The Woven Flexatube

The Woven Flexatube is an extended flexagon that can be made by filling the edges of the Zigzag Silverflexagon with extra segments. For the sake of clarity these extra segments are identified with lower case letters.

This extended flexagon forms the basis of Robert E Neale's famous Sheep and Goats puzzle and for this reason is sometimes known as the Sheep and Goats Flexagon. Details of this puzzle treatment can be found on the Puzzles page of this site.

The addition of the eight extra segments to the Zigzag Silverflexagon has the effect of restricting the ways in which the Woven Flexatube can be flexed and of lessening the number of faces that can be found. The Woven Flexatube cannot be flexed by means of rolling flexes, tube flexes, swivel flexes or tuck flexes. It has two square states, no hexagonal states and no oblong ones. Despite this the Woven Flexatube is a complex and fascinating flexagon to explore and map.

The paucity of flat states focuses attention on the multiplicity of routes between them. and on the intermediate forms (square section tubes and two-pocket parallelograms) that are the half-way points along these routes.

Making the Woven Flexatube

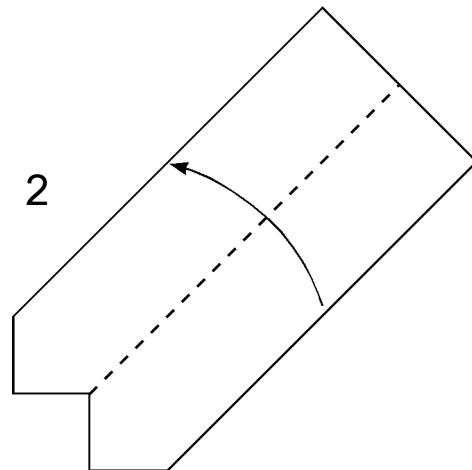A template for this flexagon can be found on the Flexagons page of this site.

1
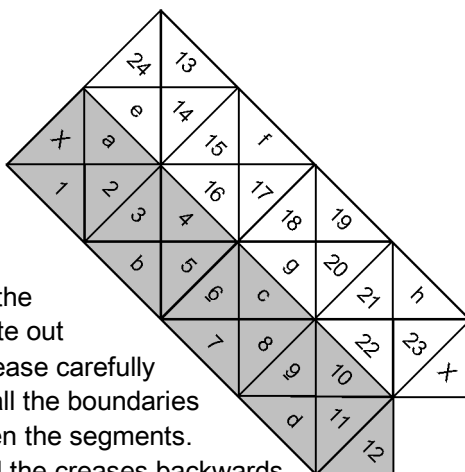
1. Cut the template out and crease carefully along all the boundaries between the segments. Fold all the creases backwards as well as forwards so that the segments move freely in both directions.
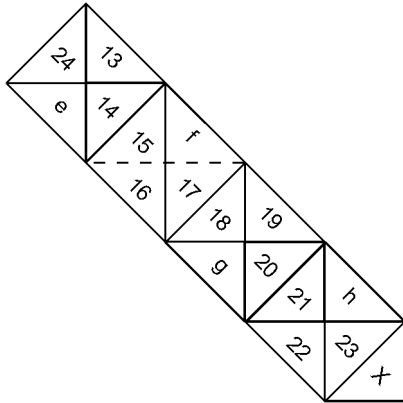

2

2. Apply glue to one half of the plain side of the template then fold one half onto the other so that all the edges line up. If necessary, trim slightly to neaten the edges.
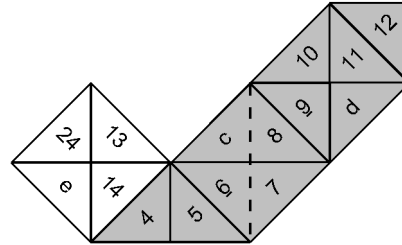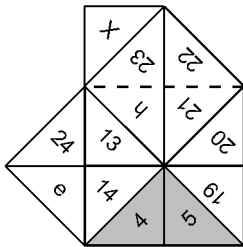
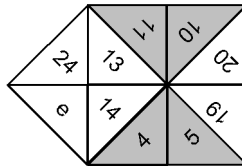**3**

3. Fold 16/17 onto 15/f.
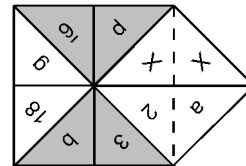
4

4. Fold 8/7 onto c/6

5

5. Fold 23/22 onto h/21 so that segment x goes underneath 13.
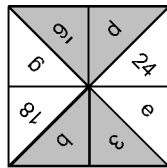
6

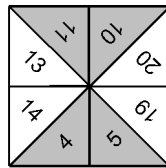
6. This is the result. Turn over sideways.

