Design Brief:
Green Digital Twins

1. **Background:** We are facing serious environmental challenges. One of the biggest is loss of biodiversity. WWF's 2022 Living Planet Report estimates a 69% decline in global populations of mammals, fish, birds, reptiles, and amphibians since 1970. The 2019 Global Assessment Report by the Intergovernmental Platform on Biodiversity and Ecosystem Services: 1 million animal and plant species are now threatened with extinction—the highest number in human history.

There are many factors that are contributing to this problem. One of them is that people are often unaware of the value and potential of the green spaces around them. For example, private garden space in Britain cover about 728,900 hectares, more space than all UK nature reserves put together (https://www.rhs.org.uk/wildlife/in-gardens). Few of them are gardened in ways that improve biodiversity.

2. **Aim:** Your aim in this project is to work in a group to create a "Green Digital Twin" that will help to improve people's **awareness**, **understanding** and **stewardship** (taking care of) of the green spaces around them.

Your target domain is the green spaces on Mile-End Camus which currently occupy around 15-20% of the total space. It includes a richly diverse set of different environments: lawns, hedges, flower beds, wooded areas, wildflower beds, herb garden, allotment, green roof areas, a new green wall, the canal and more.

3. **The Project:** Your task is to create a Green Digital Twin that improves people's awareness, understanding and stewardship of these spaces**.**

Definition of Digital Twin from IBM: "A digital twin is a **virtual representation** of an object or system that **spans its lifecycle**, is **updated from real-time data**, and uses simulation, machine learning and reasoning to help decision-making" (https://www.ibm.com/blogs/internet-of-things/iot-cheat-sheet-digital-twin/) . Digital twins are increasingly used in sectors such as manufacturing, urban planning and health. They provide a digital model of a system that allows people to monitor what is happening and think about what could happen now and in the future.

Your Green Digital Twin should exploit this combination of live data and virtual representation to provide new insights into the condition and ecology of the green spaces at Mile End. Remember that your digital twin should improve people's awareness, understanding and stewardships of some aspects of the.

In order of importance your design should be based on:

a) A **detailed**, **iterative**, **user-centred** approach to understanding the problems and opportunities created by Green Digital Twins.
b) A detailed critical analysis of people's current awareness and understanding of the green spaces around them and the gaps that could be filled by a Green Digital Twin.
c) A review of the different technologies and software infrastructures that have been used to sense and model natural ecosystems.
d) A **physical-digital design concept** that is **innovative**, takes advantage of the flexibility of the combination of live environmental data and virtual representation, and that **goes beyond** what is already available or has already been envisaged.
e) A working demonstration built using the **Arduino Platform** and **Processing** that shows in concrete detail how your design concept could be implemented. This

should build on the skills you picked up in the *Arts Application Programming* course and the *Creating Interactive Objects* course.

4. **The Groups:** To replicate the real-world experience of design, the project is carried out and assessed in groups. Group membership is assigned in advance and a key part of the project is to manage your responsibilities and commitments to each other.

For each assignment, one submission will be made per group (just one group member needs to submit the assignment and it will be automatically logged for everybody else in the group). All submissions should be made on QMplus.

Each group will be assigned a single mark. However, **individual contributions will also be assessed** and where people have made substantially different contributions the individual marks will be adjusted accordingly (both up and down).

5. Delivery

This course has a strong practical element and follows the 'crit' style of learning used in design schools and art colleges. 'Crits' are a form of ongoing feedback in which you make regular presentations of your evolving vision for the project and receive immediate verbal feedback. We expect you take advantage of this feedback to develop your ideas and, subsequently, see it reflected in your next presentation.

The lab classes and lecture slots will be delivered face to face. If for any reason a team member cannot attend the face-to-face session, **it is the responsibility of the group** to ensure they can participate via Microsoft Teams and other online channels.

- The **Tuesday lab sessions** will be used to introduce the software tools you will use. They will also provide some background materials and give technical support.
- The **Friday sessions** will be used to reflect on the design challenge, provide additional background and provocations, and some sessions will be available as 'drop-in session' to allow you to discuss particular issues with the project or to get additional advice. We will not use all the Friday sessions. **Please make sure you check the schedule on QMplus to keep track of what is expected each week.**

Outside of those times we will check the QMplus forum and Teams discussions regularly.

