5th Grade Mathematics / Fine Arts

ILS—9A, 9B, 25A, 26A, 26B

Frank Lloyd Wright's Windows

How did Frank Lloyd Wright combine math and art to create his stained and leaded glass windows?

Theme

This lesson explores how Wright used geometric shapes in his artistic windows. Using the Emil Bach House of Chicago as a starting point, students will investigate the connection between math and art in window design.

Student Objectives

- measure and manipulate two-dimensional shapes to create Wright-inspired window patterns using regular polygons
- describe the five basic steps of designing stained and leaded glass windows
- explain the inspiration behind Wright's designs

Activities

- cut out and combine all the individual shapes used in the Emil Bach house window to create a new window design (activity is similar to a tangram)
- create a stained glass window with black strips of paper and colored paper

Type

indoor, desktop activities

Timeframe

five class sessions of 30 minutes each

Materials

- **Handout A** - photographs showing example of a Wright window (abstract) and a contrasting type of stained and leaded glass window (realistic)
- **Handout B** - photographs showing process of making stained and leaded glass windows
- **Handout C** - drawings of two Wright windows, one using a tessellation pattern the other using a foil pattern
- **Handout D** - frame outline from an Emil Bach House window
- **Handout E** - individual window pieces from the Emil Bach House (2 pages)
- **Handout F** - Wright's finished window design from the Emil Bach House
- **Handout G** - an Emil Bach House window with all dimensions listed
- graph paper *(one sheet per student)*
- colored cellophane, or colored construction paper, or tissue paper *(enough for each student to make a 7" x 9" window design)*
- 1/8" or 1/4" strips of pre-cut black construction paper
- scissors, glue, rulers, crayons

Vocabulary

abstract designs designs that don't try to look exactly like real things; instead, the artist uses lines, angles, shapes, and colors to create a design that represents a new interpretation of the real thing

realistic designs designs that try to look similar to real things

Prairie Style a style of buildings, furniture, and glass (from approximately 1900-1920); the inspiration behind Prairie Style designs was the idea that the building should appear to "grow" from the natural site where it is located

tessellations a pattern of shapes that fit tightly together and are repeated over and over again

parallel lines two lines that go in the same direction, always the same distance apart, and never touch

perpendicular lines two lines that meet at a 90° angle

geometric a design using lines, angles, and solid shapes (circles, squares, triangles)

illuminate to bring light into a room

leaded glass glass made with lots of lead; the color is part of the glass

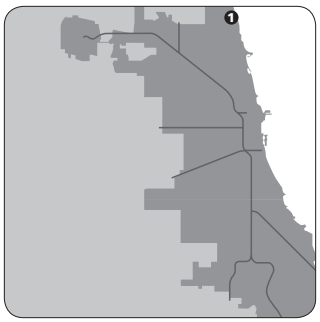
stained glass glass colored by having a metal painted and melted onto it

came, caming the strips of lead, zinc, or copper that fit between the glass pieces; the process of installing the strips is called caming

organic relating to living growing things

cartoon a drawing made by the maker of the window to be used as a pattern

a foil something that serves to frame or contrast with another object; in this case, many of Wright's windows framed the view outside



Location Information

❶ **Emil Bach House**
7415 North Sheridan Road
Chicago, Illinois

Discussion Points

- What is different about Frank Lloyd Wright's window designs from others of the same time period? (Wright's designs were abstract, while many others of the same time period were realistic.)
- What are some characteristics of each of these two window types?

Basic steps in making a real stained or leaded glass window

1. Measure and draw a full-size pattern on paper. This pattern is called a cartoon. Decide on colors for glass pieces.

2. Make another copy of the pattern and cut out individual pieces of paper.

3. Place a pattern piece on the glass, and cut around it with a glasscutter.

4. Join the finished cut pieces of glass with strips of came (usually lead, zinc, or copper).

5. Install the joined glass pieces inside a frame by soldering.

Teacher Prep

- photocopy or scan **Handouts A**, **B**, **C**, **and G** for display or projection
- photocopy **Handouts D**, **E**, **and F** of the Emil Bach House window *(one set per pair of students) (do not make double-sided copies)*
- photocopy **Handout F** *(one per student)*
- cut strips of black construction paper 1/8" or 1/4" wide on a paper cutter or using a paper shredder *(enough for each student to use in a 7" x 9" window design)*

Background Information for Teacher

Frank Lloyd Wright (1867–1959) is well known for the graceful window designs in his Prairie Style homes built between 1900 and 1920. There are significant differences between the window designs of Frank Lloyd Wright and the earlier window designs for typical Victorian homes and churches. Before Wright, window designs used colored glass and literal (realistic or representational) pictures to tell a story or commemorate an event or person. Wright, rather than filling the entire window section with images, preferred instead to use colored and clear glass to create a foil or frame through which to view the outside world.

Other main ideas about Wright's window designs:

- He never incorporated pictures of people or realistic landscapes. Instead, he used abstract organic patterns inspired by nature (usually plants).
- All his windows used geometric shapes applied on a grid system. He primarily used straight lines, with only a few windows using curves or circles. (Cutting glass with curved shapes required much more skill and time, and, therefore, curved designs were more expensive to produce.)
- Wright rarely used complex angles or many-sided polygons. His designs used small squares, rectangles, and triangles.
- Wright's windows did not block the outside view. His early designs filled in the entire window with tessellations of one or two shapes, but his most well-known windows provided a clear glass center surrounded by a complex frame of colored glass. This type of design, called a foil, framed the outdoor scene, provided protection from the elements, and added privacy without having to use curtains.
- Most used colors inspired by the prairie: greens, oranges, reds, yellows, and gold.
- Wright loved to play with light and color in his buildings. His windows were simply an extension of those ideas. Sometimes Wright's windows are referred to as "lights" or "lightscreens."

