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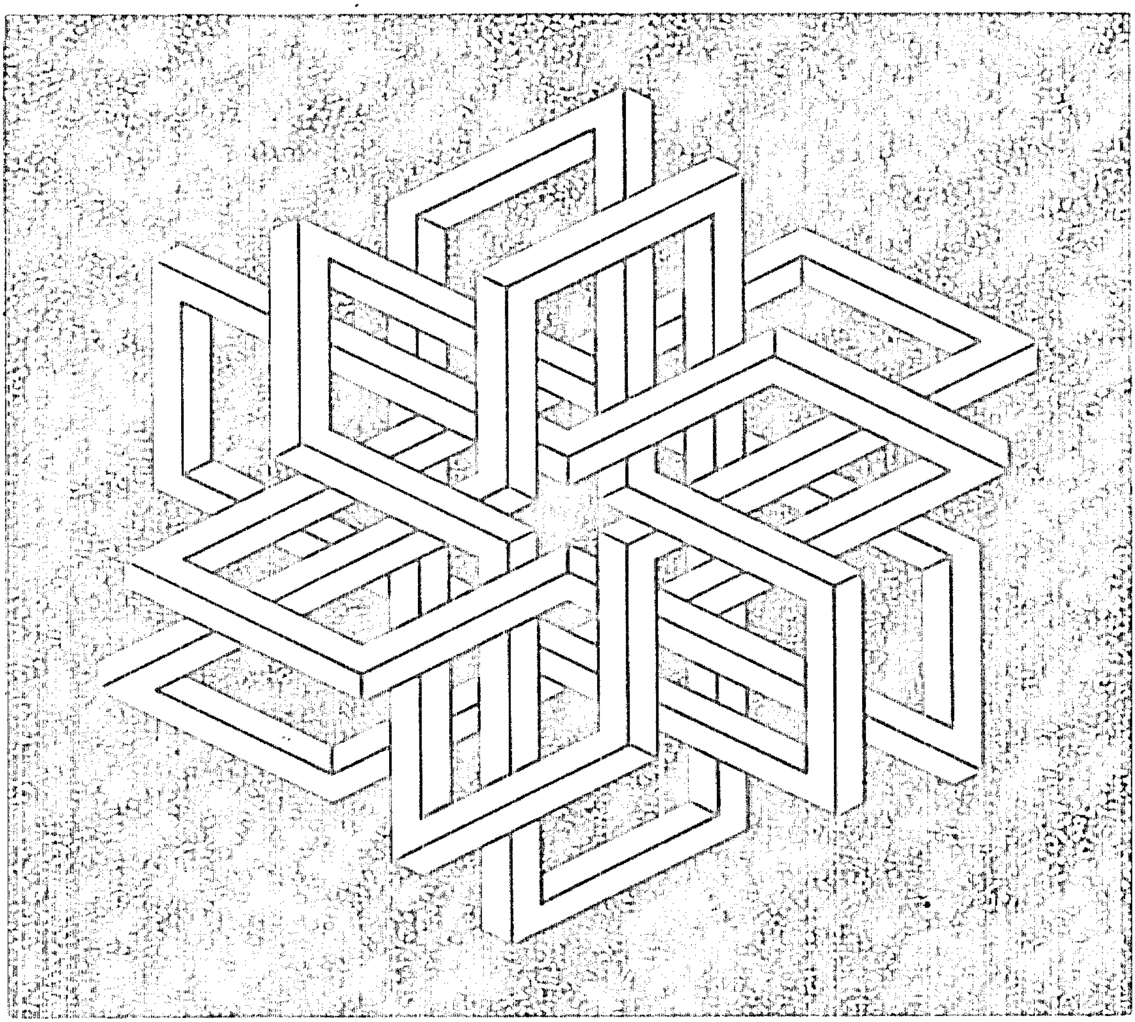

# DRAWING REGULAR HEPTAGON (7) AND REGUAR NONAGON (9) BY ORIGAMI (PAPER FOLDING)

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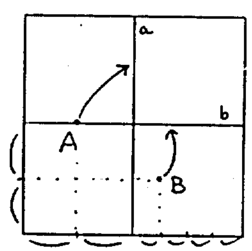
Regular heptagon and regular nonagon are good examples to show the ability of paper folding, since both can not be made by Euclidean (using ruler and compass). For the convenience starting with a square diagram the concentric polygon are here demonstrated. As you see this does not disturb the generality. Here is described only how to make them. Why and the other possible ways are left to you as a quiz.

