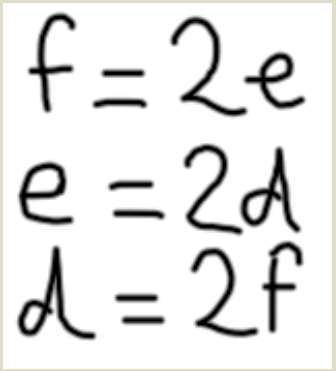
Space

An Alternate Elective after Algebra II

Henri Picciotto

MathEducation.page

Math on Another Planet



#1

A Long Month

Evary						
Mo	**Tu**	**We**	**Th**	**Fr**	**Sa**	**Su**
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	32
33	34	35	36	37	38	…

Isomorphism

+	d	e	f	d + e	e + f	d + f	d + e + f
d							
e							
f							
d + e							
e + f							
d + f							
d + e + f							

+	Mo	Tu	We	Th	Fr	Sa	Su
Mo							
Tu							
We							
Th							
Fr							
Sa							
Su							

Space: topics

- Abstract algebra

◊ Transformational geometry

◊ Symmetry

◊ Dimension

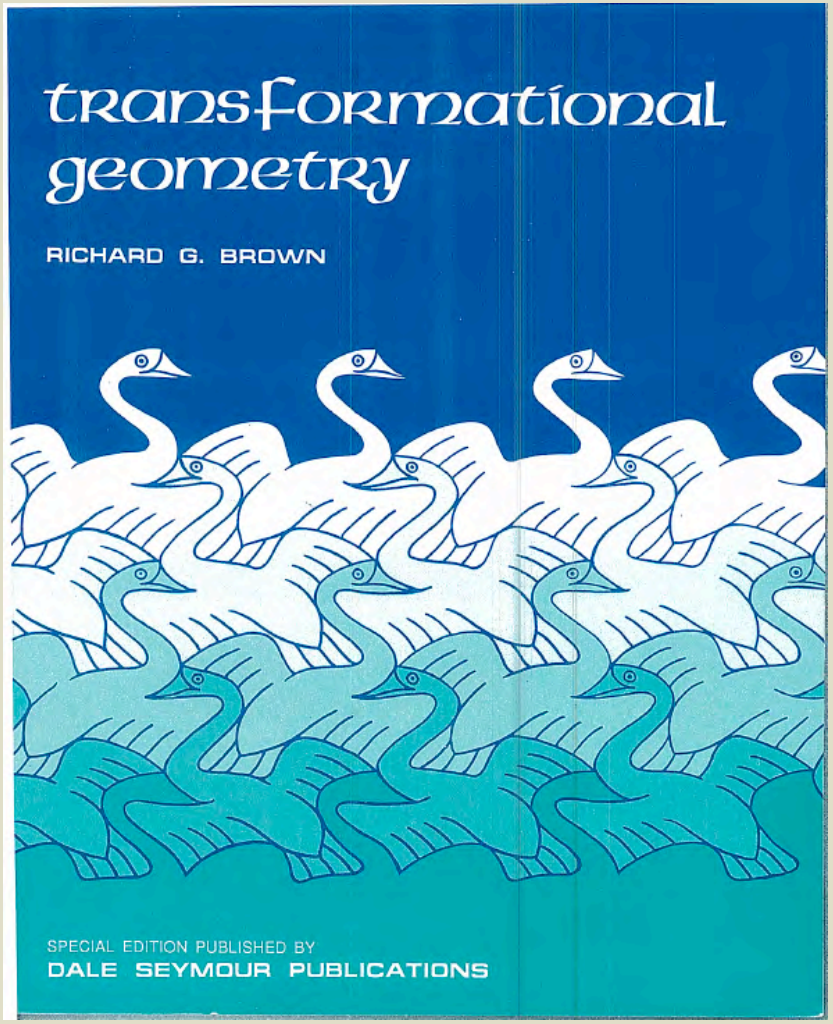
  - 3D: polyhedra

  - 4D: introduction

Transformations

Symmetry

Dimension



◊ Transformations: one-to-one functions (domain, range: the whole plane)

◊ Isometries:
transformations that preserve distance

Fundamental Theorem of Isometries:
every isometry of the plane is a reflection, a rotation, a translation, or a glide reflection.

Computing transformations

using complex numbers:

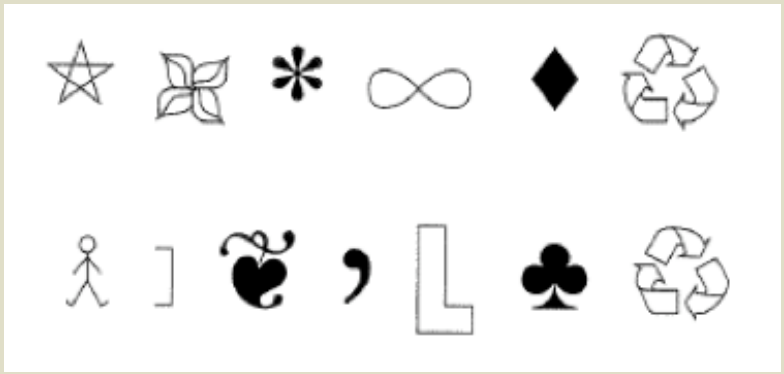
- Translation: add a+bi
- Rotation around the origin: multiply by $\cos\theta + i \sin\theta$
- Rotation around (a,b): subtract a+bi, rotate around the origin, add a+bi

Computing transformations using matrices

Transformations

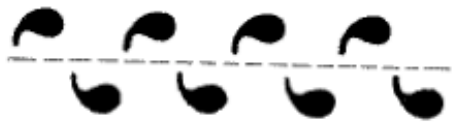
Symmetry

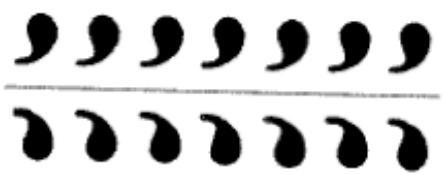
Dimension

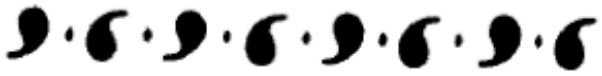


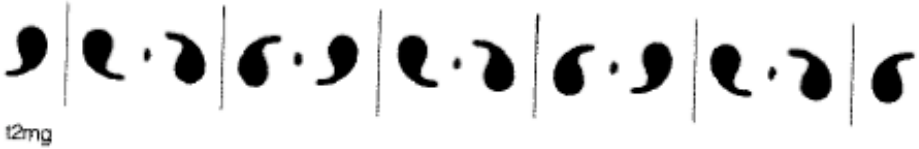
Handbook of Regular Patterns
by Peter Stevens

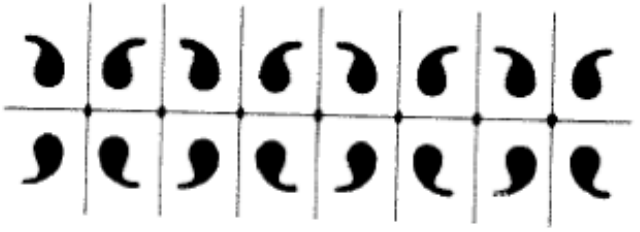
The Seven Line Symmetry Groups

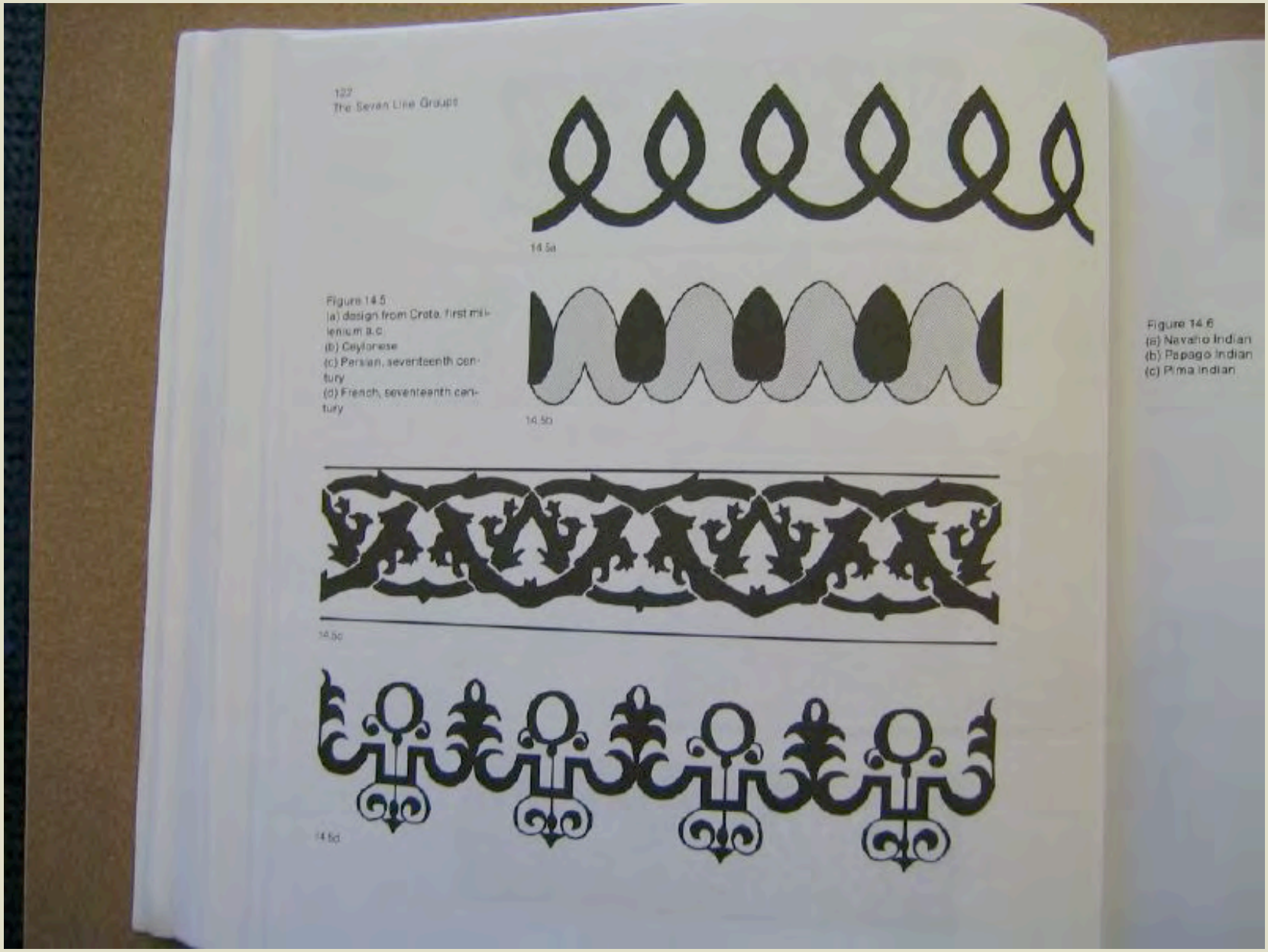












122
The Seven Line Groups

14.5a

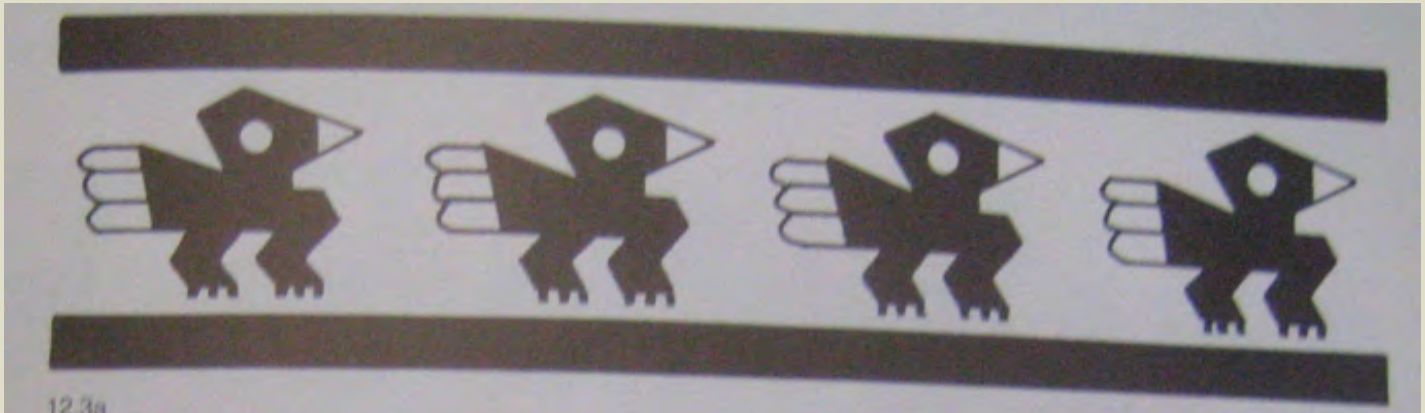
Figure 14.5
(a) design from Crete, first millenium B.C.
(b) Ceylonese
(c) Persian, seventeenth century
(d) French, seventeenth century

