BRIDGES
Mathematical Connections
in Art, Music, and Science

An Iconography of Reason and Roses

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Abstract

The author uses mathematical elements from old textbooks and engineering manuals in her artwork. This paper is a semiotic analysis of the mathematical imagery used. Semiotics, or the study of signs, is central to the concerns of twentieth century art. While most bridges between mathematics and art start by using mathematical principles to determine or augment an image, the author argues that her work uses artistic principles to augment the perception of the mathematics. Both approaches represent legitimate bridges between the disciplines, even if the former is more familiar than the latter. Many of the beautiful images and objects generated by the application of mathematics to art-work are visually compelling, but are conceptually removed from the critical dialogue associated with fine art. The author, who is an artist, believes that while the work does not break new ground mathematically, it does connect the disciplines of mathematics and art by providing an original examination of the semiotics of both disciplines.

1. Equation as Image

Mathematics is motivated by the intellect but also reflects an innately human and emotional desire for order and comprehension. The beauty of mathematics is that it offers elegant abstract constructs while providing a respite from fears and desires. Mathematics is exempt from the imperfections of biology; we are not. The author's artwork explores this theme, using pages from old mathematical textbooks and engineering manuals as raw material. The mathematical image becomes symbolic of constancy and analytical modes of thinking. Biological elements, such as leaves, roses, or bones, are then drawn or collaged into the work. These elements are chosen for their familiar connotations and symbolism. The work contrasts the analytical with the emotional and the technical with the organic, using images iconographically.

Mathematical imagery is seen through a veil of cultural assumptions that mathematics is unemotional and pure, and that its texts are stylistically neutral. The author wishes to question these assumptions, both by using mathematical imagery in her artwork, and by the semiotic analysis of the artwork presented in this paper. Hierarchical cultural values accord respect to both mathematics and fine art: the former must be logically rigorous; the latter is subject to constantly shifting interpretations. Shared, is a huge similarity in process. Both the research mathematician and the artist proceed by intuition, often aesthetically motivated, and both share a sense of discovery and achievement if and when the desired outcome is attained. Success in either endeavor feels suprapersonal and enduring.

By examining the nature and image of mathematical representation from a semiotic, rather than mathematical, viewpoint, this paper will address how art can augment the perception of mathematics. Traditionally, the interface between mathematics and art has been the mathematically augmented or determined image. Often these images are compellingly beautiful, but conceptually removed from the dialogue surrounding fine art. These images can be considered as an artistic subset of mathematics, and tend to be overlooked by museums, collectors and critics. Similarly, the work presented in this paper remains a mathematical subset of art. But a semiotic examination of mathematical imagery does break new ground in the

vast grey area separating the two disciplines

In the author's work a visual vocabulary emerges as motifs develop across a variety of media, including sculpture, drawing, painting, and handmade books. Roses are feminine and beautiful, laden with sentimental associations. Leaves recall changing seasons and, by extension, the cycles of life. Bones are a reminder of death. These images serve as foils for the orderly technical information presented in the tables and equations, which also have their emotional subtext, the desire for clarity and order.

By drawing on top of the mathematical elements these motifs are placed in the unfamiliar interpretive and subjective context of art. For the mathematician, elements such as the age of the paper, the typography, and recollections of classrooms and libraries, place the mathematical element in a context that allows for interpretive analysis. Any viewer can associate the imagery with lessons fondly or sadly remembered. The connotations are emphasized over the literal content presented.

The following sections will examine a series of pieces and discuss how the work develops a visual lexicon.