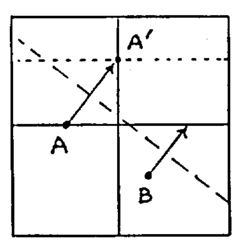
Heptagon.

1) Make two medians, vertical a and horizontal b. Get two points A and B of coordinates (1/4, 1/2) and (5/8, 1/4) respectively, considering rectangular system with (0, 0) at lower left corner and (1, 1) at upper right corner. Now FOLD such that point A comes onto line a exactly and point B comes onto line b exactly at the same time.

Folds

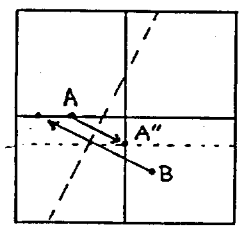



Realization I

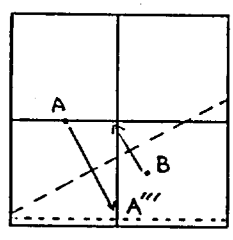



2) The realisation is not unique but you will obtain three. The three displace position of A on line a, say A', A" and A"' correspond to shoulder height, hip height and foot ground respectively.

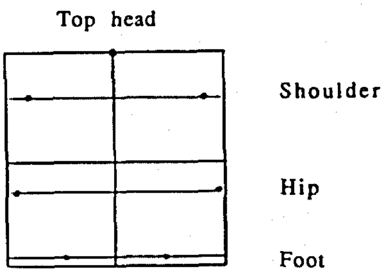
Realization II

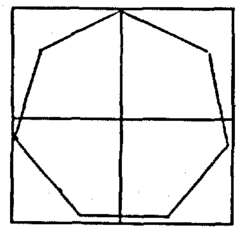



Realization III



3) Considering the upper most position of line a in the square or (1/2, 1) is the head top and the center or (1/2, 1/2) is the center of heptagon, the completion is easily made.

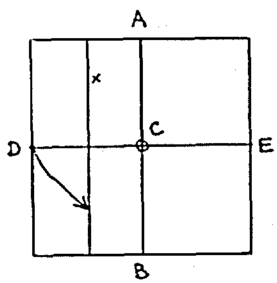


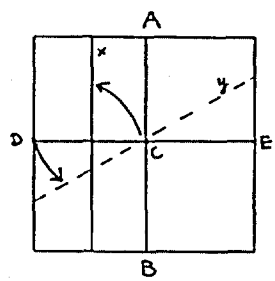
Nonagon

1) Make two medians and call AB (vertical), DE (horizontal) and their crossing (center C). Fold moving point D onto C and call the crease, line x. Fold making point C a pivot and moving point D onto crease x. Call the new crease, line y.

Fold 1

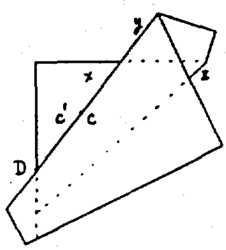



Fold 2

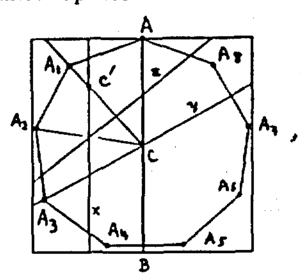



2) Fold moving point C onto line x and point D onto line y at the same time and call the crease line z.

Fold 3




Get the wanted apexes




3) Call the new position of point C on line x, point C' and call the crossing of line x and line z, point F. Make a line through C and C' and an other through C and F. On these lines and line y make points $A_1$, $A_2$ and $A_3$ equal amount of |CA| from the center C. Fold along line y obtain $A_4$, $A_5$ and $A_6$ at new positions of A2, A1 and A. By the reflection at AB, obtain $A_7$ and $A_8$. A, $A_1$, $A_2$, $A_3$, $A_4$, $A_5$, $A_6$ $A_7$ and $A_8$ are apexes of the wanted regular nonagon.

