# Application of Inside-Outside Inversion Transform Models

**Transforming Space Probes!?**

Yashiro High School

## 1 Current Status and Previous Research

**“Inside-outside inversion transform models”**

A figure with the following properties is called “Inside-outside inversion transform model”.

Cut a shape into several pieces.

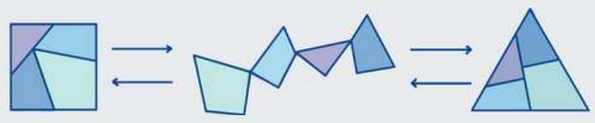
Connect the vertices and winding the pieces in a certain direction transforms them into a different shape.

Also, after winding them, the boundary of the original shape, and the boundary of the new shape is entirely made up of the interior of the original shape.

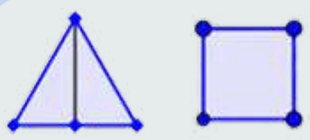
**“Tile theorem”**

Can undergo inside-out transformation

→ The model can be tiled



How to draw the lines of Dudeney’s puzzle



Internal & external of triangle & square

**Construction √√3 ► suffice!**

We proved that √√3 can be constructed

▼

This can be constructed

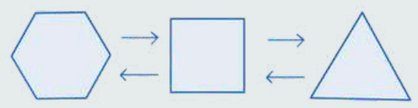
**Demands for probes**

- weight reduction
- potential for life ►high demands

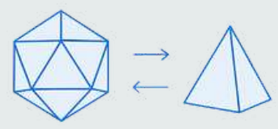
►►► nearly identical topography

## 2 Methods

Three different shapes

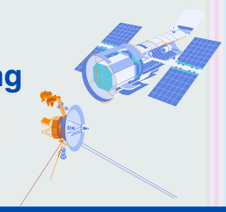


Three-dimensional



Considering regularities

Designing Probes



## 3 Hypothesis

1. In two dimensions, it is possible to transform a shape into three different shapes.
2. In three dimensions, it is possible to transform a shape into two different shapes using the transformation method derived in two dimensions.

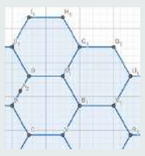
## 4 Research

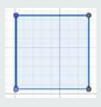
**1** Based on “Tile theorem”

Models are not able to be tiled

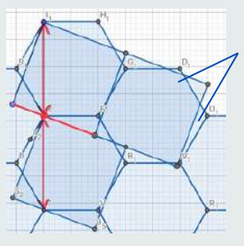
→ Cannot undergo inside-out transformation

regular hexagon ↔ square





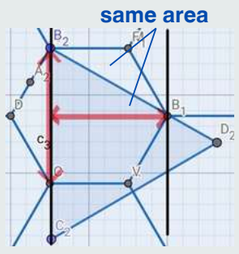
Cannot change



same area

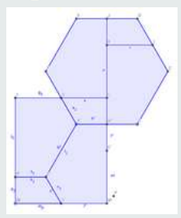
regular hexagon ↔ equilateral triangle

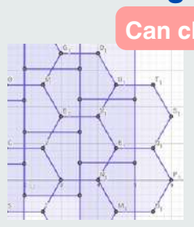
Cannot change



same area

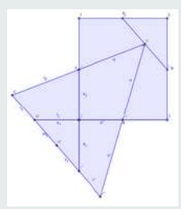
regular hexagon ↔ rectangle

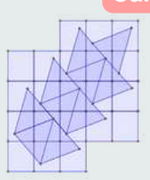




Can change

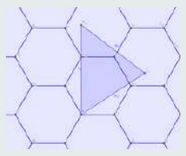
rectangle ↔ triangle





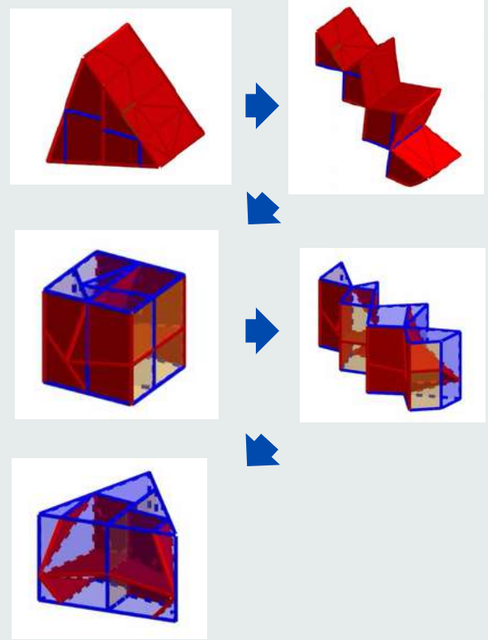
Can change

regular hexagon ↔ triangle



Can change

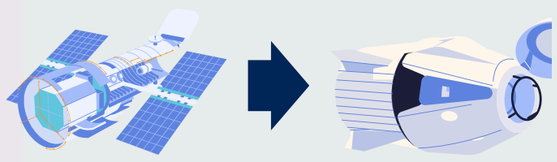
**2**



We were able to achieve it in two stages by applying the cross-sectionnes from two dimensions.

## 5 Proposal

Solar panels → Walking around



Transforming some ways

Various terrains

### Demands & Merits

Lightweight・affordable

No waste

Same materials → Multiple uses

### Other ways to use

- Environmental sample collection
- Artificial Ecological Structures


## References and Acknowledgments

J. Akiyama, Mathematics Hidden Behind Beauty

J. Akiyama and G. Nakamura, Determination of All Convex Polygons which are Chameleons, IEICE Transactions, E86-A, 978-986 (2003)

J. Akiyama and G. Nakamura : “Congruent Dudeney dissections of triangles and quadrilaterals” , Algorithms and Combinatorics 25, 43-73 (2003)

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