Mathematics, Science & Technology

PART II.5

Math, Monarchs, and Metamorphosis.........2

Exploring Transformations...........................9

NOTE: This document is a work in progress. Parts II and III, in particular, are in need of further development, and we invite the submission of additional learning experiences and local performance tasks for these sections. Inquiries regarding submission of materials should be directed to: The Mathematics, Science, and Technology Resource Guide, Room 681 EBA, New York State Education Department, Albany, NY 12234 (tel. 518-474-5922).

NEW YORK

THE STATE OF LEARNING

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ELEMENTARY

Standards & Performance Indicators

Math, Monarchs, and Metamorphosis

MST 1

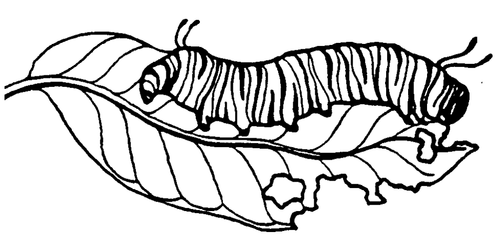
- ▲ ask why
- ▲ clarify and compare
- ▲ interpret observations/measurements
- ▲ adjust explanations

MST 3

- ▲ draw conclusions
- ▲ analyze situations
- ▲ justify answers
- ▲ logical reasoning
- ▲ spatial relationships
- ▲ multiple representations
- ▲ explain ideas
- ▲ recognize/describe/extend
- ▲ solve for unknown
- ▲ manipulatives
- ▲ interpret graphs
- ▲ two/three dimensional

MST 4

- ▲ living/nonliving variations
- ▲ life processes
- ▲ stages of life cycle
- ▲ survival behaviors



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Grade 1

BUTTERFLY LARVA

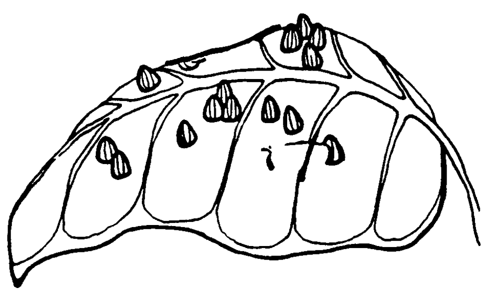
Nasco, 901 Jamesville Ave., P.O. Box 901, Fort Atkinson, Wisconsin 53538-0901, 30 Butterfly Larvae, Cat. #FB01929M, $36.40
Connecticut Valley Biological Supply Co., Inc., 82 Valley Road, P. O. Box 326, South Hampton, MA 01073, 30 Larvae, Cat.# AT4851, $38.00
Delta, Dept. CB075, P.O. Box 3000, Nashua, NH 03061-3000, 25 Larvae, Cat. #542701610, $27.20

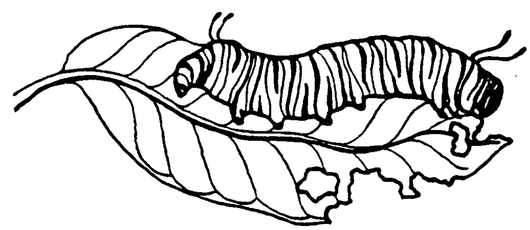
Students are taught to observe and recognize symmetry as it occurs in the natural world. They learn the mutual relation of parts in respect to position such as: limbs on a tree; veins in a leaf; and whorls in a flower. Being able to recognize patterns is a problem-solving tool which can be applied to many real world situations, even at the first grade level. Students are able to predict outcomes and results.

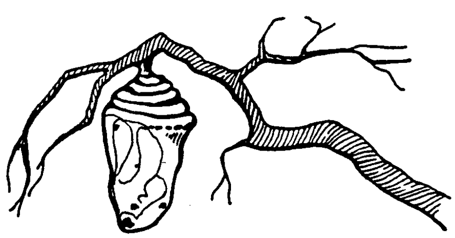
The purpose of this lesson is to give the students an understanding of the mathematical concepts of symmetry and enhance their spatial sense. The concept will be developed as part of an integrated curriculum that will include the study of insects and, specifically, the metamorphosis of the butterfly. Class discussions (characteristics of an insect); hands-on activities (move tiles to change an asymmetrical figure to a symmetric one); readings (*What is a Butterfly?*); demonstrations (metamorphosis of a butterfly, and questioning: (What can a symmetrical figure do?); problem solving (How can you change a given asymmetrical figure into a symmetrical one?;, and discovery techniques (use mirrors and pattern blocks for discovery of mirror image concept in symmetry) will be integrated. Achart story based on what they have experienced will enable students to strengthen their reading skills as well as review what they have learned.

