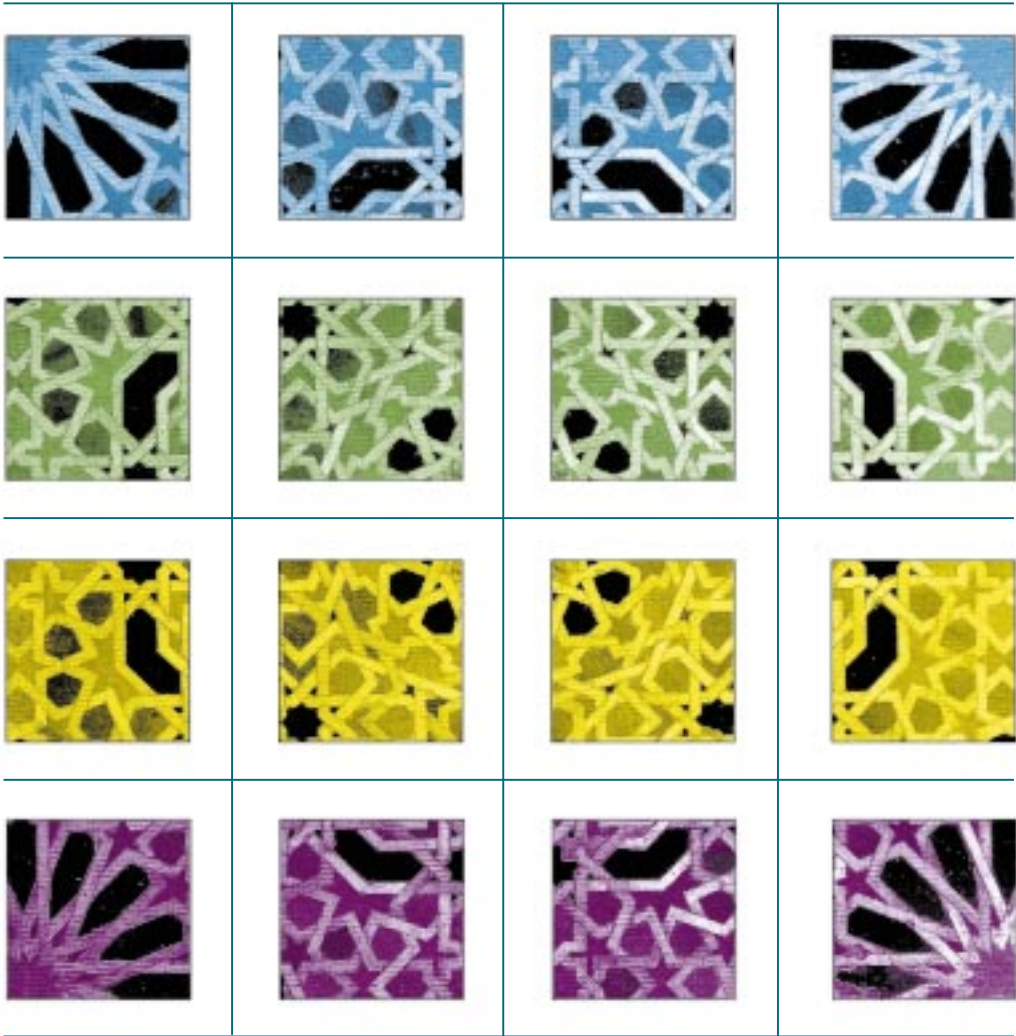
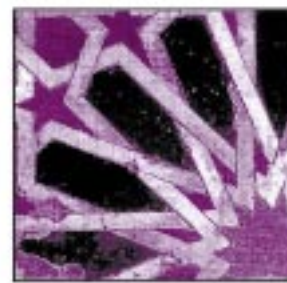
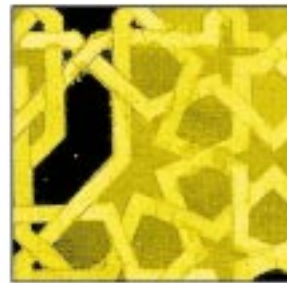


M A T H E M A T I C A L



C O N N E C T I O N S

The Quadratic Equation. Fermat's Last Theorem. The Riemann Hypothesis. Throughout the ages mathematicians have struggled to solve some of the world's most difficult puzzles. And now Professor Raymond Tennant is taking on what may be the greatest challenge found in all of mathematics—to spark interest in the discipline among mainstream university students.