This lesson uses a window design adapted from the Emil Bach House located at 7415 North Sheridan Road in Chicago. According to the Historic American Buildings survey, "This is one of the few houses in the Chicago area done by Frank Lloyd Wright after returning from Europe in 1911 but before going to Japan to supervise the work on the Imperial Hotel. It is a late modification of the fireproof design, published in the *Ladies Home Journal* in 1906." Mr. Emil Bach was a co-owner of the Bach Brick Company in Chicago. He and his wife Amelia moved into their new home on Sheridan Road in 1915.

PHOTO The Emil Bach House, Chicago. (CAF, 2002)

The Emil Bach House is not open to the public, but one of the windows has been removed and donated to the Art Institute of Chicago. Currently, the window is not on display.

Note: Due to the complexity of Wright's design for the Emil Bach House window, the pattern used in this lesson has been slightly enlarged and simplified for use by your students. The dimensions of each glass piece have been modified to be round numbers. Please also be aware that even though your school's photocopier is set at 100%, it may slightly shrink any copies you make. This may be an issue with your students' copies of **Handouts D - G**. Use a ruler to double-check the window's overall 7" by 9" dimensions and adjust your copier as needed.

Activity Procedures

DAY ONE

Introduction to stained and leaded glass and Frank Lloyd Wright's windows

"Nothing is more annoying to me than any tendency of realism of form in window-glass, to get mixed up with the view outside." - Frank Lloyd Wright, 1928

[5th grade translation: I get annoyed when stained glass windows have pictures of people or things in them, because the picture in the window gets mixed up with the view outside.]

1. Display **Handout A** that shows Wright's abstract window design alongside an example of stained and leaded glass with a realistic design not designed by him. Put Wright's quotation up on the board and talk about what it means. Explain some of the main ideas behind Wright's window designs.

2. Use **Handout B** to outline the basic process of making a stained glass window. Reinforce the idea that the process requires both artistic and mathematical skills.

3. Display **Handout C** that compares an early Wright window using tessellations with a later style Wright window that acts as a foil.

4. Introduce the vocabulary for the lesson.

Interdisciplinary Connections

Science
Students can investigate and compare prairie ecosystems, plants, and insects with types of plants, insects, and colors used in Wright's window designs. Some of his designs include wheat shafts, milkweed, sumac, wildflowers, and butterflies in greens, oranges, reds, yellows, and gold.

Social Sciences / Science
Frank Lloyd Wright spent many years of his life at two homes and studios he designed. He named them both "Taliesin." The original *Taliesin* was located near his birthplace in Spring Green, Wisconsin. Many years later, he designed *Taliesin West* for the desert of West Scottsdale, Arizona. In both homes, Wright used many indigenous materials for construction and design inspiration. Have students compare and contrast the climate, flora, and fauna of Wisconsin and the Arizona desert.

Science
Leaded glass is colored by adding different minerals and chemicals to the glass mixture. Students can research and report their findings about the connections between colors and minerals and chemicals. Suggestions may include copper, cobalt, or zinc.

Resources

The Smith Museum of Stained Glass is located at Chicago's Navy Pier. It is the first museum in the country completely dedicated to stained glass. The museum is free to the public and contains 150 secular and religious windows that can be examined close up. Most were originally installed in Chicago area buildings. For more information or to request a brochure, contact the museum at 312.595.5024.

Two homes in the Chicago area that were designed by Frank Lloyd Wright are open to the public. Call 708.848.1978 for more information about group tours for either site. **www.wrightplus.org**

Frank Lloyd Wright Home and Studio
951 West Chicago Avenue
Oak Park, Illinois 60622

Frederick C. Robie House
5757 South Woodlawn Avenue
Chicago, Illinois 60637

Frank Lloyd Wright, Ken Burns and Lynn Novick. VHS, produced by PBS, 1999.

Frank Lloyd Wright for Kids: His Life and Ideas, 21 Activities, Kathleen Thorne-Thomsen. Chicago: Chicago Review Press, 1994.

Frank Lloyd Wright's Glass Designs, Carla Lind. San Francisco: Pomegranate Artbooks. 1995.

Frank Lloyd Wright's Stained Glass & Lightscreens, Thomas A. Heinz. Salt Lake City, UT: Gibbs Smith, 2000.

Stained Glass Window Designs of Frank Lloyd Wright, Dennis Casey, renderings. Mineola, NY: Dover Publications, 1997.

DAY TWO and **DAY THREE**
Math in the windows

5 Review vocabulary and examples of Wright windows and concepts.

6 Explain to students that they are to create a new window design using the same shapes that Wright used for a window. Distribute **Handouts D and E** to each pair of students. Have the group cut out the shapes on **Handout E** and fit and glue them inside the 7" by 9" frame of **Handout D**. (The process is similar to working with a tangram.) The group may arrange the pieces in any manner, but all the pieces must fit within the frame.

[Note: You may wish to copy the first page of **Handout E** onto a colored piece of paper, and the second page of **Handout E** onto a different colored piece of paper for variety and ease of seeing the students' new window designs. Or the students can color **Handout E** before cutting out the window pieces. For this activity only, you may also want to consider enlarging **Handouts E and F** to 130% on your copier machine to fit on an 11" x 17" piece of paper if you feel the pieces are too small for younger students to manipulate.]