2. Probability and Bones

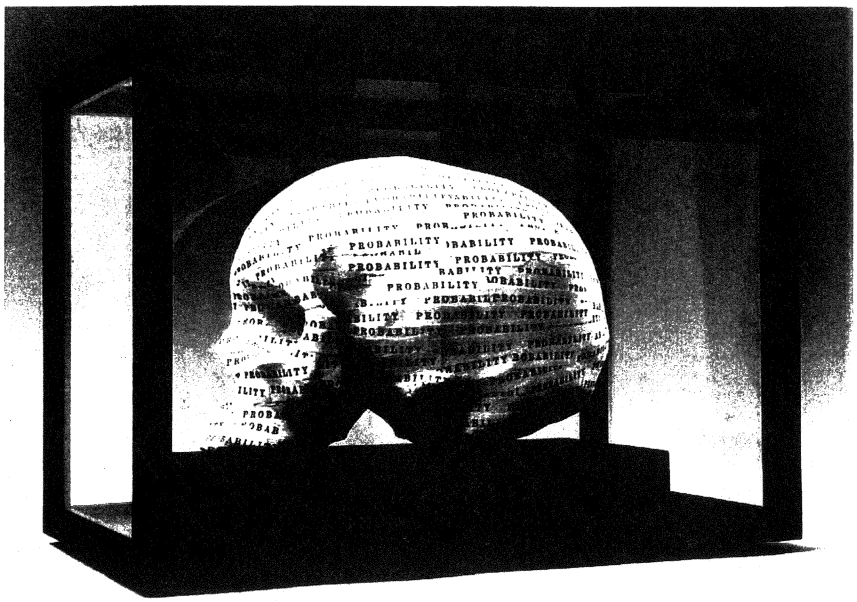

Figure 1. *"Probability", collage on skull, in a wood and glass vitrine. 1999.*

Probability is a sculpture made from a human skull, in this case a discarded nineteenth century medical specimen. It is collaged with two elements: the word "PROBABILITY" and equations from a text on probability [1]. The sculpture serves as a *memento mori*, a reminder of death. The selection of equations from probability has to do with actuarial practices, in which astonishingly accurate calculations of life expectancies of certain groups are made.

The piece began with a bisected skull. The interior was collaged with equations from a text on probability, while the exterior is entirely covered with the word "PROBABILITY" taken from the running heading of the same book. The exterior of the skull serves as a cover, with its recurring title, while the interior, which housed a human brain during life, is where the complex calculations have been placed. The skull is in a mahogany and glass vitrine to underscore its former role as specimen. The presentation of the sculptural object as a scientific specimen lends the object a more pedagogical role; it is meant to be learned from, rather than appreciated purely for its aesthetic qualities.

The use of human remains in art is problematic. In Western art there is a precedent in reliquary vessels which glorify a fragment of a deceased saint's body. These devotional containers honor people whose lives were revered and remembered. In the case of *Probability*, the skull is sadly anonymous and serves as a reminder of an unknown past life. These remains were not initially granted the respect that we would wish our own to be accorded. As a *memento mori*, the skull's anonymity reminds us that this poor soul is not only dead, but also forgotten.

3. Natural Functions

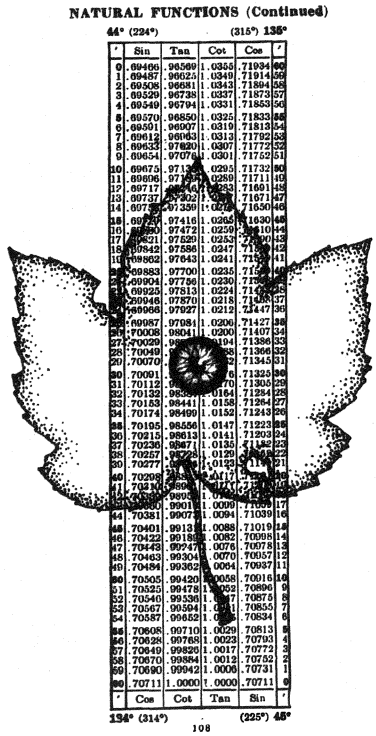

Figure 2. *"Natural Functions", collage, ink and watercolor on paper. 1998.*

The drawing, *Natural Functions*, is a collage on a table of natural functions taken from a chemist's handbook and laid down onto heavy paper. An inked and stippled outline of a decaying leaf covers the table.

The painted image of an eye looks out from the center of the leaf. The table is numerically useful, but the term "natural functions" could also apply to biological processes. The drawing supports both readings. The leaf is dying and the eye is symbolic of sight and consciousness. These elements animate the static image of the numerical table and invite a dual interpretation of the title.

This drawing is one example of an extensive series of leaf drawings over mathematical substrates over a period of four years. Rotted leaves, in life, are objects of supreme inconsequence. They are shoved into large bags and discarded. Mathematical tables, on the other hand, are implicitly confident and respected. They are predictable and correct. Unlike artistic imagery they leave little room for interpretation and opinion. By juxtaposing the delicate image of a decaying leaf with a table of natural functions, the artist quietly underscores the transient and insecure nature of life.