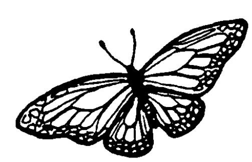
Label and color, please.

Words to use: butterfly egg caterpillar chrysalis









DAY 1

Students should be given the opportunity to observe the metamorphosis of butterflies with either a picture or, preferably, a living larva. They can look at a variety of types of butterflies pictured in the classroom and in reference books. After discussion of similarities and differences among butterflies, students will be led to the conclusion that the wings on a butterfly are mirror images of one another. The term "symmetry" will be introduced. On the overhead projector, students will manipulate a variety of acetate "wings" to make symmetric pairs.

Symmetry is a part of the natural world and is a significant concept in a wide range of disciplines. Students may begin to understand elements of it early in their education making this lesson appropriate for grades K, 1, 2, and 3.

Teacher

Optional Video Segment

To give students a specific responsibility while viewing, the teacher will say, "In this video a girl named Winnie, from Winona, is upset because she doesn't understand something. I think you can help her. When you think you can, raise your hand."

Play the tape from the beginning to where Winnie says, "...doesn't sound nice." Pause and ask the student with the raised hand what Winnie doesn't understand. Allow students to express ways to explain "symmetrical." Resume play until arcade game *Symmetrical Polygons* appears on screen. Pause and explain that a polygon is a shape with straight sides. As each polygon is presented Mathman and Mr. Glitch appears; pause tape and encourage students to predict if Mathman will chomp because the figure is symmetrical. This action will occur four times, so pause tape each time. Resume play after students predict. Resume play and pause after Winnie's drawing is "flipped over a line." Ask, "What can a symmetrical figures do?" (Flip over a line.) Stop tape after Winnie from Winona says, "Symmetry can be beautiful."

Students will practice placing a line of symmetry (six inch, thin Stick) on shapes formed on the overhead projector using overhead geometric shapes such as the hexagon and squares.

BUTTERFLIES

Berger, Melvin. A Butterfly is Born. Newbridge Communications, Inc. 1996.

Conklin, Gladys & Lathan, Barbara. I Like Butterflies. Holiday House, USA 1960.

Darby, Gene, What is a Butter fly? Benefic Press, Chicago, IL 1958.

Drew, David. Caterpillar Diar y. Rigby, Inc., Crystal Lake, IL 1990.

Gibbons, Gail. Monarch Butterfly. Holiday House, NY 1989.

Mattern, Joanne. Butterflies and Moths. Troll Associates 1993.

Sterling, Dorothy. Caterpillars. Doubleday & Co., Inc. Garden City, NY 1961.

Zoobooks. Butterflies. Volume 7 #9, Wildlife Education, Ltd., San Diego, CA, June 1990.