14.5b

14.5c

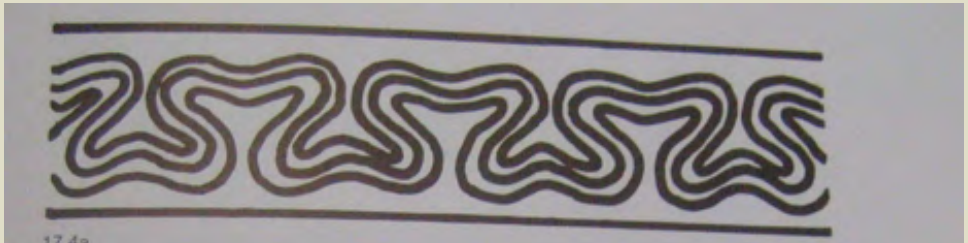
14.5d

Figure 14.6
(a) Navaho Indian
(b) Papago Indian
(c) Pima Indian

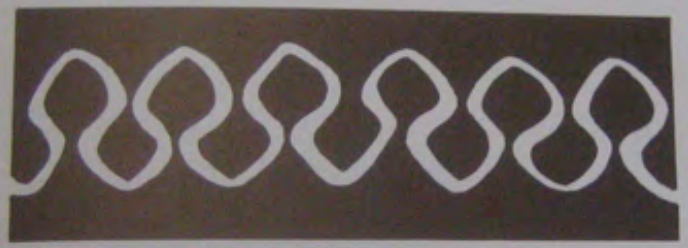


12.3a

12.3b



17.4a



17.4b

17.4c

17.3a

17.3b

17.3c

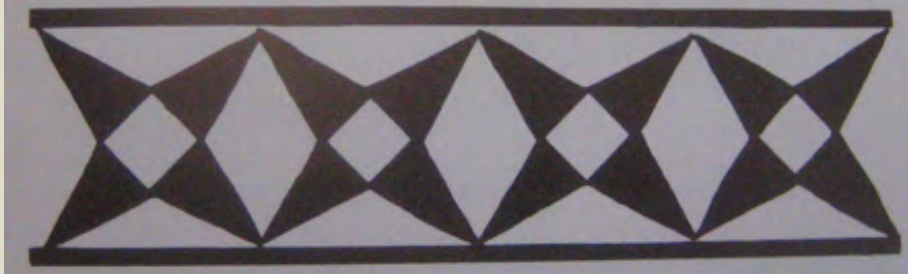
17.3d

ugh 18.10 show
ments of four-,
nfold
s we know,
and must rotate
ighest-order
ures are
examples be-
m.

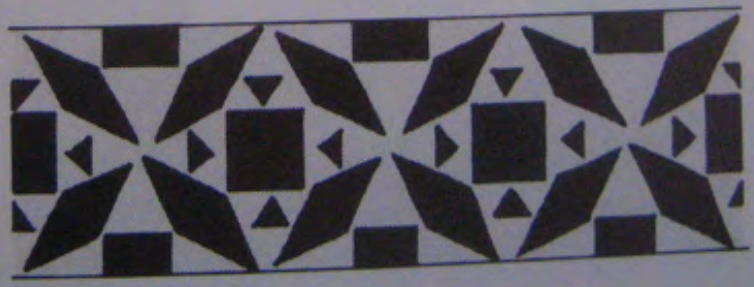
Figure 18.7
(a) Victorian ornament
(b) Arabian
(c) Pompeian mosaic
(d) Byzantine mosaic

