D R U K W E R K

PRINTED MATTER

CFF - Cubism For Fun

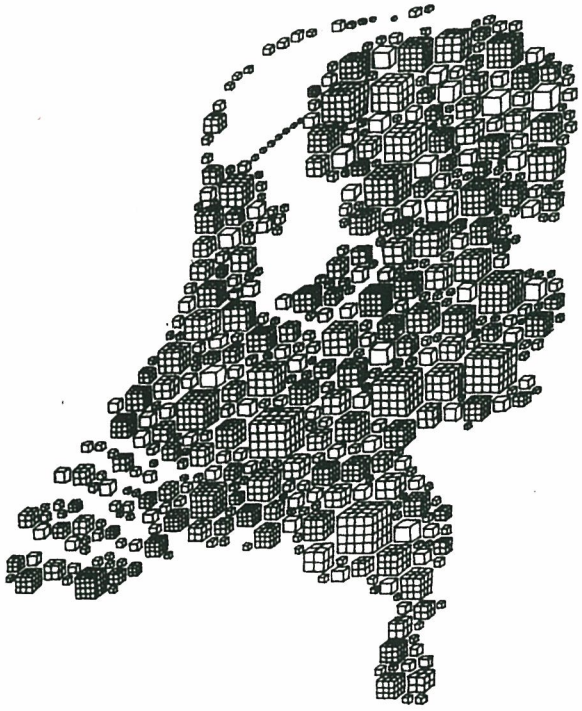
no 16
november 1987

C O N T E N T S

if undeliverable, please return to:
Anton Hanegraaf, Heemskerkstraat 9, 6662 AL ELST, The Netherlands

CFF
no 16
november 1987
CUBISM FOR FUN

newsletter from the
Dutch Cubists Club
N K C
Nederlandse Kubus Club



Heemskerkstraat 9 6662 AL ELST The Netherlands

MINIMAL SOLUTIONS FOR THE 12-MAGIC

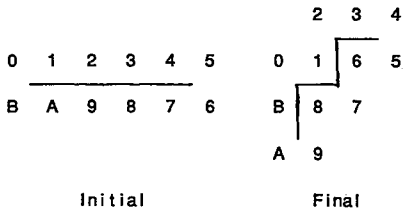
by Tom Verhoeff

The *News and Letters* section of the previous issue briefly mentioned the *Master Edition* of Rubik's MAGIC. The Master Edition consists of 12 pieces instead of the regular 8. When you buy it these pieces are arranged in a 6 by 2 rectangular shape. One side of the rectangle shows a pattern of five colorful interlocked rings contrasting with a silver background. The other side looks like a nice mess. Of course, it is to be transformed into a pattern of five unlinked rings. Mechanically, the Master Edition (also referred to as 12-MAGIC) operates exactly as the original MAGIC (or 8-MAGIC).

The Master Edition is marketed by same company (*Matchbox Toys Ltd.*) that brought out 8-MAGIC. They probably hired the same guy to write the blurb on 12-MAGIC's box: it is equally disgusting. Supposedly 8-MAGIC was too easy (for some) and 12-MAGIC should be a real mind teaser. But actually 12-MAGIC is simpler, I claim. For one thing, the instructions reveal the shape that is required for the solution. But more importantly, in a MAGIC with 12 pieces there are also 12 hinges, that is fifty percent more than in 8-MAGIC. This gives you a dynamical system with many more degrees of freedom. In effect it allows you to work on one part of the puzzle while virtually ignoring other parts. Therefore, the straightforward piecewise approach to a solution simply works (more on solving 12-MAGIC below). Planning is difficult for 8-MAGIC just because the limited amount of freedom requires you to take everything into account. Try to change one hinge on 8-MAGIC without transferring a couple of the other hinges as well.

The increase in degrees of freedom also makes 12-MAGIC more vulnerable than 8-MAGIC. It invites you to work on one part of the puzzle. Paying attention to all 12 pieces is too difficult anyway. The little bit of stretch that each hinge allows adds up to quite a bit across 12 hinges. (Guus Razoux Schultz told me that a 16-MAGIC has enough stretch to roll the ring configuration inside out without transferring hinges!) So you hardly notice that a move is in conflict with limitations imposed by the other end. If you don't realize this in time, your 12-MAGIC may turn into a real (knot) puzzle. You cannot *completely* forget about the rest.

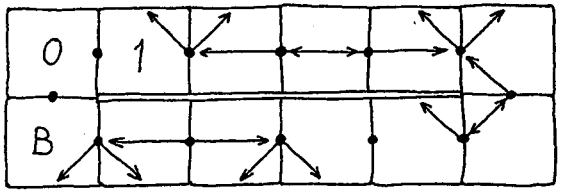
Let's investigate the minimal solutions for 12-MAGIC. Below are depicted the initial and final configurations.

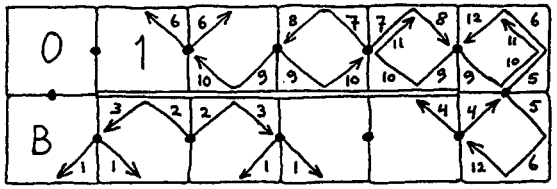


We are looking at the initially messy side of the puzzle. The pieces are labeled such that piece A carries Rubik's signature. In the final configuration pieces 2, 3, 4, 6, 9, and A are lying with their initial top edge at the bottom ("upedge down"). This allows us to deduce the minimum number of required quarter turn hinge moves.

```
piece number: 0 1 2 3 4 5 6 7 8 9 A B 0
min. # moves: 0 1 2 2 1 1 1 0 1 2 1 0  ---> at least 12
feasible    : 0 1 2 2 3 3 1 0 1 2 1 0  ---> 16
```


The minimum computed in this way is not feasible since there are some *conflicts*. That is, if a solution with this number of moves is attempted then some intermediate configurations will have pieces with a wrap outside the allowed range -2..+2. This is also explained by the pictures below. We have indicating by arrows in the initial configuration where the hinges should move to obtain the final configuration. An immediate conflict appears when two hinges have to move through each other for a minimal move. This is, for instance, the case with the two hinges between pieces 5 and 6, and between 6 and 7 (a double arrow). Since hinges cannot move through each other (another way of saying that the wrap is limited), a roundabout is required. In the second picture we have indicated more specifically how the hinges can be moved. This gives a feasible solution. It has 16 moves and cannot be improved. There are some restrictions on the order in which hinges are moved, but otherwise it is straightforward to perform this solution.





Let me also take the opportunity to draw your attention to the fact that the set of transformations of MAGIC configurations does not form a group (in the mathematical sense). This is so because the composition of transformations is not closed due to the limited wrap of individual pieces. The fact that the transformations of Rubik's CUBE do form a group makes the CUBE easier to analyse.

Erratum

It appears that some of the changes I made to my article in the previous issue didn't find their way into the final copy. These changes concerned page 27, where two systems of numbering the pieces have become mixed up. The correction is (line -8):

> For example, piece 5 needs to roll one quarter turn onto piece 4, and that requires at least one M3 move.

Tom Verhoeff