Mathematics and Arts
Finding the Horizon of Understanding for Arts Students

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Abstract

The purpose of our session is to report on conversations held with mathematicians and artists at the conference "Knotting Mathematics and Art: International Conference in Low Dimensional Topology and Mathematical Art", see [1], under the auspices of The Mathematical Association of America (MAA). The authors conducted interviews with six mathematicians and six artists attending the conference [2], and recorded a panel discussion [1] centered on questions posed by the MAA to describe what mathematical skills and dispositions are needed for the education of artists. The presentation synthesizes the common/consensus concerns expressed by all interviewees.

The authors report on the conversations that took place in formal interview sessions as well as in informal conversations and address the following topics and questions that emerged during the conversations and the panel discussion:

1. What processes of exploration and problem solving do artists and mathematicians have in common?
2. How can the needs of Arts students be addressed in the mathematics curriculum?
3. What mathematical knowledge and level of geometrical understanding is expected of Art students?
4. What is the role of mathematics and geometry, specifically, in the Art curriculum?
5. What are the points of intersection between artists and mathematicians?

1. Artists and mathematicians agreed that the creative process is in essence a problem-solving process, and the conversations revealed that artists and mathematicians alike follow a somewhat systematic approach. The artists that were interviewed generally follow the same pattern in developing their creative ideas, though they may be less conscious of the process they are following than mathematicians. Initially the designer/artist will tend to experiment in a rather random manner, collecting ideas and skills through reading or experimentation. Gradually a particular issue or question will become the focus leading to the formulation of a tentative problem. Exploration of that topic is refined eventually into a research question or design problem. In design or fine arts production, this takes the form of a succession of works created in a series. Mathematicians in contrast deconstruct models and hypotheses by elimination and counter-examples. Each effort solves certain problems, and suggests issues to be dealt with in the next work (or experiment). Artists described the serial progression as the most important aspect of the artistic design process.

2. In considering the most appropriate skill to teach mathematics to Art students, the artist and mathematicians were united—"the ability to think." Both disciplines must help students to construct their

own understanding and guide them towards experimentation. The participants commented on the similarity of methods of reasoning in art and mathematics; Pólya's principles of problem solving and discovery have their counterpart in the artistic process of invention and creation. Participants expressed a desire to initiate a dialog that teaches mathematics as a powerful language of the imagination with which to explore ideas like balance, space, time, patterns, and relationships that are central to artistic expression.

3. Mathematical concepts that Art educators want their students to understand include:
- Use proportions and ratios to solve problems involving scale
- Convert among measurement systems
- Solve non-routine problems and apply heuristics
- Recognize symmetry and tiling patterns
- Visualize extensions of patterns
- Understand the effects of transformations on objects
- Estimate mechanical properties of materials at different scales
- Understand perspective and spatial relations to produce accurate drawings
- Visualize representations of objects in two and three dimensions

Artists working in 2-D and 3-D design prioritized these concepts differently.

4. Many general education mathematics courses taken by Arts students draw their examples and applications exclusively from the areas of Business and Science-Technology-Engineering-Mathematics (STEM). Teaching concepts such as measurement, accuracy, precision, scaling and similarity with examples from the arts is essential for the Arts curriculum.

5. Artists and mathematicians want something beyond a mere listing of skills and even dispositions. They desire that art students acquire an appreciation of the connection and interplay between mathematics and art. Participants of the conference saw art and mathematics as intertwined: the works of art demonstrate the "mathematician within" the artist, and mathematics can provide the tools to inspire and guide artistic design [3].

In summary, we would like to quote from Brent Collins' artistic statement [4] his view of the interplay between mathematics and the arts that was echoed by many of the interviewees:
"Though I'm a nonmathematician, my work originates in intuitions which have consistently led to an art of visual mathematics. Such an art obviously has a special resonance for scientists and mathematicians, but being visual, it can be just as immediately engaging for general audiences."

References

[1] Conference Announcement, Program & Abstracts of *Knotting Mathematics and Art*
http://knotart.cas.usf.edu/
http://shell.cas.usf.edu/~saito/KnotArt/programKnotArt.pdf

[2] List of Interview Participants
Artists: Brent Collins, John DeHoog, Chris Hyndman, Charles Perry, Karl Shaefer, John Simms
Mathematicians: Thomas Banchoff, John Conway, George Hart, Sasho Kalajdzievski, Elaine Richards, Carlo Sequin

[3] Representative List of References on Mathematics and Art by AMS
http://www.ams.org/featurecolumn/archive/art7.html

[4] Brent Collins' Artistic Statement
http://www.sckans.edu/~bridges/bcollins/bcollins.html