7

7. Glue x onto x.

8

8. This is state A of the Woven Flexatube. Turn over sideways.

9

9. Compare this picture with picture 7 on page 13.

David Mitchell / The Woven Flexatube
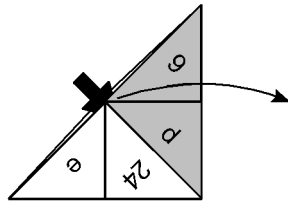
Diagonal Tube flexes

A diagonal tube flex is made in a similar way to a normal tube flex except that it begins and ends in a diagonal direction. (You can flex between states A and B of the Zigzag Silverflexagon using this kind of flex, though it is far easier in that case to use a double flip flex or normal tube flex instead.)
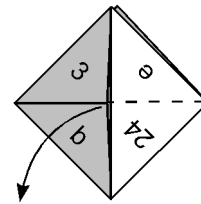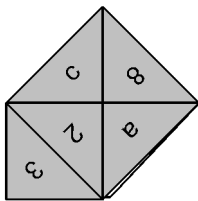
10
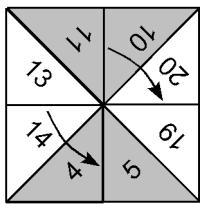
10. Fold 10 onto 20 and 14 onto 4.

11

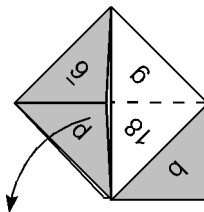11. Open up the layers at the focus and fold flap 9/d across to the right.
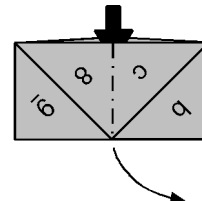
12

12. Open flap 3/b as shown.

13
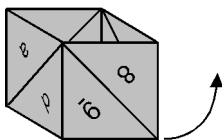
13. Turn over sideways.

14
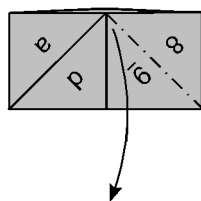
14. Open flap 9/d as shown.

15

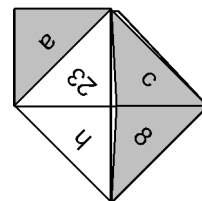15. Separate the layers to form a square section tube.

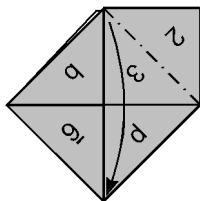## 16

16. Squash flat in the alternate direction.

17

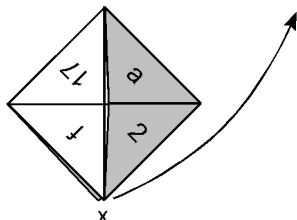17. Fold the front layers downwards.
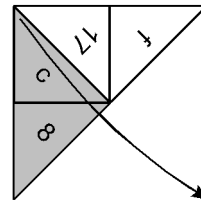
18

18. Turn over sideways.
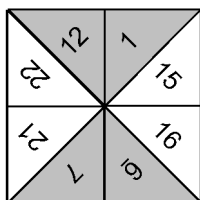
19

19. Fold b/3 onto 9/d.

20

20. Separate the layers at point x and fold the top layers diagonally upward to the right.

21

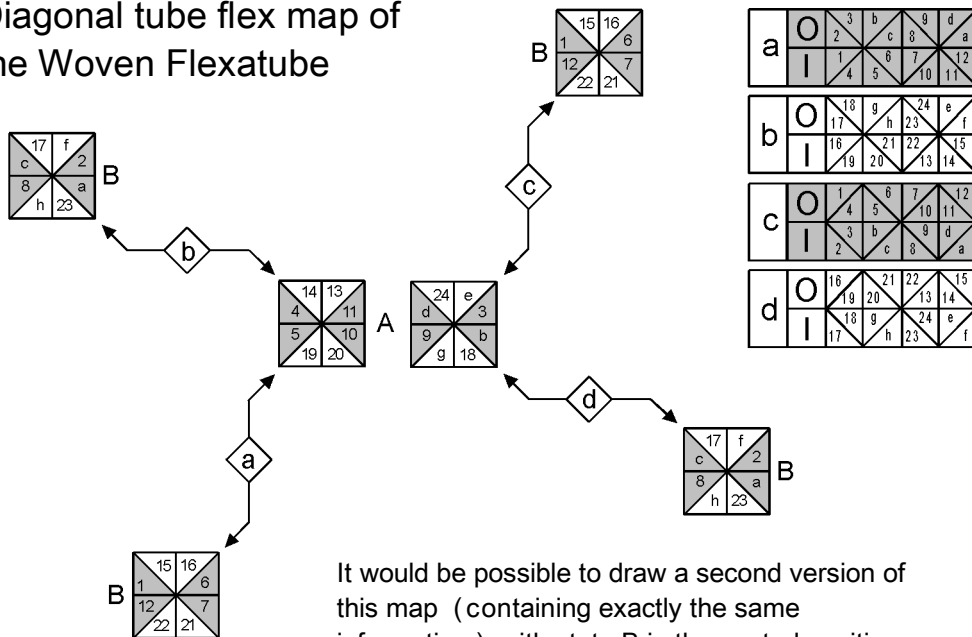**21. Fold the top layers diagonally downwards to the right.**