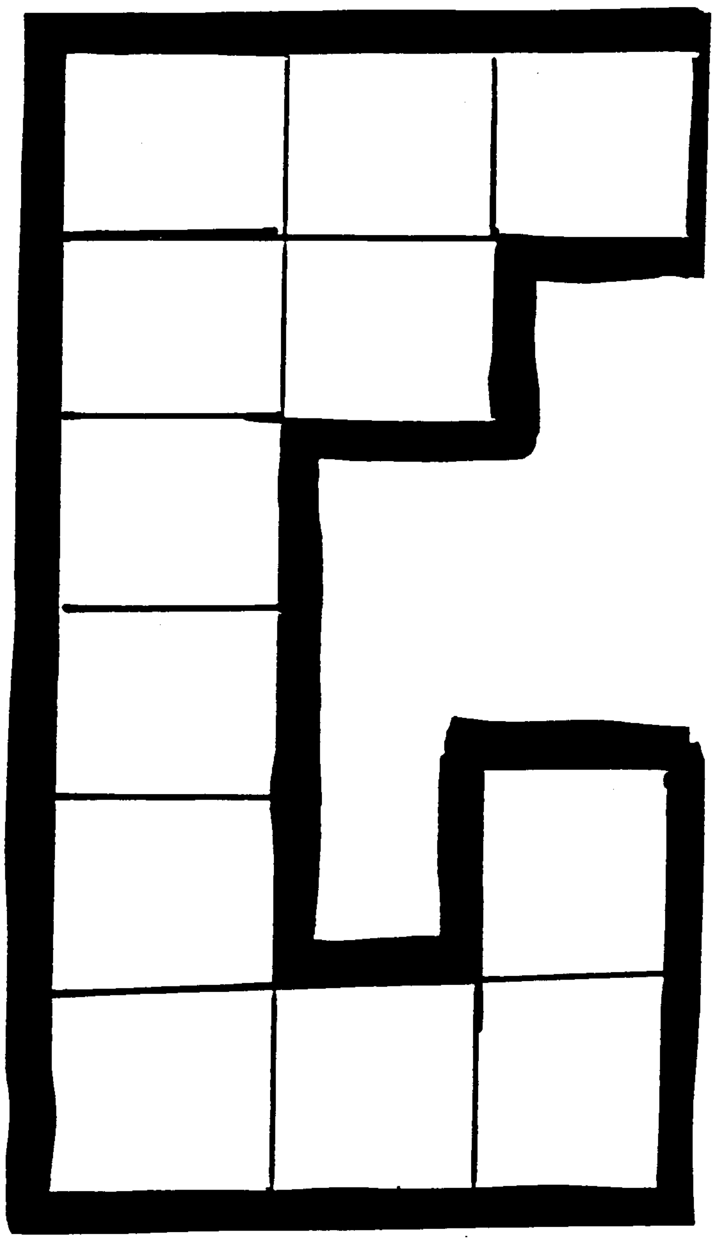
DAY 2

Containers of paper pattern block shapes and four 9" x 12" white sheets of construction paper will be distributed to each group of four students. Each student will create a symmetrical design and will glue the design on his/her white construction paper. After work has been completed, each student will receive a thin, six-inch stick to be glued on the shape to show the line of symmetry.

DAY 3

Students will sit at desks with one-inch square tiles in small containers and count the tiles to be sure they have 12. After 2 minutes of exploration, direct their attention to the overhead projector. On the overhead, 12 one-inch square tiles will be arranged in an asymmetrical figure. Sheets with that same asymmetrical tile arrangement will be distributed. Students will cover this design with their tiles and be encouraged to explore ways to rearrange the tiles to create symmetrical shapes. Students will share their shapes on the overhead.

The teacher will ask the students to dictate an experience chart story to explain the concept of symmetry.



SYMMETRY

Jonas, Ann. Reflections. Greenwillow, New York, NY 1987.
Jonas, Ann. Round Trip. Greenwillow, New York, NY 1983.
McDermott, Gerald. Arrow to the Sun. Viking Penguin, Inc., NY 1974.
Geometry and Spatial Sense. Cur riculum and Evaluation Standar ds for School Mathematics. Addenda Series. National Council of Teachers of Mathematics, Reston, VA 1993.

INSTRUCTIONAL/ENVIRONMENTAL MODIFICATIONS

Desks are arranged in groups of four, allowing students to observe each other and discuss the procedures. Sharing ideas and understandings accommodates the range of abilities and learning styles. The teacher and/or parent volunteer/aide should be available to assist a student who is confused and unable to participate. To further accommodate the students with special needs, puzzles, enlarged illustrations, and computer programs such as *Eduquest* on-line rotations are available.

EACH STUDENT WILL NEED:

- Container holding 12, one-inch square tile pieces
- Paper copy of asymmetrical design from *General Mathpital* (In groups of 4 students)
- 9 x 12 inch white construction paper
- Paper pattern block pieces
- Glue
- One thin stick (or coffee stirrer, straw) about 6 inches long (about the diameter of a toothpick (per student)

ASSESSMENT

The students are observed as they worked with the tiles and a checklist is used to note their individual levels of success. If they were able to reposition the tile pieces to form a symmetrical shape, a check was given. Arubric was designed for evaluating a paper-pattern block design based on the student's understanding of symmetry.

