# GTree

Reforestation of the Glasgow urban area
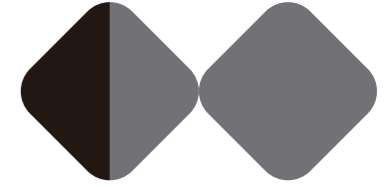
**Shuo Wang**
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**14/08/2022**

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VIA VERITAS VITA

## Motivation

In the past few years, I have always seen in the news that some countries worldwide, such as Australia, the United States, Canada, Greece and so on, have had devastating forest fires.
Britain has not had such catastrophic bushfires, but the situation remains grim.By July 2018, the area burned in the UK that year was more than four times the average of the past decaded. [1]

Reforestation is especially important because of the long wait for natural vegetation to recover after local forests have burned out in the wake of fires.Researchers found that the great potential for replanting efforts does exist. Forests could be regrown on 1.7 billion-1.8 billion hectares of denuded areas that are no longer in use, adding 1.4 billion hectares if cropland and urban areas were included. [2]

A new analysis estimates that a worldwide planting programme could remove two-thirds of all the emissions that are blown into the atmosphere by human activities. [2] Therefore, reforestation can reduce the greenhouse effect and thus curb the further deterioration of the earth's environment.This is the main reason why I chose this topic.

## The local context

As I focus my attention on local reforestation in Glasgow, I am pleased to find that Glasgow Council already has some tree-planting programmes and targets in place.
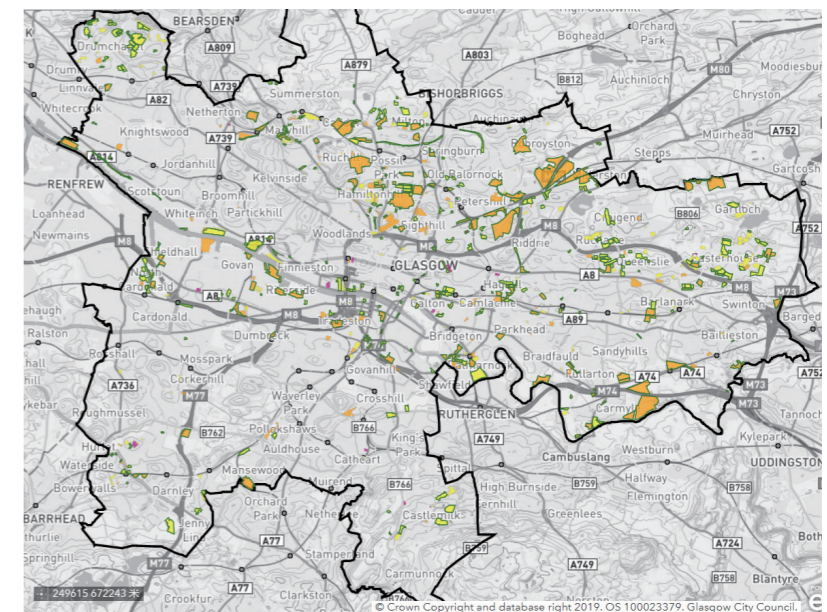
The Scottish Government wants to increase woodland cover to 21% by 2032. Glasgow's Government has a similar goal of increasing the city's tree cover to 20% over the next decade, equivalent to 10 trees for every resident. [3]
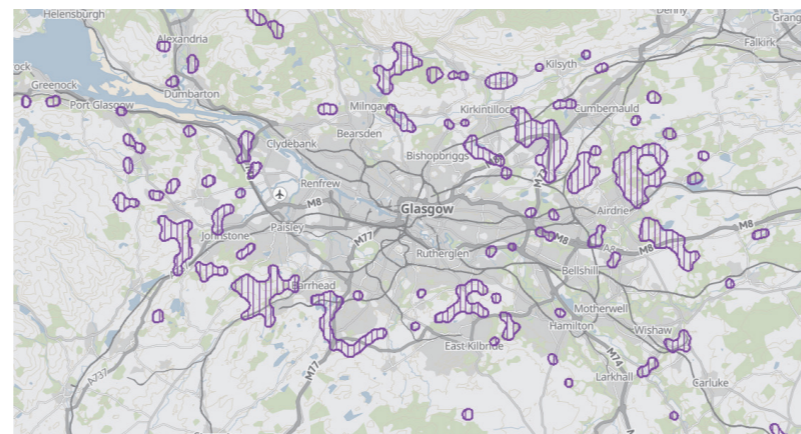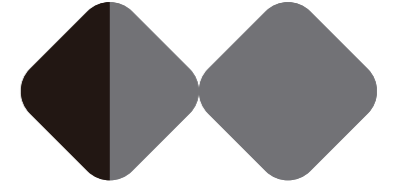


