Ku-ring-gai Stingless Beehive Box Schematics – Supporting Information

1.0 - Introduction

The Ku-ring-gai Native Stingless Bee Program has been running since 2003 and its popularity within the LGA has increased to levels unforeseen at the program's inception. As part of the program we sell a number of hives each year as well as empty hive components for standard OATH hives. The funds raised from this go straight back into the program, allowing us to innovate and continue to improve what is offered to residents and the community.

In recent years the hive design has changed radically and is now unique to the Ku-ring-gai program. As we begin to leave the old OATH (Original Australian *Tetragonula* Hive; Fig. 1a,b) hives behind, I wanted to ensure that those who have the newer style hives are able to create components that fit them now that the hives are no longer universal.

In partnership with a good friend of the program, Tim Bird, we have together created a set of schematics and instructions that would allow a hobbyist to create their own hive boxes or commission their construction from a local community workshop.

This accompanying document aims to explain the reasoning behind the hive's design, the limitations that are unique to the program, and the flexibility in the design that can be exploited by the individual.

Before reading the rest of this document I would like to point out to the reader that these schematics outline how to make the hives that we use on the program. However, keep in mind that there are numerous limitations inherent in the program that do not apply to the hobbyist. Therefore, I encourage anyone reading this to look at this as a guide, but to also realise that there may be many ways in which you can improve upon this design, incorporating hive technologies that are simply unfeasible to implement on the Council program.

2.0 - The Hive

2.1 - Hive History:

As some brief background, there have been 2 major iterations of Ku-ring-gai hive. Firstly, came the standard OATH hive (Fig. 1a,b) which follows the standard dimensions of the hive developed by Tim Heard. The second design, the KOATH (Ku-ring-gai Original Australian *Tetragonula* Hive; Fig. 1c), moved away from the universal design, maintaining the same internal dimensions but thickening the walls significantly. The KOATH incorporated polystyrene insulation into its walls and base, sandwiched between layers of plywood.

Fig.1. (a) and (b) show the original OATH, the foam box and the wooden hive housed within respectively. (c) shows the current KOATH, the dimensions of which now dictate all future designs

The move to the KOATH meant that Council could dispense with the external polystyrene box but also meant that the hive was now unique to the program i.e. one could not purchase compatible hive components from 3rd party suppliers.

The 3rd iteration, which is due to be implemented on the program in 2022 and which is documented in these schematics, is, by necessity, compatible with the KOATH. However, it aims to improve upon the current KOATH by increasing aesthetic appeal and moving away from using non-recyclable plastic as a major construction material, focusing on natural alternatives instead.

2.2 - Hive Design:

Each hive half is designed to be universal, by which I mean that a hive half can function as either a base or a top so there is no need to create separate hive designs for each of these functions.

The hive is constructed mainly of solid wood, with this forming the outer layer of the walls and the entirety of the base/top. In order to conform to the current KOATH, the walls are 60mm thick. Pine has been used for the bulk of the walls and base due to its ease of availability, cost, and insulation properties. The inner layer is constructed of plywood as this allowed the bulking out of the pine in order to reach the 60mm. The base is constructed of 45mm thick pine lengths with a 3mm plywood base inserted to ensure that there are no gaps.

The legs are created either from offcuts from the rest of the construction process or can be cut fresh. These are designed to not run the entire width of the hive so that a peaked roof can be added. Please note, that no matter the wood you use, it must be untreated.

The entrance tube is drilled at 15mm wide, too wide to be left as it is. This is done to accommodate a piece of 15mm irrigation tubing which lengthens the entrance tube and results in a 13mm diameter entrance hole. Be sure to use UV stabilised tubing so that the entrance tube does not perish.

The major addition in terms of hive components is the addition of the split bars. These have been added primarily to create clean splits by limiting or even eradicating the breaking of honey and pollen pots during a split. The space between each bar allows for the brood to move through the hive unrestricted whilst simultaneously preventing the construction of honey pots across the seam. The bars are made from 3mm plywood and recessed to sit ~2.5mm from the lip of each hive half so that when placed together they create a gap of 5mm between the bars in the bottom and the bars in the top. This allows the bees to move through the space between them and prevents the bars being strongly glued to each other with resin. Pests are attracted to spilled hive contents so minimising this during splitting will help reduce hive loss due to pests.

3.0 - Program Limitations

The Ku-ring-gai hives are designed to be the best possible home for the bees, however, as mentioned at the beginning of this document, limitations inherent in the program do mean that many new technologies and innovations cannot be easily implemented. I wanted to outline the limitations of the program below in order to highlight the possibilities when not constrained by them.

The primary constraint in terms of design freedom is the dimensions of those hives that came before, namely the current KOATH. As we have hundreds of hives on the program any new hive design needs to be compatible with the current portfolio, as it would be untenable to convert all the current hives to a new shape or to new dimensions. This means that the hives must be rectangular and must have 60mm thick walls, a thickness that is arguably overkill.

Secondly, there is cost. As most of our hives are given as part of the program at no cost to the resident, we do not accrue the same amount as a comparable commercial enterprise. We also have to make many hundreds of hives each year, something that the hobbyist need not worry about. As such, we have less funds to go towards construction and so any hive design made is more restricted on cost than most. This also limits the materials available to us.

Linked to cost is efficiency. As we make many hundred hives each year the design needs to be simple enough to be constructed on a large scale in a short period of time. This means that complicated joints or components are not really possible.

With these constraints in mind it is easy to imagine that if you were only making one or a handful of hives, the designs and materials used could be more diverse.

4.0 - Flexibility and Options to Improve

In this section I'd like to highlight some examples as to where you can be flexible with the design. This is by no means an exhaustive list but should give an idea of how you could add to or edit your hive whilst still having it be compatible with the standard Ku-ring-gai hives.

