

User Manual

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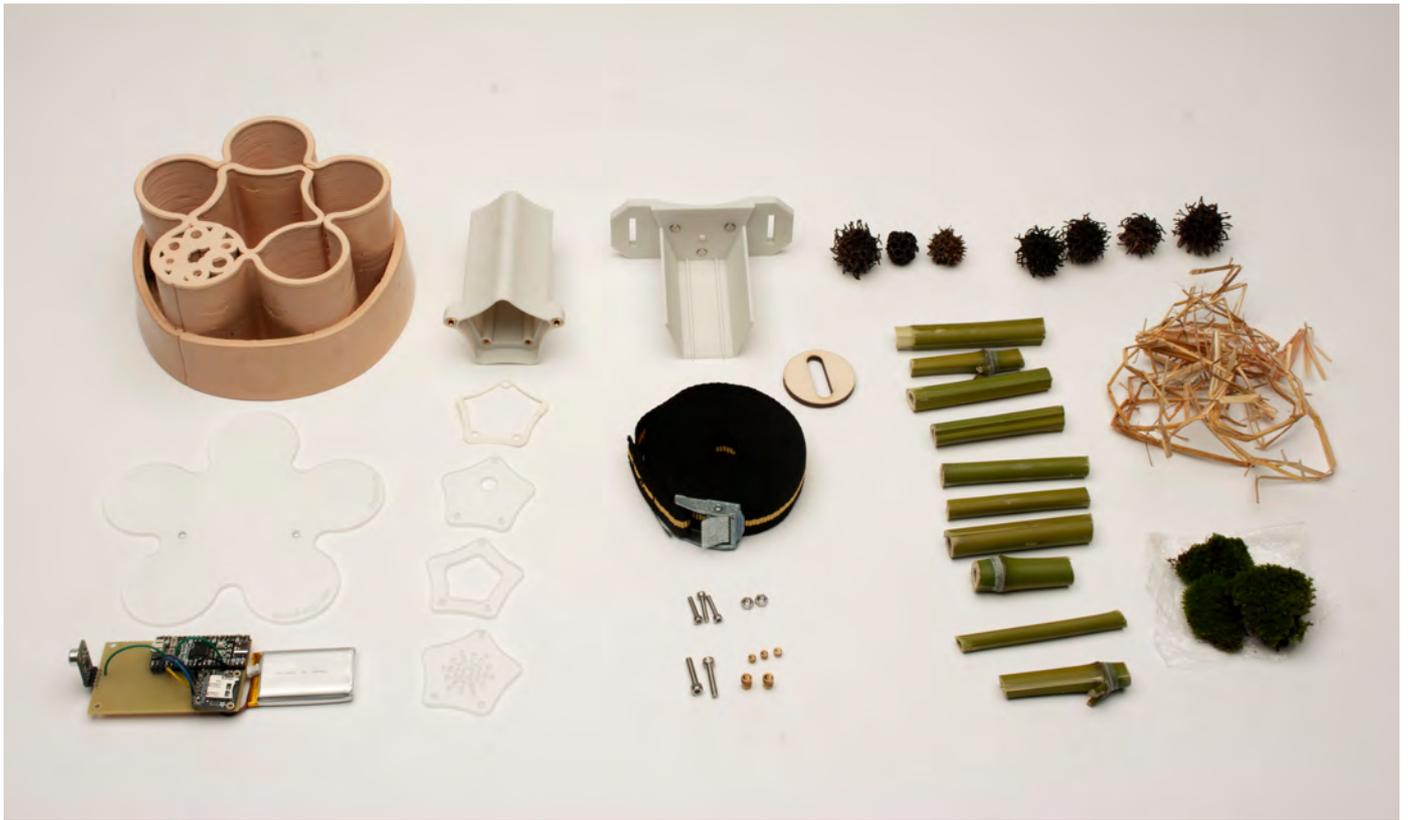
CO-AUTHORS:

POLIFACTORY (Polifactory - Politecnico di Milano)

3ee, is an advanced biodiversity monitoring system that uses acoustic sensors to identify and classify pollinator species in the environment. Our sensor is able to carefully detect surrounding sounds, recording and analysing the frequencies in order to accurately identify the various pollinator species.



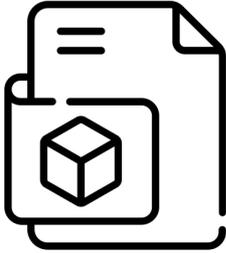
Funded by the
European Union



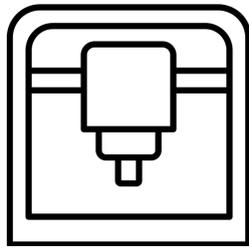
*Here is what you have and need while creating the 3EE BugHotel!
Take care of them.*

1. Instructions for making 3EE BugHotel and its components

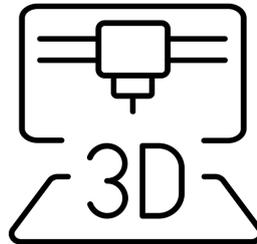
1.1 Tools to use



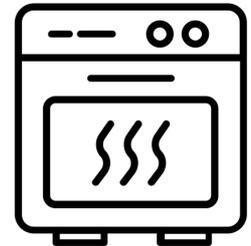
- 3D File



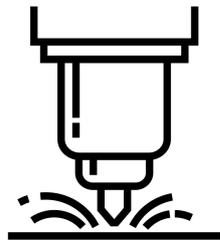
- 3D Clay Stamper



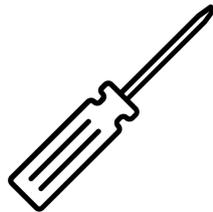
- 3D Printer



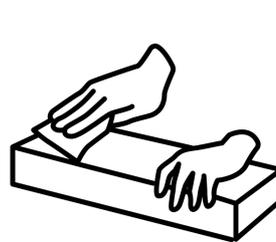
- Ceramic kiln



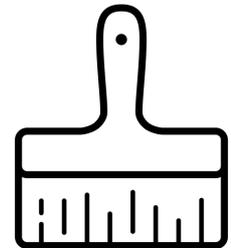
- Laser-cut Machine



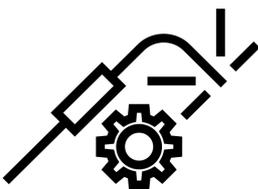
- Screwdriver



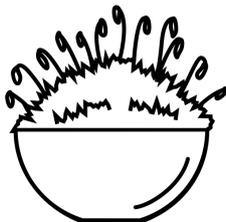
- Sandpaper



- Glaze



- Welding



- Moss



- Glue

and lots of love!