Aworksheet which allowed students to indicate their understanding of metamorphosis was given, collected, reviewed, and evaluated with each student in a conference. Another worksheet distinguishing the differences between a moth and a butterfly was evaluated as above. These worksheets are used to provide feedback.

Students create a booklet illustrating their understandings of the stages of metamorphosis. Self-reflection by students occurs during our daily class meetings.

REFLECTION

Some students could be given additional practice during free time. Ahomework assignment could help some students.

I found that using the *Pattern for Tile Arrangement* worksheet as a visual aid to constructing the asymmetrical figure works better than placing the tiles on top of the worksheet. Studies with square tiles could be expanded to the study of area measurement and other geometric shapes in helping to meet other math standards. The study of butterflies and metamorphosis could be extended to the study of other living creatures, their physical characteristics, and their stages of development. Use the concept to develop a unit on bats. Symmetry could also lead to the study of its uses in construction, engineering design, and art.

These lessons reflect the constructivist philosophy. Students are given opportunities to discover basic principles through hands-on activities and observation. The integrated nature of the unit enables them to make connections among the disciplines and incorporate new concepts into their understandings.

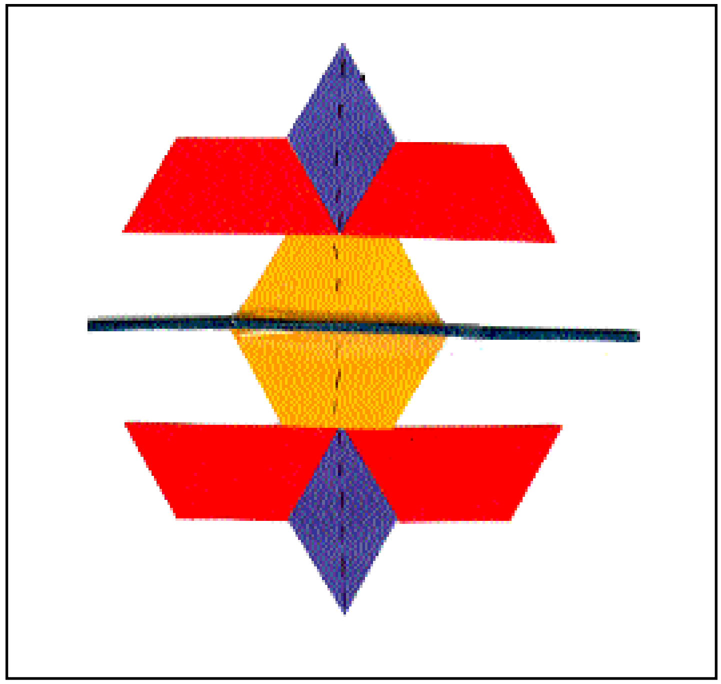
1. Students explore symmetry by manipulating acetate butterfly wings on the overhead.
2. Students construct a symmetrical design.
3. Students create a chart story to explain their understandings of the concept of symmetry.

Rubric for Symmetrical Design Made from Paper Pattern Blocks

Outstanding:	The student is able to construct a complex design that is symmetrical and can place the line or lines of symmetry accurately.
Good:	The student is able to construct a simple symmetrical design and correctly place the line of symmetry.
Fair:	The student can construct a design that contains some recognizable elements of symmetry but is asymmetrical.
Poor:	The student’s design is asymmetrical with no elements of symmetry.