FGS Target Clyde Climate Forest Woodlands for Connectivity

The Clyde Climate Forest is an important local tree planting scheme in Glasgow. Eight of Glasgow's local councils have signed up to plans for the climate forest.

Another good news is that the Scottish Government has decided to restore and use some open Spaces and derelict land for planting trees. This means that Glasgow will have more groves in and around the city in the future.
This policy support allows us to have more forests in the future.



Vacant and Derelict land of Glasgow

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**Reflection:** It took me a long time to determine the area for planting trees. I think it makes more sense to do a local project.

## Interview

**Organizer** (Community Engagement Coordinator of Earthwatch)
*"Forest project costs between 25,000 to 30,000 pounds which is very expensive. The whole point of the project is not just about planting trees but it's also about getting people connected with nature."*

**Local resident**
*"There are many important aspects of planting trees, such as weeding and supporting saplings. We use special tree spades."*

**College students (6)**
*Half of them had never planted a tree, while those with experience in planting trees last planted trees when they were young. There are two reasons why they have not planted trees in recent years:*
*No positive intention to plant trees.*
*Lack of information about tree planting activities, not knowing where to plant trees.*

**The process of planting trees**

## Parallel Products

Four main functions

**Germinate**     **Support**

**Dig**     **Protect**

£

Spade — Stake — Tie

Nersery — Seed — Pot — Planting Area — Spade — Pot — Home — Weed — Planting Area

## Current way to plant trees

**Problem**

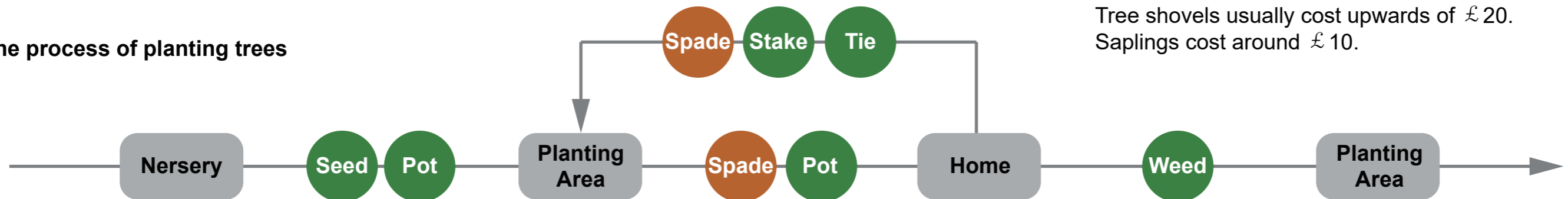Planting and maintaining trees on a large scale is not cheap.
People lack enthusiasm for planting trees and convenient channels to participate in planting activities.
It is difficult for an individual or family planter to carry a two-kilogram spade between the plant site and home.
Tree shovels usually cost upwards of £20.
Saplings cost around £10.

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**Reflection:** Although there were no suitable tree planting activities during the project, I invited my friends to dig holes in the open space with a garden shovel. The shovel was really heavy and not easy to carry.