# PERIODICAL OR QUASI-PERIODICAL 2-D PATTERNS CONSTRUCTED BY REGULAR ODD-NUMBER POLYGONS

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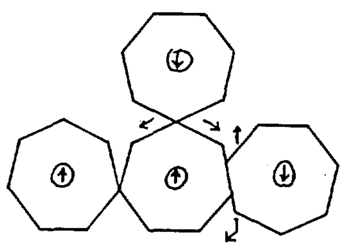
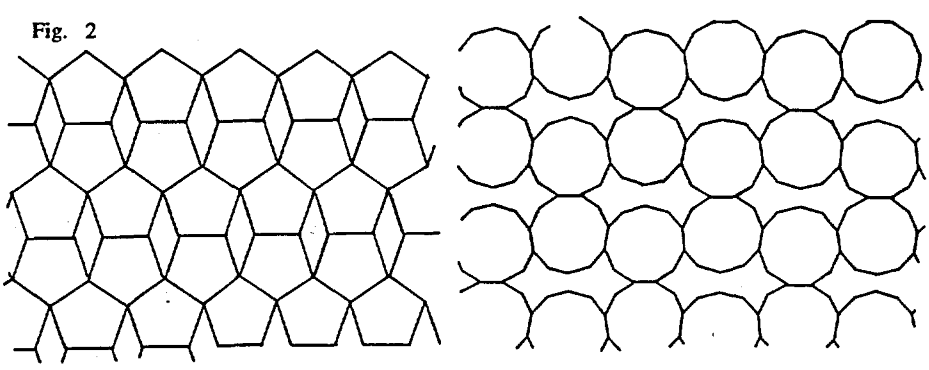
Regular odd-number polygons are not commonly applied to pattern design especially when number is larger than 7. Systematical search of patterns limiting to only two figure elements with common side unit (regular polygon and gap space) has been done starting from a simple rectangular or parallelogram reticle and applying their general characteristics to regular odd-number polygons; at the right-up position that is the bottom side horizontal (the only one horizontal side of the polygon), the highest position is the top point as ∧ at which the diagram has a left-right symmetry and the extreme left and right positions also fall on point as < and > respectively. All the sides adjacent to these three points are parallel to the corresponding sides of the points corresponding of equal but exactly upside-down polygon like ∨∧∨ and > < . Therefore the right-up and up-side-down polygons can be put in tangent at any of these pair of sides, and can be slidden along the side until point to point coincidence of both polygons is reached.

Fig. 1



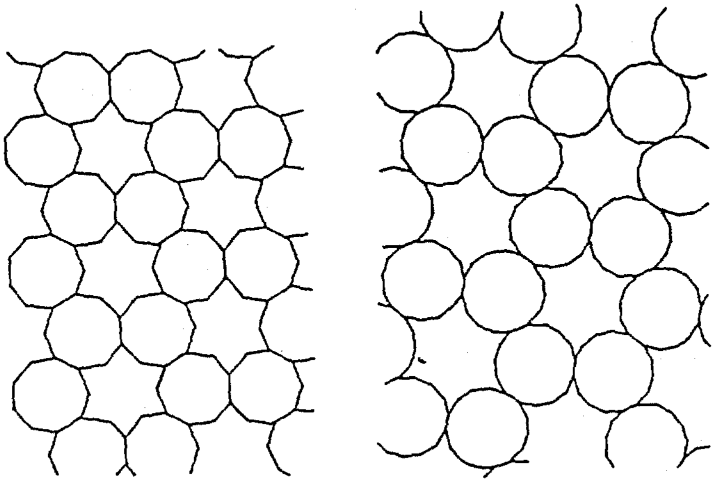
Many interesting periodical or quasi-periodical patterns come out. The interesting fact is that among these patters, hexagonal structures are formed in natural way, sometimes regular sometimes not-regular. Non regular flat hexagonal formations are possible for all the polygons of (3), 5, 7, 9, 11, 13, 15 sides etc. The cases of 5 and 11 sides are shown Fig. 2.

Fig. 2



Only for some polygons; 9, 15 and 45 also the regular hexagonal structure is possible. Curiously these numbers are all multiplicative combinations of two prime numbers 3 and 5 and 360 (degrees) becomes divisible by these into even integral numbers 40, 24 and 8. However this sturucture is less closed packing than the flat hexagonal one.

Fig. 3



Only in the case of nonagon (9) (see fig. 4) the second figure element of the flat hexagonal structure has a special character; it is not a self mirrored image. Then if the pair of mirrored images are considered equal, then an one-dimensional order-disorder like arrangement could happen.

Fig. 4

order disorder