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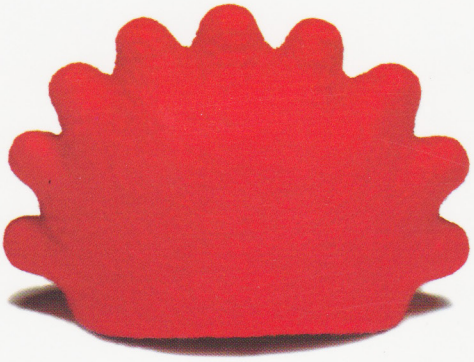
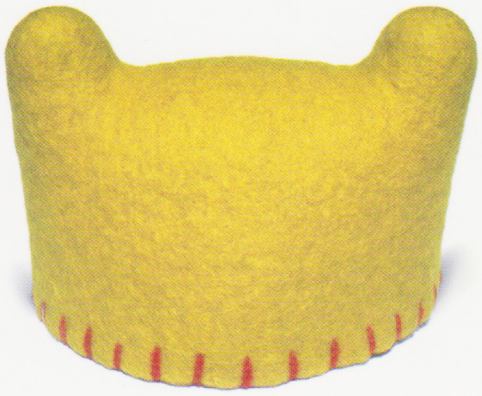
Innovation





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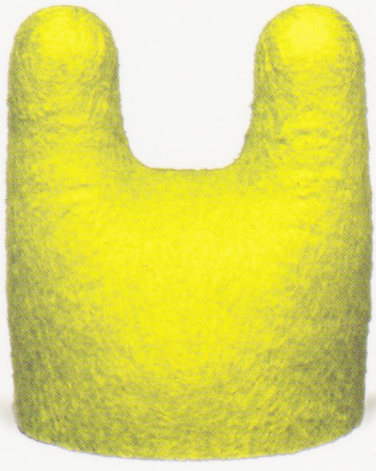

Contemplation

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Beneath Pattern:

Investigating Symmetry

Why would fifty people whose disciplines ranged from textile design to mathematics to archeology to cognitive psychology to art history to computer software design to fiber art to anthropology convene in a small conference room on the campus of the University of Wisconsin-Madison on a beautiful weekend in the spring? Pattern, pattern and more pattern—specifically, the study of the underlying structures of pattern, symmetries, and the application or interpretation of those structures. The occasion was a recent workshop entitled "Symmetries of Patterned Textiles" at the university's Friedrick Conference Center.

The coordinators of the workshop were Professors Dorothy Washburn, an anthropologist, and Donald Crowe, a mathematician, co-authors of the book, *Symmetries of Culture: Theory and Practice of Plane Pattern Analysis* (Washington University Press, 1988). This writer strongly encourages anyone who did not attend the workshop to read this book and discover a new system for understanding pattern.

The workshop was designed "to introduce academic researchers as well as practicing artisans to the...symmetries which generate the structure of patterns...[to] systematically describe and compare pattern...[as a way to arrive at] new perspectives on the ways this structural property [symmetry] interfaces with other sociocultural systems of material and conceptual culture. Although a small number attended, Washburn and Crowe were successful in drawing a group from diverse locations as well as professions. Participants hailed from as far away as Belgium, Canada, and England, as well as from every region of the United States.

A presentation by Crowe gave a heavy dose of technical classifications for plane pattern symmetries. The systems of analyzing pattern symmetries seemed logical and familiar (i.e., reflection, rotation, translation). However, the notations were like a new language (for example, p1m1, p4g/cmm), one in which many in the room were literate. After Crowe's lecture, even those among us for whom the codes were new began to gain facility with the simpler ones. The system of coding pattern, though complex, is useful for describing pattern on any surface from ceramic tiles to cloth. The ubiquity of pattern throughout the world and over the ages makes codification seem even more pertinent in the study of trends, cultural and historical preferences and comparisons, and mathematical applications.

Following the presentations on the systems used for codification of pattern symmetries, conversations centered around issues of notation itself. Many concurred that it would be worthwhile to arrange a conference on that subject. This digression included ideas about how one notates the innotable, the use of varied systems of notation for dance and music and the reinvention of notation. At the core of the discussion was the notion that all abstract thought including notation comes from physical action. Certainly the act of tying up a loom before weaving yields new ideas about pattern as does the act of block printing a cloth. Beneath the surface of the conversation was the underlying question: do theorists and practitioners come to know pattern differently? Theorists are involved with knowing, analyzing and understanding through observation, while practitioners are concerned with knowing, inventing and understanding through action.