4.1 - Materials:

This is one of the biggest areas of flexibility. There's lots of materials available but here I'm going to focus on untreated woods. We use pine and plywood because pine is a good softwood insulator and is easily available. It is also very competitive in terms of price, allowing us to create an all-wood box within the budget of the program. The plywood allows us to use standard lengths of pine and then top up the thickness.

However, when making only one or a small number of boxes for personal use, price becomes far more fluid, opening the possibility of using other materials. For example, you could use the standard pine as the inside layer and then apply a thinner layer of a wood of your choice on the outside. Or, equally, replace the plywood on the inside with a wood of higher quality.

A note on hard woods vs. softwoods: If you're thinking about using different types of wood then keep that wood's properties in mind. Generally speaking, hardwoods are far more durable and can also look lovely when stained well, however they are heavier and poorer insulators than softwoods. So, you would need a comparatively thicker piece of hardwood to provide the same insulation performance as a piece of softwood. As a balance, you could use a thicker piece of softwood for the inside frame of the hive, and then use a thinner piece of hardwood on the outside to make it durable (flipping the layers in the current hive schematic).

There are also some great all-rounders. Western red cedar is a softwood, so a great insulator, but is also very durable and naturally termite and fungus resistant. However, it is expensive, so you would have to shell out a lot more to make your hive.

So, look at the woods we use as suggestions rather than the only option. Equally, we have the thicker pine on the outside, with the thinner plywood layer on the inside. However, there's no reason why you couldn't flip this to have the thinner layer on the outside, depending on the wood you wanted to use.

4.2 – Cuts, Lengths & Grades:

Linked to materials, the wood cuts that you use could vary. On the program, we need to stick with easily available, standard cuts as it is not cost effective for us to request custom ones. This is why the hive walls are made of both pine and plywood. However, you could equally request custom lengths of your chosen wood. It would be more expensive but would allow you to create the hive from a single wood.

Similarly, the base of our hive is made of 4 parallel pine lengths. However, this could be made of one solid piece of wood (do be careful when using large lengths as some woods are prone to warping and twisting)

There is also great variation within a wood. For example, we use standard construction grade pine due to its excellent price point and ready availability. However, there are higher grades of pine that can come dressed, square-edged etc. that would make excellent material for hive construction and would result in a more aesthetically pleasing finish.

4.3 - Joints:

The screws and nails that we use are also flexible. Whatever screws you use make sure that they will last outdoors without corroding and are the correct length, but within that you could use screws with more aesthetically pleasing heads.

Alternatively, you could avoid screws altogether and go for joints or wooden pegs. Using wooden pegs to connect your hive pieces makes for an aesthetically pleasing alternative to screws, although it does require more effort.

Equally, if you had the time and the skill there's no reason why the hive frame could not be assembled with dovetail joints or similar, removing the need for screws or pegs altogether.

4.4 - Split bars:

We use a very basic split bar, however there are more elaborate versions e.g. separating plates. These plates perform the same job but have a specific circular hole to guide the brood and are usually made of stainless steel or plastic, allowing them to be far thinner than plywood

4.5 - Entrance tube:

Entrance tubes can also vary greatly. Our entrance is designed to work with an irrigation tube insert. However, the insert you use (if any) can also differ. Cones for example have a number of advantages over a standard tube, they improve ventilation and make it easier for the bees to land, and they also make it more difficult for pests such as Small Hive Beetle (SHB) and Phorid fly to enter.

4.6 - Paints, Stains & Assembly:

We use an external weatherproofing paint, as this provides the longest protection and means we don't have to repaint hives within their lifetime. The downside to this is that we lose the beautiful natural wood look of the hive. Wood stains maintain the natural wood effect but do not last anywhere near as long as paints, perhaps 5 years if you're lucky. Periodically re-staining hundreds of hives as part of the program just isn't feasible, however doing this to your own personal hive is more than reasonable and would allow for the natural wood look.

If you're super keen on looking after your wood you can even wax dip it prior to construction. This is not for the faint hearted though as it involves very hot wax so only take this on if you're confident.

Tung oil is another option but as with any stain it won't last that long. So, if considering using a stain keep in mind the need to reapply throughout the hive's lifetime.

On the point of prepping before assembly, we paint our hives after they've been constructed. However, with the two layer design of this hive, with the pine on the outside and the plywood on the inside, you could paint/stain all your pine pieces before putting them all together. Or, paint the box between stages 1 and 2 in the schematics. This way you could paint all of the pine and then add the plywood lining afterwards. Both approaches would fully cover all of the pine leaving none of it open to the elements and you'd still have the unpainted ply on the inside. This would make for a very clean, professional-looking finish.

4.7 - Shape

Changing the shape of the hive you make would, of course, make it incompatible with the hive depicted in the accompanying schematics. However, I have included it here as an example of the greater freedom that a hobbyist has and to highlight the diversity in hive designs out there.

Rectangular, square, round or hexagonal are all viable shapes. In fact, pretty much any shape is fine as long as it fulfils the needs of the bees. Related to the shape of the hive is the thickness of the materials. We use 60mm walls in the case of the Ku-ring-gai hives, however, this is perhaps excessive and makes it difficult to find standard cuts for. 45mm thick cuts of timber are far more readily available and would still likely provide adequate insulation for a hive in Sydney, if an appropriate wood is used.

Keep in mind complexity of the construction, and that should you make something of a different shape, then you will need to encourage bees into your new hive in a different way. I won't go into the method of doing this here but a simple internet search of 'eduction' will provide a wealth of information on the technique; 'Australian Stingless Bees: A Guide to Sugarbag Beekeeping' by John Klumpp is also an excellent resource for this.

5.0 - Acknowledgements

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