# Nest Building by Weaverbirds

Dinesh Govindaraju - dineshgo@andrew.cmu.edu

## 1 Introduction

Weaverbirds are a family of small to medium sized seed eating birds that are related to finches (Figure 1). These birds derive their name from the large complex nests that the males of the species weave as part of a mating ritual. Made of grass and twigs, the nests are elaborate ovoidal or kidney shaped structures with a tubular bottom extension that serves as an entrance. The outer shells of these nests consist of long strips the male Weaverbird tears from the leaves of tall grasses or palm fronds and rather than thatching this vegetation together as other birds do [1], the Weaverbird alternates them above and below other strands. This causes the nests to be particularly sturdy and structurally sound, and enables them to remain intact even when predators strike.

Figure 1: A Masked Weaver *(Ploceus velatus)* busy building its nest

In this paper, we are interested in the specific weaving processes by which the male Weaverbird constructs the outer shell of its nest. We proceed by investigating how these nests are built and the types of weaves used by the birds. We will then examine strategies that these birds employ to overcome some specific challenges that they face during the act of nest building.

## 2 The Nest Building Process

The nest built by the male Weaverbird is usually 15 centimeters long by 12 centimeters high and are often suspended from a branch. They may have a 5 to 10 centimeters long tubular extension at the entrance to the nest which is about 5 centimeters in diameter (Figure 2)[1].

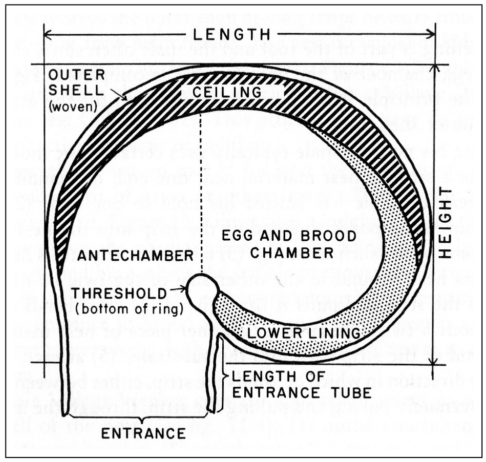


Figure 2: Diagrammatic section through a Village Weaver nest

The process of weaving the outer shell of the nest progresses incrementally through seven stages. These include the construction of the initial attachment, ring, roof, egg chamber, antechamber, entrance and entrance tube (Figure 3)[1].

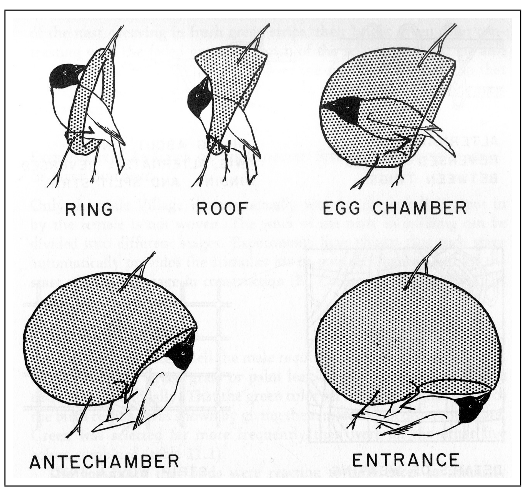


Figure 3: Sequence of stages in nest weaving

The Weaverbird constructs the initial attachment by first holding the initial strip under its foot against a twig. It then loops it back and alternately reverses the winding of the strip between the twig and the strip itself (Figure 4 left). This is similar to ”nippering” a knot, a type of fastening used by people to lash to parallel ropes together

[3]. The initial attachment is then developed into a roughly vertical ring that provides the basic support for the whole nest.

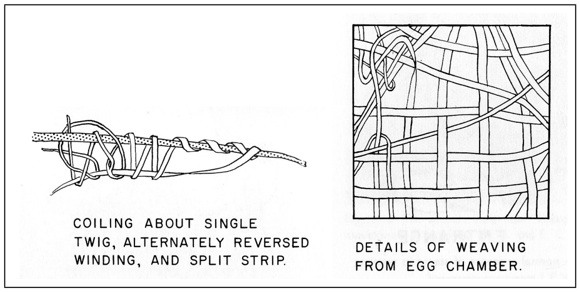


Figure 4: Types of weaves used in nest building

Once the basic support has been established, the male Weaverbird uses a certain basic set of movements to weave the rest of nest's outer hull. This involves the bird using its beak to seize a strip of nest material near one of its ends. With a vibratory motion, it then pokes the end of the strip into the bulk of the nest. Once the strip sticks, it releases its grip, moves its head to the other side of the nest mass and grabs the end of the strip again. it then loops the strip back into the nest substrate as if stitching with a needle. At each stitch it reverses the direction in which the strip is wound through the interstices of the nest (Figure 4 right). Its actions in this way are similar to the process of human weaving.