18.7a

18.7b



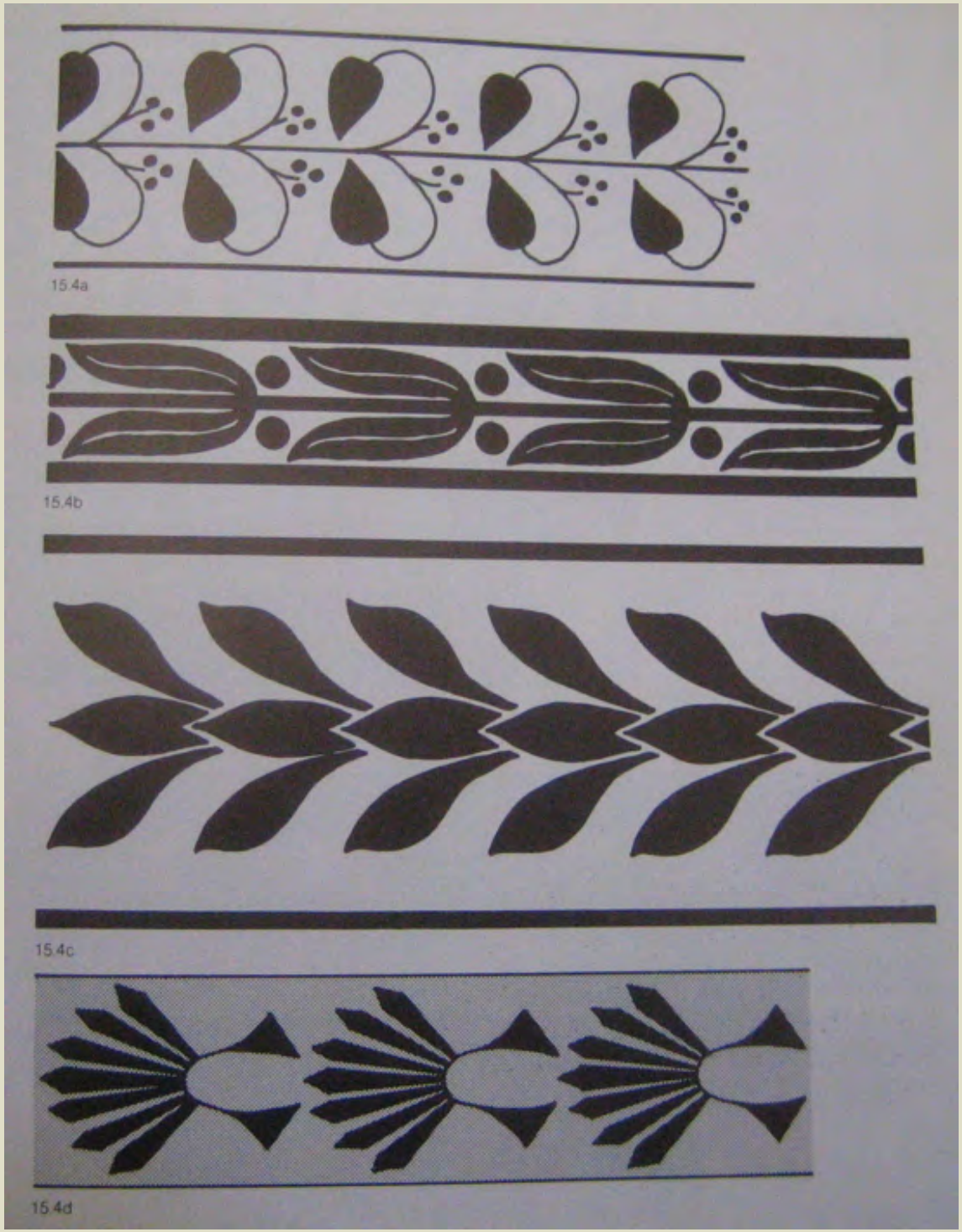
18.7c



18.7d

13.5e

13.5f



15.4a

15.4b

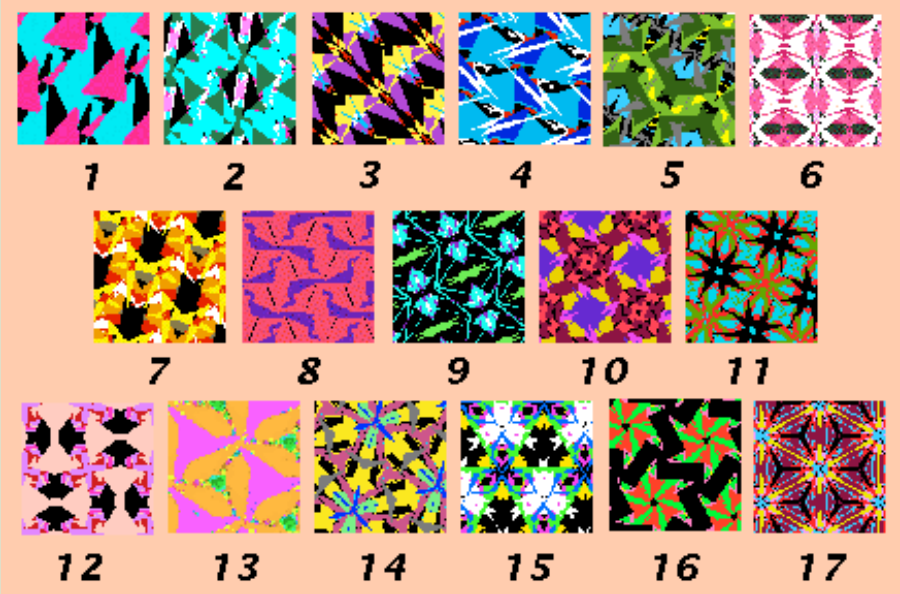
15.4c

15.4d

Transformations

Symmetry

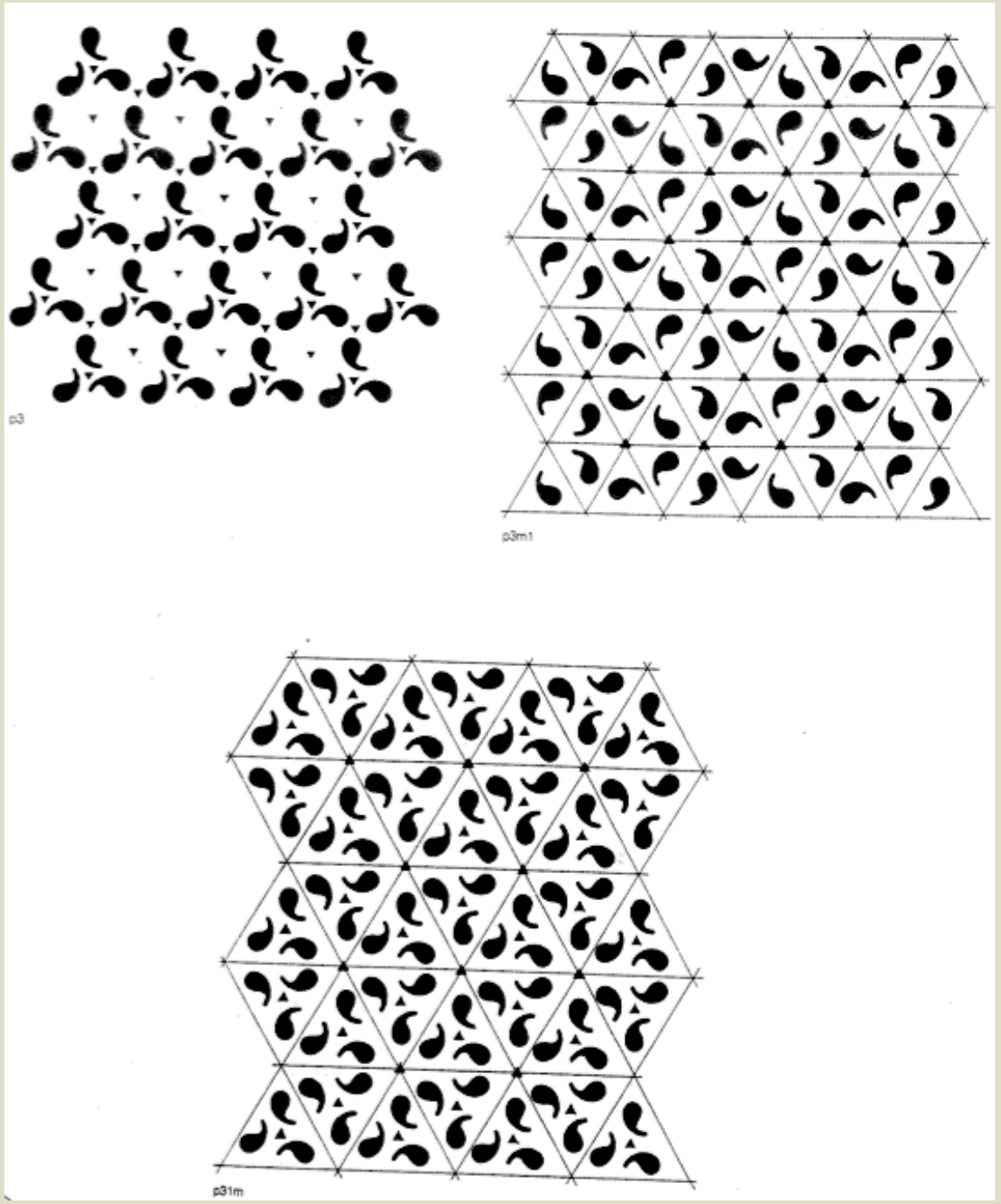
Dimension



Transformations

Symmetry

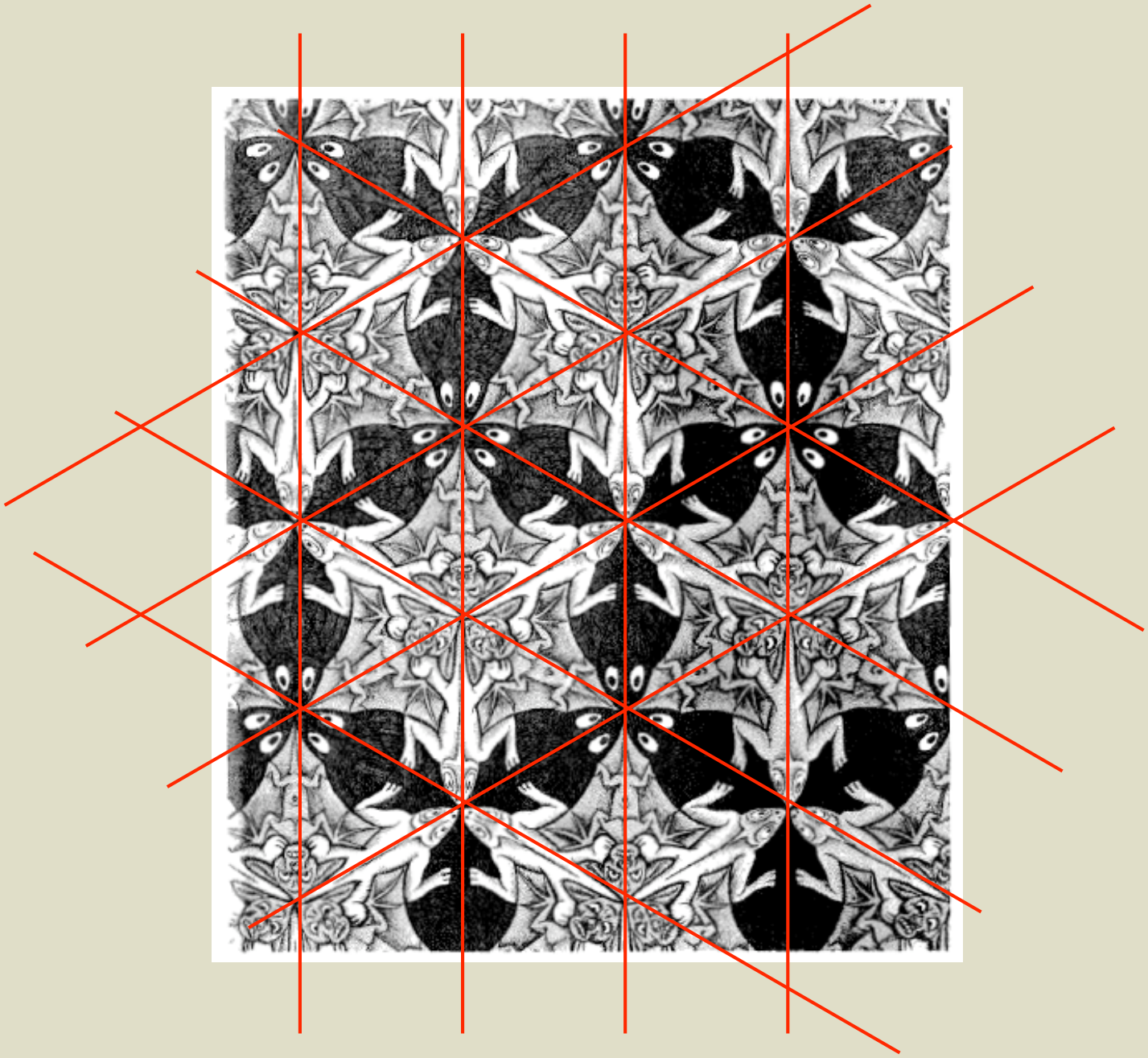
Dimension



Transformations

Symmetry

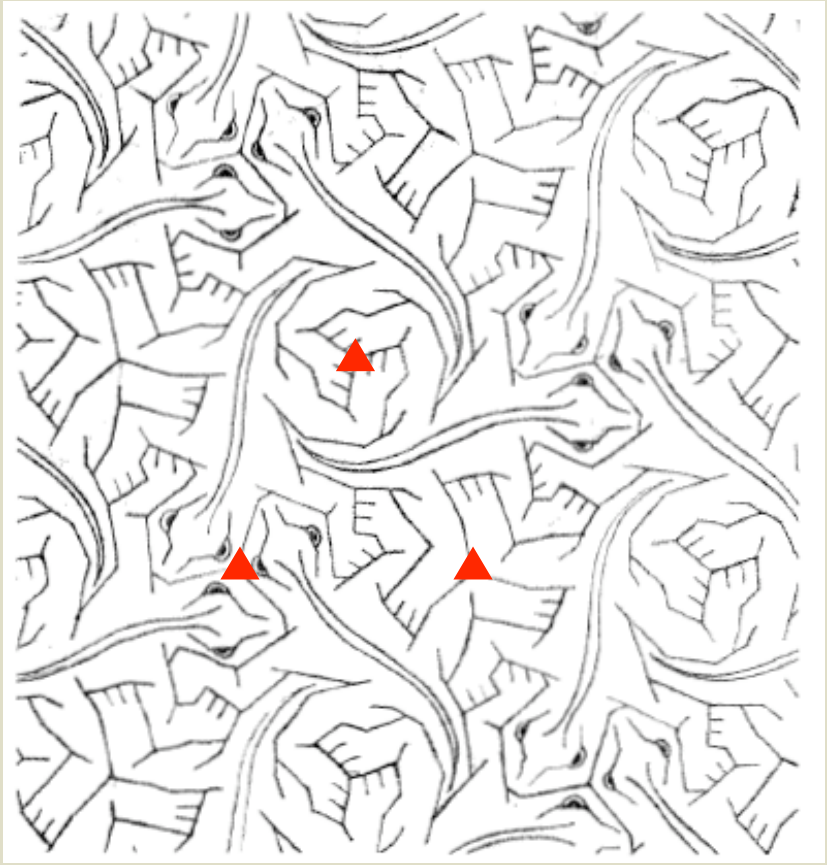
Dimension



Transformations

Symmetry

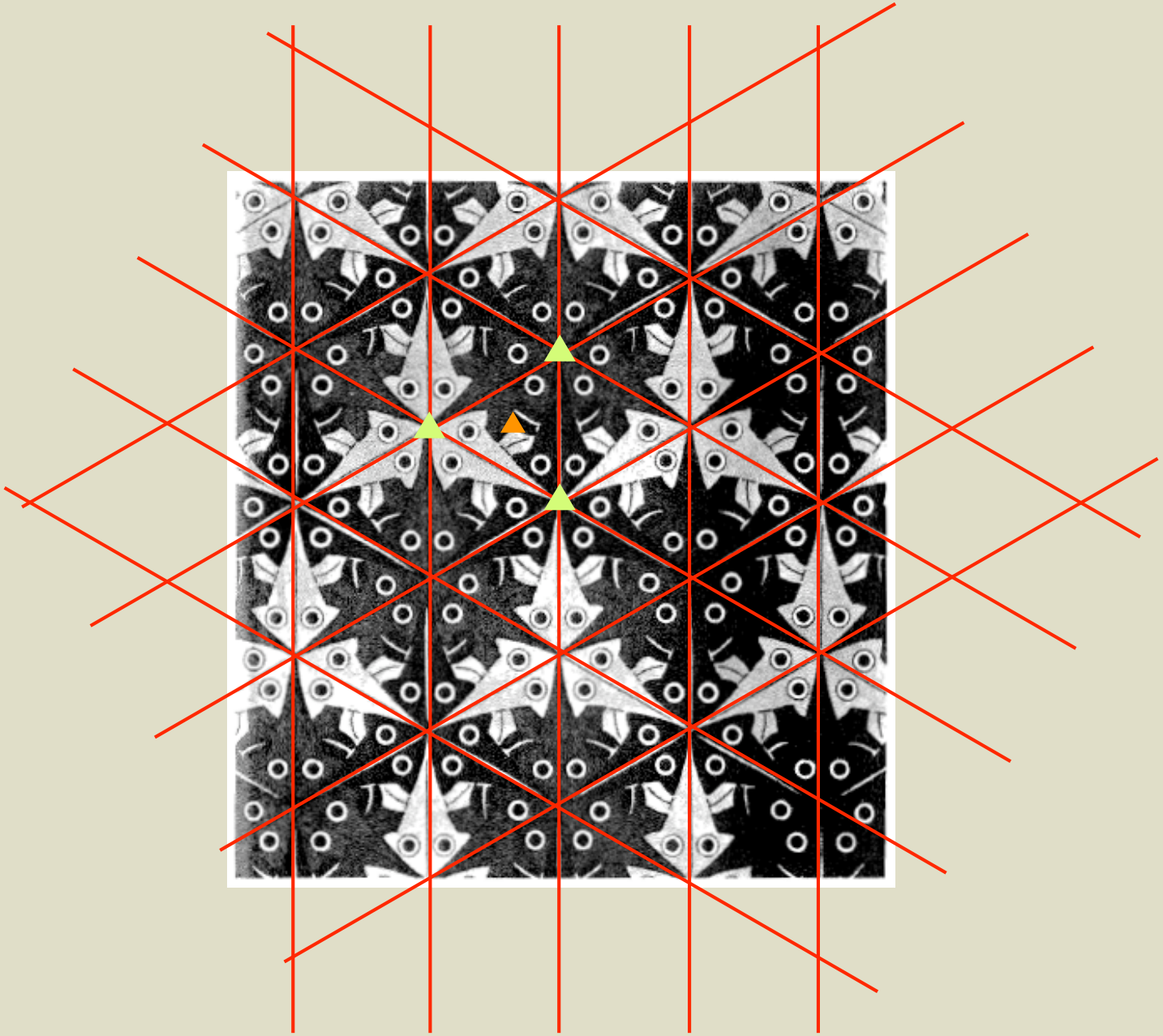
Dimension

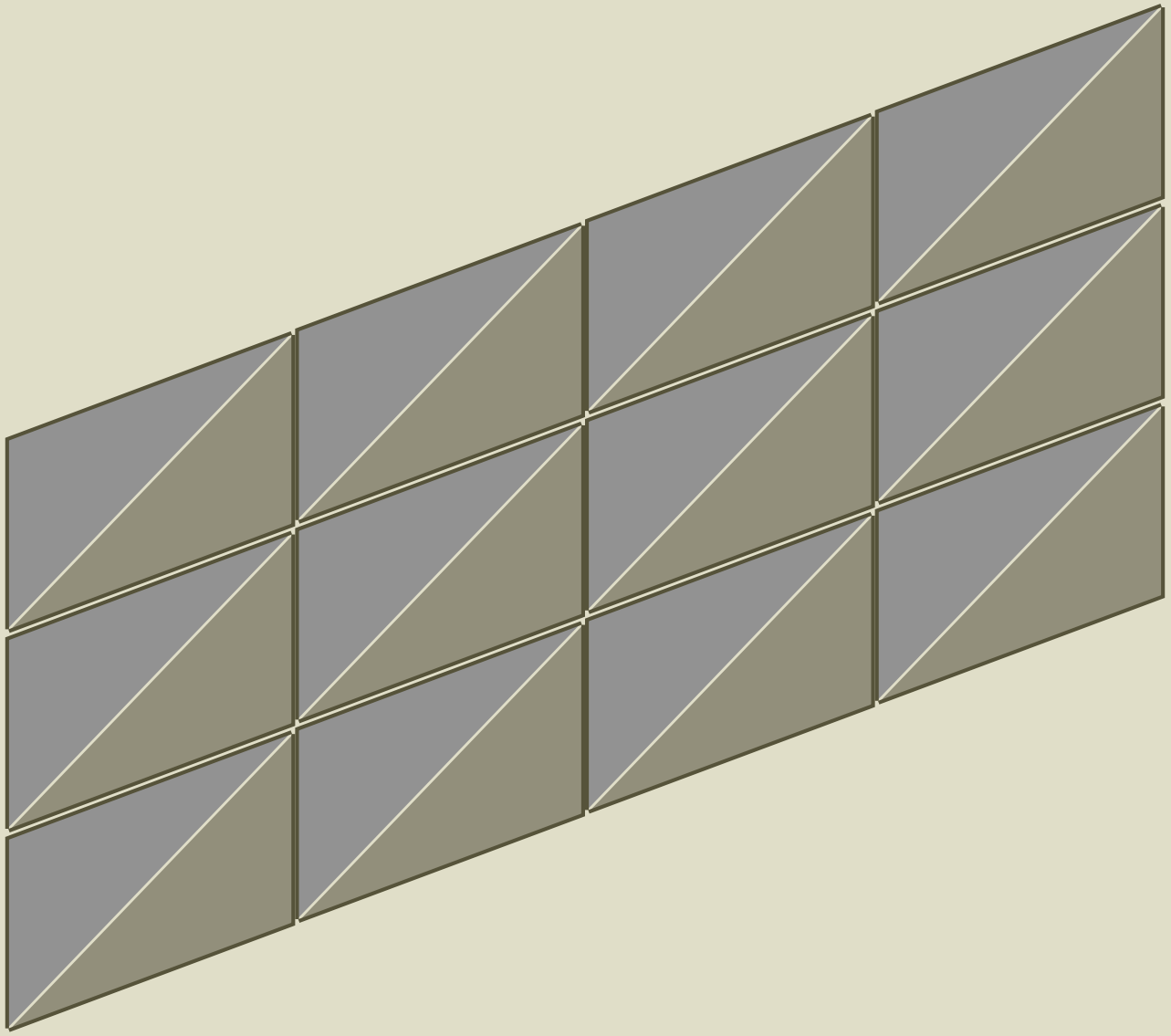


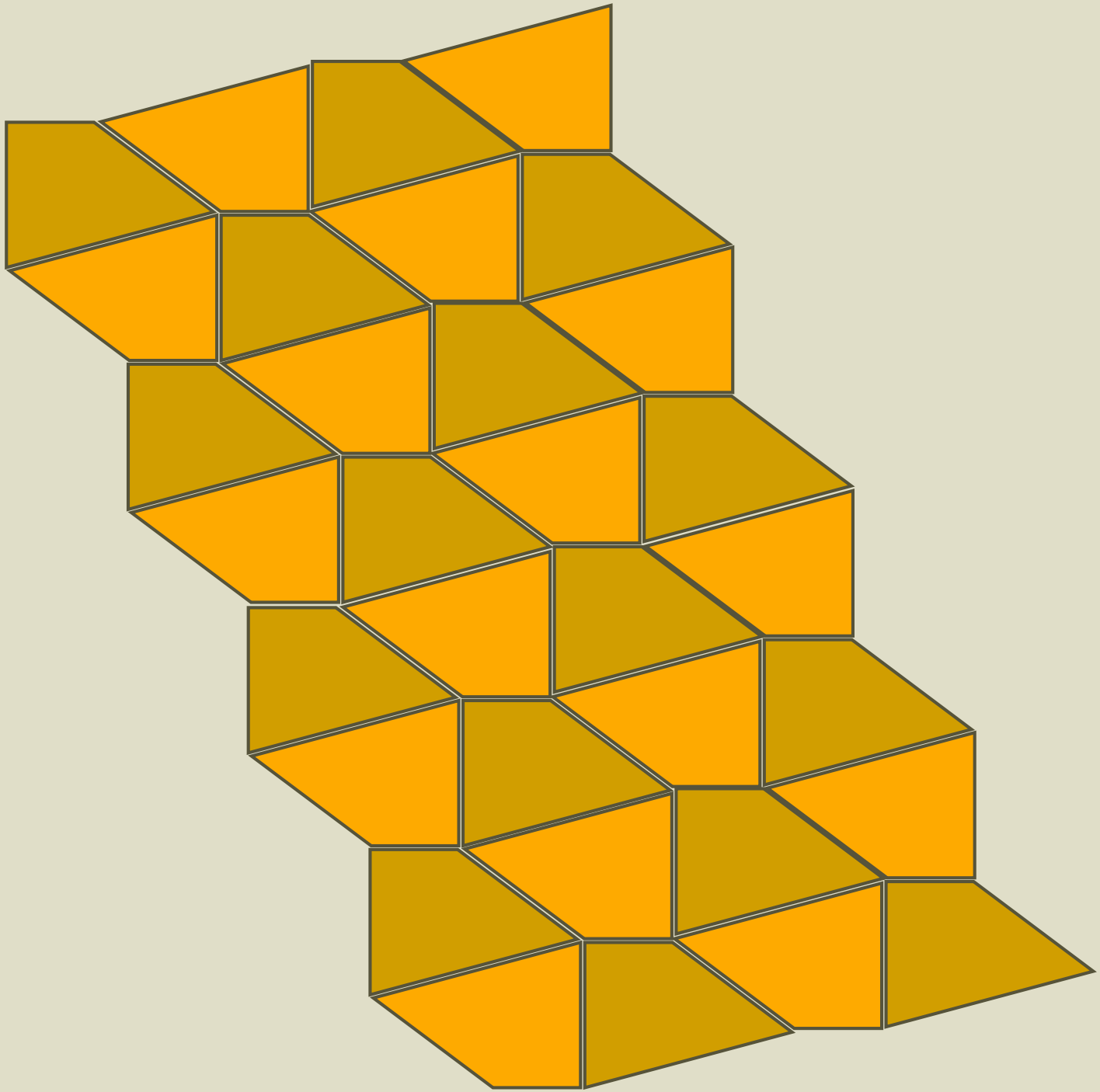
Transformations

Symmetry

Dimension







Transformations

Symmetry

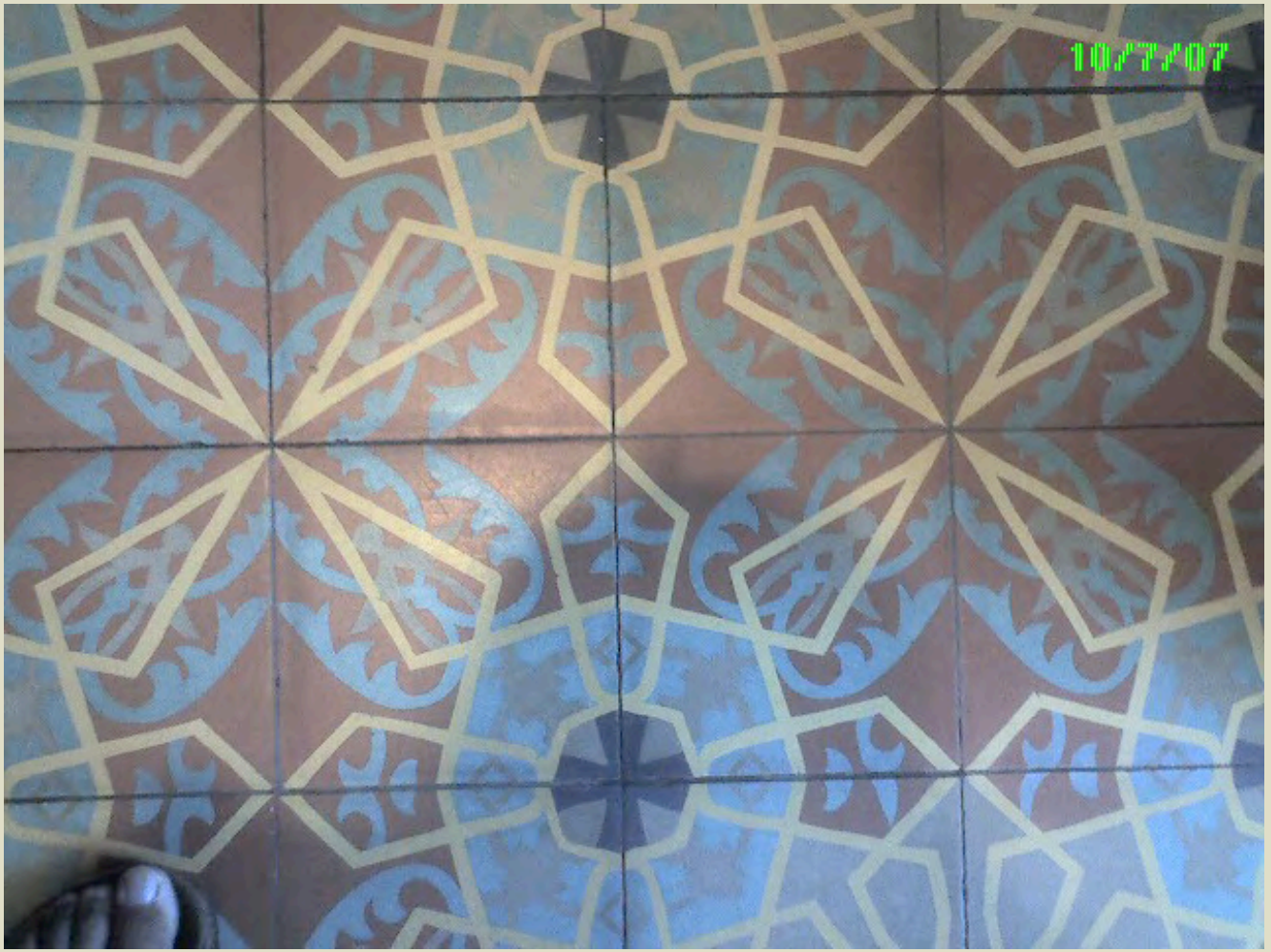
Dimension


TOYOTA

Transformations

Symmetry

Dimension

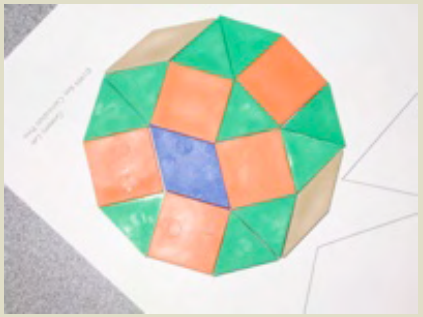