We expect you to use three tools for managing your project:

a) **A dedicated teams channel** for your group, where you can message each other and keep project relevant files and shared documents.
b) **A Trello board**, integrated into your Teams workspace, for project management. This should be used for: a) recording meeting minutes b) recording action items and who is responsible for them c) for mapping out and revising key project stages d) keeping track of progress.
c) **Github as a repository for all your code**. This provides excellent facilities for tracking progress, resolving issues with the programming and documentation.

6. **Materials:** To build your project you are encouraged to consider a range of possible technical solutions. You are encouraged to use your Arduino kit (provided by the school) however, you are not restricted to the material in your experimenter's kit, and you can use other required components if needed.

Each group has an equipment budget of **£100.** You must create an itemised budget and present it to Healey or Ford for checking before the request is forwarded to the lab technicians for purchasing. Therefore **early planning** of your project and components needed is essential in addition to a clear distribution of tasks among the group members.

7. Documentation

All stages of the design and build work must be documented on Trello and Github, including photos and videos as appropriate. Ensure that you arrange weekly group meetings outside of the scheduled module hours for updating each other on progress. This is especially critical prior to the class presentations.

During the course of the project, each group should produce a report (not exceeding **5000 words**) and video (**1 minute**) describing the development of the project.

The final report should contain the following sections:

I. Introduction

II. The Concept

a. Review related pieces of design work **(including citations)** and describe the approach chosen in detail, including the specific reasons for choosing it.

b. Detail how your design addresses **the brief.**

c. An explanation of your user-centered design process.

III. Practicalities

a. What are the key tasks involved?

b. Explain how the work was divided up in the team.

c. Timeline or Gantt chart showing tasks, dependencies, and the dates of key milestones.

IV. The Design

a. Outline and justify the key design decisions (i.e. design rationale).

b. Explain the concept including scenarios of use (use text and pictures!).

c. Detail the sequence of prototypes including abandoned ideas.

V. Evaluation Plan

a. How did you evaluate your final prototype?

VI. Discussion and Conclusions

a. Critical discussion of strengths and weaknesses (it is important to demonstrate the ability to critique your own work and identify areas for improvement).

c. Identify directions for future work.

VII. Appendix 1.

Peer review statements: each member of the group writes about their main responsibilities and performance during the project, the rest of the group approves. Send a group email including each member's statements to Pat Healey and Corey Ford before submitting the report.

VIII. Appendix 2.

Programmer's guide including:

a. Link to the Github repository, which should include commented and well-organised code.

b. Breadboard layout sheet for any circuits included.

c. Interaction diagrams, sketches, flow charts, etc.

The video should include:

- A simple description of the concept.
- Scenario of use (illustrated in any creative way).
- The video should be **1 minute** long.
- Each team member's role in the project (in the credits section).

8. Assessment.

This module's assessment will be split into two main stages containing specific tasks:

Stage I: Brainstorming and Critical Review, 30% total

1. **User Profiling,** 5%
   Week 2 (Tuesday 1st February)
2. **Design Pitch I,** 5%
   Week 3 (Friday 11th February)
3. **Design Pitch II,** 5%
   Week 4 (Friday 18th February)
4. **Design Pitch III** 5%
   Week 5 (Friday 25th of February)
5. **Mid-Project Review**, 10%
   Week 6 (March 4th)

Stage II: Final Demonstration and Report, 67% total

1. **Final Demonstration** 19%
   Week 11 (Tuesday April 12th)
2. **Final Report and Video Submission** 48%
   Week 12 (Friday April 15th)

Your Final Report submission must consist of the following:

• Report (PDF)

• Video link (upload to Vimeo or YouTube and make it public)

The Overall Assessment Criteria include:

a) Quality of class presentations.

b) Design thinking and novelty of concept.

c) Quality of the demo.

d) Quality of evaluation.

e) Quality of critical reflection.