# 3 Specific Strategies Used in Nest Building

## 3.1 Leaf Tearing

One of the first tasks a Weaverbird must learn to accomplish to successfully build a nest is to gather appropriate nest building material. The best material for this purpose include 10-15 inch long flexible strips of vegetation which are freshly torn from tall grasses (elephant grass, Mexican reed grass) and palm fronds. We observe here that if a human wished to carry out this task and was not strong enough to pluck the grass from the ground, he might employ a shearing motion at the base of the leaf to tear it breadthwise from it's base. The human would do this by using one hand to grip the blade of grass and apply an upward motion, while using the other hand to apply an opposing downward motion (Figure 5).

Gripping the base of the leaf some distance apart would result in it rotating rather than tearing motion (Figure 6). However, placing the two points of contact close together effectively immobilizes the leaf, and the forces applied cause the internal structure of the leaf itself to rupture.

For the Weaverbird, however, none of this is possible because it can only apply a single point of contact to the blade of grass with its beak. To overcome this and simultaneously pull the blade in two different directions to tear it, the Weaverbird makes use of resistive force applied by the root to keep the grass attached to the ground. Instead

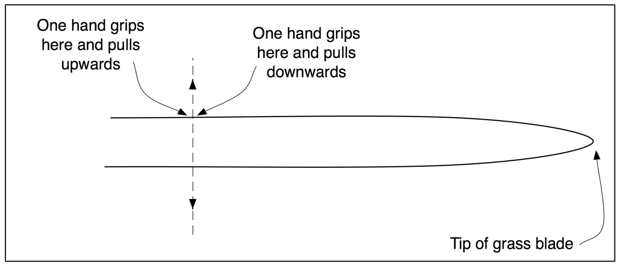


Figure 5: Human tearing off a blade of grass

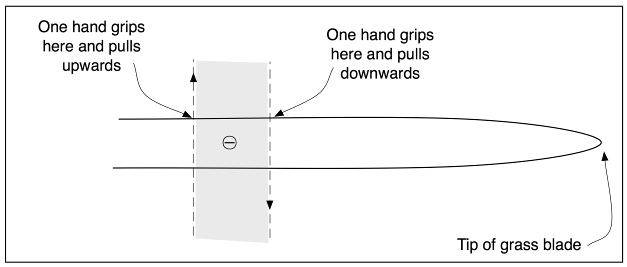


Figure 6: Rotation of leaf if hands are placed some distance apart

of tearing the blade breadthwise, the Weaverbird makes a lengthwise tear by by biting through one edge of the grass blade and subsequently flying with it in the direction of the blade tip (Figure 7). This then provides it with nest building material it needs.

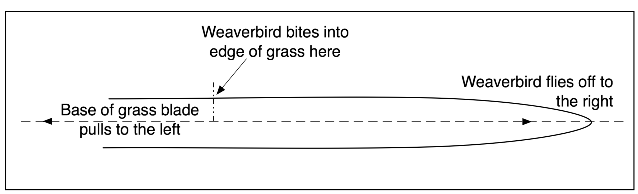


Figure 7: Weaverbird tearing off a blade of grass

## 3.2 Mandibulation

During the process of weaving its nest, the Weaverbird must often grip a strip of nest material close to its tip to facilitate carrying out the stitching and weaving motion [2]. When seizing a new strip of building material either from the ground or one protruding from the nest mass with its beak, the Weaverbird's initial grip may not always be at the desired location close to the tip. Due to this, the Weaverbird may need to manipulate the strip along its beak until it has shifted its hold onto one end.

To carry this out, the Weaverbird first ensures that the other end of the strip is immobilized by either holding it underfoot (if it's loose vegetation) or simply leaving it attached to the rest of the nest (if it's protruding from the nest mass). it then relaxes its beak to loosen the grasp on the strip and pulls its head away, causing the strip of material to slide along its mouth while the sliding motion is guided by its beak (Figure 8).When the strip slides far along enough that its grasp is close to the tip, it once again tightens its beak such that the frictional force is sufficient to resist sliding.

