SURREY WILDLIFE TRUST
(NATURE BASED SOLUTIONS IN SMALL SPACES)

PROJECT BRIEF:
"Nature based solutions (NBS) are a new concept which involve solutions that benefit both biodiversity and the climate, for example, planting a hedgerow provides important habitat as well as capturing carbon. There is a gap in our knowledge about how these might work on a smaller scale, like in peoples back gardens for example.

We'd like to know what kind of NBS you could provide in your back garden, school grounds or other small space."

POTENTIAL APPROACHES:
In our first meeting with Surrey Science And Technology Regional Organisations (Surrey SATRO) and Surrey Wildlife Trust (SWT) we discussed several ways of approaching this project. One of our mentors began listing niches to look into- he mentioned bog gardens and rain gardens, for example. As a pair we created a joint method of communication, as well as utilising the one supplied by our mentors that included another group, himself, and other relevant authority figures in this project.

Some approaches we came up with covered several areas. First off- were we going to visit any sites of relevance? Our mentor gave us the address of someone he knew with a particularly bio-diverse garden as a potential trip, and there are green walls to be found all over London.

How were we going to present our research, and how were we going to create it together? We proposed meeting up in person and/or online, with the knowledge that we were going to continue weekly meetings with SWT and the other research group working with them.

Were we going to focus on only house gardens? This is a topic that has been covered a lot in the past, and there may be benefits to finding other similar topics. Especially given that not everyone has a garden.

We decided upon using a google doc, a decision made in our first SWT meeting, allowing for real-time editing of our project from multiple parties and anytime viewing from our mentors. Our main mentor also utilised the suggestions and comments tool, allowing us to improve our writing and research span and tailor it properly to the given brief.

While one of us did briefly visit some green walls, we decided the trip to the garden would be impractical as the address was far too far from where we both lived. Travel time also made meeting in person too difficult, so we resolved to using our various joint communication methods and calling privately if it was necessary. In our group and meetings with our mentor he advised a structure and pacing to completion, setting goals for us to complete each week with flexibility to how we wished to complete our projects in our groups.

We decided to structure our work into parts: initial research for setting the scene, information on the problems, and getting inspiration from solutions already presented in the past. Then we would split into each of our niches: we decided on Nature Based Solutions in school grounds, and in urban housing (specifically apartments, office blocks and similar). The idea of implementing a version of nature based solutions in school grounds came directly from our experiences with school. Although many schools may have open fields and trees, there is often a lack in other types of plants, in addition, there was also a lack of wildlife interaction with the space. We understood that, despite school being a space in which many students interact daily, there is no link to nature specifically, and we wanted to change that. We chose the latter approach (of those listed above) because we suspected biodiversity to be at its lowest in urban areas, and that coming up with solutions that people with no gardens can implement with ease would be incredibly beneficial.

We hope to succeed with proposing our own solutions in the forms of product design and engineering, and a conclusion outlining the effects of our research.

We created a GANTT chart to map out our time and research.

	July		August				Sept.
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Discuss project brief	■						
Identify potential approaches to tackle the project brief		■					
Conduct initial research about our chose problem (biodiversity loss)		■	■				
Research at existing problems and potential solutions			■	■			
Choose our 'niches'				■			
Research further into our 'niches'				■	■		
Begin ideating our own solutions					■		
Draw/create our solutions as visual representations						■	■
Conclusion and evaluation							■

INITIAL RESEARCH:

Nature Based Solutions refers to the use of the world's natural features and the sustainable management of said features to tackle the consequences of socio-environmental changes and challenges.

These challenges include climate change, water pollution, water security, food security, biodiversity loss, human health and disaster risk management.

After our first meeting, we found out that the specific challenges Surrey Wildlife Trust wants to focus on are biodiversity and climate, of which, we would like to take forward the idea of introducing wildlife into smaller spaces. As designers, we must consider all the possible users a space may have, and how wildlife plays a key part in places such as parks and fields or homes, that may be dominated by humans in certain ways.

Biodiversity loss is a major crisis the world is facing, and along with it comes problems that not only affect other animals and the food chain, but also affects humans too.

Just to illustrate the degree of biodiversity loss we're facing, let's take you through one scientific analysis...

