Milligan College

MC ESCHER: ARTIST OR MATHEMATICIAN?

A PAPER SUBMITTED TO

Professor Marvin Glover

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF

Math Requirement

Principles of Mathematics

BY WENDY STUTZMAN SIMMONS

JOHNSON CITY, TENNESSEE

December 6, 1999

Where does the field of mathematics end and confines of art begin? Are they two different entities? The Dutch artist Maurits C. Escher creatively combined two material forms that appear unrelated. Escher's style, intricate with geometric design, appeal to both the artist and the mathematician. The student of art finds satisfaction in through Escher's use of color, spacing, and commitment to expressing reality in a creative fashion. For the student of mathematics, Escher's work encompasses two broad areas of their field: the geometry of space, and the logic of space.[1]

Born in Leeuwarden, Holland, in 1898, Escher was the son of a civil engineer. His father instilled in him a lifelong interest in mathematics and science.[2] Escher spent most of his childhood in Arnhem Hollard, aspiring to be an architect. [3] The artist attended the School for Architecture and Decorative Arts from 1919 to 1922 where his emphasis shifted from architecture to drawing and printmaking upon the encouragement of his teacher Samuel Jessurun de Mesquita. [4] In 1924, Escher married Jetta Umiker, and the couple settled in Rome to raise a family. They resided in Italy until 1935, when growing political turmoil forced them to move first to Switzerland, then to Belgium. In 1941, with World War II under way and German troops occupying Brussels, Escher returned to Holland and settled in Baarn, where he lived and worked until shortly before his death. Escher considered himself a drafter, book illustrator, tapestry

[1] National Gallery of the Arts Website http://www.nga.gov/collection/gallery/ggescher/ggeschermain1.html

[2] ibid

[3] ibid

[4] ibid

designer, and muralist, but his primary work was always as printmaker.[5] The lithograph is the medium in which he explored his most mathematical works of art.

The main subjects of Escher's early art depict Rome and the Italian countryside. While living in Italy from 1922 to 1935, he spent the spring and summer months traveling throughout the country to make drawings. Later, in his studio in Rome, Escher developed these ideas into prints. Whether depicting the winding roads of the Italian countryside, the dense architecture of small hillside towns, or details of massive buildings in Rome, Escher often created unique spatial effects by combining various vantage points from which an individual may view his prints. He frequently made such effects more dramatic through his treatment of light, using vivid contrasts of black and white.[6]

After Escher left Italy in 1935, his interest shifted from landscapes to something he described as "mental imagery." [7]A visit in 1936 to the fourteenth-century palace of the Alhambra in Granada, Spain became very influential in Escher's imagination. He was inspired by the lavish tile work contained in the ornate flooring. These geometric patterns inspired new directions in the use of color and the flattened patterning of interlocking forms that became Escher's trademark.[8] In the late 1930's, Escher developed "the regular division of the plane" by replacing the abstract patterns of the Spanish tiles with recognizable figures.[9] The artist also used this concept in creating his renowned Metamorphosis prints. After 1935, Escher increasingly explored complex architectural mazes involving perspective and the representation of impossible

[5] Hofstatder 23

[6] NGA Website

[7] Hofstadter 23

[8] Math Academy Website http://www.mathacademy.com/platonicrealms/minitext/escher.html#intro

[9] Hofstadter 23

spaces. In any perspective drawing, vanishing points are chosen which represent for the human eye the point(s) at infinity. By introducing unusual vanishing points and forcing elements of a composition to obey them, Escher was able to create scenes in which the "up/down" and "left/right" orientations of its elements shift, depending on how the viewer's eye takes it in. "In his perspective study for 'High and Low,' the artist has placed five vanishing points: top left and right, bottom left and right, and center.


Figure 1: High and Low

The result is that in the bottom half of the composition the viewer is looking up, but in the top half he or she is looking down. To emphasize what he has accomplished, Escher has made the top and bottom halves depictions of the same composition."[10]

Escher's fascinating work went almost unnoticed until his 1956 exhibition was reviewed in Time magazine. He acquired a worldwide reputation. Among his greatest admirers were mathematicians, who recognized that the artist's work possessed an extraordinary utilization of mathematical principles and ideas. His admirers were amazed that this Dutch artist "had no formal mathematics training beyond secondary school. "[11] As his work developed, he drew

[10] Math Academy website

[11] Ibid

great inspiration from the mathematical ideas he read about, often working directly from structures in plane and projective geometry. [12] Among the most important of Escher's works from a mathematical point of view are those dealing with the nature of space itself. This woodcut "Three Intersecting Planes" is a great example.


Figure 2: Three Intersecting Planes

This piece exemplifies the artist's concern "with the dimensionality of space, and with the mind's ability to discern three-dimensionality in a two-dimensional representation."[13] Another inspired drawing comes from a book by the mathematician H.S.M Coxeter. From Coxeter's ideas, Escher created beautiful representations of "hyperbolic space"[14] as in this woodcut.