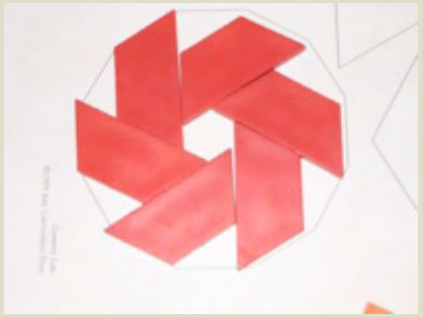
Transformations
Symmetry
Dimension

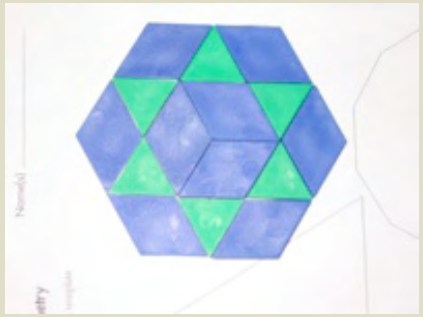
Transformations

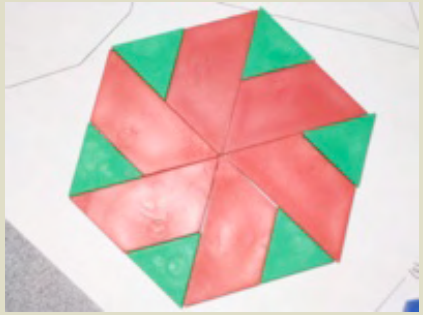
Symmetry

Dimension

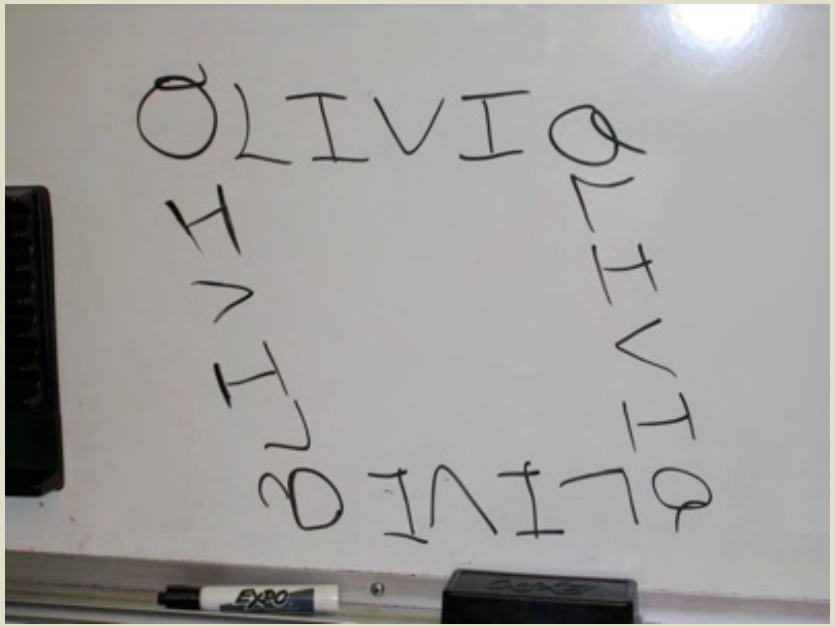


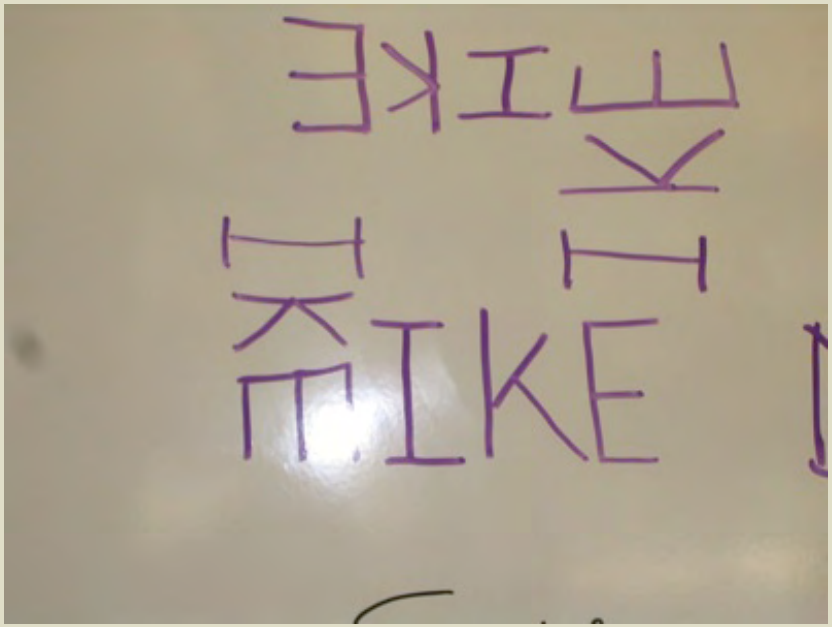


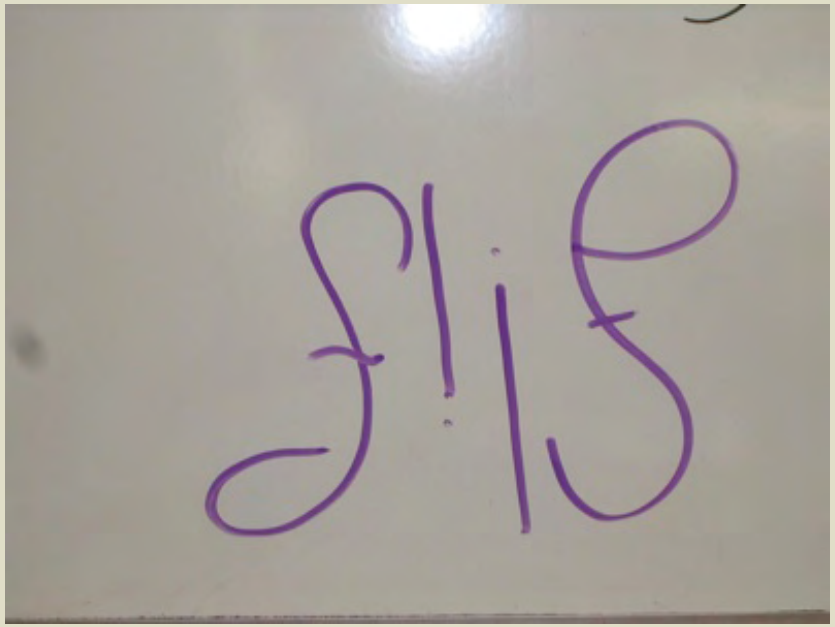


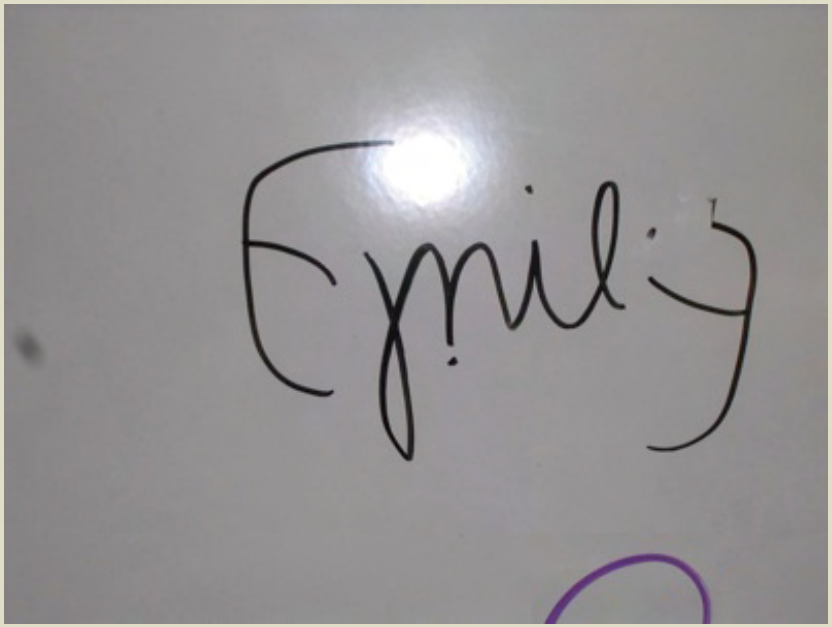


Transformations
Symmetry
Dimension





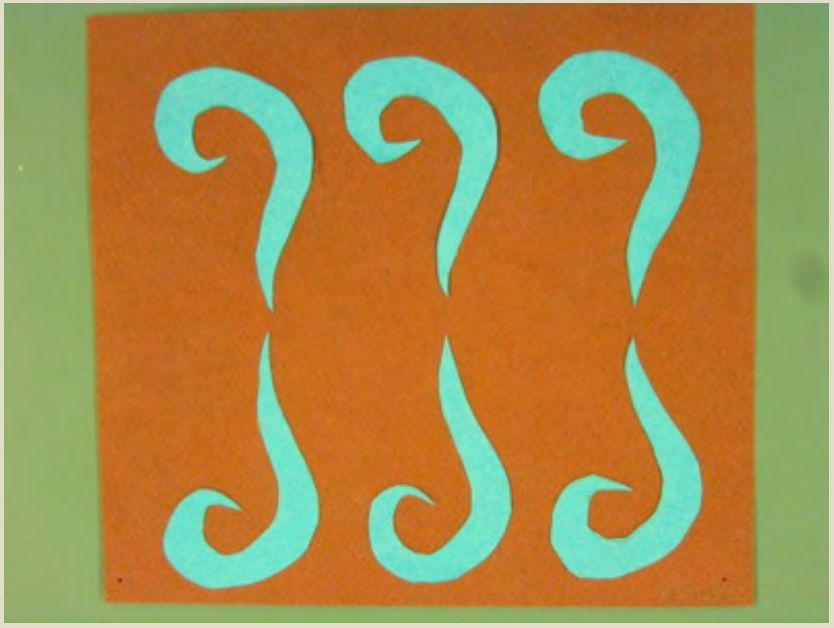




Transformations

Symmetry

Dimension

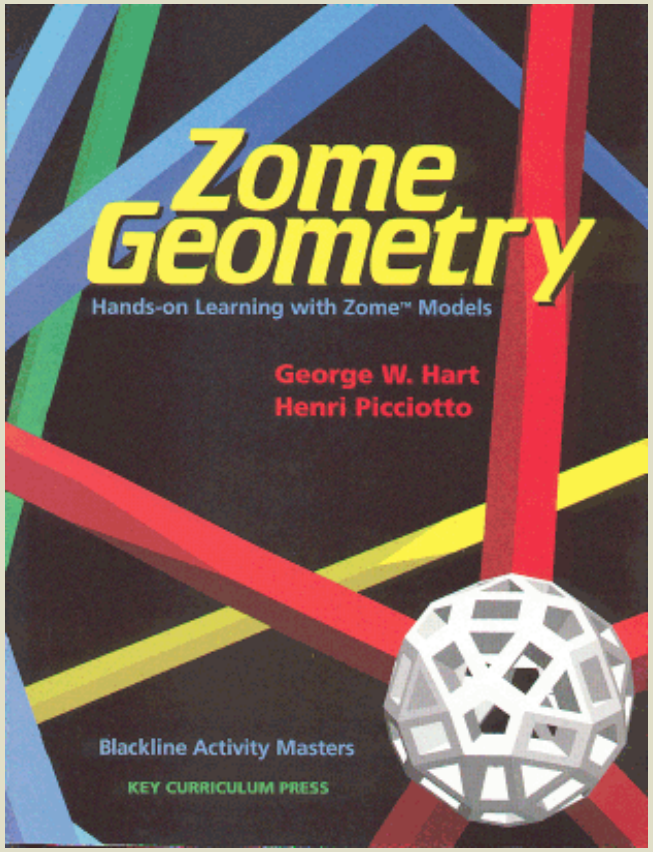


Transformations

Symmetry

Dimension

Transformations
Symmetry
Dimension: 3D



◊ Platonic and Archimedean polyhedra

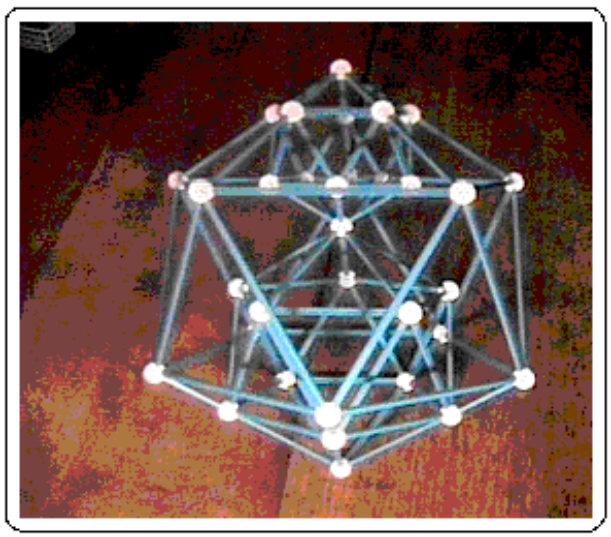
◊ Duality

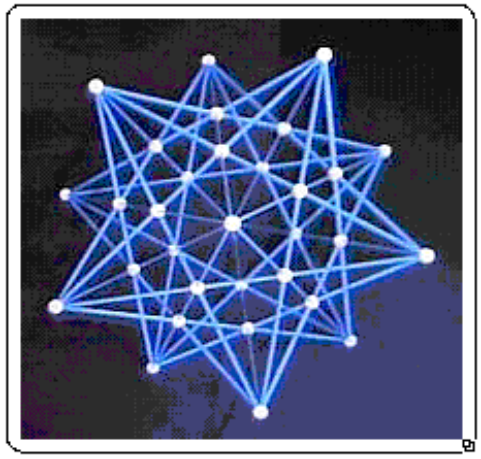
◊ Euler's and Descartes' theorems

