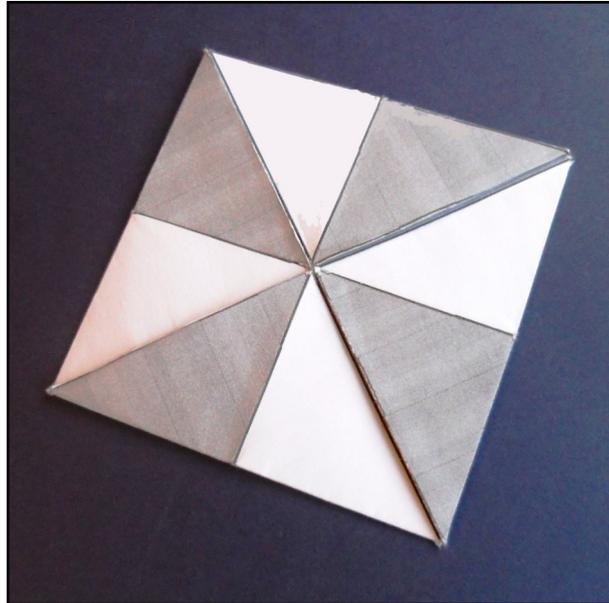


Sheep and Goats

Designed by Robert E Neale

Robert E Neale 's Sheep and Goats magical effect / puzzle was first published in May 1971 in one of Martin Gardner 's Mathematical Games column in Scientific American, Vol. 224, No. 5. If you have never seen it before you will be amazed at the transformation / that a solution is possible.



In Bob 's original version the object is to manipulate the flexagon so that the two visible faces, one white and one black, become mixed. For some reason, perhaps under the influence of the Biblical parable from which the name Sheep and Goats is drawn, I always think of it the other way around and like to start with the sheep and goats mixed together, then separate them. In fact, of course, once you have done one of these you need to do the other to reset the puzzle or continue with the effect.

Once you know how to solve the puzzle you will find that, with practice, the solution can be achieved with a smooth manipulation. Bob suggests that the effect can be presented as a magical effect if you learn to perform this manipulation behind your back. It is also fascinating to watch if performed out in the open. Diagrams for the solution can be found in a separate pdf on the Puzzles page of this site. As always it is far better to play with the effect / puzzle and discover the manipulation / solution for yourself than to look it up at too early a stage.

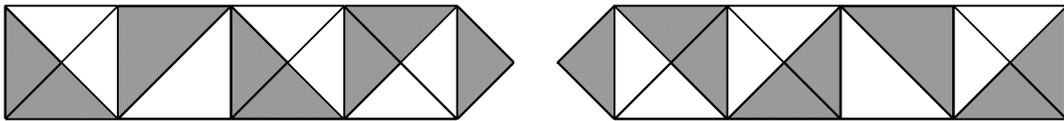
A full technical analysis of the underlying flexagon, which I call the Woven Flexatube, can be found on the Flexagons page of this site.