1.2 Main Clay Structure

The main element that makes up the bug hotel itself is a 3D-printed clay structure. This is characterised by **five different compartments**, each dedicated to housing a different species of insects. Only one compartment features the printed clay itself, while the other four are empty and will need to be filled with material or a butterfly plug later.

1.2.1 How to make it?

1. Download the 3D file. "3ee_Clay"



[Link to download the 3D file](#)

2. Print the piece on a 3D clay printer using a 4mm nozzle.



Don't forget to check the machine all the time for possible mistakes.
We don't want to waste material and time.

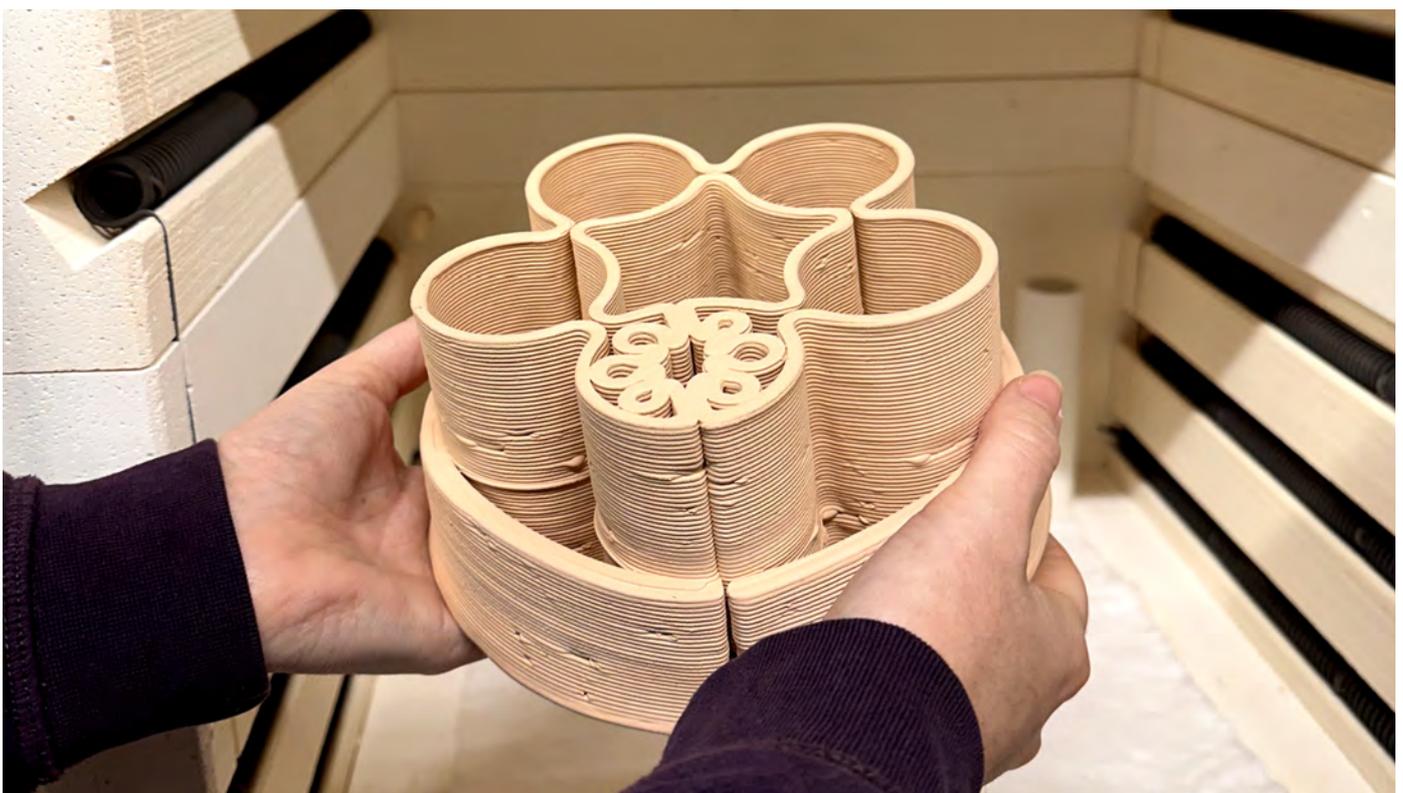


3. Cover the printed piece and let it dry for a few days.



4. Once the piece has dried, proceed to firing in the kiln.

Careful with the timing and heat of the kiln; it is important to not cook less or try to take it off before it is cooled.



5. Glaze it.

Once you have the clay piece, use crystalline glaze to glaze it, making sure not to glaze the inner cavities of the bug hotel, only the outer ones. Enamelling protects the piece, **preventing it from absorbing moisture** and compromising the properties of the material from the walls exposed to the outside and those in contact with moss.



Do it **two** times and clean the top as much as you can with a wet sponge so the top wouldn't be glazed.

6. Repeat the baking process.



Careful with the timing and heat of the kiln; it is important to not cook less or try to take it off before it is cooled.

7. Voila! The main structure is ready!



1.3 Central Support

The central element has a threefold function: to support the clay part, to allow it to be fixed by means of straps and to contain the electronic component module.

The part assembly is produced by xxx 3D printing.