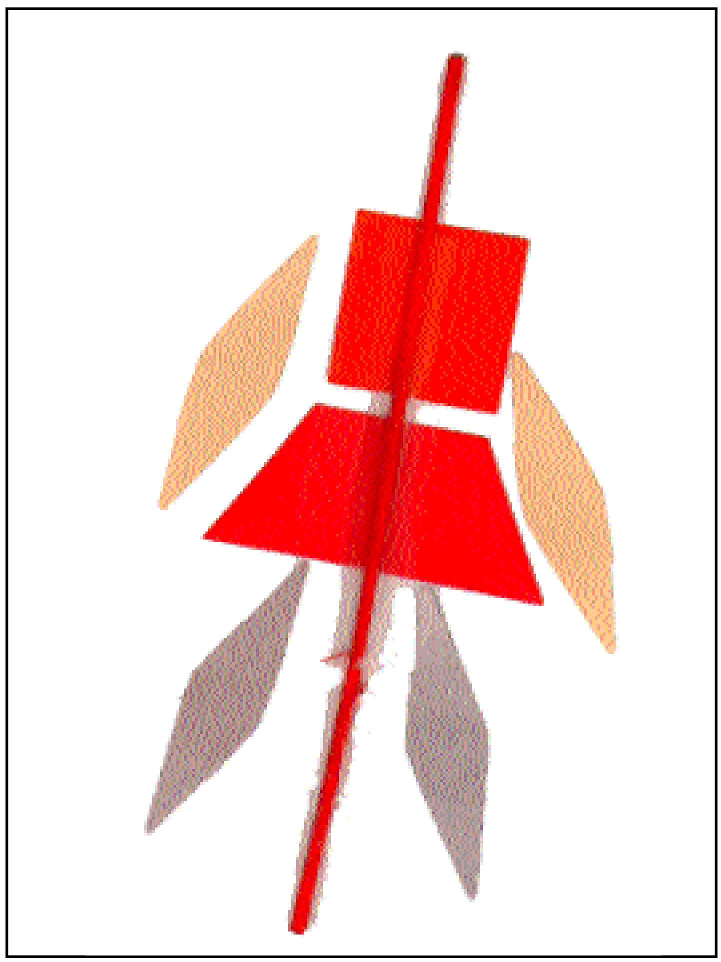
This student excelled in most performance tasks and had no difficulty creating a symmetrical design. The student said he could create a second line of symmetry if he had another stick. The dotted line is where he showed the teacher it would be placed.

SCORE: *Outstanding*



The student was unsure, lacked confidence in his own ability. He copied pattern design of a friend but was able to demonstrate to teacher correct placement of the line of symmetry and explained the shape was that of a person: one leg and one arm on each side of the body.

SCORE: *Good*



COMMENCEMENT

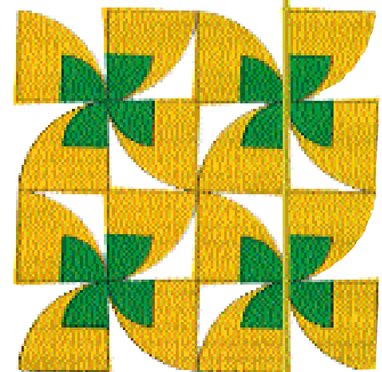
Standards & Performance Indicators

EXPLORING TRANSFORMATIONS

On The Computer And Using Transformat
On The Computer To Create A Unique De

Generally, the students learn the material faster and better than the traditional way using graph paper and ruler.

Teacher



MST 3

- ▲ transformations
- ▲ learning technologies
- ▲ investigate transformations
- ▲ graphing utilities
- ▲ transformations to functions

MST 7

- ▲ analyze problems/issues
- ▲ design solutions
- ▲ work effectively
- ▲ gather/process information
- ▲ present results

Geometer's Sketchpad 3.0, Key Curriculum Press, Berkeley, CA

This experience was created to integrate computers into the regular Sequential 2 math program and to combine ideas from two disciplines, math and art. All participants were ninth-graders taking Sequential 2 and none of them had previous experience with the software.

Despite the extra work, I have continued to employ the self-teaching concept because I feel strongly that it is the best way for students to learn.

Teacher

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Grade 9

Phase One—Exploration

In the first part, students explore what happens when geometric figures are transformed on the coordinate plane. The teacher uses the first day to review the basic transformations that students learned in *Sequential Math 1*. During the next four class sessions in the computer lab, the students work together in pairs, moving geometric shapes in the plane, measuring the coordinates of the original and image figures, making conjectures regarding rules for each transformation, and testing their hypotheses. They then formalize their rules as functions. Throughout the activity, the students direct their own learning using only their knowledge of the program learned earlier in the year and the tutorial provided by the teacher.

The class was given 2 to 3 successive days in the lab during the first activity, and then a discussion of the results obtained to date was held in the regular classroom. Thus, all students were able to get feedback regarding their work; those who were successful would know that they were, and those who were in error could be steered back in the right direction. In the lab itself, the teacher serves as a facilitator, observing each 2-person team and making suggestions and answering questions, thus keeping the lessons focused.