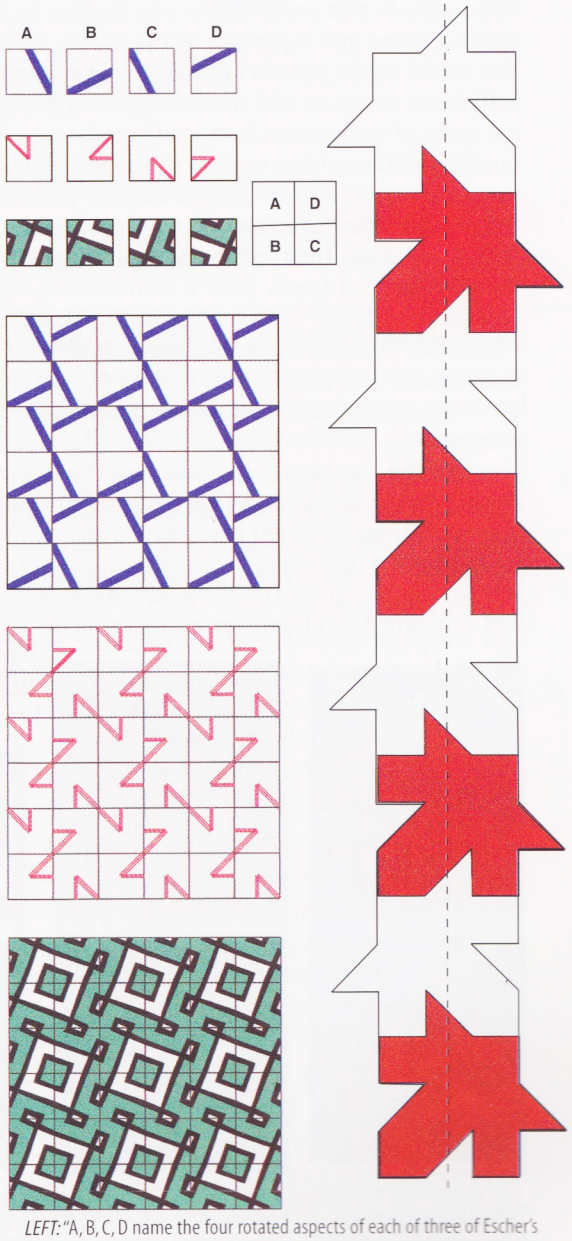
Among the more noteworthy presentations were those of Doris Schattschneider, Professor of Mathematics at Moravian College. Her discussions of "Color Symmetries" and "Combinatorial Patterns" highlighted the hands-on work of her students and the work of the artist, M. C. Escher. Schattschneider's clear, thoughtful lectures were

by Sonya Y.S.Clark

well illustrated with slides. Using simple visual aids such as overlaid color transparencies, she brought a new understanding to repeat design and the use of color compatible with symmetry in design. Schattschneider's presentations were well received in the midst of the discourse on understanding pattern either through observation or action. She led participants through Escher's own attempts at understanding the possibilities of pattern.

For example, Escher systematically determined how many patterns could be generated by a single motif, following the rules of a simple algorithm. Here are Escher's rules: Take a square and place inside it an asymmetric design or motif. then put together four copies of the decorated square to form a 2x2 square array. The four copies of the square in the 2x2 array can be in any aspect—that is, each can be any rotated or reflected copy of the original decorated square. Finally, take the 2x2 array and repeat it in the usual manner to fill the plane—that is, translate it over and over in the directions of the sides of the array. Three different decorated squares and the patterns they generate for one particular choice of 2x2 array are shown here. Answering the question, "How many different patterns are created with a single motif, following Escher's rules?" is a good problem for any student of surface design or mathematics to tackle. Escher showed that when no reflected copies of the decorated square are allowed, the answer to his question is 23.[1]