David Mitchell

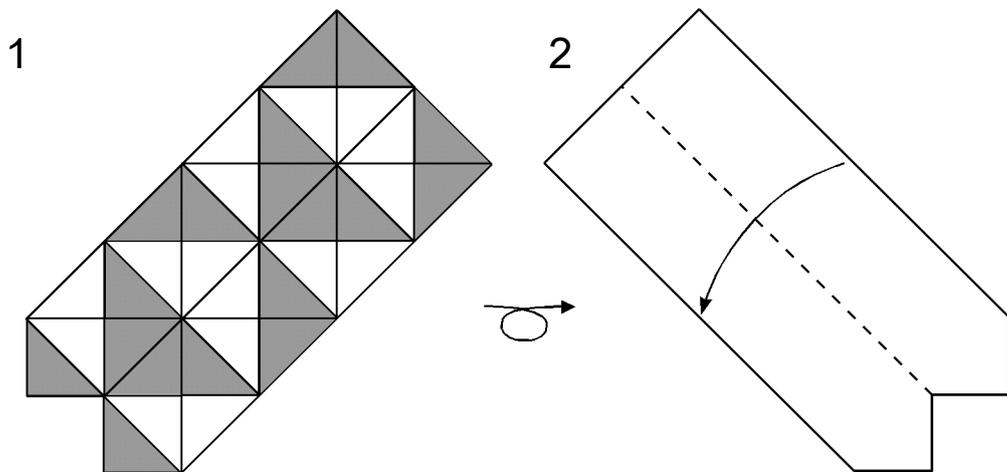
Robert E Neale / Sheep and Goats

Constructing the puzzle

If you want a robust version of Sheep and Goats the best way to make it is to cut a piece of light card up into a strip of four and a quarter squares, decorate both sides in the way shown below and fold it along all the lines between the squares and all their diagonals, making sure that each of the sections of the puzzle will fold backwards and forwards smoothly in relation to its neighbours. This strip can then be folded up and glued together in the way shown in instructions 3 to 8 below.

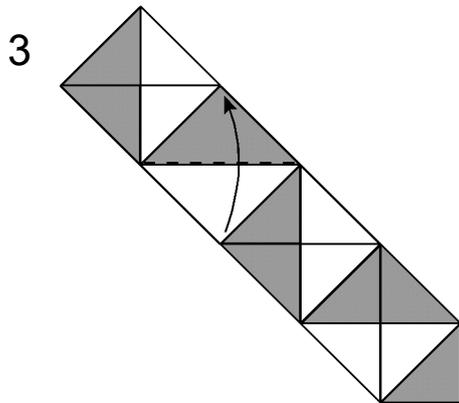


Alternatively, you will find a template on the last page of this pdf, or a larger version on the Puzzles page of this site, which you can print, cut out and fold up following the instructions below.

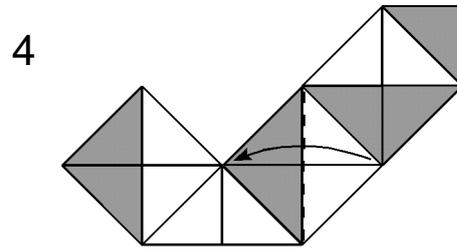


1. Cut the template out and crease carefully along all the boundaries between the segments. Fold all the creases backwards as well as forwards so that the segments move freely in both directions. Turn over sideways.

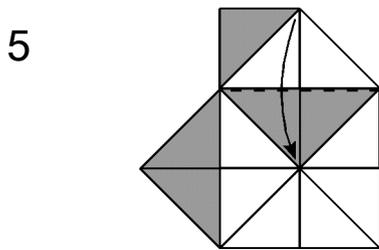
2. Apply glue to one half of the plain side of the template then fold one half onto the other so that all the edges line up. If necessary, trim slightly to neaten the edges.



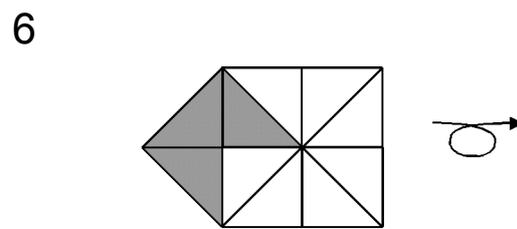
3. Arrange the strip of squares like this and fold the lower part upwards as shown.



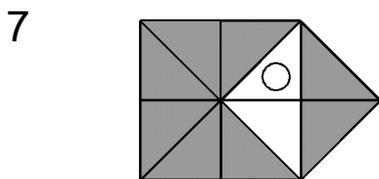
4. Now fold the right hand part across to the left as shown.



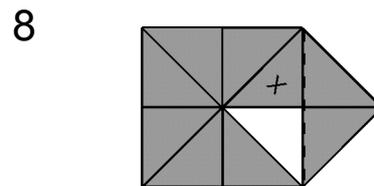
5. Fold the top part downwards.