The leaf drawings, like the sculpture, *Probability*, are also *memento mori*. *Natural Functions* was drawn on a page taken from an old book, but many of the leaf drawings use relief prints of magic squares [2] and random numbers. The relief prints were designed by the artist and printed with a letterpress in order to do multiple drawings on a similar theme. The relief prints serve as a visual and conceptual background for the drawings. All of the leaf drawings have a symmetrical and centered composition, promoting a symbolic interpretation. The leaf does not occur in pictorial space, but instead appears as a sign centered over a field of numbers or equations. The leaf does not negate the equations, but rather brings them into a different context, where they too function visually and symbolically.

4. Reason and Roses

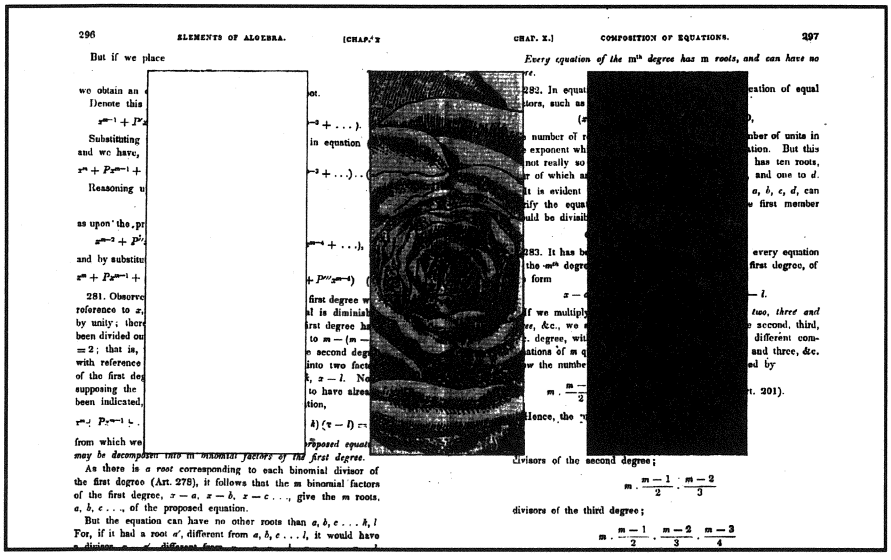

Figure 3. *"Reason and Roses", detail view, acrylic and collage on canvas. 1999.*

Reason and Roses is a painting in which the central image is a two-page spread from a nineteenth century algebra book, placed centrally on a background of large ornate roses. There are vertical rectangles on each page of the algebra lesson, one black and one white. Centered between them is a rectangle of red containing a rose identical to those on the background. The central red rose is the conceptual and visual

focus of the work, framed by the geometric elements and the algebra lesson.

Reason and Roses is part of an ongoing exploration of cultural assumptions about femininity and masculinity. The locus of beauty is ambiguous; it could be in the rose, the geometry, or the mathematics. The rose has the central position, but the canvas is dominated by straightforward, symmetric geometry. Heavy black and red squares are superimposed on the decorative and feminine background of roses. This superposition is then negated by the reappearance of the rose as the central image. A tension and balance exist between the feminine and roseate imagery and the geometrical and mathematical imagery, but there are parallels as well.

Intuition and a desire for comprehension and beauty can motivate a mathematician or an artist. A mathematical proof which is entirely correct but boring is second rate, just as portrait can be an excellent likeness but artistically dull. Mathematicians and artists often use a similar vocabulary of a search led by intuition to describe their working process. Often the outcome is described in terms of discovery, meaning that the outcome was not known beforehand but seemed to exist a priori. Both often have only a sense of the outcome, rather than knowledge of it, and follow their intuition to their goals, which they recognize only when they get there. "There" is were things "feel" resolved and complete. The mathematical discovery has to withstand the rigid demands of the discipline, while the artistic discovery is subject to constant reinterpretation and debate. Both disciplines are driven by human emotions and desires, which appear explicitly in the art, and implicitly in the mathematics.