22

22. This is state B.

Making a diagonal tube flex from any face of either square state in any direction will take you to the other square state.

Diagonal tube flex map of the Woven Flexatube

It would be possible to draw a second version of this map (containing exactly the same information) with state B in the central position.

David Mitchell / The Woven Flexatube

The four possible tube forms of the Woven Flexatube are identified on this map by the letters a, b, c and d placed inside the diagonal tube flex symbols. The four boxes to the top right of the map show which surfaces form the outside (O) and inside (I) of each of these four tubes. The background of the boxes has been shaded to show the pattern produced on the outside and inside of these tubes when the strip is cut from differentiated paper.

You will notice that the outside of tube a is the same as the inside of tube c and vice versa. This allows us to design a puzzle treatment of the flexagon in which the object is to turn a tube inside out, a challenge very similar to that of the Flexatube which is explained elsewhere in this book. If you investigate this possibility you will find that there are two quite separate ways in which such a challenge can be solved. The obvious solution is to flex straight through state A or B but it is also possible to avoid going through either state. This second solution can be found as Easy Street in the solutions given for the Flexatube (see pages 98 and 99).

You will also notice that the visible surface of tubes a and c is entirely shaded and that of tubes d and b entirely white. This allows us to design a further puzzle treatment in which the object is to turn a tube of entirely one colour or pattern into a tube of entirely another. Here again the solution is to flex through square states A or B but in this case the axis of the flex must be altered at right angles when the square state is reached.
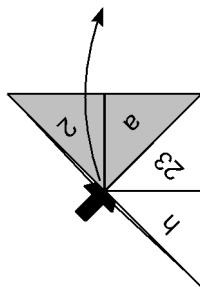
Taking the Scenic Route

Somewhat remarkably it is possible to flex between states A and B without making a tube flex. Here's how to do it.
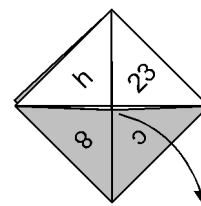
23
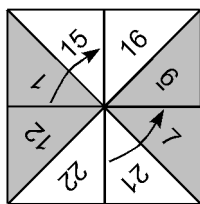
23. Just for a change this is state B. Fold 1 onto 15 and 21 onto 7.
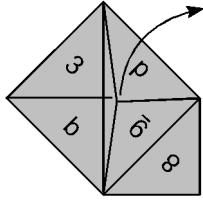
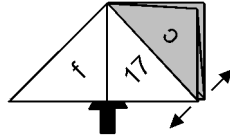**24**

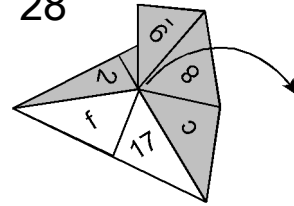24. Open the focus and fold 2/a upwards.

25

24. Open flap 8/c as shown.
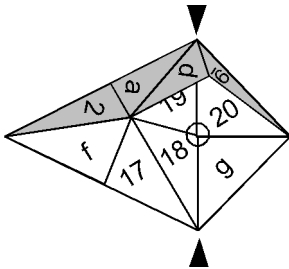
26

26. Open flap 9/d as shown.

27

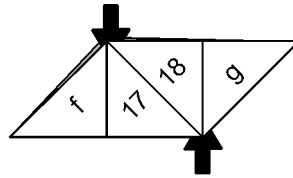27. Open to form a pyramid.