7 After students have finished cutting and gluing, distribute one copy of **Handout F** to each pair to show how Wright used the same the pieces to create his window design. Compare his window to your students' work. Remind students that their designs are not wrong, just another creative way to solve the problem. Talk about the way Wright organized his window, looking for parallel and perpendicular lines, geometric shapes, repeating patterns, etc.

8 Using **Handout F** (copied at 100%) and rulers, have the student pairs measure and label dimensions for Wright's window. Each pair can also find the perimeter or area of the whole window or just some of the shapes you call for, such as all the triangles, certain rectangles, or all the squares, etc. Check their answers by displaying **Handout G**.

DAY FOUR and **DAY FIVE**
Art in the windows

9 Give each student another copy of **Handout F** that shows Wright's design for the Emil Bach House window, and have them use only one crayon to design the color pattern for the window. Discuss: Which shapes will you highlight? What happens to the patterns once you begin adding color? Have students compare designs.

10 Hand out graph paper for students to design their own stained glass window. You may wish to display pictures of plants, flowers, or trees to spark students' creativity, or you may choose to go outside and use real plants for inspiration. Allow them to choose a plant and then design a window using an abstracted (not realistic) form. Remind students they can use only simple geometric shapes as Wright did.

You may choose to set parameters for their window designs, depending on certain math skills you are studying. Examples: their window must include 'x' number of right triangles, 'y' number of 3" squares, 'z' number of 2" x 6" rectangles, etc.

11 Working with colored cellophane (or colored construction or tissue paper), students should cut out pieces that match their patterns. Use the thin pre-cut black paper strips to represent came strips and glue the window design together. Note: Their individual pieces will remain the same size as their patterns; however, the overall dimension of the window will increase somewhat due to the width of the came strips.

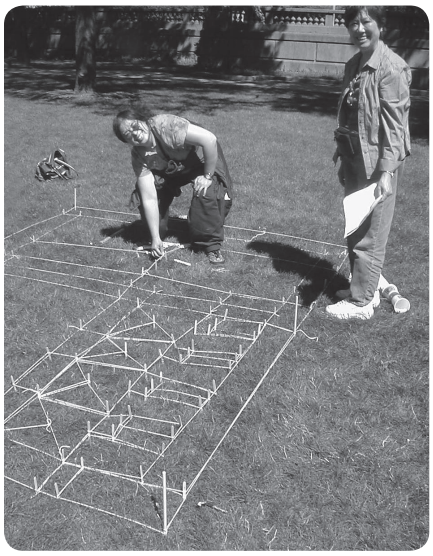
12 When the designs are finished, hang them in your classroom windows to let the sunlight shine through.

Extensions

- Rather than having each student make their own window design, combine your efforts for a group project. Measure your classroom windows, and make a scaled drawing of the frame. Have students design a Wright-inspired window pattern on paper. Then, using that design, cover an entire classroom window with cellophane or tissue paper and black paper dividers.

- Have students design a window that tessellates. Use one of Wright's early patterns from his Home and Studio in Oak Park, Illinois seen on **Handout C** as an example.

- Create very large versions of Wright-inspired windows with your class. Change the unit of measurement and let inches from their paper designs equal feet in these large versions. Using a measuring tape and rolls of masking tape on the gym floor (or small wooden stakes and brightly colored string on the playground), have students lay out their designs.



Illinois Learning Standards and Benchmarks

9A Demonstrate and apply geometric concepts involving points, lines, planes and space.

9.A.2a Build physical models of two- and three-dimensional shapes.

9.A.2b Identify and describe how geometric figures are use in practical settings.

9.A.2c Describe and draw representations of geometric relationships, patterns, symmetries, and designs, in two- and three dimensions with and without technology.

9B Identify, describe, classify and compare relationships using points, lines, planes and solids.

9.B.2 Compare geometric figures and determine their properties including parallel, perpendicular, similar, congruent and line symmetry.

25A Understand the sensory elements, organizational principals and expressive qualities of the arts.

25.A.2d Identify and describe the elements of 2- and 3- dimensional space, figure ground, value and form; the principles of rhythm, size, proportion and composition; and the expressive qualities of symbol and story.

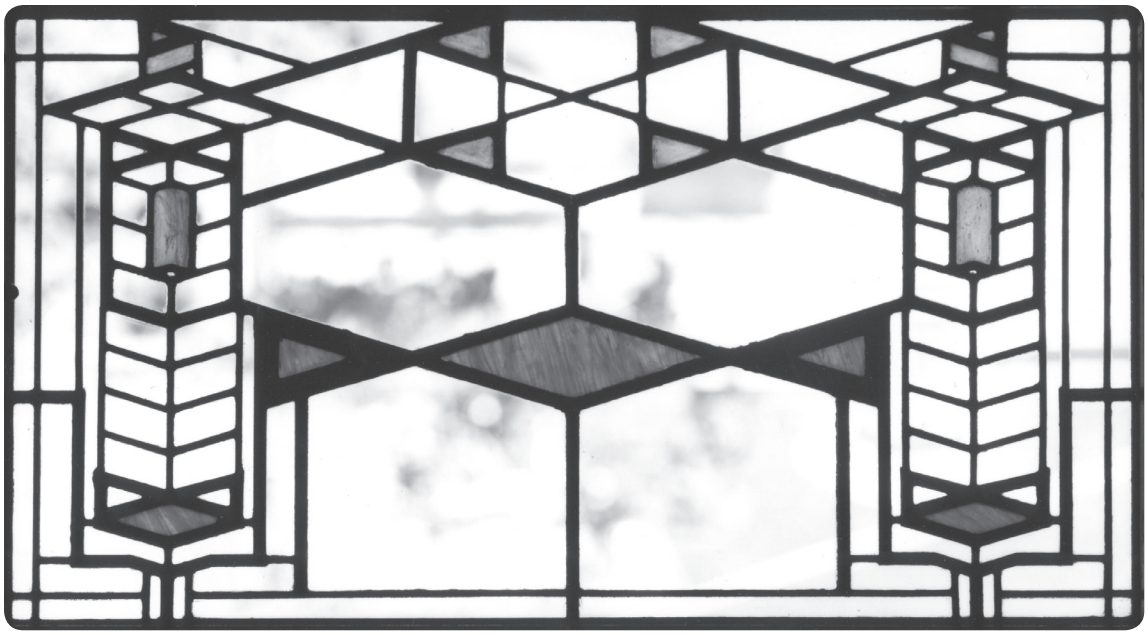
26A Understand processes, traditional tools, and modern technologies in the arts.