- The rapid loss of species we are seeing today is estimated by experts to be between 1,000 and 10,000 times higher than the *natural extinction rate*.*

- These experts calculate that between 0.01 and 0.1% of all species will become extinct each year.

- If the low estimate of the number of species out there is true - i.e. that there are around 2 million different species on our planet** - then that means between 200 and 2,000 extinctions occur every year.

- But if the upper estimate of species numbers is true - that there are 100 million different species co-existing with us on our planet - then between 10,000 and 100,000 species are becoming extinct each year.

*Experts actually call this *natural extinction rate* the background extinction rate. This simply means the rate of species extinctions that would occur if we humans were not around.

** Between 1.4 and 1.8 million species have already been scientifically identified.

[1] These statistics show just how big the biodiversity crisis is, which makes it crucial that as humans we try our best to preserve the wildlife around us, and this could simply start in someone's garden, local park or even school.

By encouraging local wildlife to venture out into spaces humans also share, we can provide a safe space for animals to build homes and feed. A richness in animal population also has a positive impact on human mental health. Plant and bird species richness are positively related to mental health, access to a local green space also improves both mental and physical health.

Multi-sensory elements such as bird sounds or wildflower smells also have beneficial effects on mental restoration, calm and creativity. The biodiversity we as humans are facing means that as the richness of wildlife decreases around us, we can expect to see a decline in human mental health and well-being too. [2] [3]

Biodiversity loss can have significant direct human health impacts if the services our ecosystem provides are no longer abundant enough to meet social demands. Changes in ecosystem services may also begin to indirectly affect livelihood and income.[4]

Biodiversity provides many useful goods and services that are essential to human life
Biodiversity plays the biggest role in human nutrition in a sense that access to an abundant supply of nutritious food is essential to human health. With biodiversity becoming more and more visible, there is a threat to the food security of humans. With food security already being an existing problem, the loss of biodiversity is simply adding to the problem.
The natural ecosystem also provides a means of health care. Medicinal plants are gained via the collection of wild populations and cultivation, and helps to make a wide range of both commercially used medicines but also locally made primary health care: naturopathy. With biodiversity loss occurring, these medicines that so many rely on are at risk of availability. Not only this, but, there is a risk that a life-changing medicine sourced from plants may become extinct before humans even get the chance to discover it.

Green Social Prescribing is the act of assigning nature-based activities to help support people's mental health. With biodiversity and nature decreasing, the chances of these GSP activities being useful are slowly decreasing, and may soon prove to be ineffective as opportunities decrease.

Biodiversity protects humans [5]
A richness in biodiversity means humans are less likely to come in contact with diseases. As biodiversity is lost, the number of disease-carrying animals in local populations will increase, putting humans at a higher risk of catching said diseases.

As previously mentioned, there is a direct link to biodiversity and human health. All the problems mentioned above will cause an immense amount of stress and worries to humans, but a lack of animal and nature interactions also affect human well-being. As the views of nature decrease alongside the decrease in biodiversity, human mental health will also decrease significantly.

POTENTIAL SOLUTIONS

When considering possible solutions to these problems it would be beneficial to look at examples of urban biodiversity in action.

Singapore's Green Buildings
Singapore's famously green architecture is certainly an inspiring movement.

As a densely populated city-state taking just over $720 \ km^2$ of land, adaptation was essential. While their buildings mainly focus on using carbon neutral and recycled materials, they also show the practical benefits of incorporating greenery into cities. Installing green roofs onto buildings greatly reduces the amount of energy absorbed into the building from the sun which, if we continue to have summers as hot as we have seen this year in 2022, could prove to be an incredibly beneficial change to our buildings that have been made to keep heat in. With this adjustment it would be more plausible to keep schools and office blocks open during these times. [7]
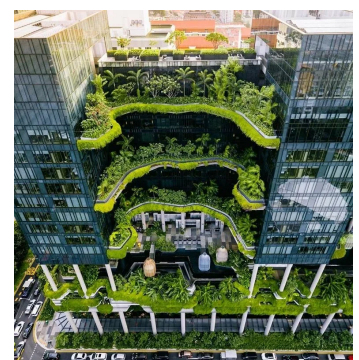
Planting Trees and Hedgerows Reduces Flooding
Other practical benefits to introducing more greenery, such as bushes and hedgerows, into gardens include the effect of flood control. With our climate proving to be all the more variable with storms bringing higher

amounts of rain it is estimated that one in six homes in Britain are at risk of flooding. Concrete and stone pathways lead to slower draining times, as well as narrower streets and enclosed gardens leading to rain building up at a faster rate. Planting trees can reduce these negative effects greatly, an effect which can be extended to hedgerows. The leaves and branches cause rainfall to be spread over a larger surface area allowing for faster evaporation, as well as slowing the speed at which rainfall hits the ground, protecting smaller essential plants and insects. Studies show that up to 30% of rainfall falling onto a tree could be evaporated this way without ever touching the ground.