◊ Review of geometry and trigonometry

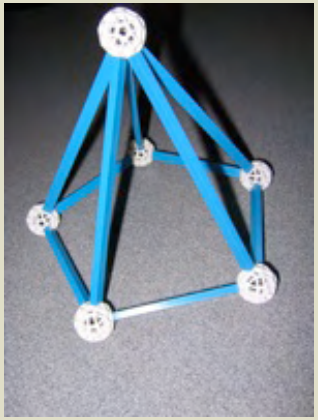
Dimension: 3D

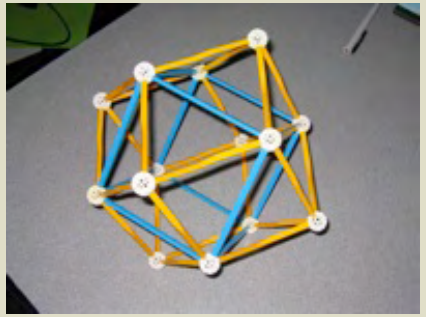
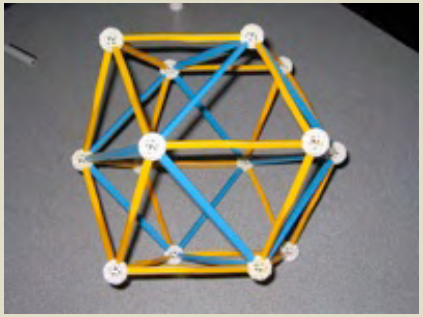
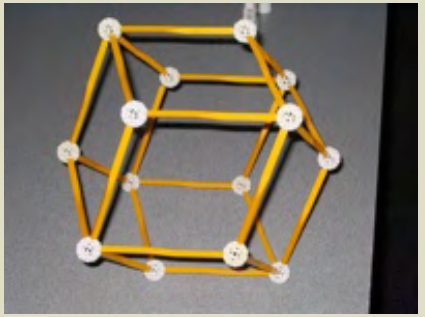
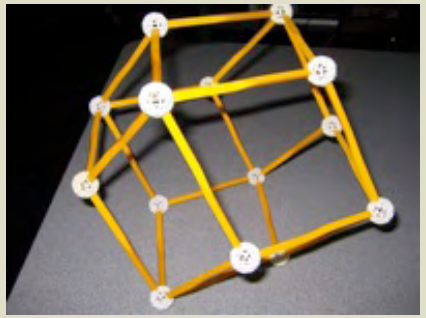
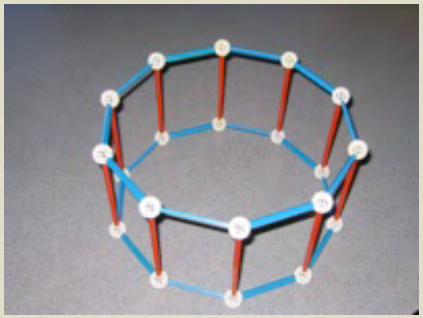
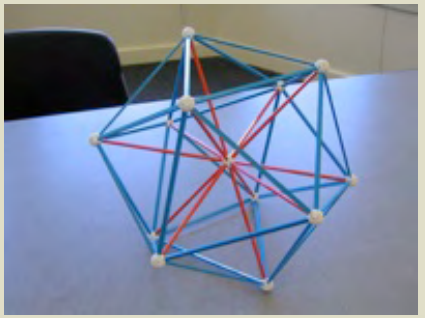
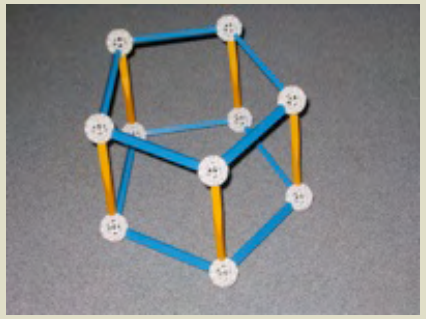
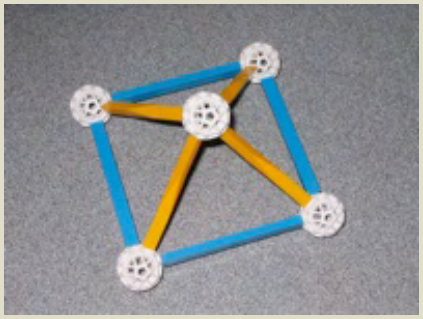
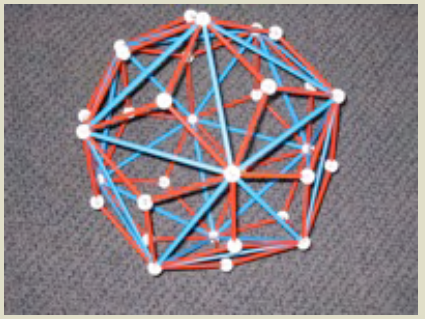
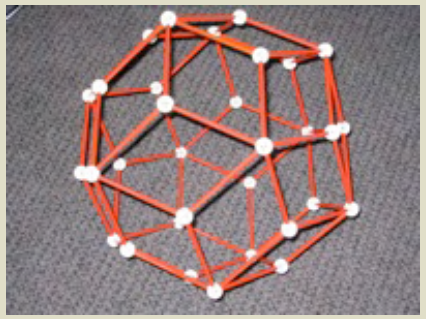
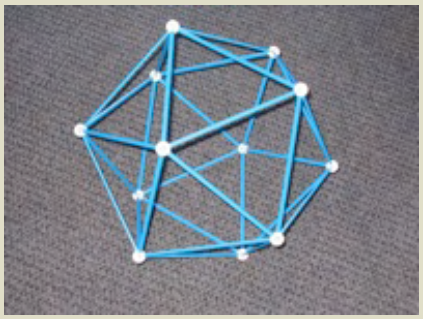
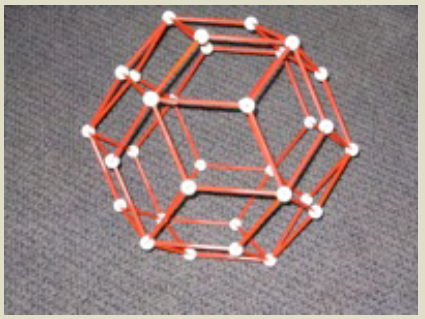
The chief reason for studying regular polyhedra is still the same as in the time of the Pythagoreans, namely, that their symmetrical shapes appeal to one's artistic sense. ---H.S.M. Coxeter