26.A.2e Describe the relationships among media, tools/technology and processes.

26B Apply skills and knowledge necessary to create and perform in one or more of the arts.

26.B.2d Demonstrate knowledge and skills to create works of visual art using problem solving, observing, designing, sketching and constructing.

Handout A



TOP Window in the Frederick C. Robie House, designed by Frank Lloyd Wright, Chicago, 1910. (© HEDRICH BLESSING, PHOTO BY CHRIS BARRETT. COURTESY FRANK LLOYD WRIGHT PRESERVATION TRUST. USED WITH PERMISSION.)

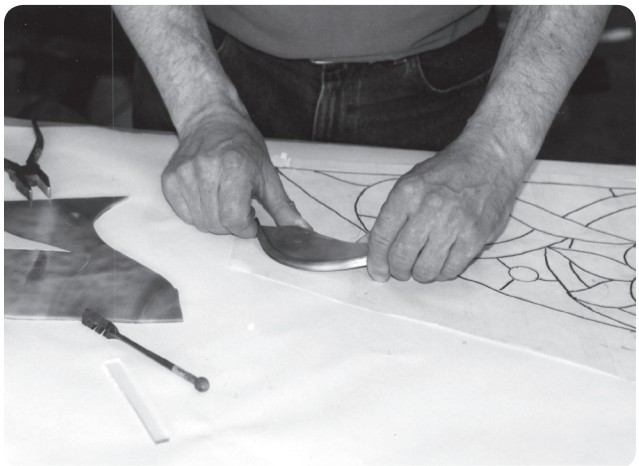
BOTTOM View of a church window at Unity Church, North Easton, Massachusetts. (CAF, 1999)

Handout B

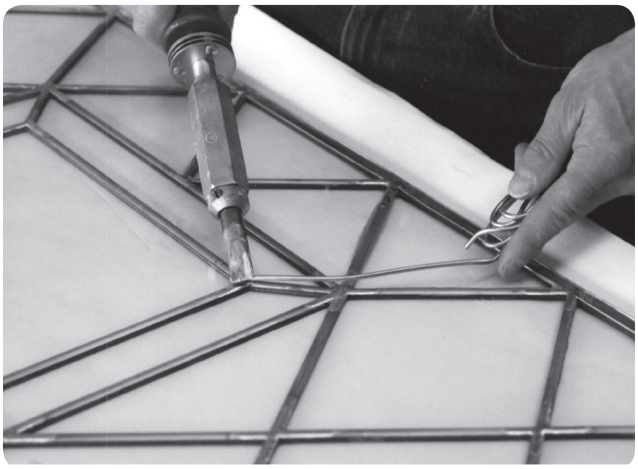
1. Measure and draw a full-size pattern on paper. This pattern is called a cartoon. Decide on colors for glass pieces.