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## Opportunity

The opportunity is to design a product that can increase the interest of people living in the city in planting trees and make it a simple and feasible activity for them.
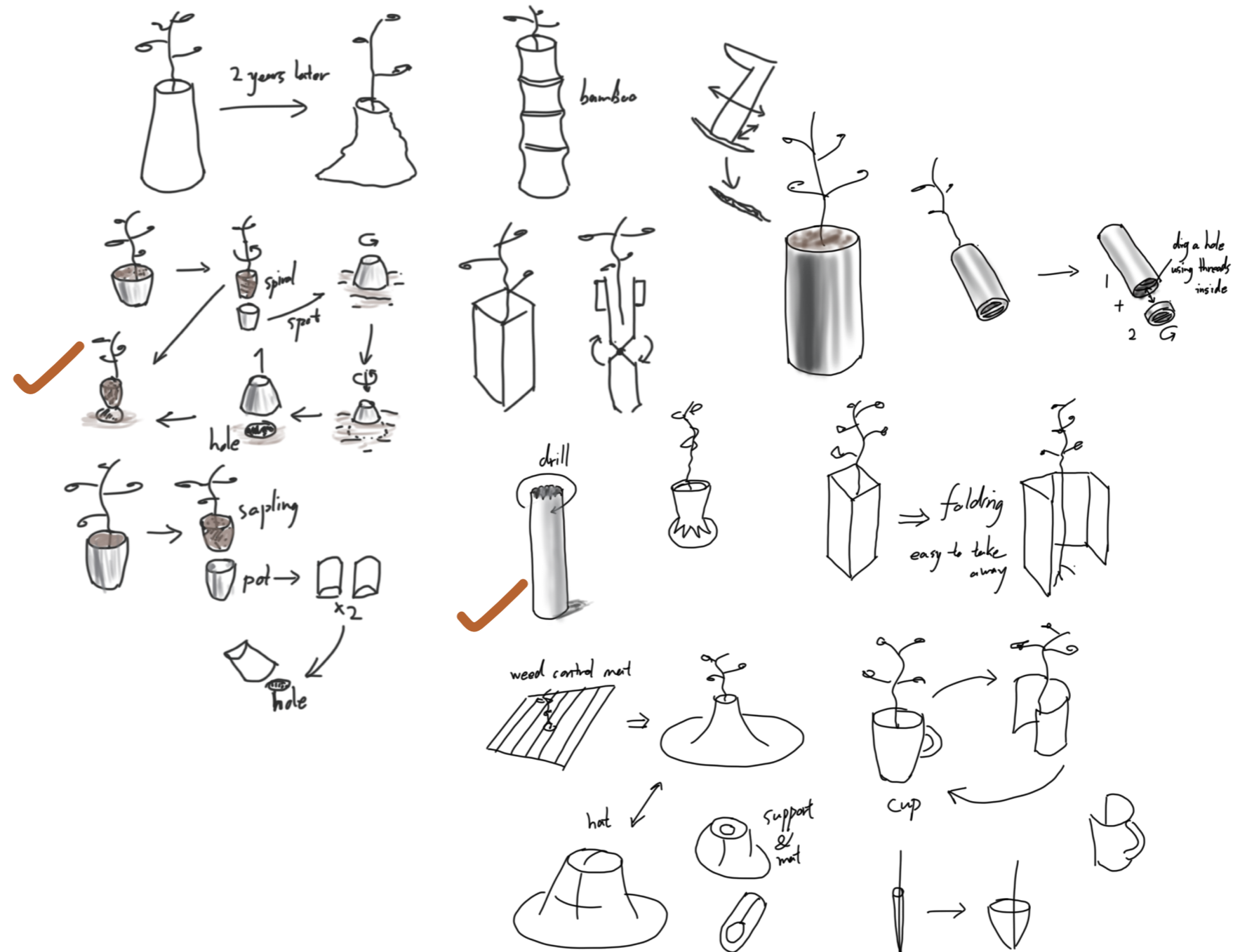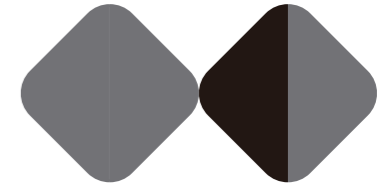
## Key insights:

Cheep
Portable
Planting trees is easy to carry out.