“There is a powerful spirit which runs through mathematics, part of the human spirit. It is this dimension which I try to open up to my students.” Raymond Tennant waxes eloquently on his passion for mathematics. “Unfortunately, it has become synonymous in the minds of most people with a long list of formulae and equations that must be memorized by rote. I try to bring people back to the heart of mathematics—logical, and sometimes creative problem solving.”



Figure 1. Raymond Tennant in front of Alhambra Tilings.

Tennant’s love for mathematics was sparked early on in life, and an interest in the beauty of symmetrical geometry helped to shape his career choices. After spending time “traveling and exploring” following his graduation from high school, he worked as a professional potter for six years. “I was especially interested in the geometry and symmetry found in pottery.” After earning a college degree, Tennant decided to follow his passion: he went to graduate school, got a doctorate, and became a mathematics professor.

A Humanistic Approach

Tennant is a strong advocate of the “humanistic” approach to mathematics education, which he defines as “a philosophy of teaching and learning which attempts to

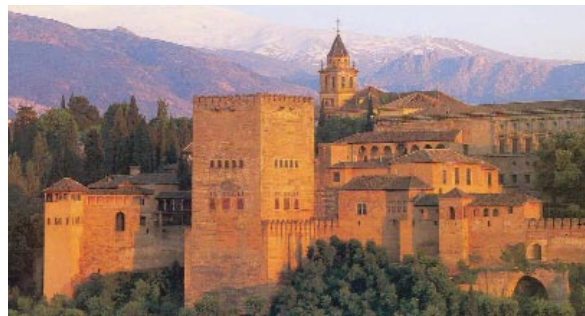


Figure 2. The Alhambra Palace, Granada, Spain.

explore the human side of mathematical thought and to guide students to discover this beauty of mathematics.”

Throughout most of the world, according to Tennant, mathematics is taught as a “monotonous set of rules used to solve tedious exercises which seem to have no useful purpose.” If, however, formulae and equations are used as tools to solve problems, then the discipline is extremely helpful in strengthening the logical, problem-solving facilities of the mind. These strengthened cognitive skills are what enable normal people “to apply the concepts of mathematics outside specific equations within a classroom setting.”



Figure 3. Nasir al-Din al-Tusi’s Proof of the Pythagorean Theorem

New Skills for a New Era

Over the past several decades there has been a general shift toward an image- and technology-based culture throughout the world, and education is no exception to this trend. In Tennant's opinion, previous generations were probably better at mental calculation than the current one, but the current generation is highly skilled with computers and more "visually literate" than their parents.



Figure 4. Radial Symmetry in the Alhambra Tilings.

One way to make mathematics education more vibrant and relevant today is to shift toward a more visual approach. Tennant explains that applications such as the Geometer's Sketchpad are excellent tools for teaching geometry and other forms of mathematics visually. In the early years of mathematical exploration, text was the main tool of explaining relationships (see Al-Tusi's proof of the Pythagorean Theorem in Figure 3). Over time, text shifted to abstract symbols, and now there is another shift, this time toward visual representation.

The Cultural Connection

From the ninth through the fifteenth century A.D., Islamic mathematicians and astronomers were at the forefront of the scientific world, making important contributions to modern theories that are used today. In his classes,

Tennant mines the rich Arab-Islamic heritage for historical connections that resonate with his students. The linking of mathematical concepts and ideas with specific historical figures or places from the student's cultural heritage can help to spark excitement and create a sense of personal ownership.

"In my own experience of teaching and lecturing in various countries, when cultural connections are made with the audience, the mathematics becomes enlivened and more stimulating," says Tennant.

"Whether speaking to students in Chennai about the Indian mathematician Srinivasa Ramanujan or to students [at Zayed University] about the Islamic mathematician and astronomer Nasir al-Din al-Tusi, students get energized and become more involved if the connection is made to their own culture much as one is excited by one's own genealogy."