Their roots allow water to drain into the ground deeper and faster, stopping it from saturating the upper layer of soil and reducing surface run-off. These hedgerows also absorb a lot of water through their roots; overall trees can reduce surface-runoff by 80% when compared to asphalt. [8]

No Mow May

Another example of action you can easily take to increase biodiversity is the No Mow May campaign, encouraging people to stop cutting the grass in their gardens for a month. The largest survey ever held on home garden research that took place from 23rd May to 31st May 2021 revealed the incredible change in biodiversity- not just in plant life, but in the amount of pollinators found in the lawns of those who took part. Rare flowers began to spring up including the meadow saxifrage and knotted clover, and an average of around 400 bees could be found supporting each of these gardens every day. The campaign gave Britain our first National Nectar Score, revealing that 23kg of nectar were being produced per day from the green spaces behind our homes, supporting about 60,000 hives of honeybees.

The Every Flower Counts survey discovered that the gardens that produced the most nectar were not the ones that were not cut at all, but rather the ones that were cut every four weeks, which could increase nectar production ten times over. Gardens that were cut scarcely however would produce more diversity in plant life than those cut more often. As Dr Trevor Dines of Plantlife states, "The sheer quantity of flowers and nectar production on lawns mown once a month can be astonishing." [9][10]

SMALL CHANGES [11]

There are many easy ways to increase biodiversity in a garden.

- Leaving an area in your garden to grow and only mowing once every four weeks, as previously stated from the No Mow Campaign.
- Leaving a pile of leaves or logs for insects and small mammals to live in or receive cover from– a 'Bug Hotel'. Rotting wood is often removed, but a lot of deadwood insects such as the lesser stag beetles make their homes here.
- Placing feeders, baths and nest boxes for birds. There are also such things as bat boxes and hedgehog houses.
- Have a green driveway instead of the usual stone or asphalt.
- Small ponds are incredibly beneficial to a vast number of creatures, including newts and frogs.
- Use organic pesticides and herbicides, such as a salt or onion/garlic spray for unwanted insects, and citric acids and cinnamon as herbicides. [12][13]

If you don't have a garden, there are still ways you can make changes.

- Having a bird feeder is possible if you have a balcony, or even just a wall to hang one from.
- Window boxes and hanging baskets are similarly possible.
- Decorating a balcony with plant life can not only increase biodiversity, but look incredibly attractive.

NBS IN SCHOOL GROUNDS:

There are two main areas that we identified would help benefit a wide range of people. One of the said areas we decided to focus on was 'school grounds.'

[13] Upcoming tests, too much homework, heavy workloads, too little 'down time', lack of support, hard classes, changes to routine, teachers or classes, the list seems never ending. Stress and School will often be found discussed alongside each other, with schools being a space of immense stress to many who attend.

From such issues arise possible consequences, that if not dealt with as early as possible, could negatively impact a student's life, with some consequences as bad as anxiety, social isolation, inability to relax and even stimulant abuse in the hopes to feel better. [14]

Among the seemingly endless stresses that school may provide, I wanted to offer a nature based solution that would not only support and benefit the stress ridden mental health of students, but will also provide a space that actively responds to the biodiversity issue.

As previously mentioned, by encouraging local wildlife to venture out into school spaces we can provide a safe space for animals to build homes and feed. With a richness in animal population having a positive impact on human mental health, access to a local green space and interaction with wildlife improves both mental and physical health, so why not introduce this idea into school spaces as well? Multi-sensory elements such as bird sounds or wildflower smells also have beneficial effects on mental restoration, calm and creativity, giving all the more reason as to why an introduction of wildlife into school spaces would be highly beneficial.