2. Make another copy of the pattern and cut out individual pieces of paper.

3. Place a pattern piece on the glass, and cut around it with a glasscutter.



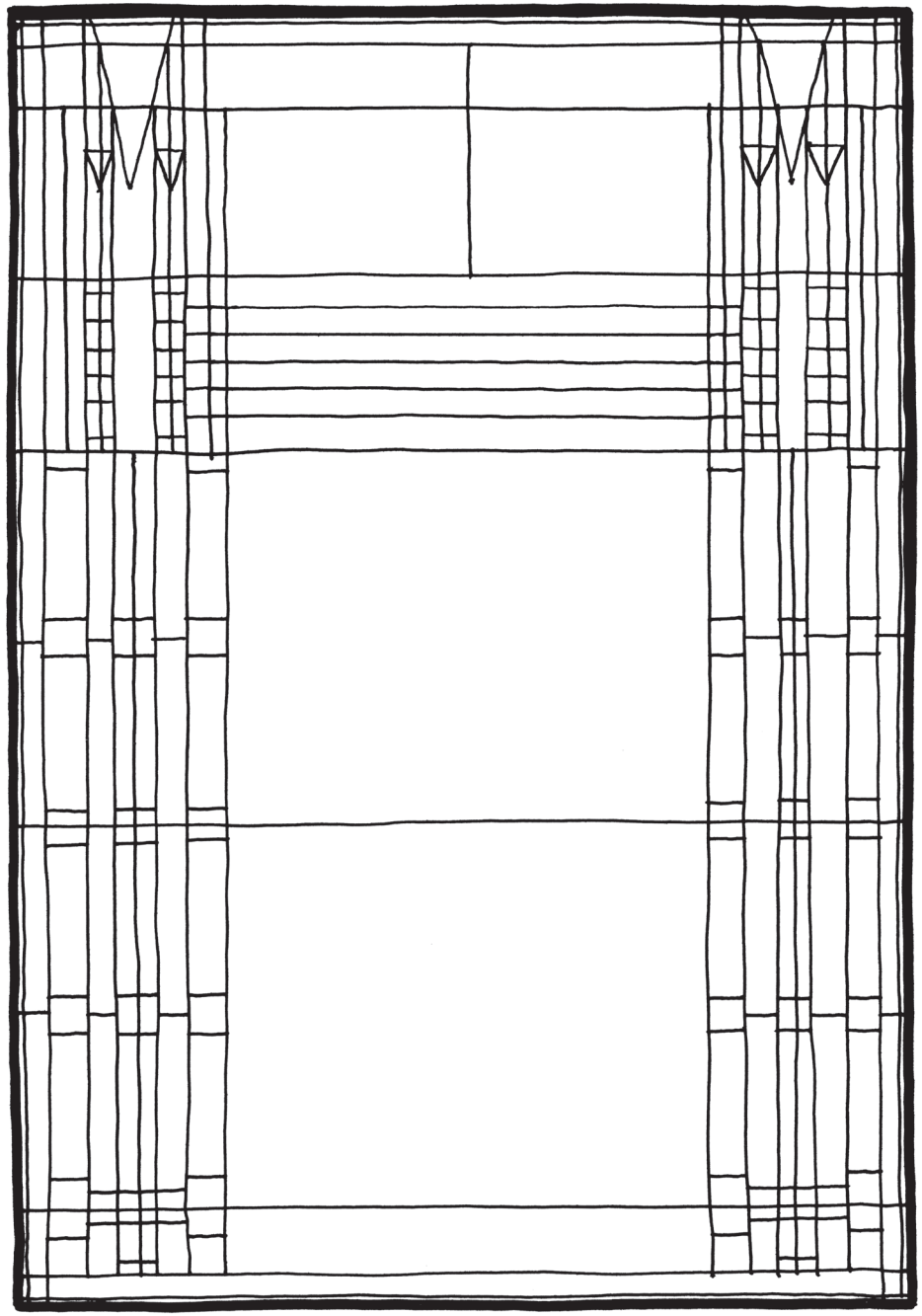
4. Join the finished cut pieces of glass with strips of came (usually lead, zinc, or copper).

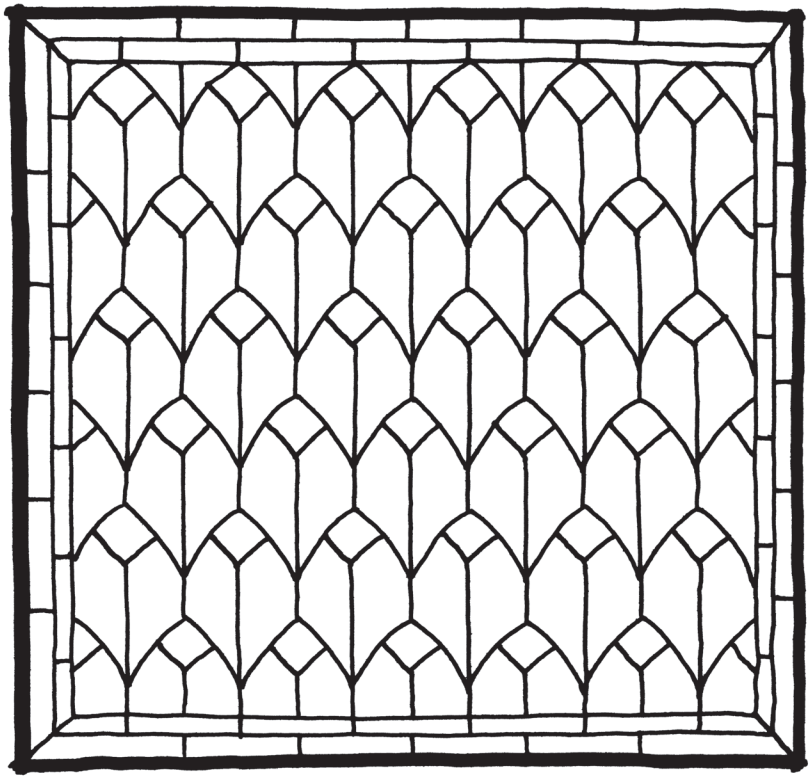


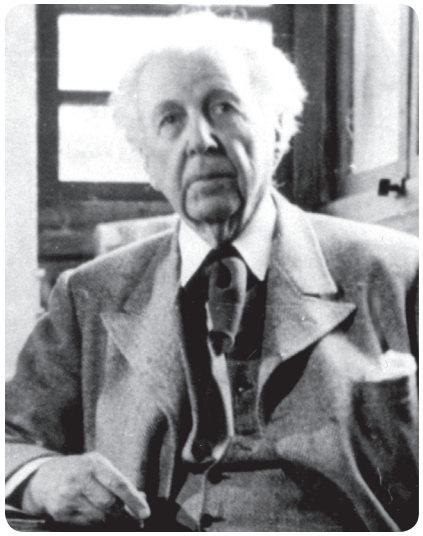
5. Install the joined glass pieces inside a frame by soldering *(pronounced SAH - der - ing)*. A soldering iron (shown in the photograph) is used to heat the metal and permanently join metal pieces together.