## Product Requirements:

|  | Weight |
|---|---|
| Cost-effective | 2 |
| Can be used multiple times | 3 |
| Light weight | 4 |
| Easy to assemble | 2 |
| Durable | 4 |
| Easy to use | 4 |
| Contains the main function of planting trees | 5 |

By using rapid ideation, some ideas were generated. And then develop some more viable concepts. In the end, the idea of a structure similar to the hole saw was chosen as the final concept.

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**Reflection:** There are other sketches in the design journal.

## Clip-on bit



### Insights

The original idea was to clamp four clips with sharp edges to the main body. However, tests showed that the structure was not robust and complicated to implement. Other PDE students had the same feedback and opinions after the test.

The advantage of this structure is that it can save material, and its relatively small size can make the product lighter and easier to carry and store.

In any case, the product's reliability is the first indicator of the selection of the scheme. In the case of normal use, to make the product have a longer life is one of the goals of this design.

## Split type



### Insights

This design is an improvement on the first concept，increasing the head's volume and improving the serrated part's stability.

In tests, users reported that the drill bit with this configuration was more stable than the first one.

How the head meets the body is something to consider later. In addition, it is important to pay attention to the discharge of soil during the actual digging of the hole.
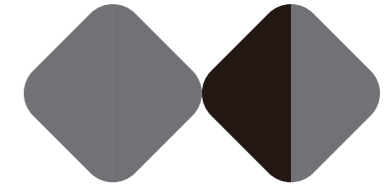
## Integrated molding



### Insights

This solution has the closest model to the real product. So the concept has been field-tested. The sharp edges of the product are integrated with the body.

The problem with this product is that the sharp edges need to be hidden or they will scratch the user.

After four tests, the serrated part is seriously deformed. This means that further design is needed to improve the strength.

Interestingly, while using canned food as a model, I came up with a new idea: using can as part of the product.

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**Reflection:** Unfortunately, the first two models were made of foam, which, to some extent, affected the product's performance during testing.

### Observation

Rotating a can with one hand is laborious and inefficient. In the process of using the model for a long time, the palm will ache.
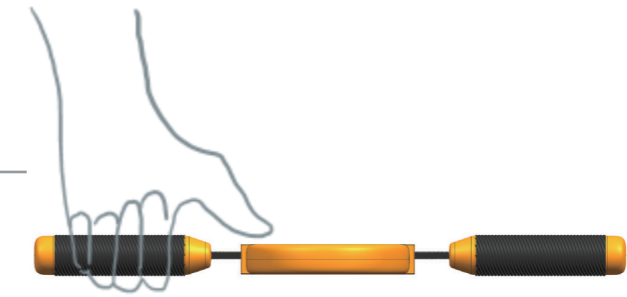


### Develop

In order to make the user use the product with less effort and make the product more ergonomic, a proper handle is necessary.
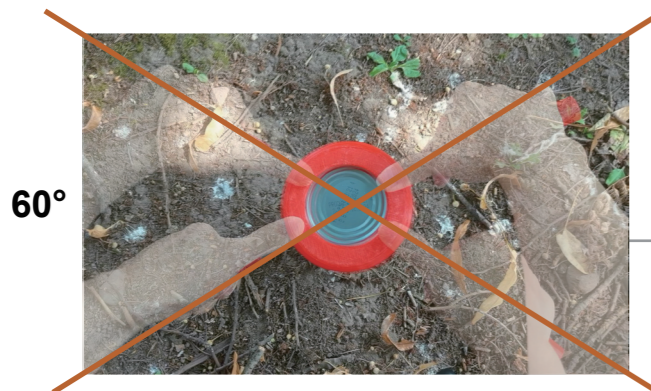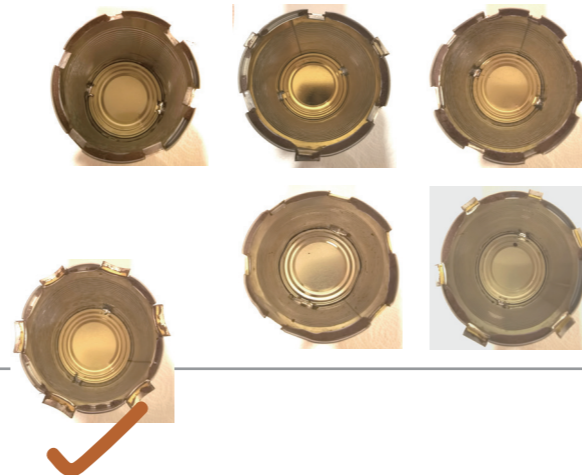


