High Style: Fashion In the Mathematics Classroom

GRADES: 5-12

Minaret Dress 1995
Created By: Issey Miyake
Location Created: Tokyo, Japan
Accession Number: 1997.6
Credit Line: Gift of Miyake Design Studio in memory of Otto Charles Thieme
Type: Costume and Accessory
Medium: Polyester

"Issey Miyake (b. 1938) has been producing groundbreaking collections since 1971, when he showed his first collection in New York. He does not conform to the dictates of seasonal fashion. His designs do not go out of style because they have little relation to contemporary trends. With strong roots in his native Japan, Miyake often uses elements of traditional Japanese dress for modern purposes. Utilizing the kimono's basic concept of space between the body and the cloth, his designs allow the wearer and the garment to interact. Miyake's clothing is not complete until it is placed on the body. Movement and the wearer's creativity in arranging the clothing to suit his or her own desires are required to bring the garments to life. Miyake is fascinated with textile technology. His fabrics are an important component in the adjustability, comfort, and individual expression of his clothes. Miyake's best-known designs are created from permanently twisted, crumpled, wrinkled, pleated, and folded fabrics that are lightweight and fit any body type. This piece acquired its name because it resembles a minaret – a slender tower with projecting balconies. Miyake constructed the dress of pleated polyester in two shades of orange and green made sculptural by a succession of hoops. The garment sways and bounces with the wearer's movements. Essentially, it is a kinetic sculpture that happens to be a dress" (www.cincinnatiartmueum.org).

According to a recent ABC News story (as cited on the American Mathematical Society's website), "*Fashion and Advanced Mathematics Meet at Miyake*: Fashion and advanced mathematics collide at Japanese label Issey Miyake, (2010) generated a lot of interest in the mathematics and fashion communities. Drawings by William Thurston (a pioneer in the field of low-dimensional topology, 1982 Fields Medal winner, and professor of mathematics and computer science at Cornell University) inspired designer Dai Fujiwara (Issey Miyake, Inc.)." Thurston noted that both he and Fujiwara were, "… trying to understand the best 3-dimensional forms of 2-dimensional surfaces, and he noted that we each, independently, had come around to asking our students to peel oranges to explore these relationships. This resonated strongly with me, for I have long been fascinated (from a distance) by the art of clothing design and its connections to mathematics" (http://www.ams.org/news/ams-news-releases/thurston-miyake).

See the Resources section for more websites, blogs, and slide shows that make connections between mathematics and fashion design.

OBJECTIVES

Students will:

- Compare and contrast designs and materials that are used to make Issey Miyake's fashions.
- Describe the mathematics of fashion design (for a list see the Resources section).
- Describe the mathematics in the Minaret Dress. (Launch)
- Create two-dimensional patterns for the three-dimensional hoops in the Minaret Dress (Group Activity Sheet). (Explore)
- Use the two-dimensional patterns, hoops, fabric, and other materials to create a mockup one-half scale Minaret Dress.
- Use mathematical vocabulary/academic language (see list below) to explain how they created their two-dimensional patterns and the mockup one-half scale Minaret Dress. (Summarize)

CONCEPT

When students ask, "When are we ever going to use this?," you will have an answer. Fashion design! Drafting the patterns for fashions such as those created by Issey Miyake requires the creative use of mathematical thinking and mathematical skills such as spatial visualization, proportional reasoning, and measurement. Designers also need strong communication skills to convey the mathematical aspects of their creative process to their production team. This lesson is intended to introduce middle grades or high school students to mathematical aspects of fashion design so that they might envision mathematics as connected to future careers. It also invites students to make connections between the mathematical and artistic elements of the design process.

MATERIALS

Hoops: Based on an internet search of what to use for the hoops, here are several suggestions: 4' long plastic zip ties from a hardware store; ties that hold lumber together which you can possibly get for free at a lumber store; ¼" Plastic "Pex Pipe" tubing or "plumbers coil" which comes in 5' pieces and you can get in the plumbing section of a hardware store.
Fabric: Experiment with different kinds of paper to use such as "pleater paper" or thick tissue paper.
Tape measures (one per group)
Rulers/meter sticks (one per group)
Chart paper for the patterns (one sheet per group)
Scissors
Compasses
Protractors
Clear packaging tape (one roll per group)
Stapler and staples

VOCABULARY/ACADEMIC LANGUAGE

Ratio – the comparison of two quantities by division
Proportion – two ratios that are equal
Scale factor – the ratio of corresponding sides in two similar geometric figures
Similar/similarity – plane figures (2-dimensional) and solid figures (3-dimensional) which have the same shape but not necessarily the same size
Concentric circles –circles with a common center; the space between concentric circles with different radii is called an annulus
Circumference – the perimeter of a circle
Diameter – a line segment that passes through the center of a circle and intersects any two points on the circle
Convex – curved outward
Concave – curved inward

PROCEDURE

Launch

Show photos and read quotes from *Mathematics Meets Fashion: Thurston's Concepts Inspire Designer* by Suzy Menkes, New York Times, March 5, 2010. (http://www.ams.org/news/ams-news-releases/thurston-miyake). At the bottom of this page click on youtube.com links ["Interview with Dai Fujiwara and Professor William Thurston at the Issey Miyake Fashion Show in Paris" and "Issey Miyake Fashion Show: Women's Ready to Wear Autumn/Winter

2010/11"] and show each of these. Pose the following questions and focus on the use of mathematical vocabulary (see list above):

- How is mathematics evident in Miyake's fashions?
- What mathematics do you see in the designs?