Phase Two—Design

In the second part, students use their new-found knowledge of transformations to create an original artistic design, such as a tessellation, according to a suggested real-life situation. Students must work together effectively, process information, observe common themes, and present their results. It also serves to acquaint them with an assignment such as they might reasonably expect to encounter in the world of work.

> ***By far the greatest amount of time must be devoted to the teacher's own self-preparation.***
>
> Teacher

Students working in teams of two are given the following scenario and instructed to use the computer to create an original drawing which satisfies the criteria.

Imagine the following situation: You are employed by a design firm which creates designs for vendors who manufacture wallpaper, wrapping paper, tile, and fabric. Your supervisor has assigned you to develop a new design which may be sold to one of these vendors.

The design must contain the following elements:

- It must employ at least two types of transformations: line reflections, point reflections, rotations, dilations, and/or translations.
- It must use at least two colors.
- It can be extended to cover at least 75% of the piece of paper.
- It must be relatively easy to reproduce.

In addition, you must write an explanation of how you created your design. This explanation must be clear and easy to read, typed on a word processor, and illustrate your knowledge of transformations. It should be easy to understand so that anyone who reads it can duplicate your design from the instructions.

ASSESSMENT

Phase One—Exploration

Evidence of students' progress is provided in a number of ways. While they are working in the computer lab, the teacher observes their work, answers questions, and asks other questions,which can point them to further discoveries. The tutorial worksheet requires student responses, and students can also record their discoveries in a script box on the sketchpad workpage. Two or three times during the unit the students report to their regular classroom to discuss, compare, and analyze their findings. Homework from the text is assigned as students complete each of their explorations in each type of transformation. At the conclusion of the unit, each student submits a set of four problems using composition of transformations. These are done using a ruler and graph paper (not the computer) and are scored on a scale of 1 to 10 points, exactly as they are on the Sequential Regents' exams. This assignment assesses individual learning. Each student does the work on his/her own, and is given a separate rating.

Phase Two—Design

Assess whether the students understand how to apply transformations to achieve artistic effects.

Design Rubric

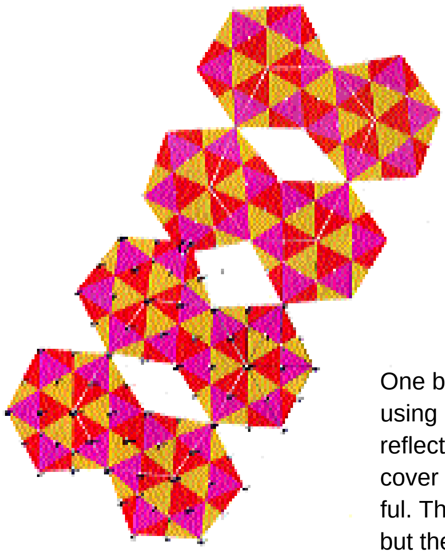
Projects are evaluated according to the following criteria:

THE DESIGN:	
• was created using at least two different transformations.	10
• can be duplicated repeatedly to cover the surface.	5
• uses at least two colors.	5
• is adaptable to a commercial use.	5
• is fairly simple to reproduce.	5
• is pleasing to the eye.	5
Total:	**35 points**
THE DESIGN DESCRIPTION:	
• can be easily duplicated by the anyone who reads it.	7
• is clear and easy-to-read, with no run-on sentences and no spelling errors.	5
• is typed on a word processor.	3
Total:	**15 points**
Project Total:	**50 points**