### Final

According to the person's hand and thumb length, the final product handle through the calculation of the appropriate size. (The calculation process is on page 8 of the technical report)
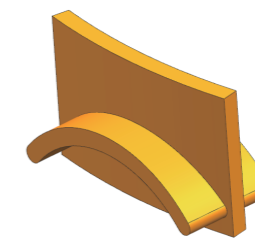


During the test, the user would unconsciously rotate back and forth at an Angle of about 60 degrees. This motion mode keeps the product moving at a high speed and is ergonomic.Therefore, the number of teeth must be at least 6 to cut off all possible roots while turning only 60 degrees.

**60°**



To further improve the drilling efficiency, cans with six different edge shapes were tested for digging by people of different genders.
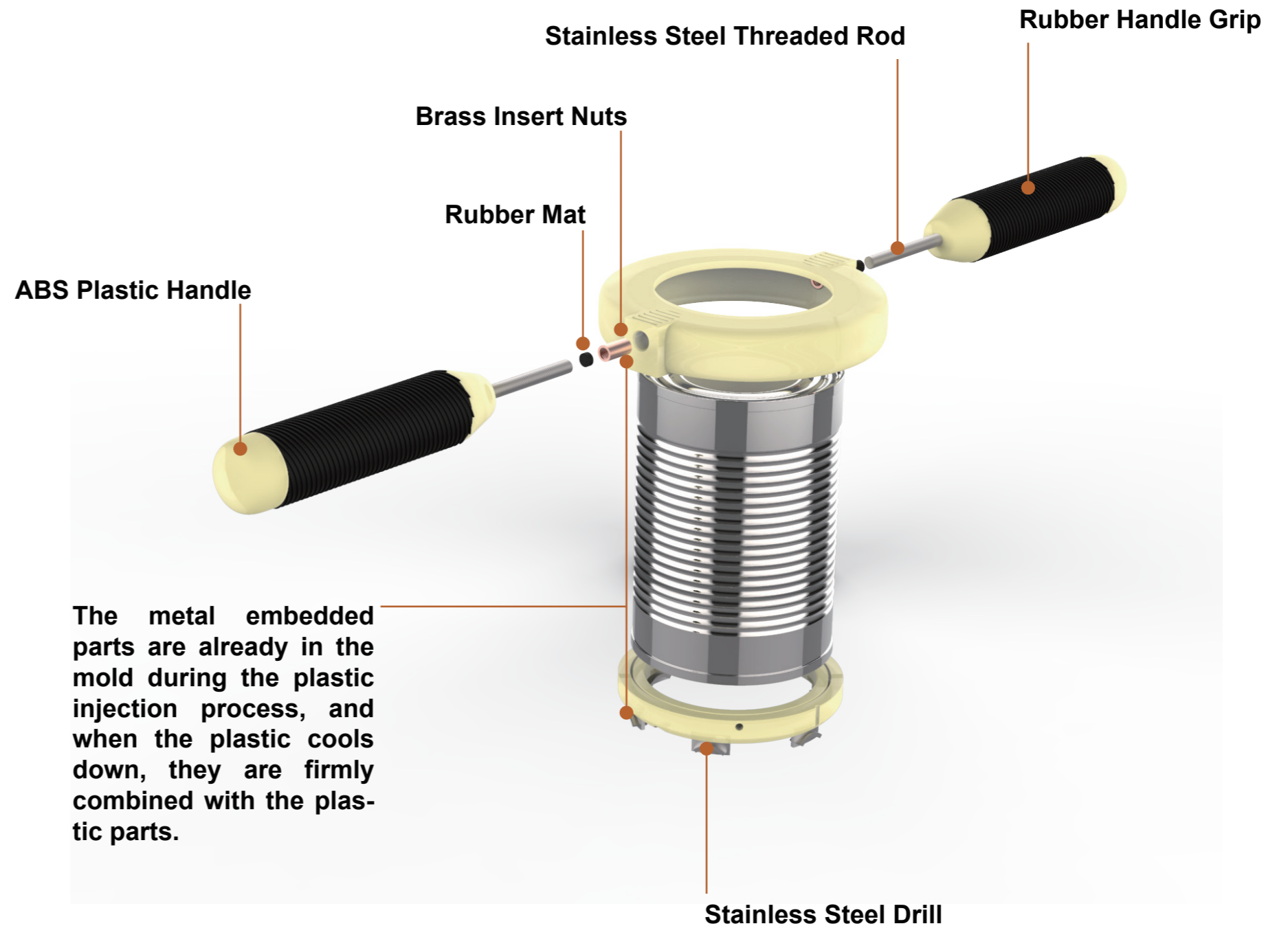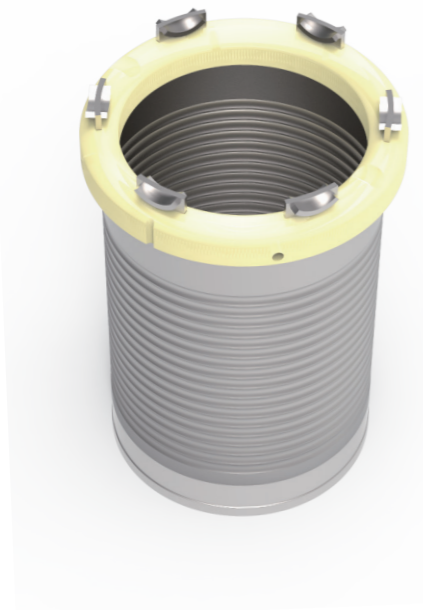