1.3.1 How to manufacture it?

1. Download the 3D model.

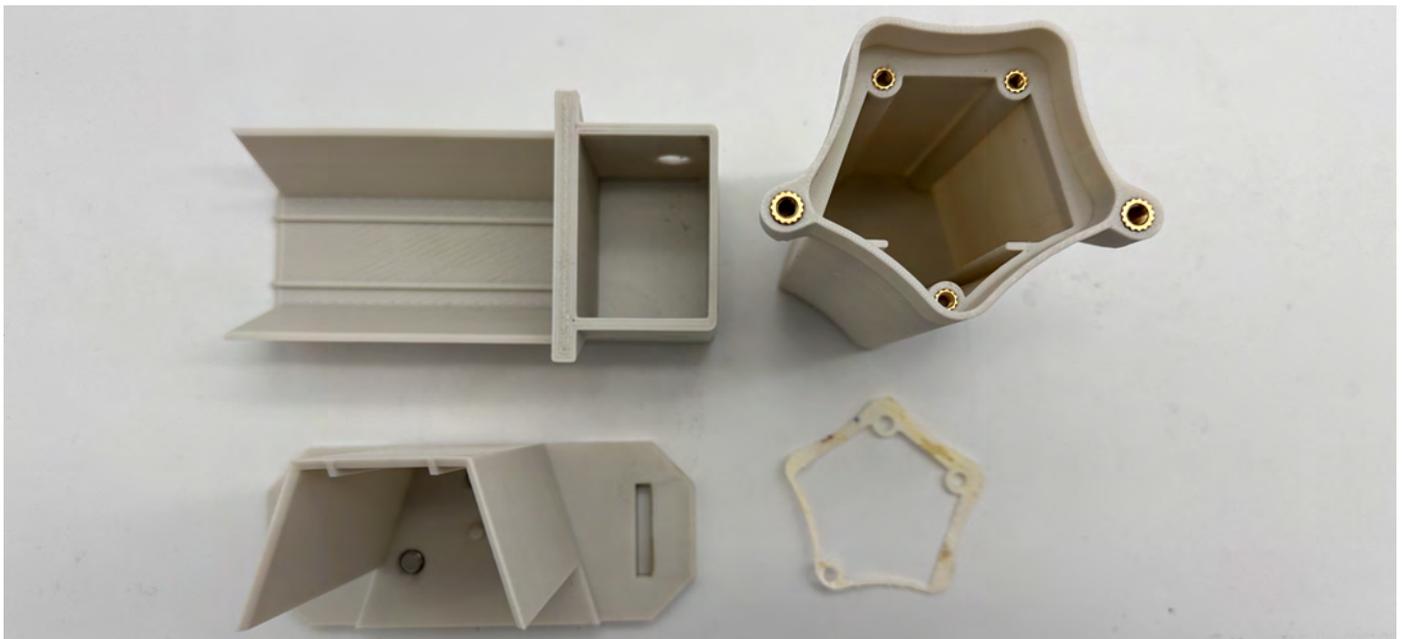
“3ee_Device+Lid+Gasket” “3ee_PoleMonting_Belt” “3ee_PoleMonting_Viti”



Link to download

2. Once the clay piece has been manufactured, measure the space available in the centre hole.
3. In the 3D model of the central support, if needed, modify the circumference in which the hexagon is inscribed so that it can be inserted into the main structure. Make sure that there is sufficient space to insert the electronics.

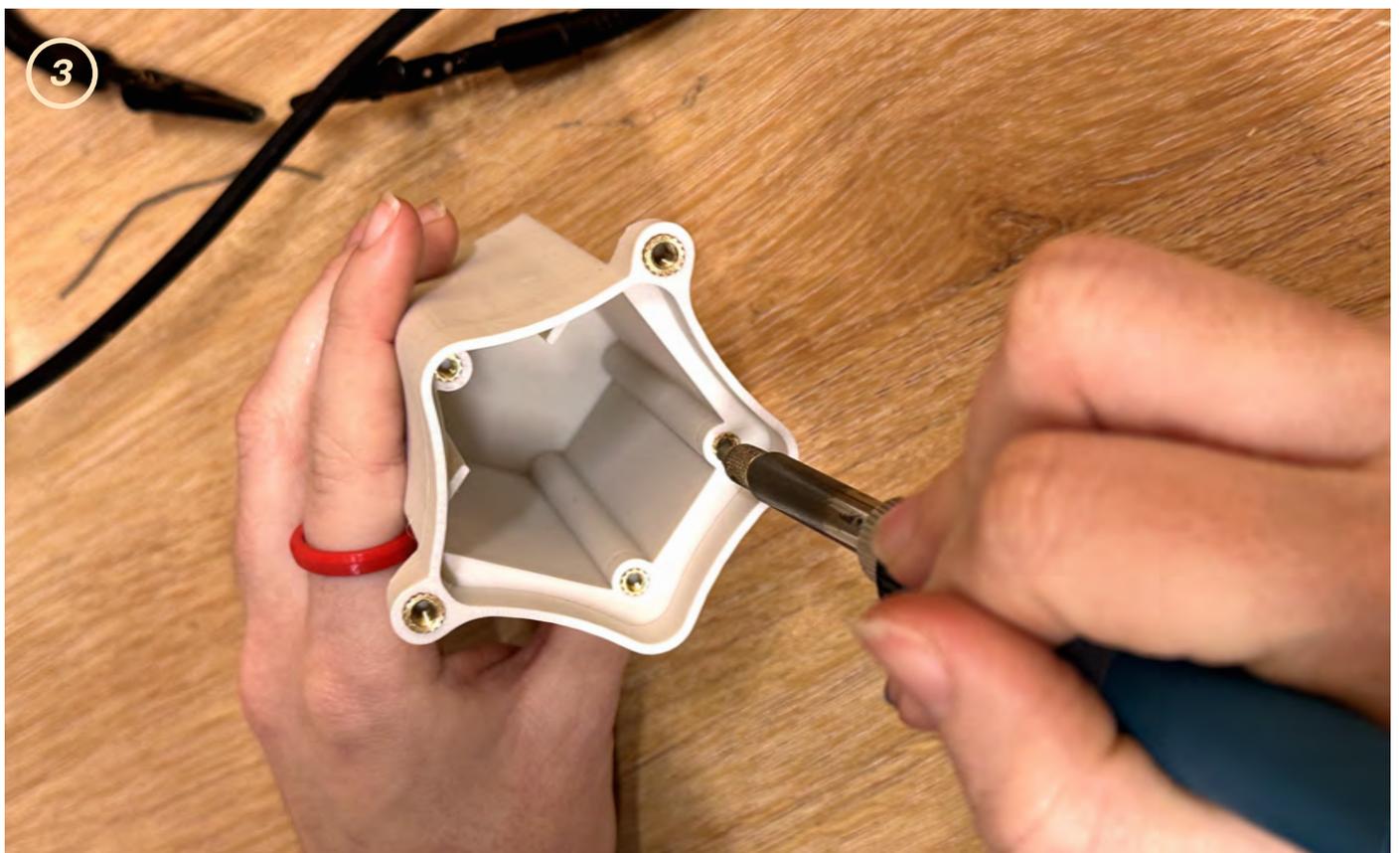
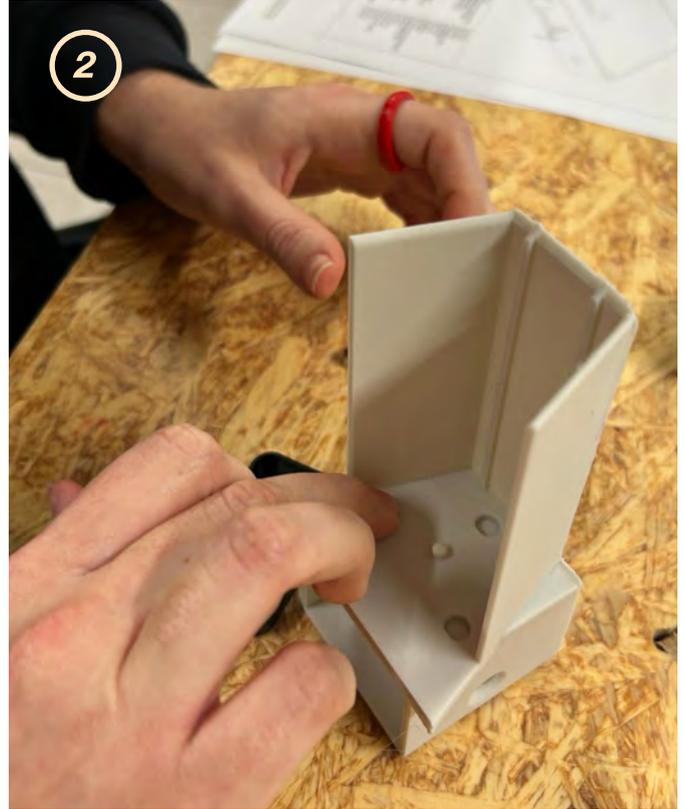
Note well: The part must be produced after the clay element is manufactured, as the dimensions may vary due to shrinkage during drying.