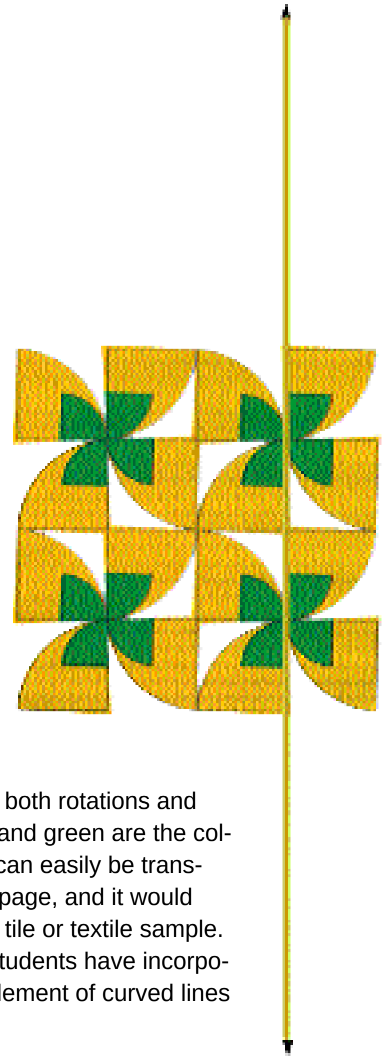
Each team of two people is given the same project score. Individuals are assessed according to the assignment described above, and on subsequent tests.

APPENDIX

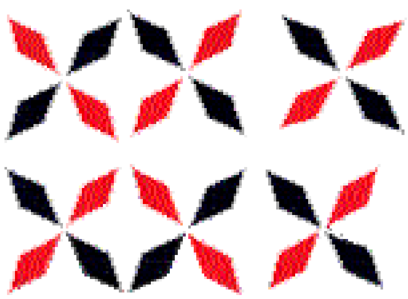
If you are using *Geometer's Sketchpad 3.0* the following **Course 2 Transformations** worksheet is a guide created for this learning experience.



One basic shape has been divided using dilations, then rotated and reflected. It is easily reproduced to cover a surface and commercially useful. The three colors are eye-catching, but the repetitive triangles render it less appealing to the eye.

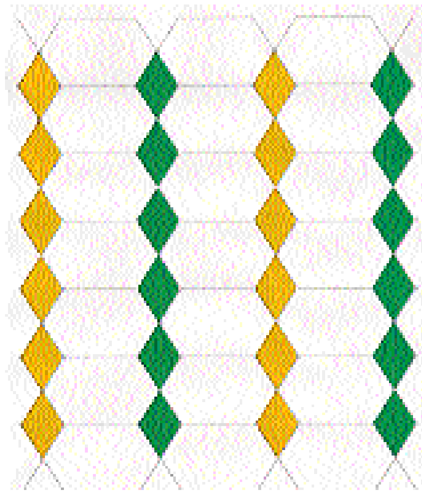


The design uses both rotations and dilations; yellow and green are the colors. The design can easily be translated across the page, and it would make a pleasant tile or textile sample. In addition, the students have incorporated the extra element of curved lines (arcs).



The design is very pleasing to the eye and has nice color contrast. The student has used rotation well, but the translations were done using different directions and distances, resulting in a picture which is not symmetrical. This was probably not intentional, but the unequal white spaces are not only disturbing to view, but render the design difficult to duplicate on the page and therefore not commercially usable. Some minor adjustments, particularly the use of one translation vector, would correct the problems.

This design is deceptively simplistic. The two colored figures are not in fact congruent, but were created by adding and subtracting pieces from congruent squares in the manner of M. C. Escher, then rotated and translated to produce a tessellation. This design is both simple to recreate and infinitely extendible. It is adaptable to many color combinations, making it a useful design for any number fabric items, although a different set of colors would have had more personal appeal, I think.



Two shapes have been created from one basic trapezoid through the use of reflections and translations. The minimal use of two colors keeps the design from looking too cluttered, rendering it pleasant to look at, and useful as a wall tile design. It is easy to recreate and duplicate across the page.

Following is a students' written explanation of how this design was created.

Create an isosceles trapezoid (shorter base = 4.5cm./10nger base = 7cm./ sides = 2.5)

- Keep reflecting the trapezoids until you have the desired length.
- Reflect the trapezoid over the longer base...then the shorter base...then the longer...
- Reflect the column of trapezoids to create to columns...then three...until you have reached the desired length.
- Delete the longer base of each of the trapezoids. Now you should have overlapping hexagons.
- Color in the diamonds created by the overlapping hexagons. All colors are allowable, but we used yellow and green.

This written description received a score of 15 according to the following criteria:

• easily duplicated by the reader	7
• clear and easy-to-read instructions, with no run-on sentences or spelling errors	5
• typed on a word processor.	3
Total:	**15 points**