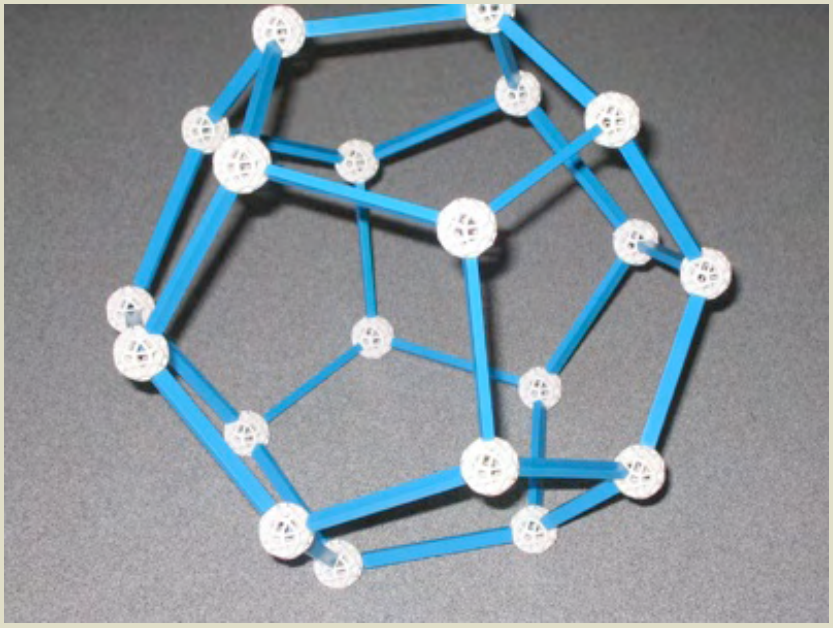
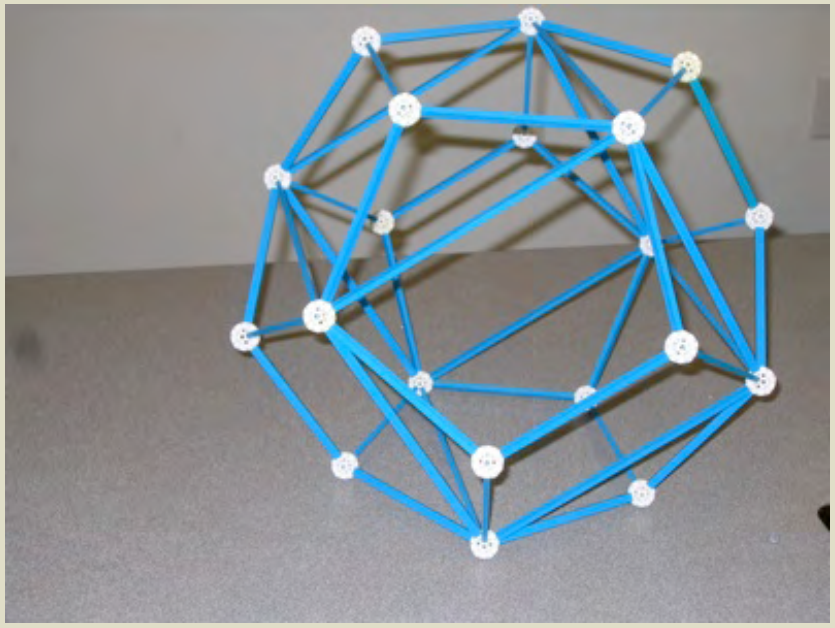
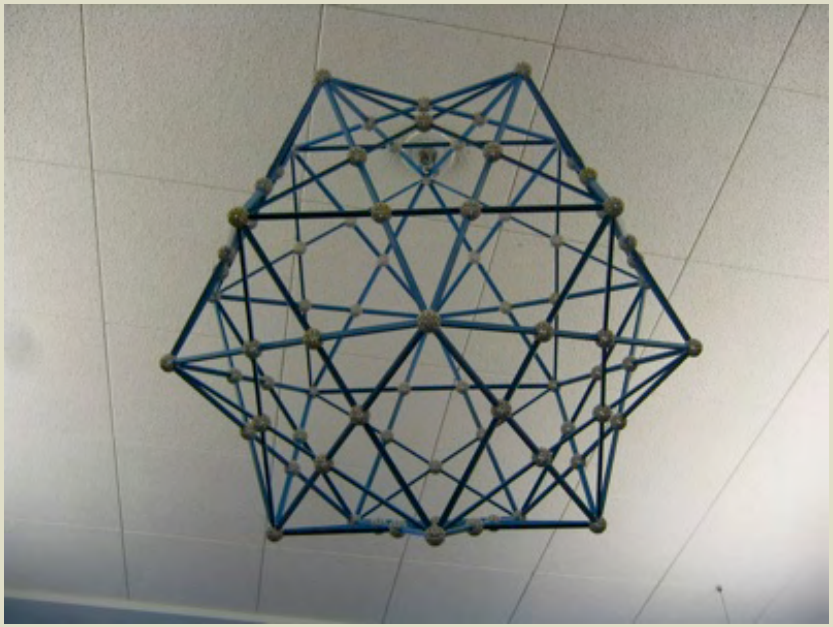