1.3.2 How to assembly it?

To make it tight.

1. Prepare the glue
2. Put the glue in the holes and place the magnets
3. Insert threaded inserts and weld them in place so they are tight and strong.



1.4 Assembly of Electronic Components

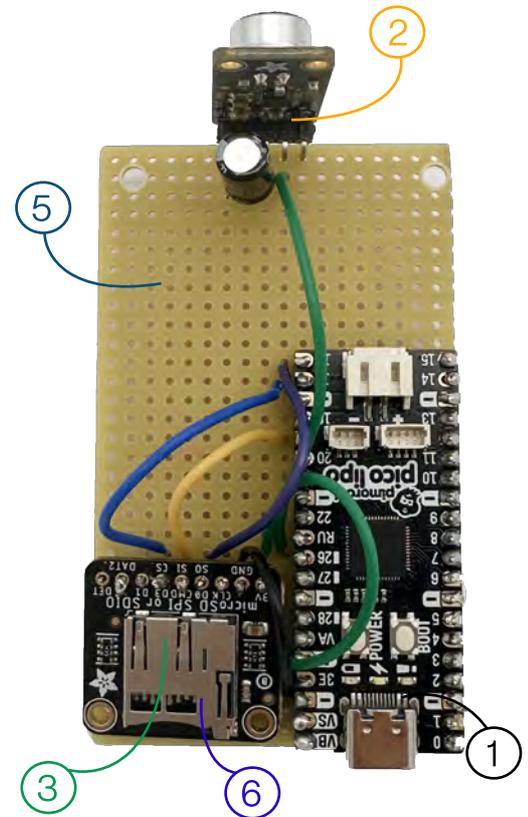
The electronic part is intended to pick up the sounds produced by the insects via a microphone and store the data on an SD card, which will then be used to transfer it to a computer.

Required components:

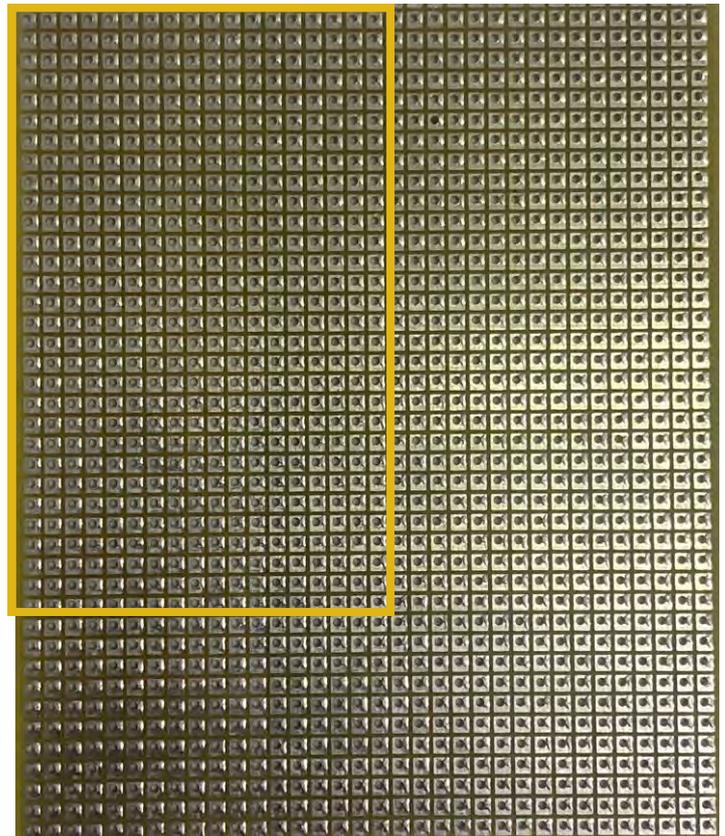
1. Microcontroller (we used Pico Lipo 16 MB)
2. Microphone
3. SD module
4. Battery
5. Matrix Board
6. Card
7. Jumper wires
8. Welding

4.3.1 How to build the electronic part?

1. We start with putting the pieces in the right place and identify where to weld them.
2. Here we have put the matrix board, microphone, sd module and the crucial part the microcontroller. Don't forget to put the card inside SD Module.



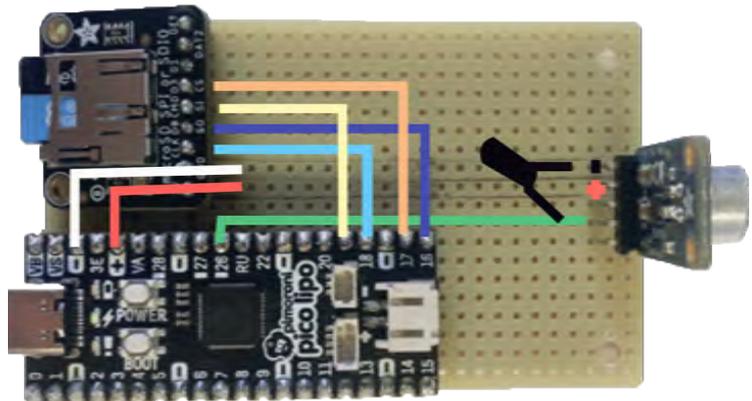
Remember to cut the matrix board, counting **how many pins** you are going to need to connect all your components.