I sent around a google form to people ages 13+, to see just how successful the idea of having a wildlife space in a school setting may be.

Would you say school causes you stress?
30 responses
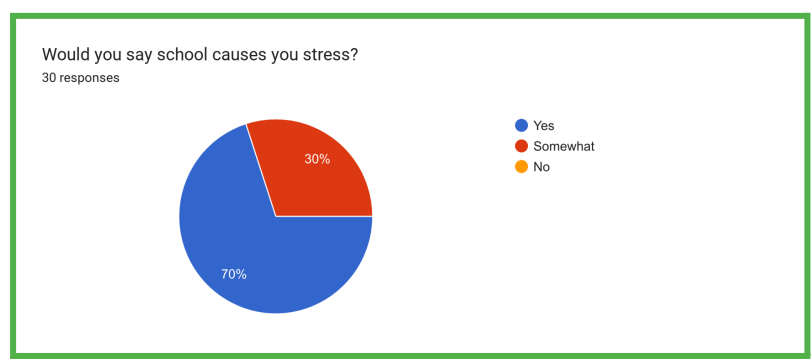
As seen from my results, first hand we can see that all the people who responded agree that school causes stress, whether this is 'somewhat' caused or not.
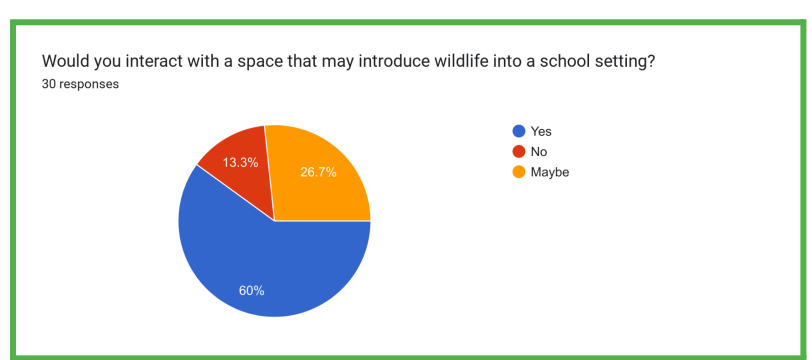
Following on from whether school causes stress or not, I gained positive feedback to the idea of creating a wildlife/green space within school grounds, with many people saying they definitely or maybe would interact with such a spot.

Would you interact with a space that may introduce wildlife into a school setting?
30 responses

From this I decided that specifically high/secondary school grounds is the specific type of 'school grounds' I would like to focus on.

However I had to consider how exactly I would go about having nature based solutions integrated into school grounds. After having researched various ways of introducing wildlife into a variety of different places, I decided that having a vertical/ wall mounted green space would be the best option when considering what

type of space a school actually is.

Having a vertical system is much easier to set up and maintain which is essential in a school space, as a school may not have a lot of space to designate to wildlife, however all schools have fences, so having a product that can attach onto fences and tessellate together would be ideal.

Andrei Petrar created his own product, using a coconut composite to create a nutritious and eco-friendly alternative to the standard way of tiling roofs.

Using said tiles, not only can you grow plants and create a green roof, you can tessellate the tiles to create sheets.

I can also borrow the usage of coconut composite (a sustainable, long living material) and implement it into my product.

After sketching possible ideas, I began to 3d render the best option.
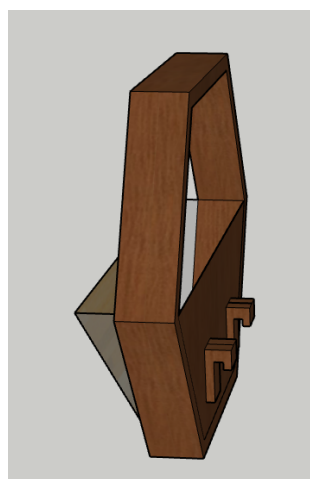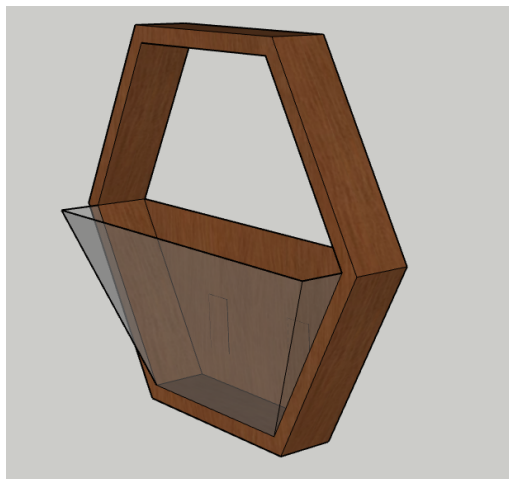
The hooks at the back allow the product to be simply hung up on any fence. The uniform shape means that multiple of the product can be hung together to tessellate together seamlessly.