Figure 3: Circle Limit 3

In addition to this type of artistic geometry, Escher was also interested in visual aspects of topology, a branch of mathematics just coming into the mainstream of the subject area during his

[12] Math Academy Website

[13] Ibid

[14] Hofstadter 25.

lifetime.[15] According to Escher, topology concerns itself with "those properties of a space which are unchanged by distortions that may stretch or bend it – but which do not tear or puncture it."[16] The Möbius strip is a well-known example of this mathematical figure. Escher made many representations of this material depiction of infinity.

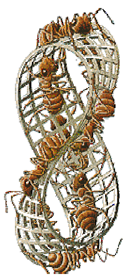
Figure 4: Mobius Strip II

Douglas R. Hofstadter in his 1980 Pulitzer Prize winning book, "Gödel, Escher, Bach: An Eternal Golden Braid" deals with both of these areas of mathematics, the nature and the logic of space in a theory that is utilized by both Escher and J.S. Bach. Hofstadter states that Kurt Gödel formulated the principle of infinity in mathematical terms. Gödel's Theorem appears as Proposition VI in his 1931 paper "On Formally Undecidable Propositions in *Principia Mathematica* and Related Systems I. It states:

> To every *w*-consistent recursive sign *k* of *formulae* there correspond recursive *class-signs r*, such that neither *v* Gen *r* nor Neg (vGen*r)* belongs to Flg *(K) (*where *v is* the free variable of *r.)* [17]

This postulate is coined by Hofstadter as the "Theory of Endless Loop" and paraphrased by the author, "All consistent axiomatic formulations of number theory include undecidable

[15] Math Academy Website

[16] Hofstadter 25

[17] Hofstadter 25

propositions."[18] Hofstadter informs his reader that many of the works of Bach and Escher rely on this paradoxical theory that captures an anomaly of the human mind. These artists seem to have recognized that the human brain insists upon using visual clues to construct a three-dimensional object from a two-dimensional representation. This central concept of self-reference, which Hofstadter claims, "lurks near the heart of the enigma of consciousness and the human ability to process information in a way that no computer has yet mimicked successfully in research in the fields of information science and artificial intelligence."[19] This aspect of his work has been largely overlooked in previous studies, but the case for its importance to these fields was forcefully made in the lithograph "Drawing Hands" and the woodcut "Fish and Scales." Each of these pieces captures the idea of self-reference in a different way.


Figure 5: Fish and Scales

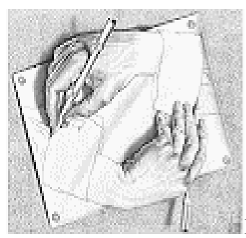
Figure 6: Drawing Hands

In "Fish and Scales," the points of self-reference work together in a recognizable pattern of self-resemblance. "In this way, the woodcut describes not only fish but all organisms, for although we are not built, at least physically, from small copies of ourselves, in an information-theoretic sense we are built in just such a way, for every cell of our bodies carries the complete information describing the entire creature, in the form of DNA."[20]

[18] Hofstadter 17

[19] Ibid

[20] Math Academy

In “Drawing Hands,” the self-reference is direct and conceptual; the hands draw themselves much the way that consciousness considers and constructs itself, mysteriously, with both self and self-reference inseparable and coequal.[21] Dr. Sidney Smith rightly claims that this aspect of Escher’s work has a more personal significance. He states, “On a deeper level, self-reference is found in the way our worlds of perception reflect and intersect one another. We are each like a character in a book who is reading his or her own story, or like a picture of a mirror reflecting its own landscape.”[22]

Another broad area of mathematics that intrigued Escher is the “logic” of space. According to Escher, this logic contains “those spatial relations among physical objects which are necessary, and which when violated result in visual paradoxes.” [23] These works are known in 20th Century vernacular as optical illusions. Escher’s understanding of the geometry of space determines its logic, as paradoxically, the logic of space often determines its geometry.[24] One of the features of Escher’s logic of space is the play of light and shadow on concave and convex objects. In the lithograph “Cube with Ribbons,” the bumps on the bands are our visual clue to how they are intertwined with the cube.

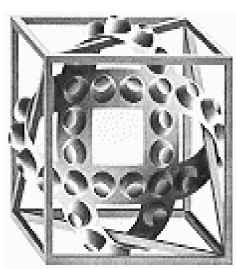
Figure 7: Cube With Ribbons

[21] Math Academy Website

[22] Ibid

[23] Hofstadter 17

[24] Math Academy website

Upon his death in 1972, Escher left to us a remarkable body of work. The vast legacy of M.C. Escher is open for mathematicians and artists alike to consider and explore the intersections between the world of imagination, of mathematics and the infinite reality of our physical surroundings.

Works Cited

Hofstadter, Richard. *Godel, Escher, Bach: An Eternal Golden Braid.*

Math Academy Website
http://www.mathacademy.com/platonicrealms/minitext/escher.html#intro

National Gallery of the Arts Website
http://www.nga.gov/collection/gallery/ggescher/ggeschermain1.html