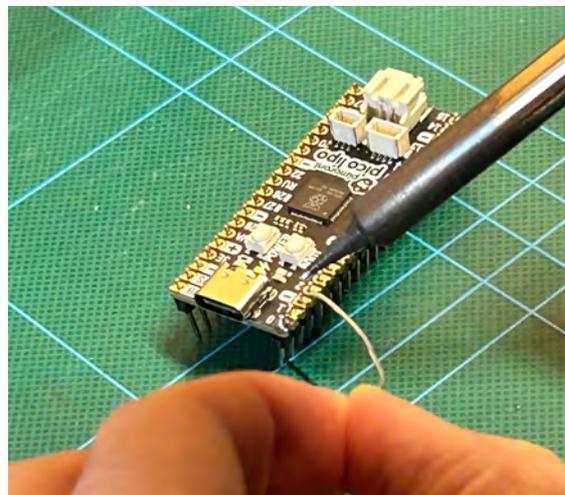
3. Do the welding with the **jumper wires**.

Don't forget to be careful with the heat of the welding machine.

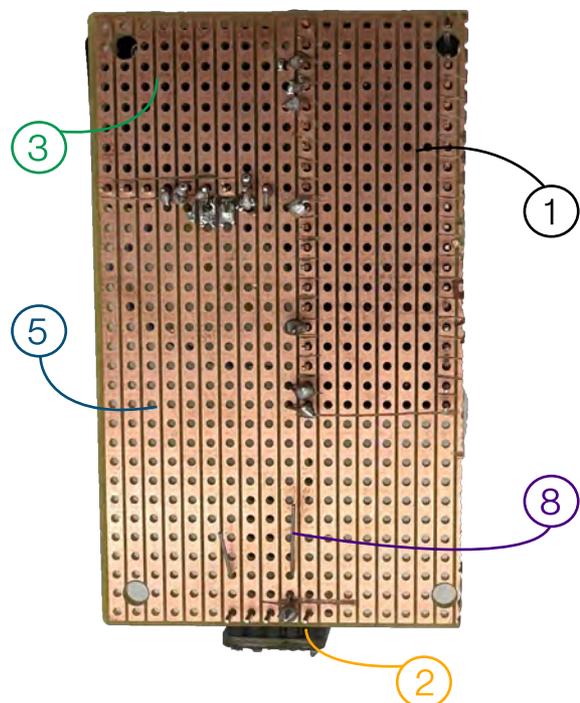
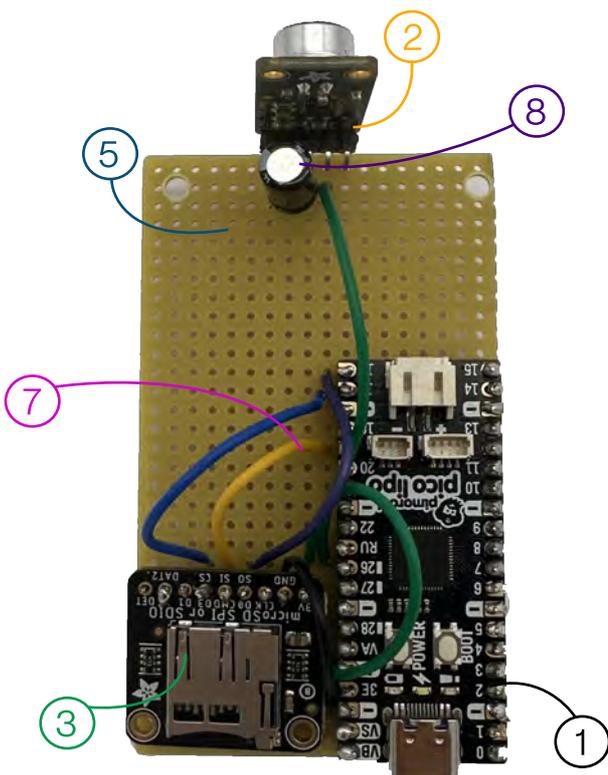
Don't forget the wire the components with wires, different colors are different wires to connect the components together!



Welding process:



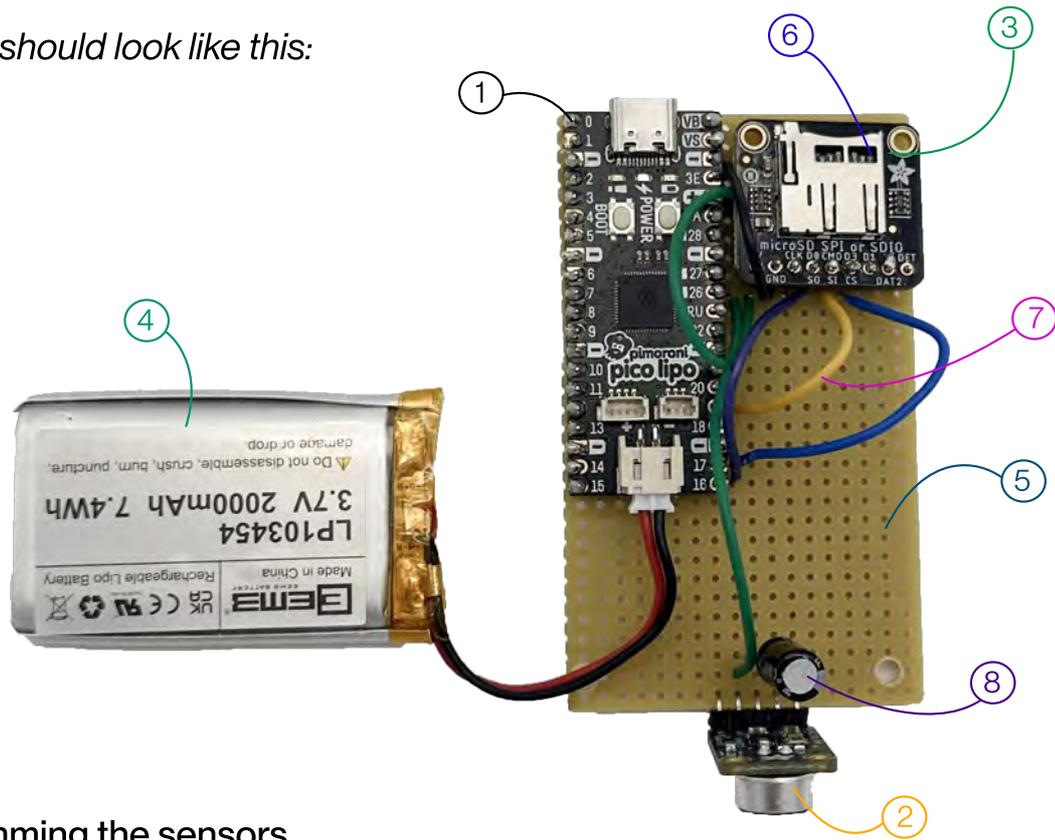
*note: this should be the **final** welded matrix board that you added the components:*



4. Connect the battery with the microcontroller.

Careful with the + and - of the battery, they should be stuck in the same way.