Bill Klopsch, a stained glass craftsman in Skokie, Illinois, showing the steps in creating a stained glass window. (CAF, 2002)

Handout C





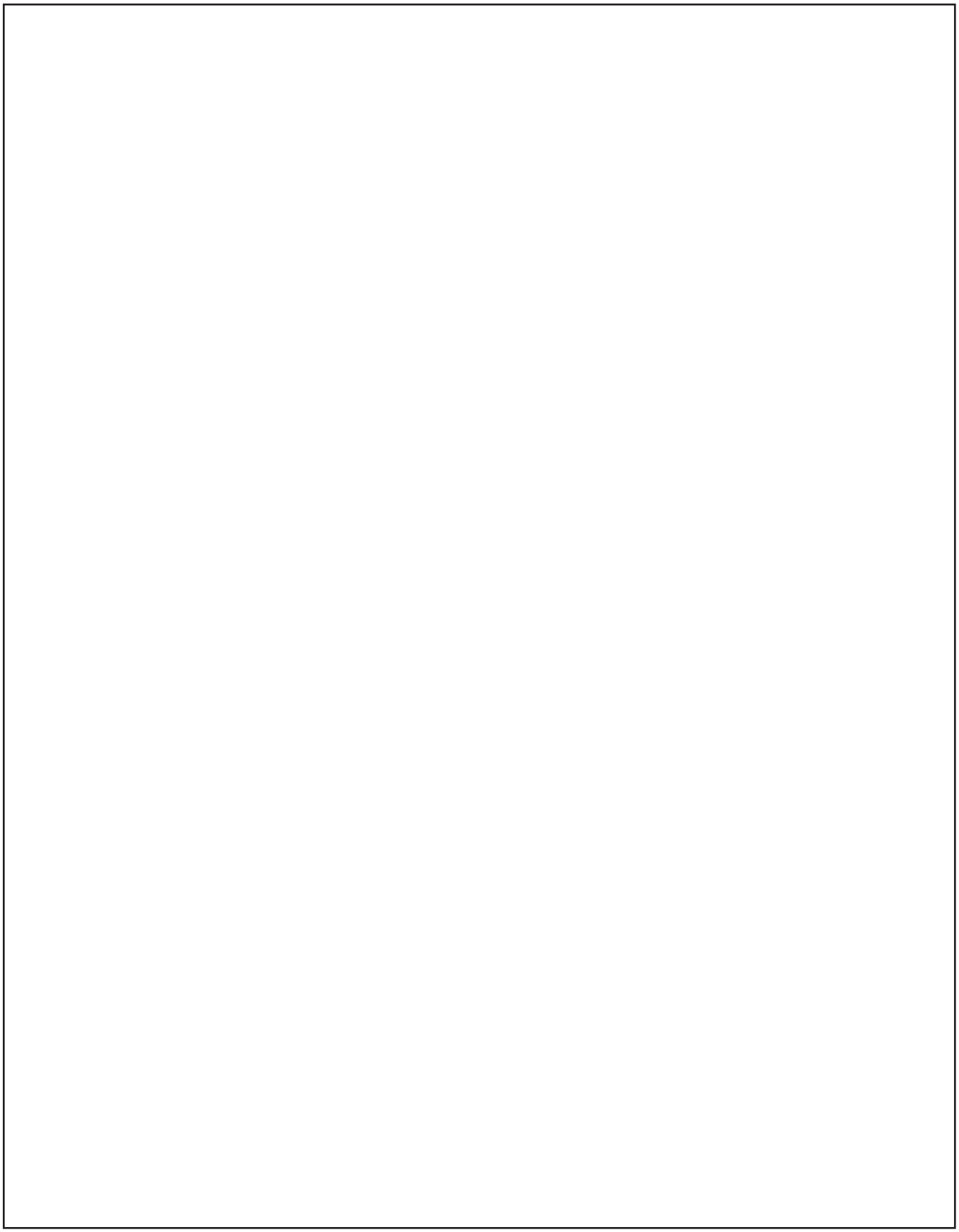


LEFT Drawing of a window in the Frank W. Thomas House, designed by Frank Lloyd Wright, Oak Park, Illinois. (CAF, 2002)

TOP RIGHT Drawing of dining room window in the Frank Lloyd Wright Home and Studio, designed by Frank Lloyd Wright, Oak Park, Illinois. (CAF, 2002)

