# Symmetry: Culture and Science

## SYMPOSIUM Symmetry of Patterns

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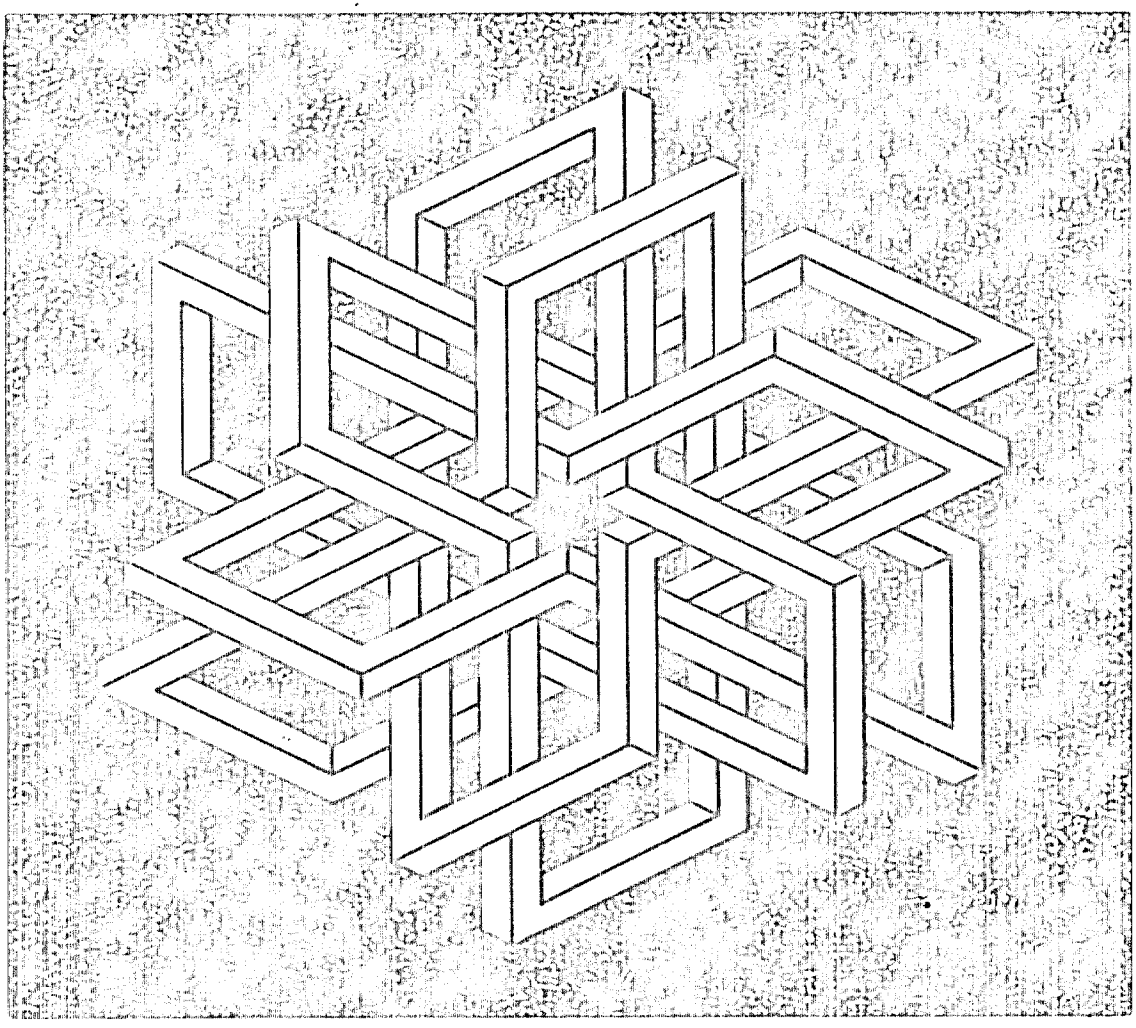