Transformations
Symmetry
Dimension: 3D

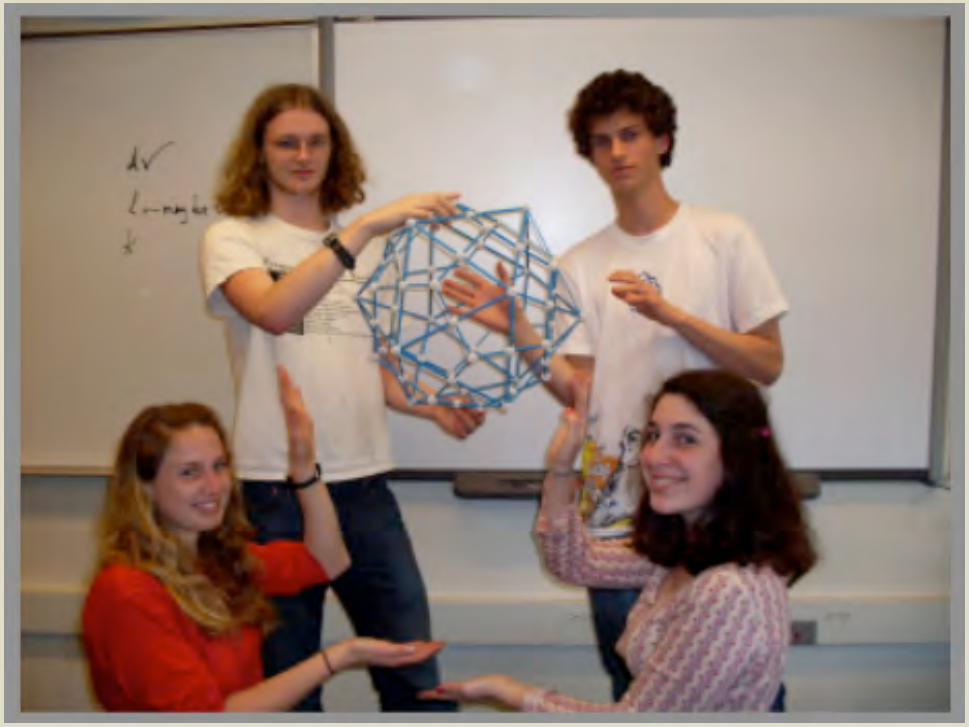


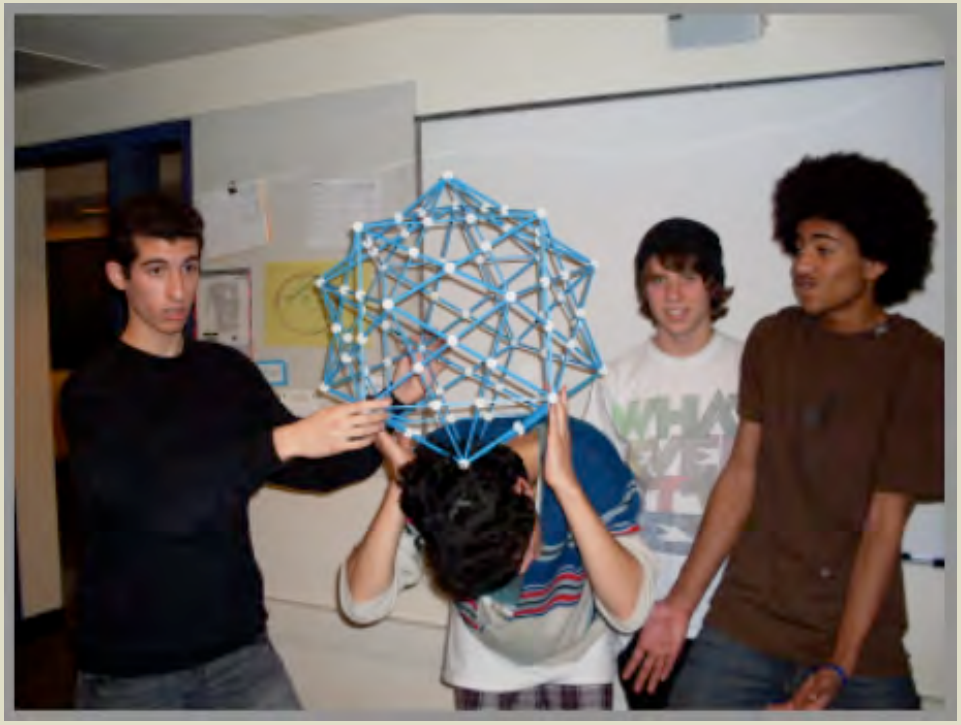













Transformations
Symmetry
Dimension: 3D

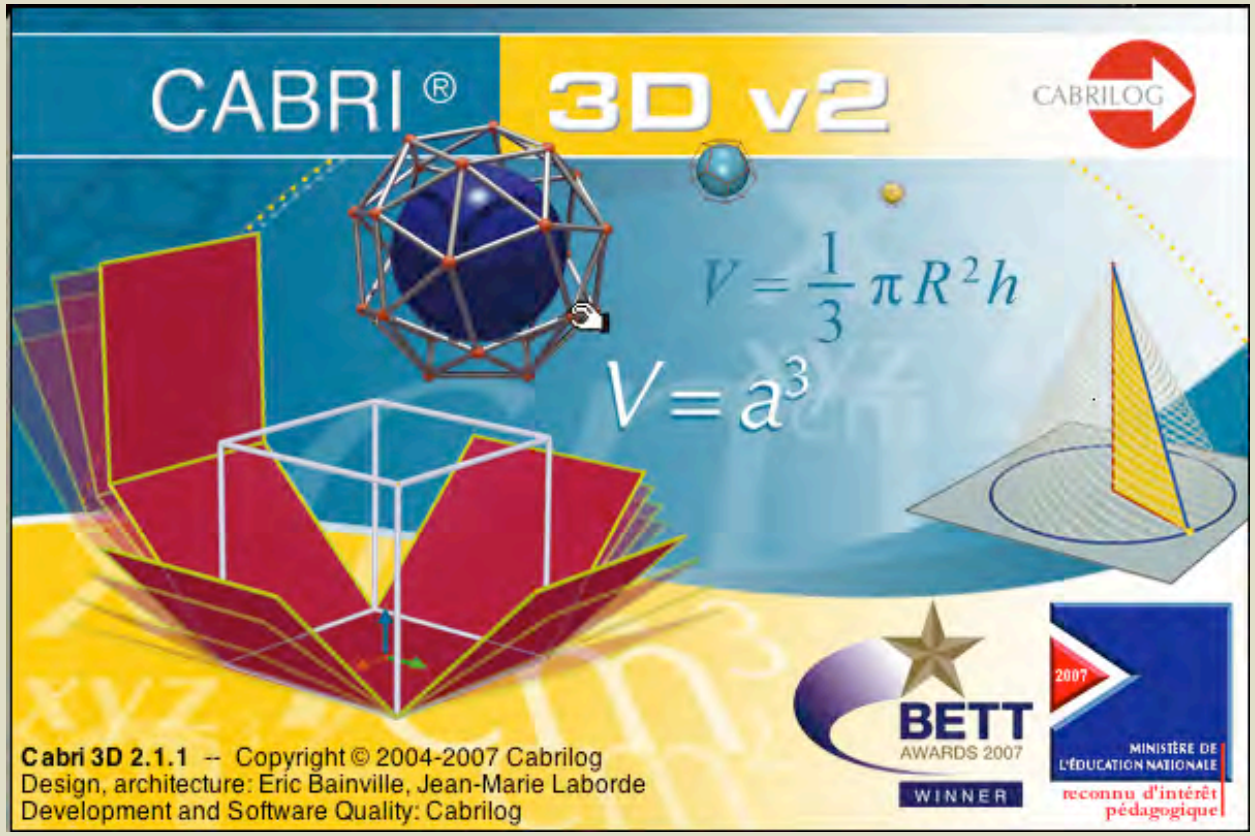





Transformations
Symmetry
Dimension: 3D

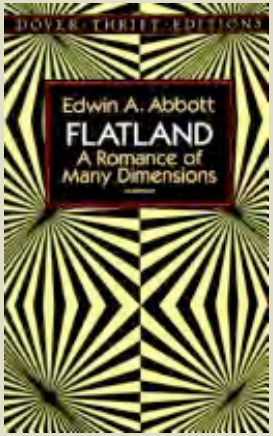


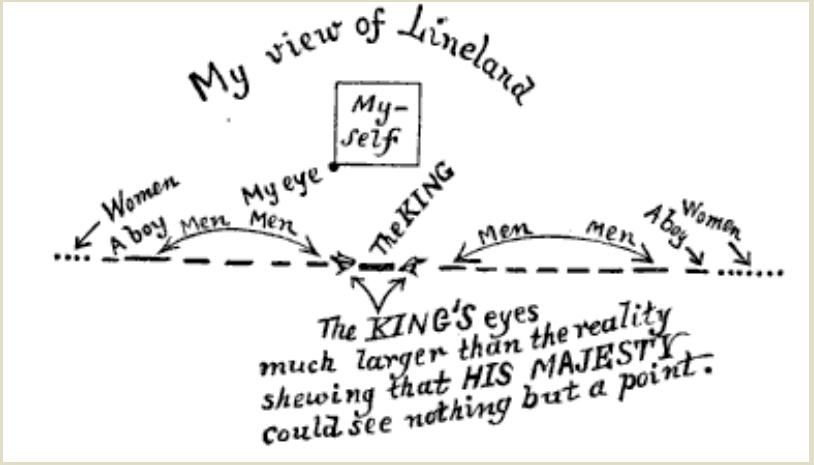


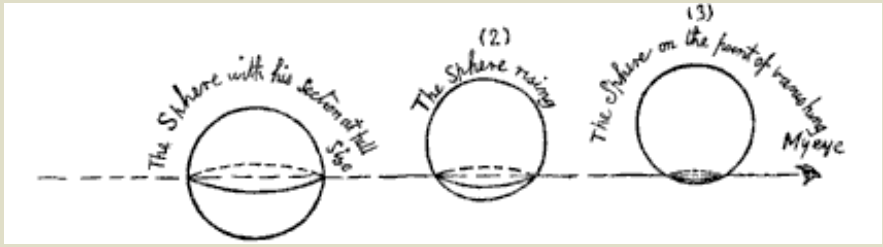
Transformations
Symmetry
Dimension: 3D



Transformations
Symmetry
Dimension: 4D







Transformations
Symmetry
Dimension: 4D

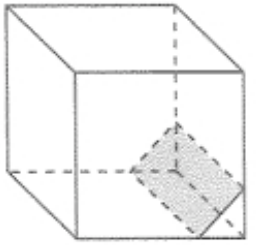
LAB 6.5
Slicing a Cube

Name(s) _____

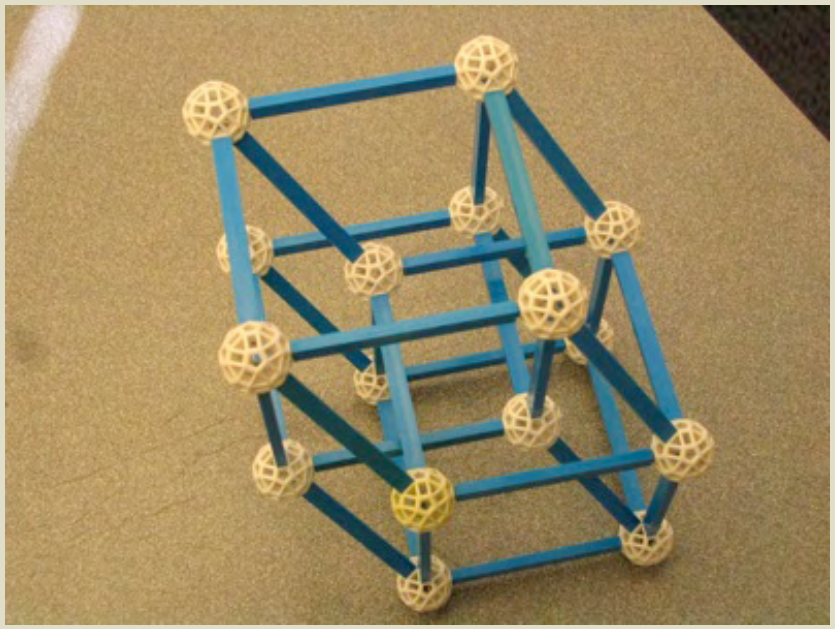
Equipment: Transparency, stiff paper, scissors, adhesive tape

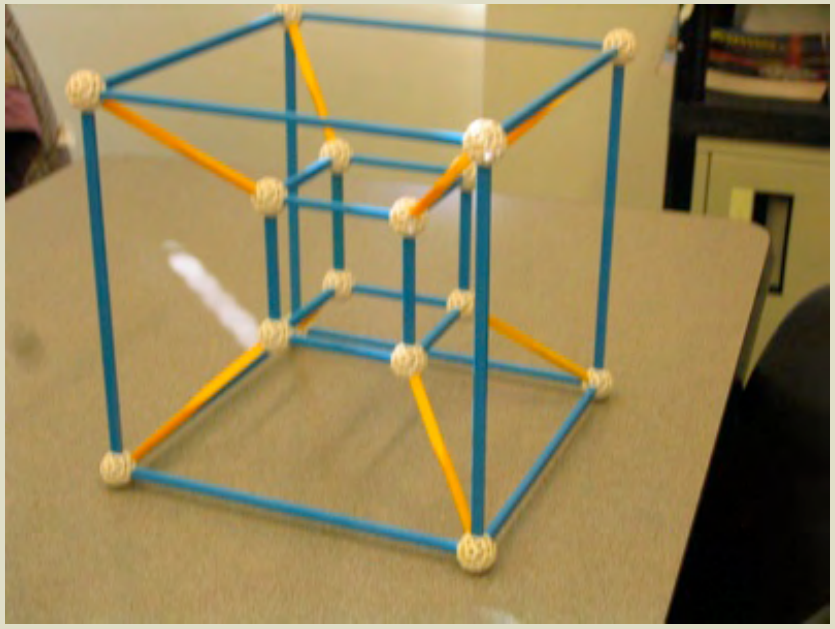
Imagine that you slice a cube in a direction parallel to one of the faces. The shape of the slice will be a square. Now imagine that you slice a cube parallel to one of the bottom edges, but tilted from the horizontal. The shape of the slice will be a rectangle.

What shapes are possible for a slice? To investigate this, you will use a hollow transparent cube and stiff paper to simulate the slices.