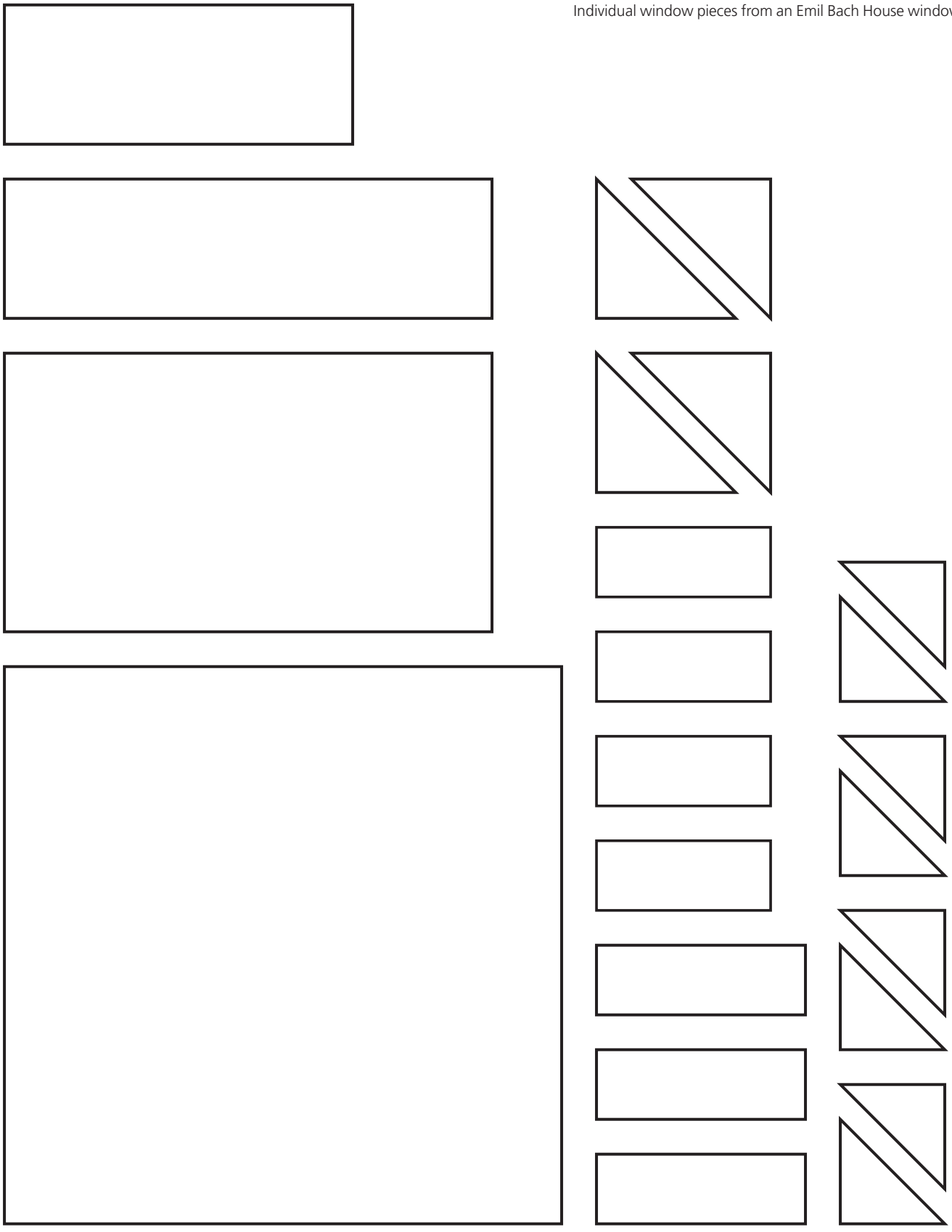
BOTTOM RIGHT Frank Lloyd Wright, circa 1930. (WRIGHTIANA COLLECTION, THE ART INSTITUTE OF CHICAGO. ALL RIGHTS RESERVED.)