Show photo of the Minaret Dress (Issey Miyake, 1995) from the Cincinnati Art Museum's permanent collection. Pose the following question:

- If the model in this photo is 5'10" tall, how could you estimate the circumference of the largest hoop at the bottom of the dress?

Allow students to talk in their groups (a minute or two) and then come back together as a whole group and ask them to share their group ideas. Allow them to use their methods and find the estimate. As a whole group, come to a consensus, perhaps using averages, about the circumference of the largest hoop. Now ask the groups to estimate the circumferences for the other 9 hoops or concentric circles in full scale (Group Activity Sheet question #1). After about 5 minutes come to whole group consensus about estimates for the circumferences of all hoops and create a list of these.

Ask the following: How would you propose creating the hoop skirt at the bottom of the dress? Engage students in a conversation about their ideas.

Divide the number of hoops by the number of groups and assign the different hoops to different groups. For example, there are 10 in the Minaret Dress, 5 hoops for the "convex portion" of the dress and 5 hoops for the "concave portion" of the dress. If you have five groups then each group will be assigned 2 hoops that are attached to each other.

Explore

Working in small groups, students will create segments of the hoop portion of the Minaret Dress in half-scale. Using the list of full-scale measurements they designated during the Launch, chart paper, materials to make the hoops, materials for the "fabric", tape measures, compasses, rulers/meter sticks, clear heavy duty packing tape, staplers/staples, etc. Each group will make a portion of the mockup dress. [See Activity Sheet]

As students are working in groups, observe the strategies they are using and ask mathematical questions that push their thinking.

Summarize

After the activity, come together as a whole class and put the hoop sections together. Pose the following questions:

- What strategies and tools did you use to create your hoop sections?
- What mathematics did you use to engineer your hoop sections?
- What advice would you give to someone working to recreate a mockup of the Minaret Dress?

ASSESSMENT

Actual product – Is the mockup Minaret Dress mathematically similar to the original one? Did the students create the mockup in half-scale?
Formatively assess their understanding based on the answers students give to the questions in the Launch and Summarize. Formatively assess their progress as they engineer the mockup Minaret Dress while working in their groups during the Explore. Will their two-dimensional patterns lead to three-dimensional mockups? Are they correctly using a half scale factor?

Exit Slips – (See Group Activity Sheet) Assess these by posing questions, in writing on their Exit Slips, and then giving them back to the groups the following day. Ask the students to answer your questions and submit the Exit Slips back to you a second time.

NATIONAL STANDARDS

National Standards for Arts Education:
Visual Arts (Grades 5-8, Content Standard 6)
Making connections between visual arts and other disciplines. Compare the characteristics of works in two or more art forms that share similar subject matter, historical periods, or cultural context. Describe ways in which the principles and subject matter of other disciplines taught in the school are interrelated with the visual arts. (http://artsedge.kennedy-center.org /teach/ standards/standards_58.cfm#04

Common Core Standards for School Mathematics:
Mathematical Practice 4, Model with Mathematics–Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace.
Mathematical Practice 6, Attend to Precision–Mathematically proficient students try to communicate precisely to others.
Grade 6 RP–Understand ratio concepts and use ratio reasoning to solve problems.
Grade 7 RP–Analyze proportional relationships and use them to solve real-world and mathematical problems.
Grade 7G–Draw, construct and describe geometrical figures and describe the relationships between them.
Grade 8G–Understand congruence and similarity using physical models, transparencies, and geometry software. (www.corestandards.org)

RESOURCES

How Does Being a Fashion Designer Involve Math? (https://www.youtube.com/watch?v=iY3cqChYeIs)

Mathematics & Fashion Designing: Fashion Design & Simple Styles (https://www.youtube.com/watch?v=pbQZQzDDUjA)

fashionandmath.blogspot (http://fashionandmath.blogspot.com/p/how-math-is-related-to-fshion.html)

pbs.org (http://www.pbs.org/teachers/mathline/concepts/designandmath/activity3.shtm)
Activity 3: Fashion Design: Patterns and Weaving (Grade Level 8-11)

How Fashion Designers Use Math (http://www.slideshare.net/helgasrodrigues/how-fashion-designers-use-math) [This is a slide show that includes interactive questions and relates fashion design to patterns, profit, angles, parallel lines, perpendicular lines, congruent shapes, symmetry, tessellation, prototypes, fabric, measurement, fractions, fashion show logistics, and buying materials for mass production).]

Mathematics Meets Fashion: Thurston's Concepts Inspire Designer (http://www.ams.org/news/ams-news-releases/thurston-miyake)

Career Interview: Fashion Designer (Professor Sandy Black) (https://plus.maths.org/content/career-interview-fashion-designer)

Math in Fashion: Chloe Dao (season two winner or Project Runway) (http://www.thirteen.org/get-the-math/the-challenges/math-in-fashion/introduction/12/)

Group Activity Sheet

The Minaret Dress
Issey Miyake
1995

From the top, number the hoops, 1-10.
Assume the model is 5’10” tall.
Assume the concave hoops (2, 4, 6, 8, 10) are all the same size.
Goal: You are going to make a portion of the Minaret Dress, in half-scale, and when you are finished work with the other groups to construct the Half-Scale Minaret Dress.

1. Estimate the actual sizes of the convex hoops (1, 3, 5, 7, 9) which are concentric circles. Approximately, what are their diameters and circumferences? (As a group we will compare estimates, use averages, and make a list of the sizes.)

2. Use a half-scale ratio and create the dress from hoop number _____ to hoop number _____.

Group Exit Slip: On a separate piece of paper show all work and explain your thinking.