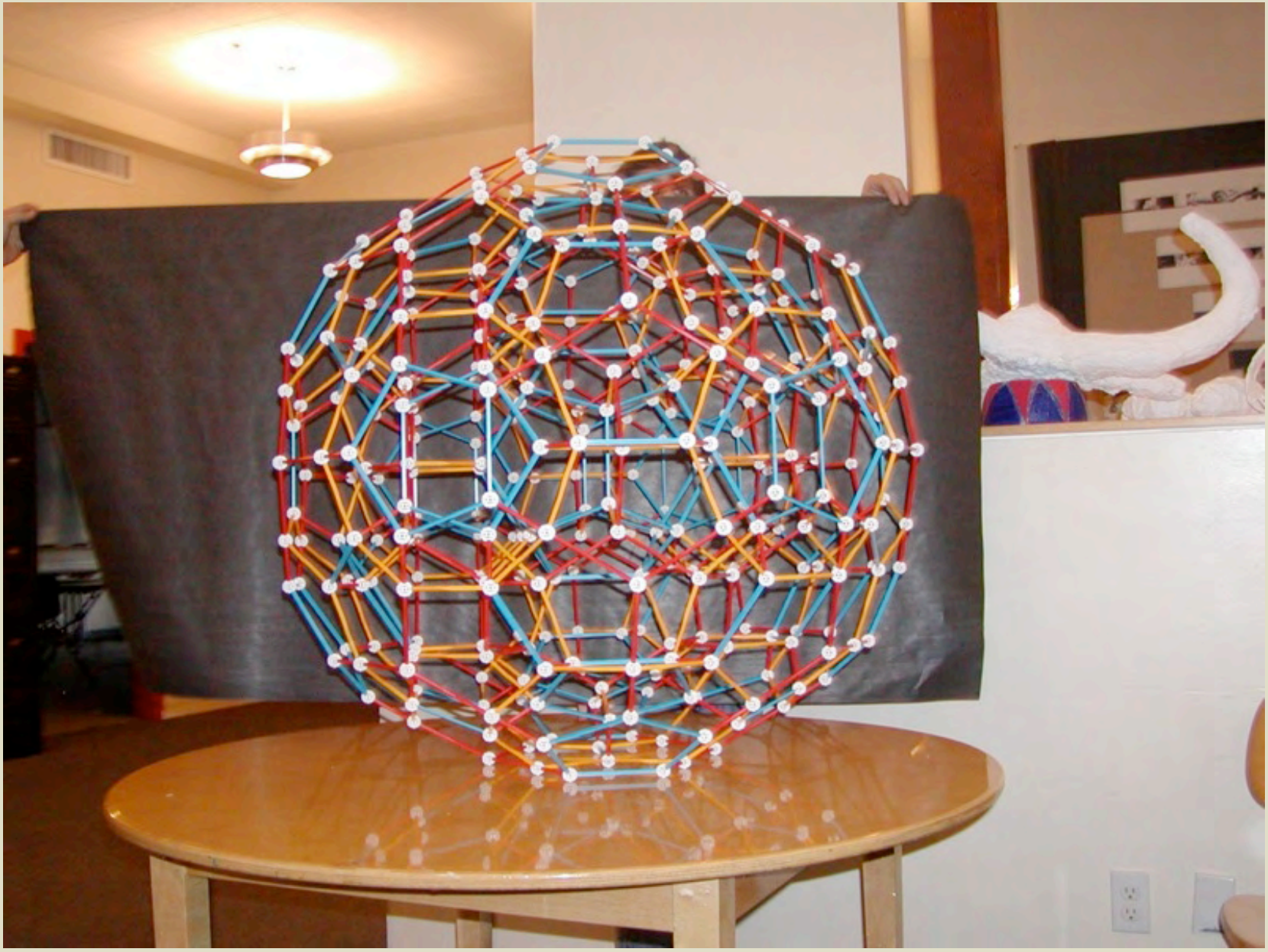


Transformations
Symmetry
Dimension: 4D

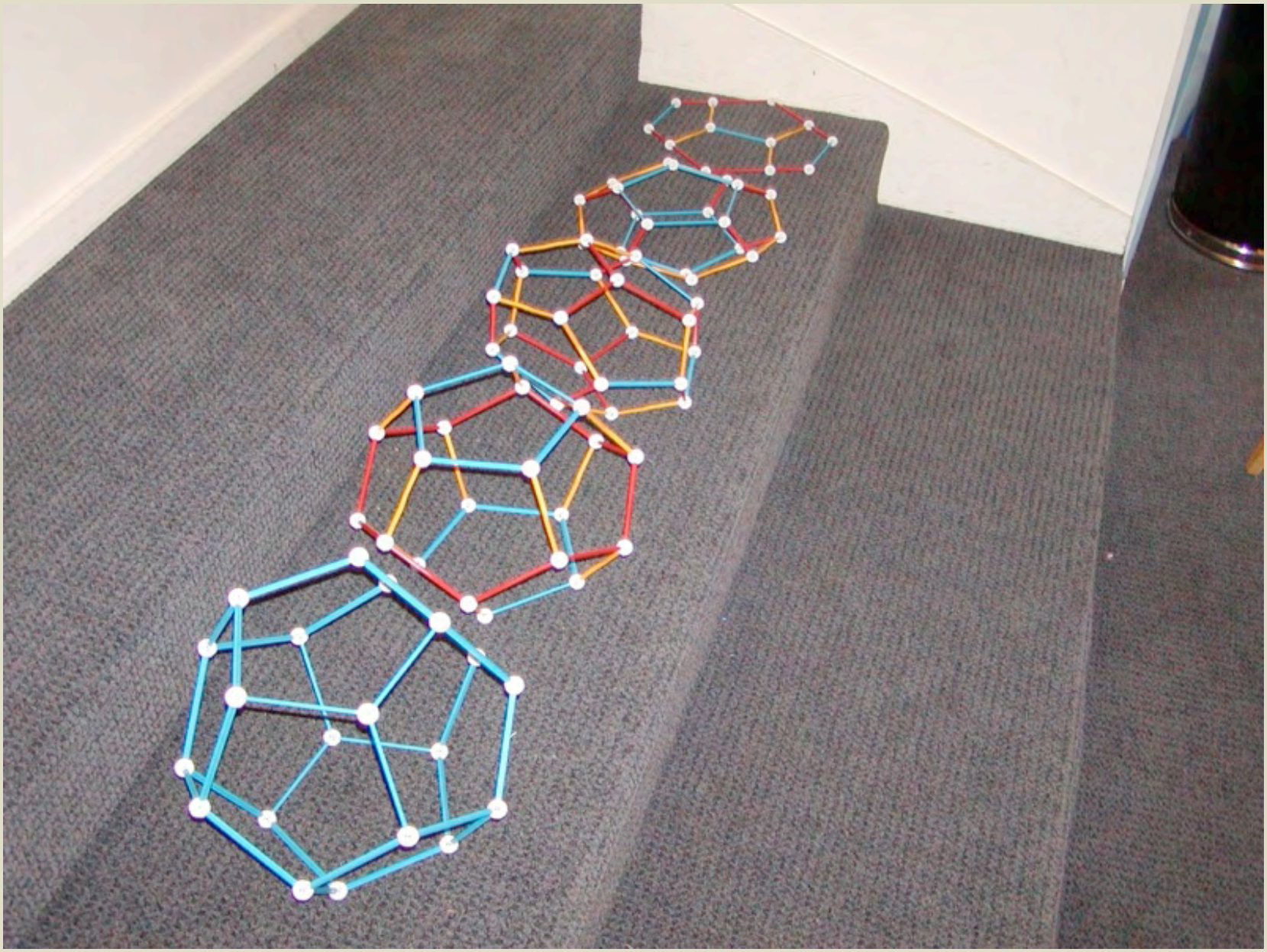




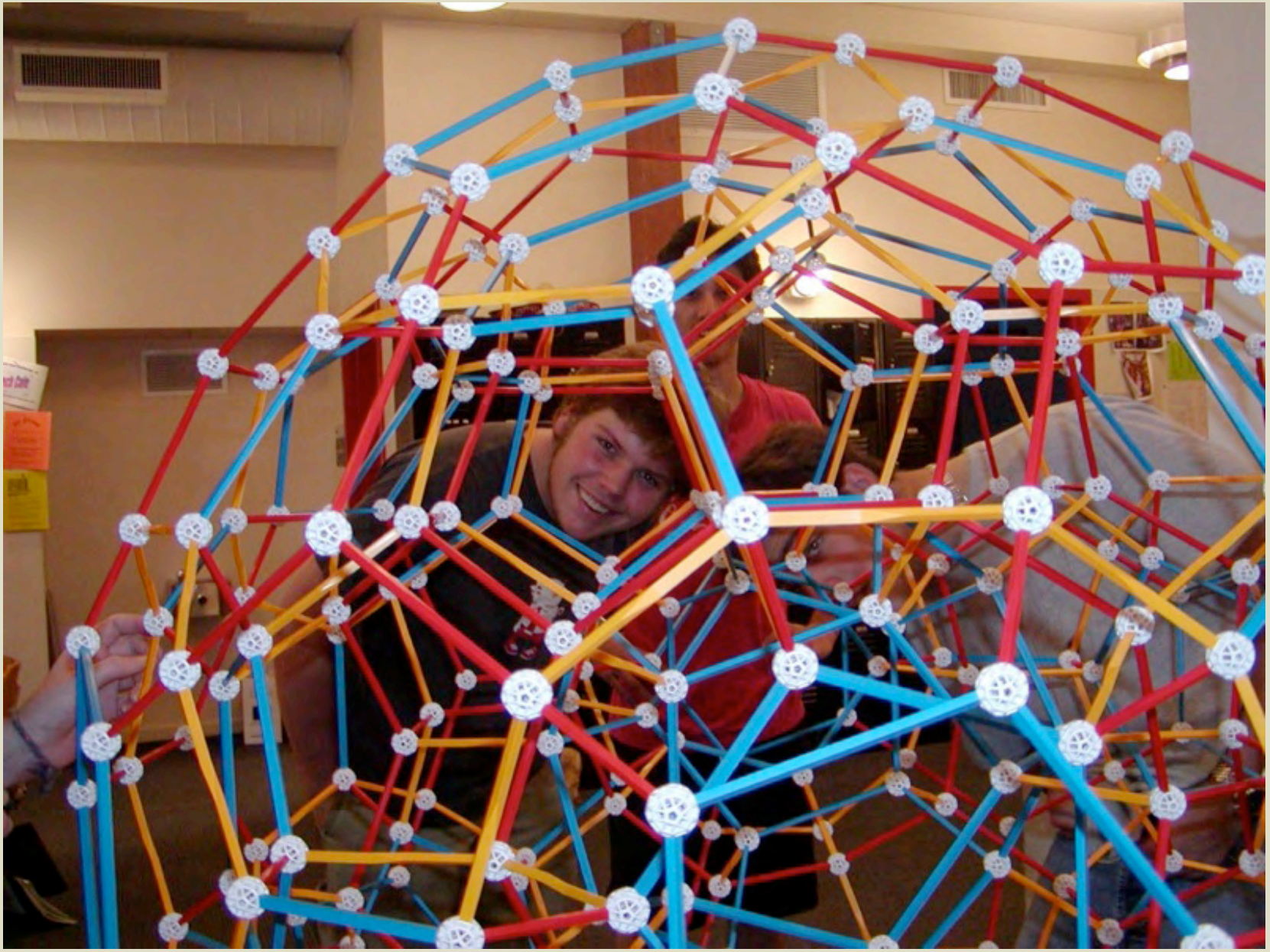
Transformations
Symmetry
Dimension: 4D



Transformations
Symmetry
Dimension: 4D



Transformations
Symmetry
Dimension: 4D

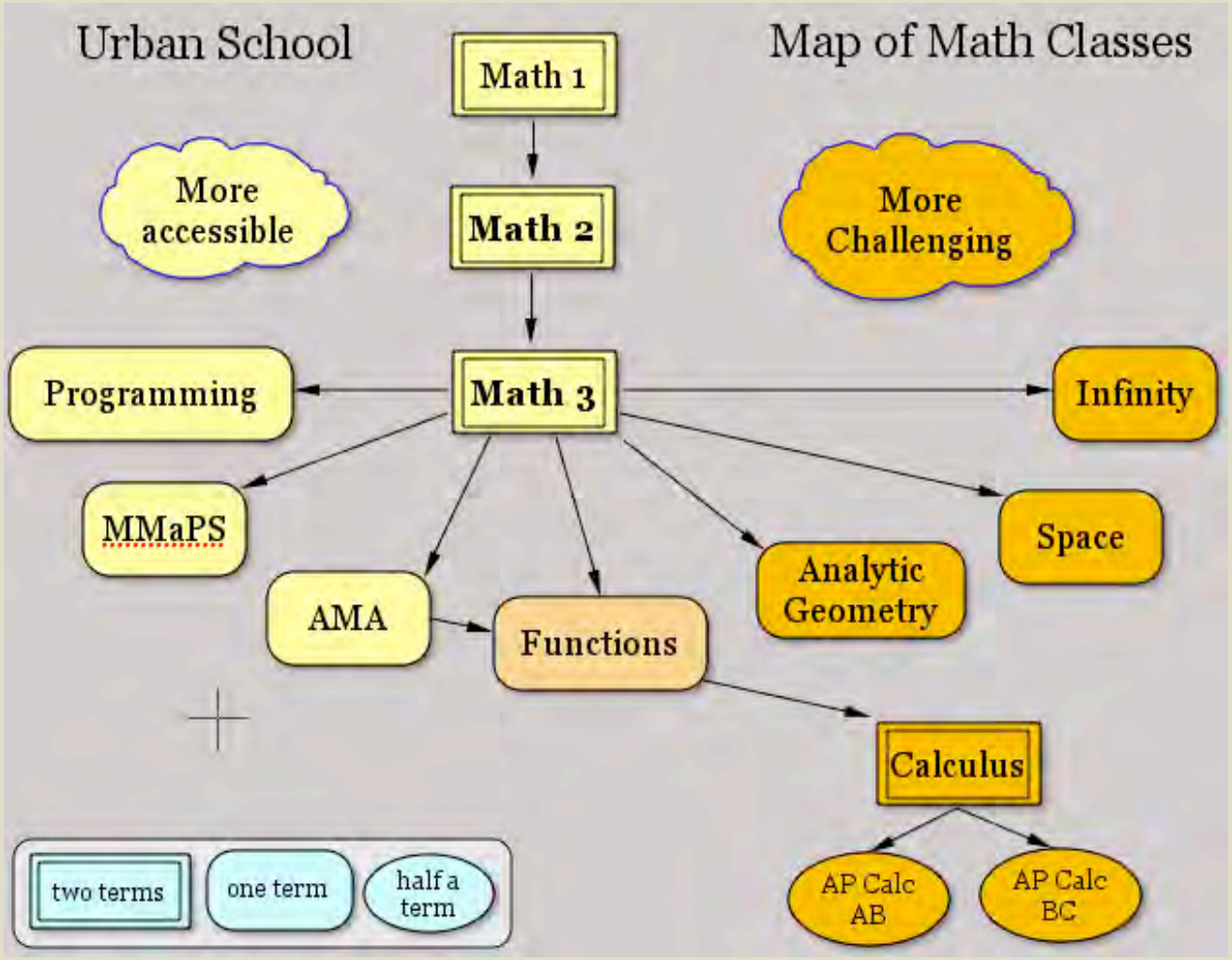


Space

An Alternate Elective after Algebra II

Henri Picciotto
The Urban School of San Francisco

math-ed@picciotto.org
www.picciotto.org/math-ed


Urban School
Map of Math Classes
Math 1
More accessible
Math 2
More Challenging
Programming
Math 3
Infinity
MMaPS
Space
AMA
Functions
Analytic Geometry
Calculus
AP Calc AB
AP Calc BC
two terms
one term
half a term

Space overview

Who takes the class

Topics

Review

Resources

Computer tools

Juniors, before Calculus

Seniors, instead of or in addition to Calculus

Space overview

Who takes the class

Topics

Review

Resources

Computer tools

Abstract algebra

Transformations

Symmetry

Dimension (3D, 4D)

Space overview

Who takes the class

Topics

Review

Resources

Computer tools

Algebra

Geometry

Trigonometry

Space overview

Who takes the class

Topics

Review

Resources

Computer tools

Transformational Geometry
by Richard Brown

Algebra: Themes, Tools, Concepts
by Anita Wah and Henri Picciotto

Geometry Labs by Henri Picciotto

Handbook of Regular Patterns
by Peter Stevens

Zome Geometry
by George Hart and Henri Picciotto

Flatland by Edwin Abbott

Space overview

Who takes the class

Topics

Review

Resources

Computer tools

Cabri II+

Cabri 3D

(vZome)

Space

An Alternate Elective after Algebra II

Henri Picciotto
The Urban School of San Francisco

math-ed@picciotto.org
www.picciotto.org/math-ed

Summer Workshops for Teachers

August 4-7
Grades 8-11: Visual Algebra
August 10-11
Grades 11-12: No Limits!

Henri Picciotto
Center for Innovative Teaching
Urban School of San Francisco

math-ed@picciotto.org
www.picciotto.org/math-ed/cit