Handout D

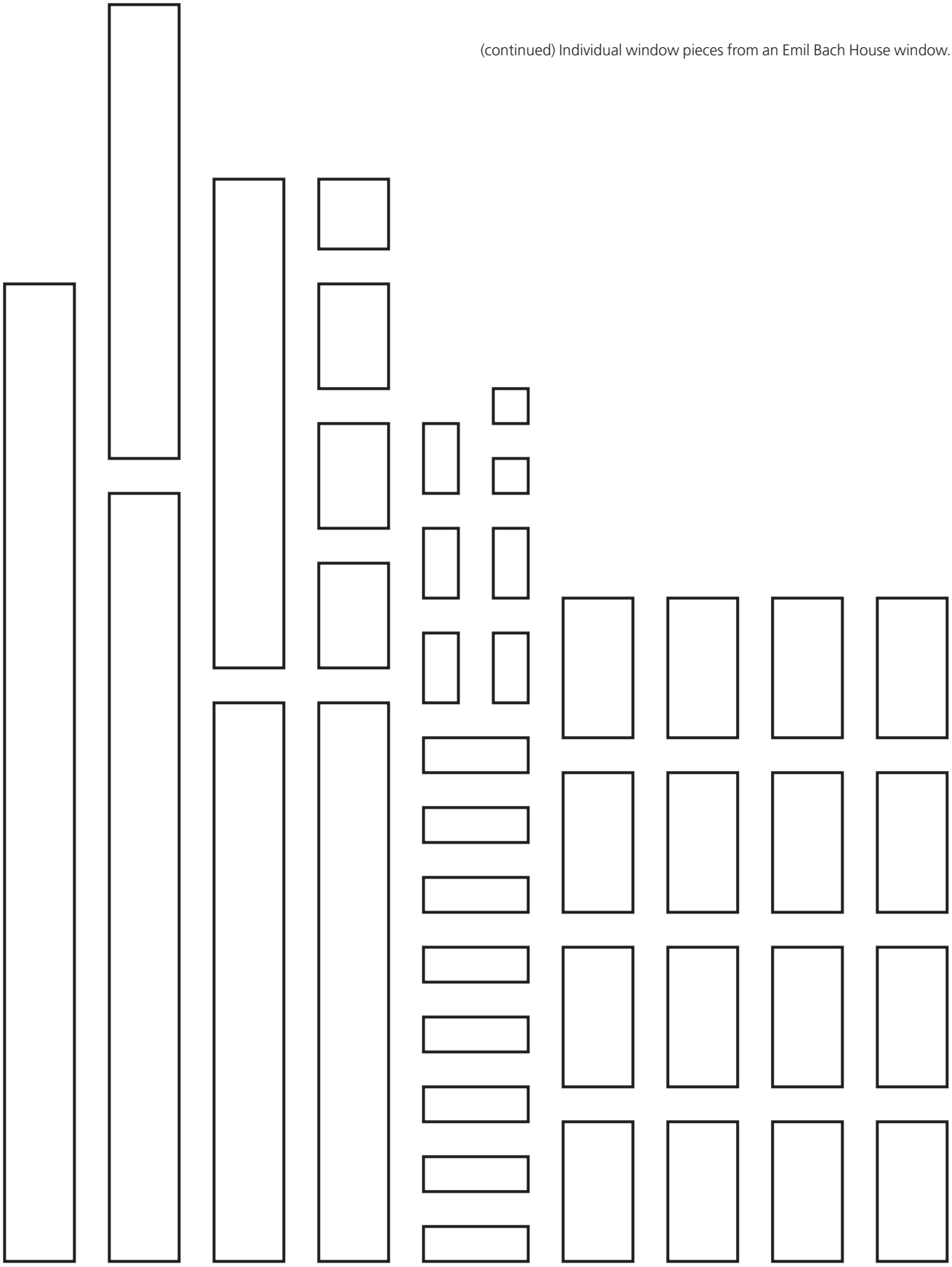


Frame outline from an Emil Bach House window.

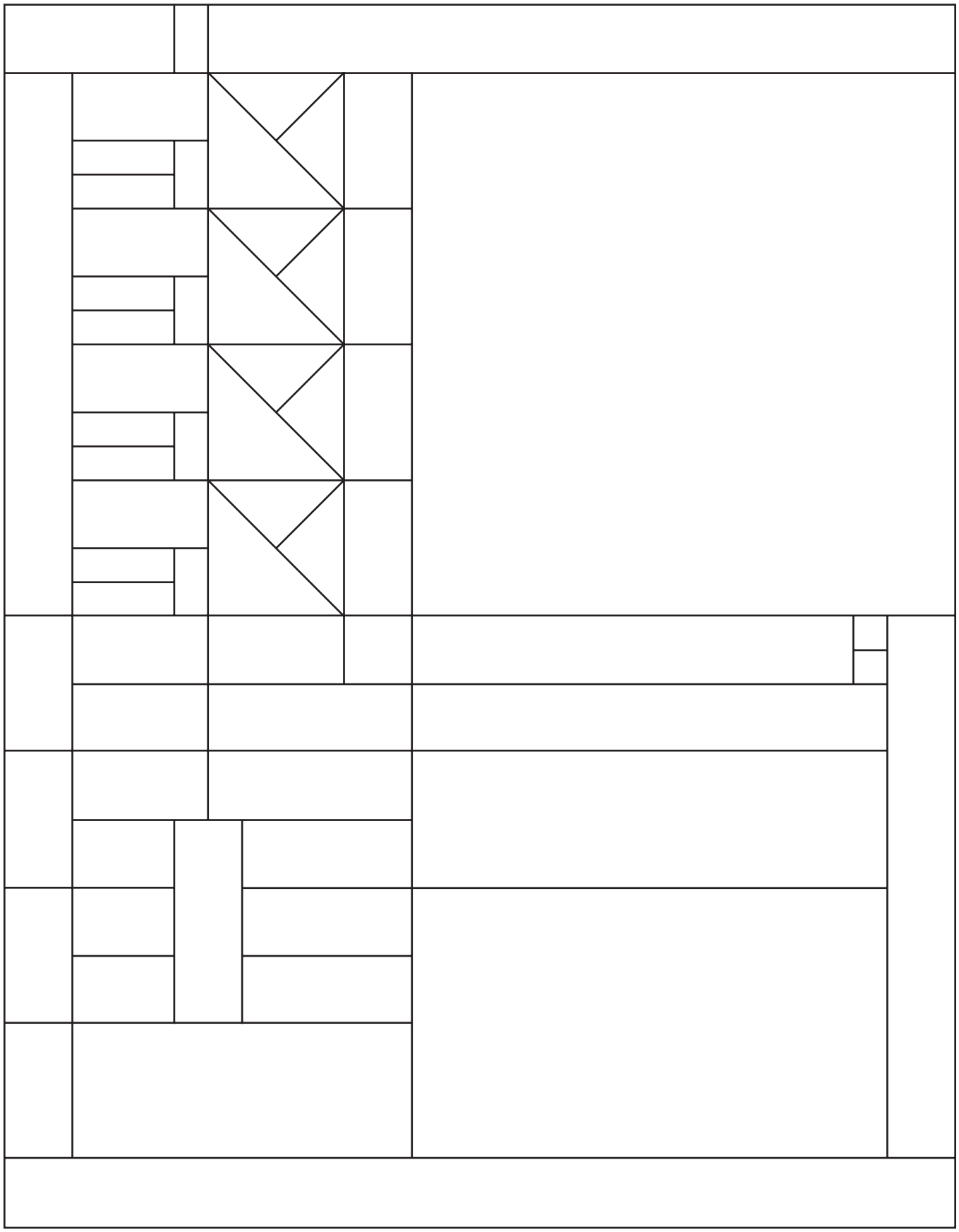
Individual window pieces from an Emil Bach House window.



(continued) Individual window pieces from an Emil Bach House window.



Handout F



Drawing adapted from a window in the Emil Bach House, designed by Frank Lloyd Wright, Chicago. (CAF, 2002)

Handout G