Further development of initial idea: *parallel arms clamp* for how to get the nesting box held securely to the tree

Initial concept: As the parallel arms move, the protruding screws move closer together, consequently gripping to the trunk of the tree.

**Testing the idea**

**Evaluation:** The parallel arm mechanism worked well, in that it gripped to the tree. The screws were not long enough to grip the centre of the tree trunk. Having longer screws would mean that stability would be lost. Only three screws made contact with the tree, as trees are not exactly parallel. Having two screws on one side and one screw on the other would work just as well.

**Conclusion:** I will further investigate the idea of using a parallel arms clamping mechanism, with two screws on one side and one on the other.
**Lightbulb moment:** Only 3 pins are needed to hold the frame to the tree; the fourth screw is not required. Instead of making a frame with two parallel arms, I can use the nesting box to act as one of the arms. The nesting box can have two of the spikes on it, and the arm can have the 3rd screw/screw thread.

Fourth pin not required

block of wood represents nesting box

only one arm is needed to get the third contact point on the tree
Evaluation: This was a successful idea (nesting box worked well as being part of the frame), and the protruding screw heads helped keep it secure on the tree trunk. Yet relying on the weight of the nesting box to hold it to the tree was not successful (especially if it was in a storm situation).

Conclusion: I need a mechanism to pull the arm shut.

Developing Idea:
Evaluation of the initial nesting box clamping structure

**Positives**
- Once the frame is secure to the tree, it will not fall (shook it to test)
- The frame is versatile; and sized nesting box as long as it has a flat back can be attached to the back supporting bar.
- Easy to tighten

As thread is turned, bar is moved closer to nesting box, hence tightening onto the tree.

**Negatives**
- Has a tendency to spin around the tree; the wooden arm has been twisted slightly due to the pressure of the clamping mechanism and therefore it makes it easy to spin in one direction around the tree.
- Only some spikes (screws) touch the tree (2/6 on the top, and 2/6 on the bottom).
- Threaded rod took a long time to tighten (even though it was easy)

**Conclusion:** I am going to make next prototype out of metal to stop it bending and being able to spin around the tree, and rather than using spikes, I will use a v-frame.
- If the back supporting bar was made of metal, the thread could go inside the bar, rather than being attached with a nut. I will attempt to minimise the number of different components in order to make it simpler and easier to use.
- I will experiment with using a cordless drill.
Experiment: Test the idea of the hook permanently connected to telescopic pole

Aim: Increase the safety of the hook design, by attaching the hook permanently to the end of the pole. Test to see if the pole would get in the way when lifting the nesting box.

Method: Permanently attached the same short steel hook, with the pulley design attached to the telescopic pole.

Results:

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<th>Evaluation</th>
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<td>1. The hook permanently attached to the pole worked really well. The pole was not a major problem when lifting the nesting box. The angle of the bend allowed me to easily place the hook over the branch, and it sat securely in the fork of the tree. The pulley was very effective, as I did not need to use much effort to raise the nesting box into the tree.</td>
<td>1. In my final design, the hook will be permanently attached to the end of the telescopic pole.</td>
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<td>2. Holding the rope continuously was difficult.</td>
<td>2. Use a bracket on the bottom of the telescopic pole (like a curtain/blind cord hook), so that I don't have to constantly hold the rope once the nesting box is elevated in tree.</td>
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| 3. When the pole was fully extended, it was hard to get upright. | 3. a) Make the hook out of aluminium in my final design, as this will make the end of the pole lighter and easier to lift. 

b) Use a weight on the bottom of the telescopic pole to counteract the weight of the hook. |
I bent a hook out of steel rod, and welded it to a piece of square tubing. Being attached to square tubing, I could use a square driver bit and drill to turn the hook.

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<td>1. Using a third pole (the square tubing) Rather than attaching the hook to a third pole, I could make a hook attachment that could be interchangeable with the square spike on the second telescopic pole. Therefore, I would only need two poles instead of three.</td>
<td>I will weld the hook to a small piece of steel tubing that can fit onto the end of the telescopic pole.</td>
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<td>2. The square driver bit didn’t work easily; if pressure was being pushed down to keep the hook in the ring, then the square drive would come out of the bottom of the square tube. If pressure was being pushed up to keep the square drive in the tube, then the hook would slip out of the ring at the top.</td>
<td>I will permanently attach the driver bit to the pole, so that the downward pressure can be put on without the hook falling out of the ring.</td>
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<td>3. Turning the hook worked, but it sometimes slipped out of the ring.</td>
<td>Make the hook longer so it doesn’t slip out</td>
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<td>4. Positioning the hook into the ring at the bottom of the iron rod (when the nesting box was in the tree), was a bit awkward, but worked adequately.</td>
<td>1. Use an elongated ring rather than a circular ring attached to the bottom of the iron rod, as it would make it easier to fit the hook into the hole. Elongated ring could be a chain link</td>
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