Figure 5. Periodic Tiling from the Alhambra.

Islamic Tilings and the Alhambra Palace

According to Tennant and other proponents of the humanistic approach, exposing students to historical and cultural connections helps to highlight the global relevance and applicability of mathematical concepts. Likewise, students are more likely to be energized by solving real historical problems than by rote memorization of equations and formulae.

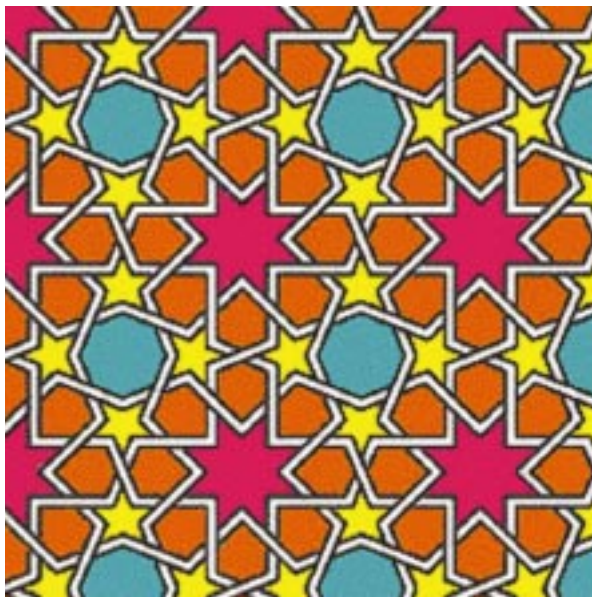


Figure 6. Tiling Constructed with Geometer's Sketchpad.

In Tennant's opinion, the highly symmetrical Islamic art and architecture found in mosques and other ornamental constructions throughout the world provide useful examples of geometric constructions for classroom use. In his classes at Zayed University, Tennant challenges students to discover what geometry was needed by Islamic artisans to create the symmetrical tilings of the Alhambra Palace in Granada, Spain. Built by the Moors beginning in the thirteenth century A.D., the Alhambra is possibly the best-known example of Islamic architecture in the West.

While attending a conference on mathematical symmetry there in 2003, Tennant toured the Alhambra Palace and was struck by the precise geometrical calcula-

tion that went into its design. "The tile patterns found in the Alhambra are governed by rules of geometric repetition, symmetry and continuity."

According to Tennant, the mathematical concepts used in designing the tilings "are useful in illustrating concepts ranging from geometry and abstract algebra to general education." For instance, specific tilings exemplify the four types of symmetry: translation, rotation, reflection and glide reflection. Radial patterns in the tilings literally illustrate the concept of finite symmetry groups (see Figure 4), and periodic patterns represent infinite symmetry groups (see Figure 5).

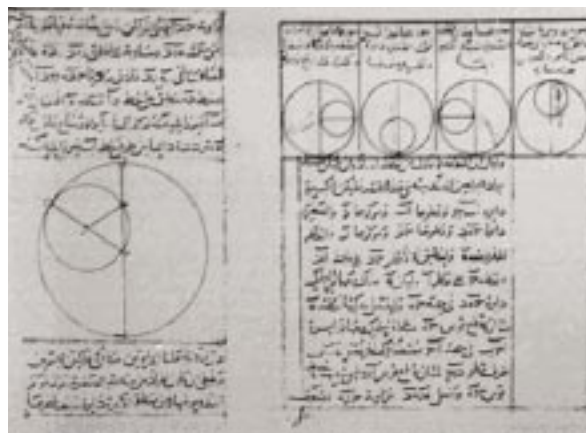


Figure 7. Nasir al-Din al-Tusi's Manuscript on Planetary Motion.

Using the symmetrical tilings from the Alhambra Palace to demonstrate mathematical concepts links the visual with the abstract, while inspiring student learning by drawing from their cultural heritage. In Tennant's words, "Understanding the mathematics behind the symmetry and construction of these Islamic patterns is the key to then using these intricate patterns as motivational tools in the classroom. It is this interdisciplinary bridge between mathematics and art that allows students to view mathematics as a part of a bigger picture, which includes aesthetics, culture, and history." □