The glass storage in this version (above) could be filled with coconut composite from above to create a space for plants and flowers to grow.

Similarly, this bird feeder (on the right) has 3 hooks that allow bird feeding tubes to be added on, as well as a landing platform for birds to rest on while they feed.

By keeping the shape of this the same as the one used to grow plants, the idea of tessellation is kept, allowing multiple products to be put together to create one shape, rather than looking like entirely different products.

A problem I faced when creating my product was how to make my product universal to all schools. From this arose the idea to add hooks at the back as a means of fixture.
Although not all schools may have open spaces, they will surely have some form of fencing, and my product can simply be hung on said fencing via the hooks attached at the back.
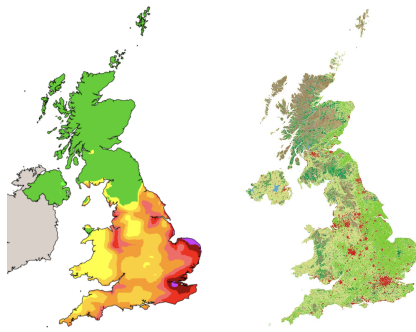
NBS IN AN URBAN SETTING:

The other area we made a focus on was biodiversity in a modern urban environment.

These images are a quick comparison of air pollution (left) to urban fabrics (right). The air pollution data was collected for Friday 25th March, 2022. [17]

Air pollution has negative effects on humans and ecosystems. For humans, short term effects can be illnesses such as bronchitis and pneumonia, and irritations of the nose and mouth. Long term can be as serious as causing death- through respiratory diseases, or cancer of the heart or lungs. [18]

A study by EPA explored how areas with a lower level of exposure to ozone than the National Ambient Air Quality Standard (NAAQS) could affect African American children with asthma that is difficult to treat. A correlation was found between an increase in ozone concentration and a decrease in lung function, as well as an increase in fatty substances in the blood. [19]

Air pollution also affects the natural environments around and in urban areas. Particulates of pollutants settle on the earth's surface and can poison surface water and soil, killing greenery. Sulphur and nitrogen dioxide dissolves into the water in clouds and can fall back to the earth as acid rain, eroding structures and forests. It also changes the pH of soil and bodies of water, which can throw ecosystems into disarray. [18] A change of water purity can lead to the overpopulation of certain algae types, which can block sunlight or saturate waters with too much oxygen, killing other aquatic plants and animals and decreasing the water's biodiversity.

Urban growth is having a direct impact on biodiversity, both in cities and around them. It is estimated that another 2 billion people will be living in cities before 2030, which is a tall order for expansion- almost $800km^2$ of city development every 6 weeks. Biodiversity in cities is on average 50% lower than in a functional natural habitat.

But the worst of the loss actually comes from the impact of cities on areas outside of their land. An international team of researchers funded by sDiv estimate that the area of land needed to generate enough food for cities is 36 times greater than the urban materials they live in. Pollution from industrial areas affect more than just their immediate vicinities, travelling through rivers and as air pollution, as previously discussed. [20]

So, to combat the harm urban settings are having on the environment we must work on increasing biodiversity inside our cities, but also on becoming more sustainable for the good of biodiversity outside of our cities.

The International Biodiversity Property Council (IBPC) has recently released a "deep dive" into increasing sustainability in hotels and hospitality, an industry rather infamous for its negative impact on the environment. Six Senses is a hospitality company that owns many resorts, hotels and spas, and their current CEO Neil Jacobs took part in this conference session.

Jacobs explained the steps his company is taking, or has been taking since their founding, to become more sustainable as well as increase biodiversity where they can.