28

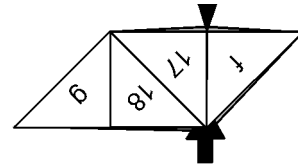28. Open flap c/8.

29

29. Squeeze the sides together so that the point marked with a circle rises upwards.
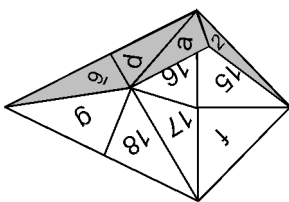
30

30. This parallelogram form has pockets to top and bottom. Rotate through 180 degrees.
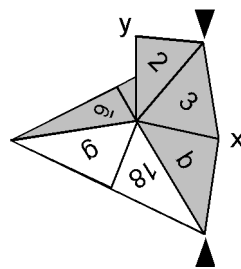
31

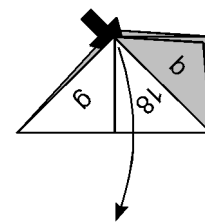31. Open the pocket at the bottom and push down on the front top edge between 17 and f.
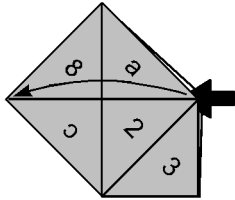
32

32. Fold f onto 17 and 15 onto 16.

33

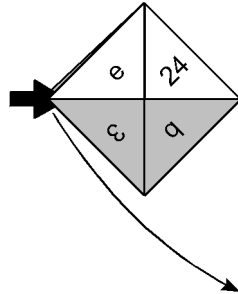33. Squeeze flat sideways so that x and y come together.

34

34. Fold flap 18/g downwards.
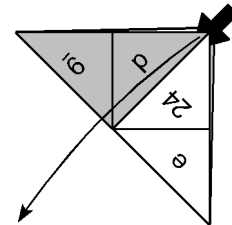
David Mitchell / The Woven Flexatube
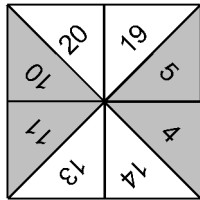
35

35. Fold a/2 onto 8/c.

36

36. Separate the layers at the left side and fold the front left corner diagonally downwards.

37

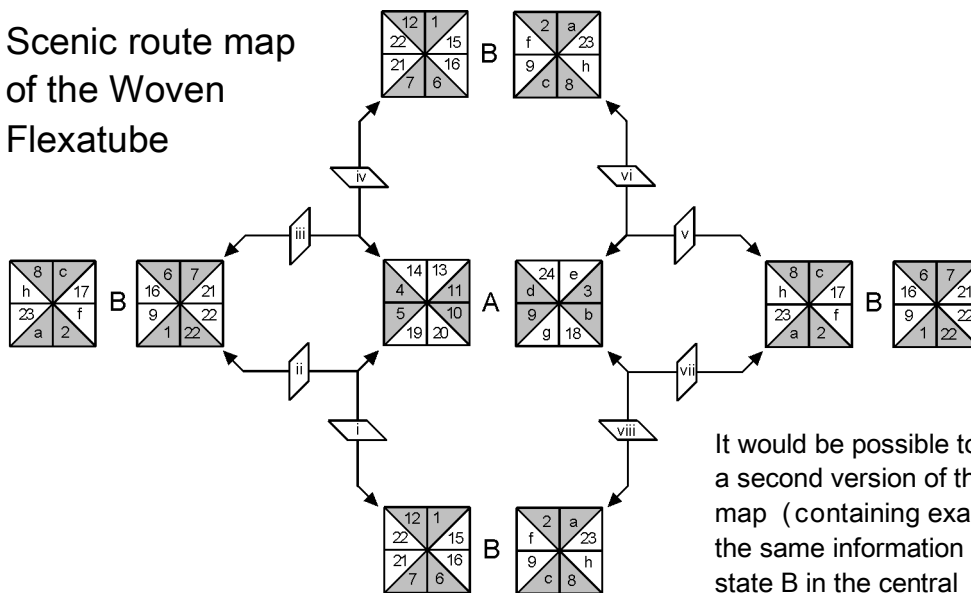37. Separate the layers at the top right corner and fold the front layer diagonally downwards.

38

38. This is state A.

There are eight of these scenic routes altogether, each of which goes through a different two-pocket parallelogram. You may like to investigate the relationship between these eight parallelograms, the four tubes and the two square states in more detail for yourself.

Scenic route map of the Woven Flexatube

It would be possible to draw a second version of this map (containing exactly the same information) with state B in the central