# ORIGAMI AS SIMULATION METHOD FOR NATURE'S FOLDING PATTERNS

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It is presumed that nature can undergo collapse without fatal damage and that it even takes advantage of mechanical failure in its structures.
In techniques, the failure of a structure is the engineer's main challenge, preventing or lessening the probability of collapse is his greatest art.
Engineers therefore tend to overlook what they would call weak points in the mechanical achievements of natural engineering works, and look only at the strong points of structures they consider to be optimized, especially stiff and tough, and mechanically high resistant.
An interest in natural structures with geometrical patterns apparently due to failure and collapse was born at the Budapest symposium on symmetry in 1989. Here it was shown that even geometry may have a mechanical sense: by Miura's demonstrations with folding paper (that 'miura-ori' is a folding technique suitable to solar energy collectors for space platforms), and by Kajikawa's transformations of all into one (all regular reticular polyhedra into one tetrahedron).
If natural growth is seen as a dynamic process of gradually overcoming unstable and sensitive stages with slow adaptation to external and internal constraints, then axes of symmetry may be defined as the neutral axes of oscillation and bistability.

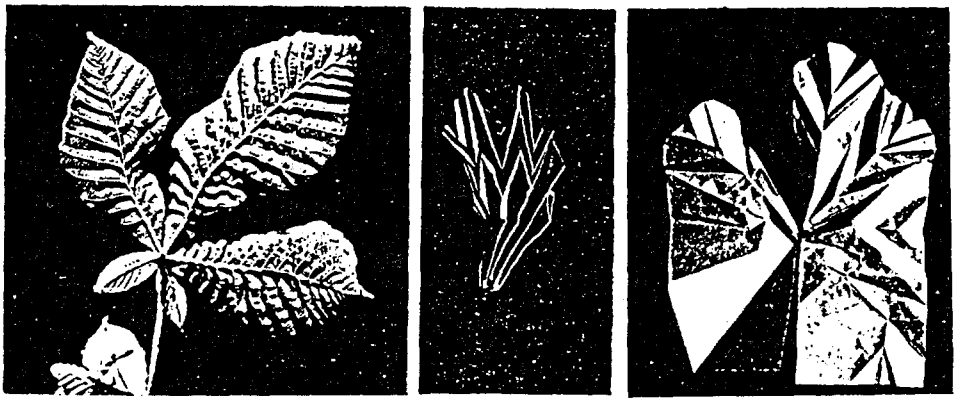

Figure 1. Chestnut tree leaves after burgeoning, and simulation by origami of the unfolding of the lobes. For leaves of this type there are two series of radially symmetrical axes: 1) the central vein of the lobe, 2) the line in the space between two adjacent lobes, a line of intense shear force and ultimatly of tearing during the unfolding process.

An excellent material for modelling such sensitive states is paper which folds, buckles, tears and collapses under the slightest stress.
Foldable and transformable design based on natural mecanical patterns has in the last three years become the main program of instruction at four french design institutes. Exhibition objects and 'one second workshops' developed with design students will demonstrate through means of paper folding (origami) and paper crushing how to simulate certain natural symmetrical patterns such as insect wings, folded leaves, pine cones and pineapples.

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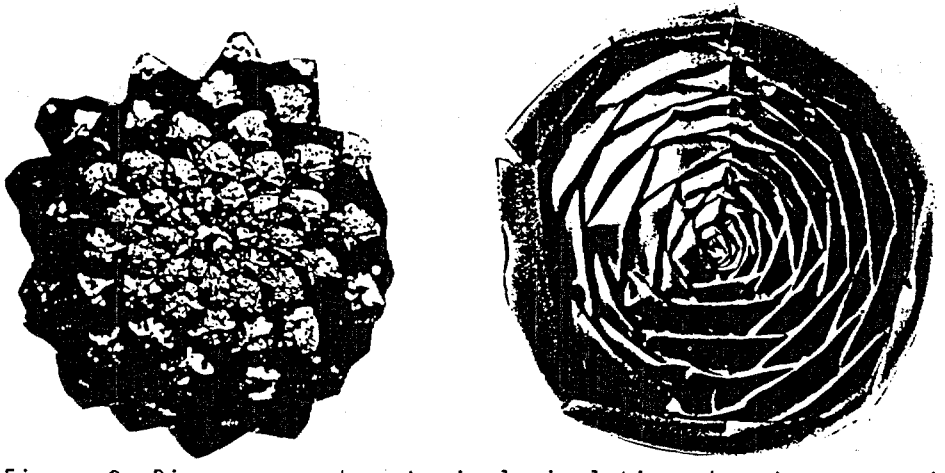

Figure 2. Pine cone and mechanical simulation by 'one second origami' of the growth patterns due to folding and tearing.