The final tooth shape of the product is the arc.

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**Reflection:** I did a lot of calculations and product testing in this part of the design. The upper and lower parts of the product are designed separately here.

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The upper part of the product can be fixed to the can, allowing the user to rotate the product more effortlessly and efficiently.
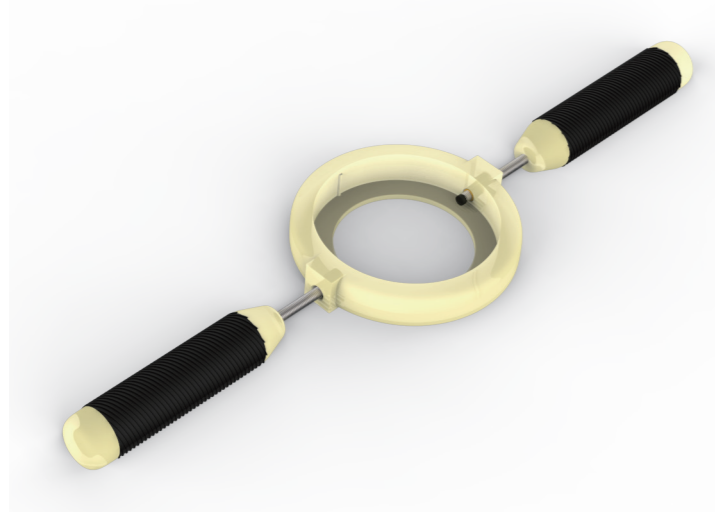
Can fit with the bottom product interference and can be directly inserted into the product with no other fixation.