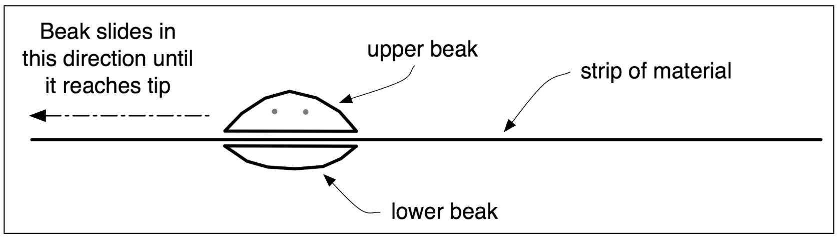


Figure 8: Strip of vegetation sliding along a Weaverbird's beak

If we consider $f_s$ to be the relative sliding force exerted by pulling motion of the bird's head and $A$ to be the total area of the beak in contact with the strip. Coulomb's law gives us a measure of the limit of pressure $p_l$, exerted by the beaks on the strip, above which sliding can no longer occur. This can be seen in Eq. (1) where for simplicity, we ignore the difference between the static and dynamic coefficients of friction.

$$p_l = \frac{f_s}{\mu A} \tag{1}$$

From this we see that to get its beak to the correct location along the strip of nest building material, the Weaverbird must first relax it's beak until the pressure it exerts on the strip is less than $p_l$. Once the beak has reached the tip of the strip, it needs to exert a pressure of more than $p_l$ so that the sliding movement stops, and the strip is once again in its grasp.

## 3.3 Choice of Weaving Pattern

When observing the design employed by Cassin's Malimbe (one particular species of Weaverbirds) in constructing the entrance tubes to their nests, we notice that a very regular lattice-like weaving pattern is used. In particular the entrance tube consists of two sets of long, thin strips woven in a configuration of opposing spirals (Figure 9).

The reason for the use of this particular design becomes clear when we consider the advantages that it confers. The two cris-crossing systems of strips and their orientation at 45 degrees to the long axis of the tube provide the best resistance to the shear stress generated when the bird hangs from one side of the entrance at the bottom of the tube during nest building. If the two sets of strips were parallel to and at right angles to the long axis of the tube, only the vertical strips would bear the full weight of the bird, and therefore would be more prone to unravelling or breaking [1]. This can be seen in Figure 10, with the mass of the bird taken to be $m_b$.

The 45-degree orientation of the weaving pattern also means that the the entrance tube would extend along its long axis if a weight was applied to the bottom, and that

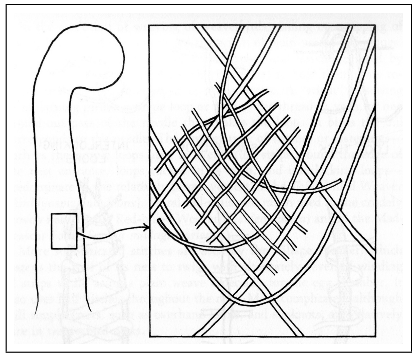

Figure 9: Weaving pattern used by Cassin's Malimbe in weaving the entrance tube

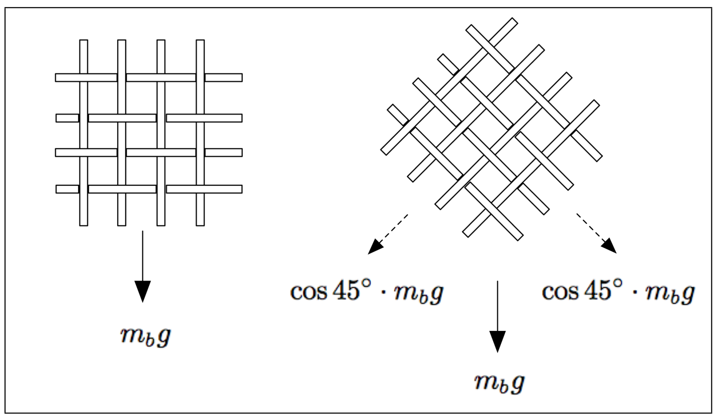


Figure 10: Distribution of weight resulting from orientation of weaving pattern

it would simultaneously contract considerably along the perpendicular radii. And so if a tree snake were to crawl down the outside of the entrance tube, the tubular structure would compress under the weight of the snake and the distortion of the entrance tube might shake the serpent off.

## 4 Conclusion

In this paper we have been introduced to the specific weaving processes by which the male Weaverbird constructs its nest so as to attract a mate. We have taken a closer look at the manner in which these nests are built and also at some specific types of weaves used by the birds. We then analyzed particular strategies that these fascinating creatures have used to successfully overcome challenges that are presented to them during the nest building process.

## References

[1] N. E. Collias and E. C. Collias, Nest Building and Bird Behavior, Princeton: Princeton University Press, 1984

[2] http://www.harunyahya.com/download/download.php?id=14927 (http://67.15.194.37/download/26/04/9a501301bd33ffef4b6b73a22a04e838/architects_in_nature_03.mpg)

[3] P. N. Hasluck, Knotting and Splicing Ropes and Cordage, Philadelphia: D. McKay Co., 1942