Final result should look like this:



5. Programming the sensors.

Test to see if everything works properly and if it records audio

1. Download the code.



1.5 Laser Cut Pieces

Frontal protection is to protect insects from birds. This takes the form of a laser-cut panel that follows the shape of the hotel bug and is positioned X centimetres in front of the modules.

Three lids in opaque plexiglass:

Lid 1 is to insert microphone.

Lid 2 and **lid 3** are layers to have a proper distance of microphone from outside world, to prevent water, dust and other 'outside' materials.

Butterfly lid is to put inside the clay printed BugHotel, to protect the butterfly hole and make it attractive for butterflies and it is made of 3mm wood.

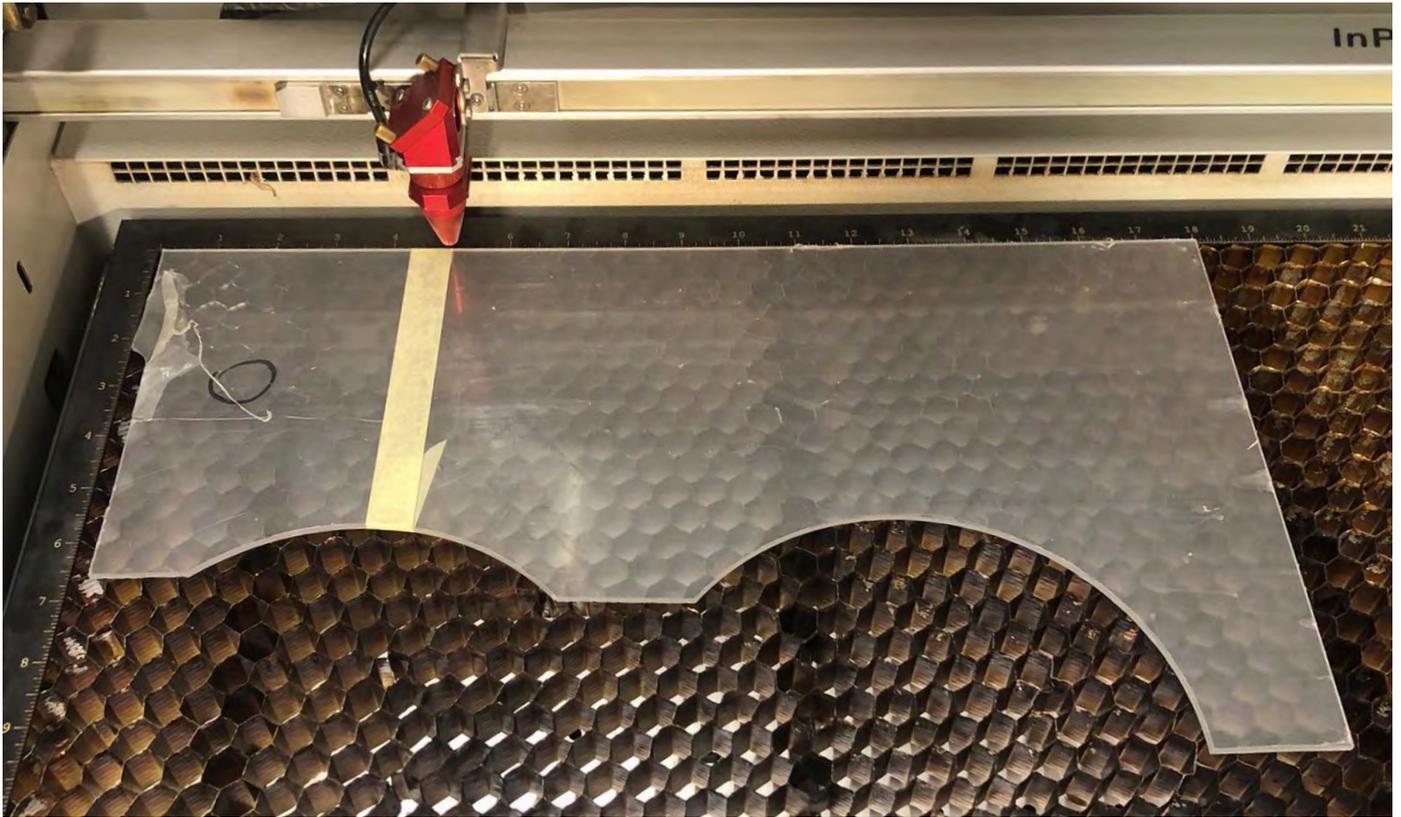
4.5.1 How to make it?

1. Download '3ee_Laser_Cut' file



Link to download the pieces indicated in the file.

2. Laser-cut a sheet of 3mm thickness (opaque plexiglass)



3. Print the pieces in right temperature and time to have the perfect laser cut.
These are the pieces that you'll get:





Look at the little laser cut name of the BugHotel!

1.5.2 Recommendations

Be aware of unexpected large millimeters. To be able to prevent the misplacement, try to make the pieces smoother by using sandpaper.

In this point you should have all the elements ready to assembly!



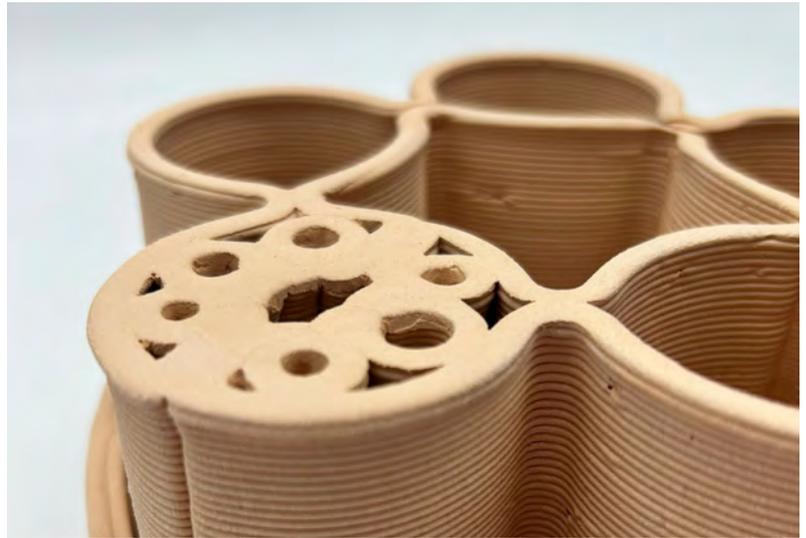
1.6 Insect Modules

Which insect, what material?