"Right from the beginning through to today, we grow a lot of our own food, and all resorts have organic gardens. Even some of the urban properties that we are working on at the moment have organic gardens in one form or another, perhaps more vertical than horizontal. But that's always been our greater intention- to bring the green inside."

Jacobs later on explains how their New York property has a large roof, and while most was expecting them to use it for a pool they instead created a rooftop garden for "some urban farming and hydroponics so that we can go upward as well."

The report discusses how you could view these resorts as a "city in miniature", and very similar approaches can be taken when attempting to improve biodiversity and sustainability in urban environments. [21]

So how can all of this fit into small, personal spaces? Not only that, but small spaces in urban housing, maybe even flats with no gardens? I would suggest that, much like in our previous section, vertical surfaces are our friend. I have made some 3D renders of layout suggestions and potential designs after some trials of my ideas through sketching on paper and in an app for creating digital art.

Flat or Office Balconies

By maximising the space from the external surfaces of a balcony, food can be grown without any space within the balcony being taken up. Growing your own carrots and strawberries would no longer need a garden space with this approach.

The straight edges of trough-like plant pots are much more stable against flat balcony barriers than the usual round shape as well as using more available space. A variety of materials can be used, such as wood, recycled plastics or
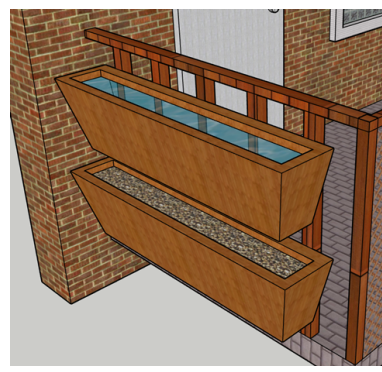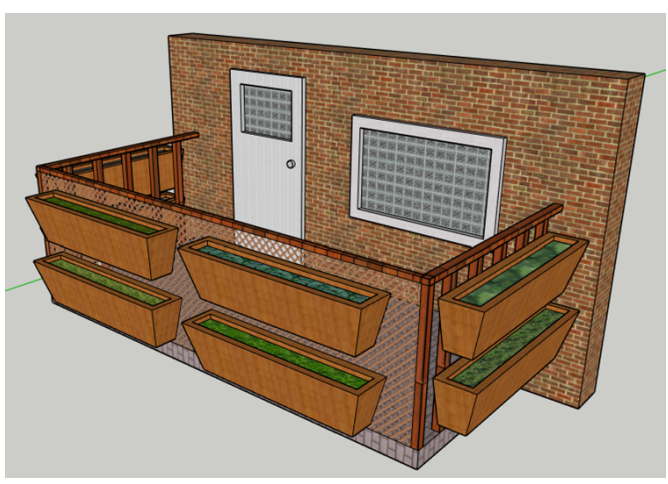

the coconut composite previously mentioned. It must have drainage holes to avoid drowning the plants when it rains, and also to avoid making the pots too heavy from the water.

One could also intentionally fill a pot with water as a bird bath, increasing the mass significantly to the point where it would be unsafe to support the pots by drilling or hooking them onto the barriers from only a couple of points. Instead a metal frame could be built with the pots attached to hang over the balcony rim. This can also be an alternative design for barriers that can not be hooked or drilled into.