**Stainless Steel Threaded Rod**

**Rubber Handle Grip**

**Brass Insert Nuts**

**Rubber Mat**

**ABS Plastic Handle**

The metal embedded parts are already in the mold during the plastic injection process, and when the plastic cools down, they are firmly combined with the plastic parts.

**Stainless Steel Drill**

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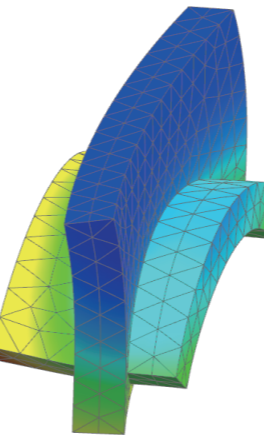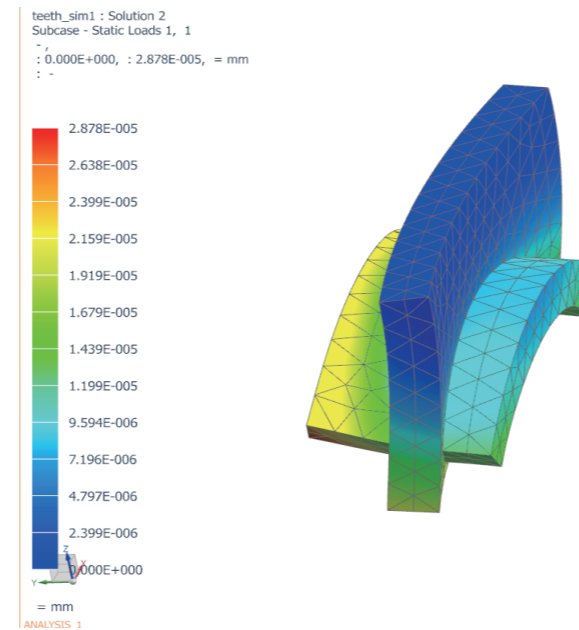MSc Product Design Engineering
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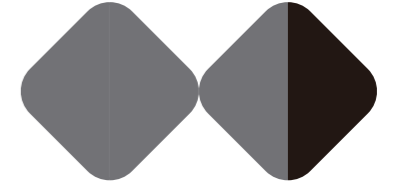
### FMEA

The main wear part of the product is the teeth. Therefore, the stress and deformation of the teeth are the focus of attention. The finite element analysis was done on the teeth in UG, and the results were as follows:



teeth_sim1 : Solution 2
Subcase - Static Loads 1, 1
: 0.000E+000, : 7.342E-005, = mm
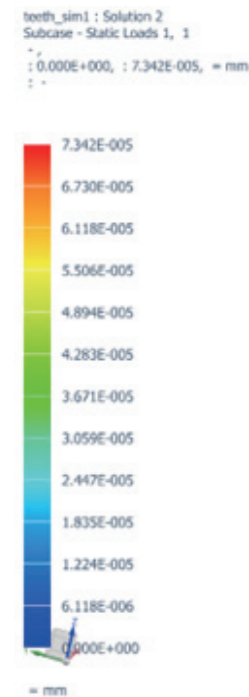
The analysis showed that plastic could not be used as teeth to cut through the soil. Even if steel is selected as the material, attention should be paid to structural optimization or increasing the teeth' thickness.
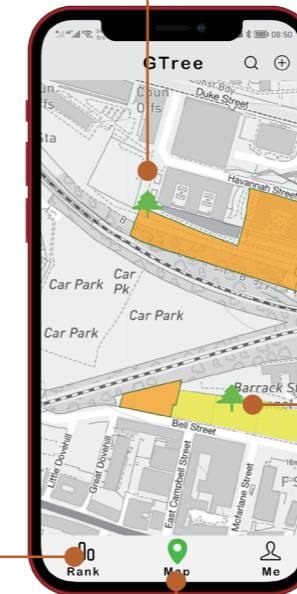
This is the result of optimizing the product.