There are five modules in the bug hotel to house different types of insects. One of these, for bees, is built together with the structure itself by means of clay moulding. The other four are presented as containers into which different types of material can be placed.

1.6.1 Modules

Bees: Moulded directly in clay



Butterflies: Laser-cut the butterfly lid (explained in the 4.5.1) out of 3mm wood. It is important to have a vertical hole in the material to allow the entrance of the butterflies and not other insects.



Spider mites, mealybugs and aphids: Bamboo sticks



Beetles, centipedes and woodlice: Wood, loose bark and straws.



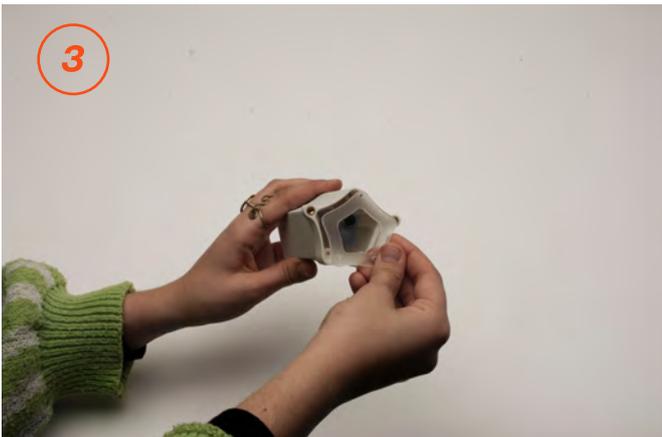
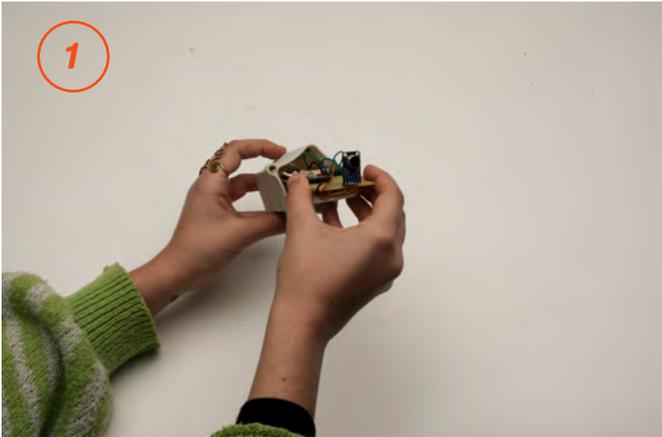
Ladybugs: Insert small pine cones and dry leaves.



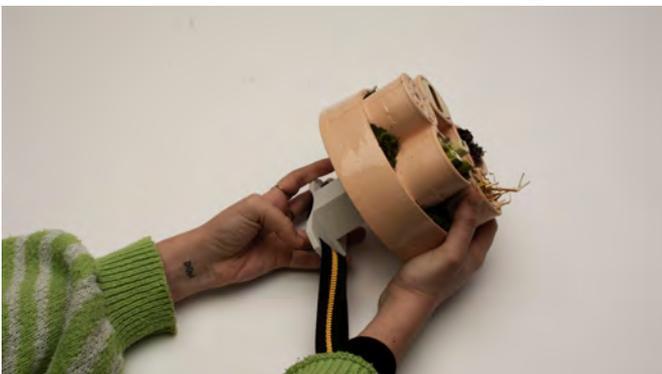
1.7 Assembly of the final bugshotel

Let's put them together!

1. Insert the electronic component in the 3D printed support.
2. Place Lid 1 over the microphone.
3. Place Lid 2 and Lid 3.
4. Use screws to fix the elements in place



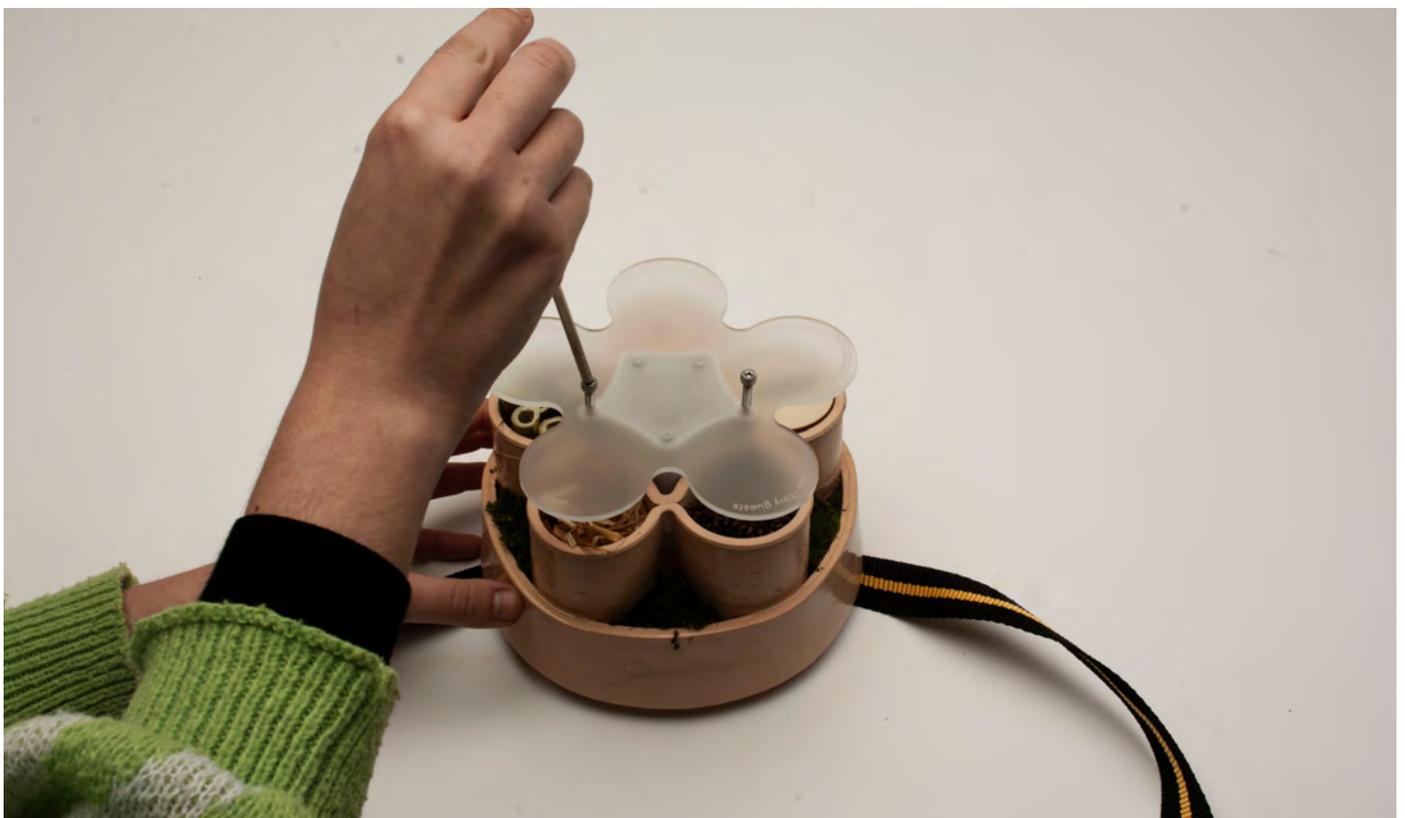
5. Insert the 3D printed support in the main clay element.



