil spheres are most impactful
* Establish mechanisms for ensuring desirable qualities within biomaterials (i.e. mycelium stone)
* Modelling morphogenetic growth in 3 dimensions, investigating the accuracy of dynamic point cloud generation, reinforcement learning and mathematical/rule driven/L-function approaches
* Coverting volumetric generated structures into STL/STEP files for testing strength properties for modelling reinforcement (FEA)
* Model carbon absorption, damaged incurred to bonded structure over time etc.
* Inform the design of new structures aimed at working with regenerative plant growth
* Establish the relative ‘randomness’ to build uncertainty values and enforce homogeneous design properties

## Why Am I Suited?

This project is largely inspired by a developing interest in computational architecture and intersects with my existing interest in the field of sustainability, as a former research and development engineer building weather compensation models for sustainable heating alternatives. I envision a greener future for the built environment, and any advances towards that future are beneficial.

# Emd-01(Elena) On Morphogenetic Modelling and Simulation in Ecological Architecture

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# AFP-2 (Freddie) Progressive Primary

After having spoken to Freddie about this project, I am excited by the possibility to design change for a fairer voting system in the UK. Following the recent general election, our current system tends to polarise the population, punishing smaller parties and misrepresenting public priorities in parliament. Electronic voting systems pose many risks (i.e. technical faults, gerrymandering etc.) and so I would be keen to investigate secure ways to implement a new voting system that gives smaller parties better representation and moves us away from the existing 2 party state (i.e. ranked system). There is a possibility here for game theory analysis of acting players and negative biases that I believe could be interesting to explore.

# PPinson-0 (Pierre) Fairer Vaccine Distribution

## Project Brief

Almost 80% of people in high income countries have been vaccinated with at least one dose of the COVID-19 vaccine, whilst only 32% have in low-income countries. This disparity can be explained by several factors: companies acting in the interest of maximising profits, national interest, difficulties in transportation and storage and public perception to name a few. This project aims to build a game theory inspired marketplace for fairer allocation of vaccines, considering a country’s ‘readiness’ (i.e. storage), manufacturing capabilities, macro-economic impacts etc. There is scope in this project to include a sharing economies model for resource distribution (i.e. shared cold chain infrastructure).

## Why Am I Suited?

This project has social change at the core, and offers the potential to leverage data analytics, game theory, sharing economies business models and front-end development. Existing models for vaccine sharing don’t seem to consider the practical distribution factors.

# Kh-01 (Kamyar) Vaccine Transportation Optimisation

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# Sarif-0 (Sheraz) A Swarm Robotic Approach to Habitat Reconstruction

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