6. Turn over sideways.

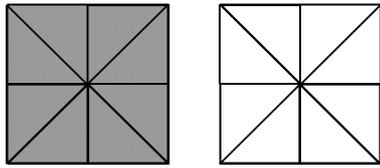


7. There is a concealed flap at the position marked with a circle in this picture. Bring this flap to the front.



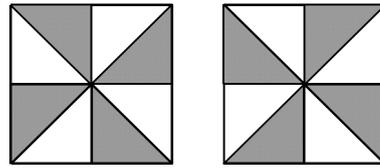
8. Cover the flap marked with a X with glue and fold the right corner over on top of it. Press firmly to fix the two surfaces together.

9



9. The resulting flexagon is white one side and shaded on the other. The shaded and white faces represent the sheep and the goats. You can decide for yourself which are which.

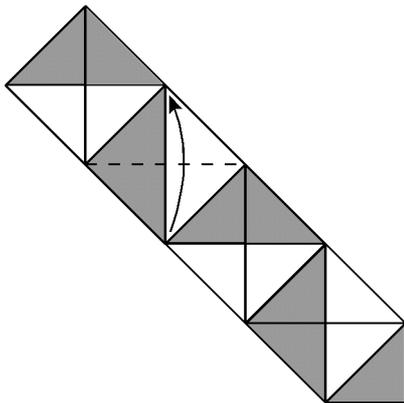
10



10. The challenge is to manipulate the flexagon to mix the sheep and goats together. When you have solved the puzzle the two faces of the flexagon will look like this.

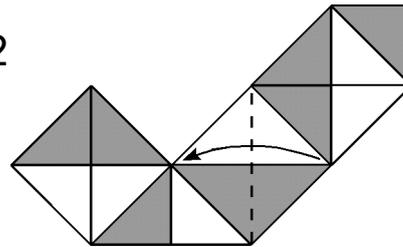
Alternatively, if you want to begin with the sheep and goats mixed together and try to separate them you can put the flexagon together like this:

11



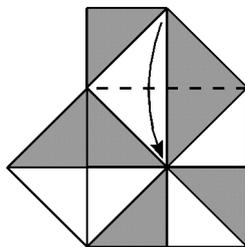
11. Arrange the strip of squares like this and fold the lower part upwards as shown.

12



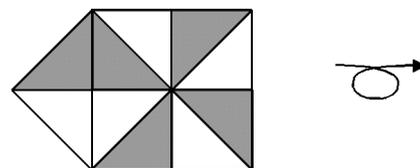
12. Now fold the right hand part across to the left as shown.

13



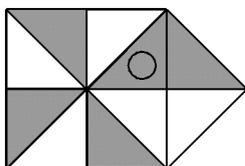
13. Fold the top part downwards.

14



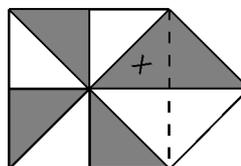
14. Turn over sideways.

15



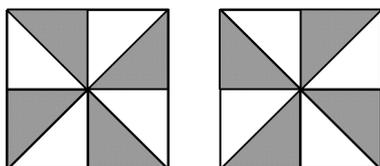
15. There is a concealed flap at the position marked with a circle in this picture. Bring this flap to the front.

16



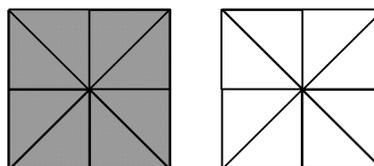
16. Cover the flap marked with a X with glue and fold the right corner over on top of it. Press firmly to fix the two surfaces together.

17



17. The result will look like this. There should be a pattern of shaded and white triangles on each face of the flexagon. These are the sheep and the goats. You can decide for yourself which are which.

18



18. The challenge of this version is to manipulate the flexagon to separate the sheep from the goats. When you have solved the puzzle one face of the flexagon will be entirely shaded and the other will be entirely white.

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