teeth_sim1 : Solution 2
Subcase - Static Loads 1, 1
: 0.000E+000, : 2.878E-005, = mm

### APP



**After planting a tree, people can upload the location.**

**The app will remind nearby users to maintain the saplings for the next two years.**

**People can check their ranking of planting, watering and weeding. The goal here is to inspire a sense of collection and achievement.**

**Users open the Gtree APP and look for nearby available planting sites.**

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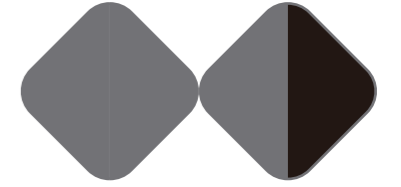
The user cleans the used can, plants the seeds of his favourite tree, and waits three to four months for it to sprout and grow.



Users open the Gtree APP and look for nearby available planting sites. Once you've found your destination, set off with the product and a can of saplings.



Users upload the planting location through the APP, and the app will remind nearby users to maintain the saplings for the next two years.
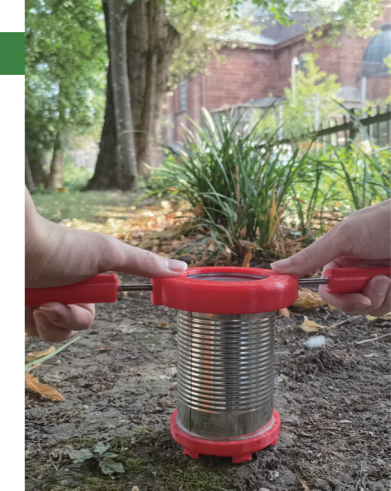
When users arrive at the planting site, they dump out the saplings and then assemble the product with the cans.
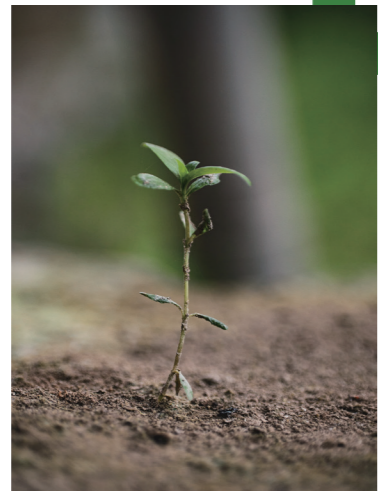


Put the sapling into the hole and cover it with soil.



The user uses the product to make holes in the ground.

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## Reflection

In this project design, I have learned a lot of new knowledge. For example, finite element analysis is something that I rarely touched before. Secondly, the part about ergonomics, which is also the critical content of this project. After many product tests, I found a lot of size or operation mode is unreasonable.

There are also many aspects worth improving in this design. The first is the aesthetics of the product. The product still looks like a boring industrial product. Secondly, the product details are not perfect, and many assembly errors are found in the later stage.

## Future work

There's a lot more I can do with this project in the future. The latest models, for example, need further testing. If the model proves effective, the next step is to find a professional tree planting team to test it. It is easier to find problems in practical use.

In addition, the product's strength can be tested by a more professional structural engineer. The same goes for the software part. I also need to learn the service process design of the whole system.

## References

[1] Pozniak, Helena. (2019). *Are wildfires getting worse?*. Available at: https://eandt.theiet.org/content/articles/2019/01/are-wildfires-getting-worse/. [Accessed 29 May 22].

[2] Heubl, Ben. (2019). *Climate scientists emphatic about replanting trees to tackle global temperature.* Available at: https://eandt.theiet.org/content/articles/2019/07/climate-scientists-emphatic-about-replanting-trees/. [Accessed 30 May 22].

[3] Bond, Andy. (2021). Woodland Trust £2.9 million to fund trees and green spaces for local communities. Available at: https://www.woodlandtrust.org.uk/press-centre/2021/03/emergency-tree-fund/. [Accessed 7 June 22].

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