6. Insert the screws in the frontal protection and use them to attach it to the 3D printed support.



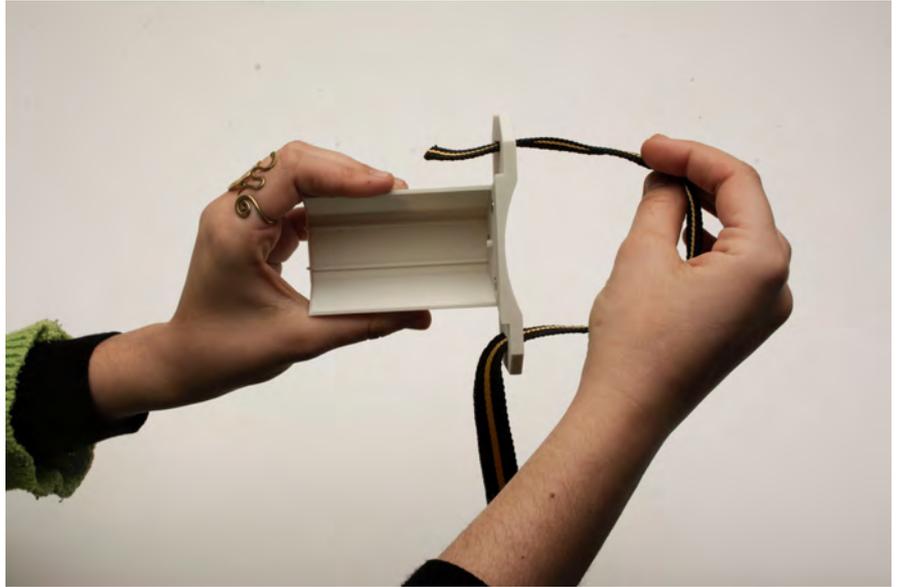
7. Use screws to fix the frontal piece and viola!



4.8 Arranging the belt

How to place it?

1. Get the belt in the right direction and place it, as you see on the photo, in the 3D printed piece.



2. Place the 3EE BugHotel on the tree or the structure that you want to hang, and pull the belt to make it tight!

Note to position it height 1.5 metres!



1.9 Other Details

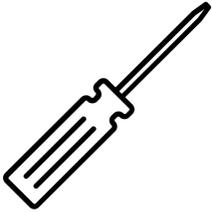
To attract more insects and give them an efficient environment to monitor, we created a design that allows moss to grow outside so it can produce its own water, which attracts more insects. For better moss growth, we recommend applying a paste made of yoghurt and dried moss between the clay and the moss, to make it adhere well to the product and allow it to continue growing and not die or dry out.



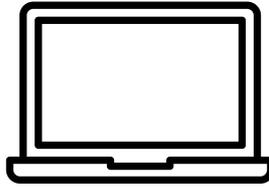
3EE BugHotel with grown moss

2. How to use 3EE BugHotel

5.1 Tools to use



- Screwdriver



- Computer

and lots of love!

5.2 Operation

Once activated (by connecting it to the battery) and positioned, the product will record an 8-second audio every 15 minutes, saving it as a file and storing it on the SD card. The user can retrieve the data by removing the cover with a screwdriver and pulling out only the device in order to open and retrieve the SD card. Downloading files from the SD card should be done at least every 1/2 week to monitor.



5.3 Maintenance

Check the condition of the product once or twice a month, checking if it has fallen down and inspecting the growth of moss in the cracks and filling the holes with new material such as straw, pine cones and bamboo. Be sure to recharge the sensor battery every fortnight.



3. Analysis

Case study research was carried out in order to understand how to analyse the data once it had been collected. A number of opportunities and techniques emerged from the research. The first opportunity seems to be the use of Machine Learning (ML) and a support vector machine (SVM) as discussed in the paper '[Automated classification of bees and hornets using acoustic analysis of their flight sounds](#)', while the second seems to be CNN models combined with Log Mel-Spectrogram representations and strong data augmentation as discussed in the paper '[Automatic acoustic recognition of pollinating bee species can be highly improved by Deep Learning models accompanied by pre-training and strong data augmentation](#)'.

The project is therefore proposed as an open source opportunity to combine the skills and background of designers and developers, who, with the appropriate knowledge, can implement the system for analysing the data collected through our Bugs Hotel.

4. Credits of 3EE BugHotel

3EE BugHotel is a project publicly released and made available in open source mode according to the Creative Common License (CCBY) and promoted by Distributed Design Platform with the related documentation. The authors of 3EE BugHotel are by Martina Comola, Cemre Ercan, Chiara Guarino, Valerio Libardo and Andrea Somenzi.

3EE BugHotel is a project developed with the collaboration of Polifactory within the Distributed Design Platform project co-funded by the Creative Europe Programme of the European Union.

5. Downloadable Files

For any problems please contact us!!!



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