Mathematics and the Arts: The Curriculum Foundations Workshop

By Hartmut Höft, Joanne Caniglia, John DeHoog, and Chris Hyndman

A Mathematics and the Arts workshop was held on November 1–4, 2007 as part of MAA's *Curriculum Foundations* Project. It was part of the Knotting Mathematics and Art Conference, hosted by The University of South Florida (USF), with additional sponsorship by Eastern Michigan University and a National Science Foundation grant awarded to USF. The workshop was an opportunity for conversations between mathematicians, artists, and art educators about the mathematical understanding needed by art students. Participants were asked four questions meant to generate foundational materials based heavily on the needs of art students, from which appropriate mathematics curricula can be constructed. The questions were: What are the common processes of exploration and problem solving? How can mathematicians address the needs of art students in mathematics classes? What is the expected level of mathematical understanding for art students? And finally, what are the points of intersection between art and mathematics? Each of the sections below records some of what we found out.

What Are the Common Processes of Exploration and Problem Solving?

Art educators and artists would prefer to deemphasize the linear nature of the content in some undergraduate mathematics courses required of art majors. They instead support mathematics courses that emphasize exploration in solving a problem or creating a design. Artists and mathematicians both agree that the problem solving/design process involves the collection of ideas through experiment and the development of skills. Both disciplines refine the problem solving/design process through tentative problem/design formulations. Artists cautioned against teaching this process using an algorithmic approach.

George Hart's creation, constructed and displayed during the workshop.

How Can Mathematicians Address the Needs of Art Students in Mathematics Classes?

Art educators talked about the importance of addressing students' fear of mathematics and their tendency to delay taking their mathematics course requirements. A fear of mathematics often makes art students see mathematics and art as separate entities, leading to this delay. For example, art students learn proportions and percentages in mathematics classes, yet do not seem able to use that knowledge when they are required to mix paints and create color combinations. Artists and art educators remarked that their best mathematics courses were the ones that encouraged experimentation and exploration — a playful approach to design.

What is the Expected Level of Mathematical Understanding for Art Students?

In terms of numerical skills, all participants agreed that proficiency in percentages, proportion, measurement, and unit conversions is essential. Necessary geometrical competencies include scaling, perspective, transformations, and symmetry. Artists stressed the importance of using essential art concepts (such as precision, accuracy, effects of scaling, spatial relationships, perspective, and visualization in two and three dimensions) in all mathematics courses, as a means of teaching appreciation and observation. Technology also plays an integral part in the development of an art student. Specifically, competency in the use of measurement tools (e.g., rulers, protrac-

tors, and computer programs such as *Geometers' Sketchpad*) is critical for subsequent art classes.

What Are the Points of Intersection Between Art and Mathematics?

Throughout the workshop, participants discussed points of intersection between art and mathematics in terms of content and process. Content-based interconnections include *patterns* — recognition of arrangements in nature; *transformations* — the realization of motion in space and time — and *symmetry* — the extraction of order in visually complex objects. Process-based interconnections include *constraints* — the comprehension of ratio, proportions, similarity, and transformation; and, *inspiration* — the process in solving problems and in design.

A conference such as Knotting Mathematics and Art generates excitement. Experiencing the interconnections between mathematics and art with artists, art educators, and mathematicians instilled a desire to renew the mathematics curriculum around the guiding principles of inspiration and creativity. Mathematicians should utilize inspiration as a central tool in the teaching of both art and mathematics and recognize the connections between creating art and solving mathematical problems. Alas, most mathematics courses required for non-mathematics majors currently center on business-science-technology-engineering problem sets, bypassing the aestheetic, the arts, and the humanities entirely.

Goals for renewing the mathematics curriculum were compatible between mathematicians and artists. All participants agreed on the importance of interdisciplinary courses, appropriate timing of mathematics courses in the art curriculum, hands-on activities that connect concepts with tools, and the fusion of creating art objects with numerical tools and physical topics. Artists and mathematicians agreed that basic mathematical tools and skills are a necessary foundation for art students, but an appreciation of the connection and interplay between mathematics and art also is critical. The works of artists shown at the workshop can illustrate the "mathematician within" the artist, just as the tools of mathematicians can provide inspiration and guidance to the student for artistic design. Renewal of mathematics courses in the spirit outlined during the workshop will help to make this interdependence between art and mathematics explicit in the curriculum.

Blosme 2, by Brent Collins. This geometrically coherent blossom ("blosme" is the Middle English spelling) is formed from helical paths and helicoidal surfaces. The result is a beautiful surface that looks as if it might have evolved naturally.

The final draft of the workshop report and other details about the workshop can be found at http://www.emich.edu/cas/maa.

Joanne Caniglia (Mathematics Education, Kent State University) and Hartmut Höft (Computer Science, Eastern Michigan University) co-chaired the workshop with Elaine Richards (Developmental Mathematics, Eastern Michigan University). John DeHoog and Chris Hyndman, both professors of art at Eastern Michigan University, were participants.