Apartment Block Windows

For apartments that do not have balconies, miniature green walls are a possibility. While designing this I originally was going to have it all be one piece, but later realised that larger slats would not be able to fit through smaller windows, and for second floors and above going from the outside would not be possible. Instead, multiple smaller sections can be used.
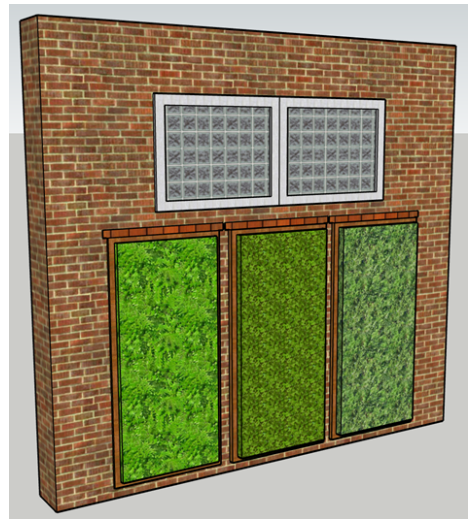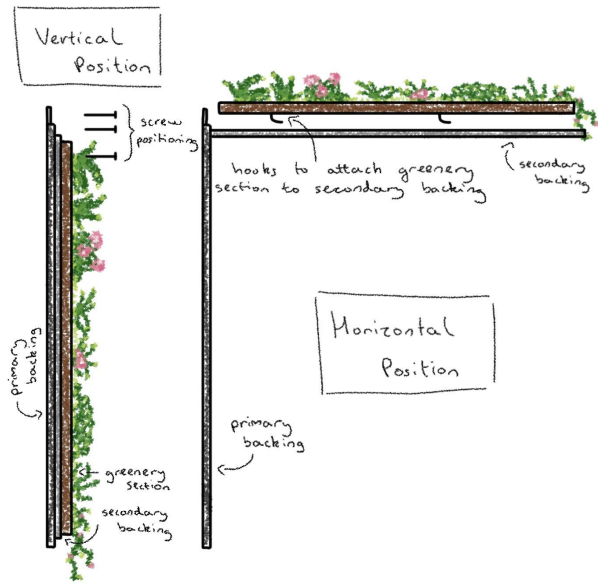
I also decided to draw out a diagram of the slats in both their vertical and horizontal position.

These slats of green wall can be attached at the top only with multiple large screws, allowing for installation from the windows of apartments. The primary and secondary backing is attached permanently to the wall before the greenery section is slotted into place, and can be removed if desired. If a piece of twine is attached to either side of the far end it can be pulled to bring the slat to a horizontal position, allowing for easier removal of the greenery section from the secondary backing. One may decide to install a version with the long side nearest to their window for growing foods so they can reach the furthest side easier.

CONCLUSION

Through this project we have created two, easy to install nature based products that are accessible to all. Just because we envisioned specific spaces in which our designs can exist, this does not mean that they are bound to just their relative spaces but rather can be used wherever a user may see fit.

We believe we have created practical and feasible products that may be easily implemented into many locations. By having such accessible products, if used by enough people we can surely have our own little impact on the world, starting in places we (and people our age) will relate to and recognise like schools and homes. We, like many other researchers creating solutions to the world's problems, are creating products that become more and more effective as the number of users increases.

Due to our decision to not partake in any specific site visits (such as the biodiverse garden our mentors mentioned), it could be argued that we created a broader space for our ideas to blossom from. This then meant that the products and solutions we created again are not limited to one space in particular, but rather can be used in a variety of different spaces. It could also be responsible for our decision to branch into the separate and more underrepresented areas that we did. If we had, however, had a specific area and/or client in mind, we may have been able to create a more personalised and intricate product that could blend and fit seamlessly into the place or places we had in mind. For example, matching our designs to specific fencing types rather than generic hook attachments.

Constructing prototype models may have been beneficial to us in different ways.
Making a small model for our mini green wall design would have helped us to test for various contingencies, such as the structures not being properly supported by the fixture placements to the wall. It may have also given us an idea of sizing aspects, and how to adapt the shapes of the backing parts to be less bulky when stacked like they are in the design. The reason for having two sets of backings was an underdeveloped idea we had to reduce the risk of the fixture breaking from the surface the green wall is attached to– the force of moments would greatly increase when it is in its horizontal position, so actually designing some kind of system to disperse the force down the wall would have been valuable. If we had had more time we could have potentially seen if food could really grow from a vertical surface.

Prototyping the second hexagon shaped planter would've also benefited in a sense that it would have allowed a practical assessment of the product, to see how feasible the idea would've been if it were to be made and implemented into a school setting. Assessing the model after having made it (by setting up cameras to record the number of interactions with nature made) and noting how successful or unsuccessful it was, could have allowed for a better design to be created, and may have even completely changed the shape and form of the 3D render we already have, allowing for a pivotal moment in the development of the product, to create the most effective and best-suited final design.

From reflection on this project, collectively we are more understanding of the aspect of small change for a greater difference. For this being our first joint research project, we better comprehend the importance of communication to work together to create a final product. We feel our designs fulfilled the given brief in straightforward but effective manner.

KEY:

Contributed by Enny-

Contributed by Jasvene-

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