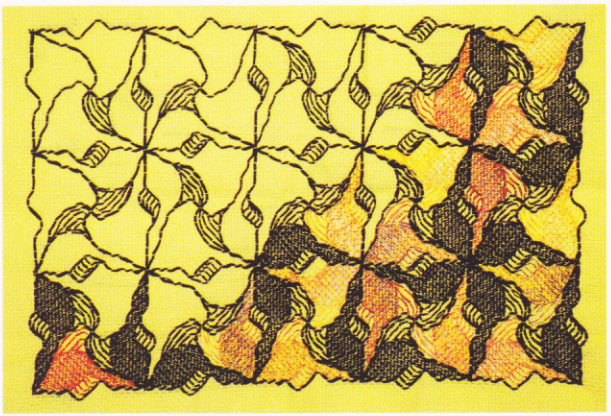
Schattschneider also discussed color symmetry, that is, how patterns with repeated motifs can be colored in a way that is compatible with their symmetry. The simplest such patterns are colored with two colors. For these patterns, a color symmetry is a motion that moves motifs onto other motifs in such a way that all colors are preserved or all colors are reversed. The patterns are often called counterchange patterns. Examples are shown in



LEFT: "A, B, C, D name the four rotated aspects of each of three of Escher's motifs. The 2x2 translation block makes the patterns shown."
—Doris Schattschneider, presenter.
RIGHT: "In a border design, each tile glides vertically and reflects in the dashed line to land on the next tile; this glide-reflection is color-reversing."
—Doris Schattschneider, presenter.

which the same tile (found in the Alhambra) repeats to make the design.

Other lectures included "Weaving Symmetries on the Loom" by Lynn Teague, Curator of Archeology at Arizona State University. Teague discussed the logic of the pattern maker, given certain tools exemplified by a loom. No doubt the vocabulary in this presentation was familiar to the textile makers and historians in the group. Teague also spoke about pattern symmetry in conjunction with fabric structure and showed weaving drafts of the types of symmetries discussed in earlier presentations. This brought an entirely different dimension to the conversation and created another version of the notation discussion among the non-weavers.



Bonnie Datta *Fishes* Cotton floss embroidery on cotton huckaback , 9" x 12'.
"This image, inspired by M.C. Escher's work, illustrates rotational four-fold symmetry. It can be seen as twining fish, blossoms, or a simple linear mosaic, depending on color fill and scale." —*Bonnie Datta, participant.*

Michael Hann of the School of Textiles at the University of Leeds gave a spirited and entertaining after-dinner presentation on H.J. Woods, an English textile physicist whose work in the 1930s was very influential. The intimate attendance allowed for some impromptu talks. For example, Bonnie Datta shared her experiences with pattern as it related to her card or tablet weaving explorations. Datta also mentioned the creation of software for tablet weaving designs and passed many of her pieces through the audience as tangible examples.

The workshop concluded with the use of computer software designed by presenter Kevin Lee for generating many of the types of patterns that we had learned to classify during the weekend. The program, "KaleidoMania!" provided many eager participants with the opportunity to turn theory into practice. Handouts for this portion of the workshop included excerpts from *KaleidoMania! Interactive Symmetry Activity Book,* also by Lee. On the worksheets from the activity book, the symmetry vocabulary was used with definitions and activities laid out simply and defined clearly enough for use in a secondary school setting. All in all, "Symmetries of Patterned Textiles," guided participants to realize the depth and breadth to be found in the study and creation of pattern. The plethora of related topics offered something for everyone.

1. More on Schattschneider's work on manipulation of motifs and Escher can be found online at the website for the electronic journal of combinatorics: www. ejc.org (Volume #2, 1997, #R17) or in her book *M.C. Escher: Visions of Symmetry.*

—Sonya Clark is Assistant Professor of Environment, Textiles, and Design at the University of Wisconsin-Madison.

LEFT: Detail of belt in a pattern derived from Haykaku Sisan pattern, woven by **Fidelia Callanaupa** of Chinchero, Cuzco, Peru, about 1976.
Middle: Detail of belt with Tanka Loraypo pattern, woven by Cipriana quispe, Chinchero, Cuzco, Peru about 1982.
"Contemporary Inca weavers use complex symmetrical formats as a guide but embellish their patterns beyond the rules of formal symmetry. The lattice concepts of Branko Grunbaum (a professor of mathematics at the University of Washington) provide more satisfing analysis of these symmetrical operations than more standard approaches."
—Ed Franquemont, participant.
RIGHT: "Navajo rugs, like all tapestries, illustrate the freedom of design possible when the human hand creates the pattern while relying on loom mechanisms only for basic structure, rather than for pattern creation. This rug also illustrates the tendency to create symmetry in patterns even when the constraint of a loom mechanism is absent."—Lynn Teague