5. The Rose Album

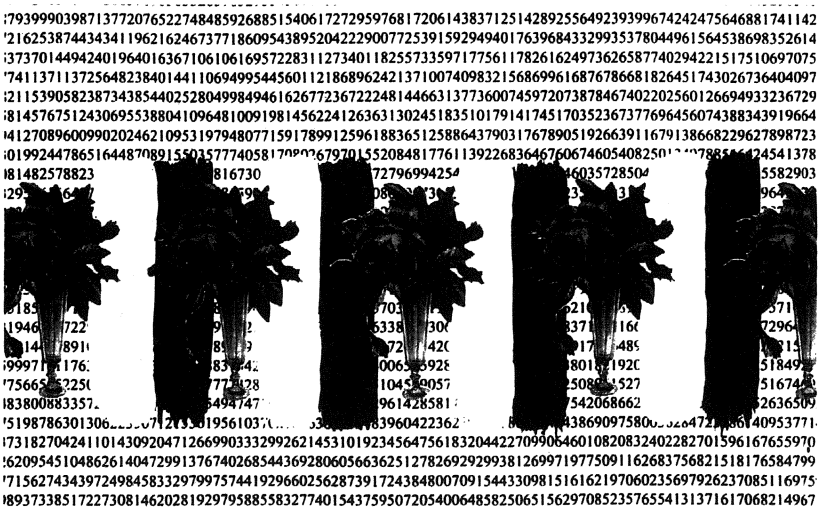

Figure 4. *Page 127 from "Rose Album", printed text, collage and ink on paper. 1999.*

Rose Album is a handmade artist's book in which 186 drawings of roses are superimposed on a printout of the largest known prime number at that time [3]. The number was typeset and bound into an album. The length of the book was determined by the size of the number. The artist then drew into the album over the course of six months. The drawings combine images of roses taken from popular sources (such as wrapping paper) with elements from hard-edged geometric abstraction. On every page the running "text" of

the prime appears as the background.

The text of the prime number is paginated like a conventional book, and presented with half and full title pages and a colophon. Is it possible to "read" such a large number? The prime number is so large that it is unintelligible. It presents information that only a supercomputer could comprehend.

The ardent effort required to generate this number is staggering. Determining a larger prime has been a classic mathematical problem for centuries. The man-years cumulatively expended seeking larger primes are evidence of a collective passion. Numbers of so many digits have few practical applications. They are unwieldy to work with and incomprehensibly large. It is "math for math's sake" and like the millionth digit of π so removed from the give and take of daily life that the number takes on almost a devotional aspect.

There are parallels in the practice of art for art's sake, which can be similarly obsessive and removed from daily life. The author chose to use visual elements from the painterly tradition of hard-edged geometric abstraction because of the hegemonic vocabulary once associated with them. Words like "pure", "timeless", "basic", "universal" were attributed to works that were free of deceptive pictorial representation. The aesthetic was reductivist, but the accompanying vocabulary was self-impressed and grandiose.

In *Rose Album*, both the mathematics and the geometric abstractions are somewhat subverted by the abundance of roses that appear. The arrangement is not meant to negate the other elements, but rather to allow for a more intricate reading of what is beautiful and what is respected. Mathematics and geometry are highbrow phenomena; roses are colorful, sensual and feminine. These lovely flowers share attributes with things that are culturally enjoyed, but intellectually marginalized.

Neither the rose nor the large prime can be explained in purely rational terms. It is obvious that no equation can define the rose's form or sweet smell. It is less obvious that the large prime exists because of an enduring collective passion that defies practical reason. Acknowledging certain applications in encryption technology and testing supercomputers, the search for a larger prime can still only be explained in terms of desire. Although the search for a larger prime occurs within the practice of mathematics, which is viewed as supremely logical, it is motivated by the desire to participate in the beauty of the infinite, the desire to achieve, and the excitement of participating in an endless process of discovery.

6. Mekanic

Mekanic is a book made from the pages of another book. Brittle, brown pages were taken from an engineer's handbook, *Des Igenieurs Taschenbuch* [4], backed with a stronger paper, and sewn into a new binding. Lines from a Shakespearean sonnet were glued into the text, along with roseate imagery taken from the paintings of Pierre Joseph Redoute [5]. The sonnet is about the transient nature of beauty; its metaphor is a rose [6]. *Mekanic* has a dual text paralleled by dual imagery. The original text and images relate to analytic geometry and appear in German. The added text and imagery relates to roses. The duality first appears the cover: the title block reads "Mekanic", but the image is a large engraving of a rose.

Roses, like a love, can be the objects of obsessive desire. Mathematicians can be obsessed with mathematics, in the way that artists can be obsessed with art.

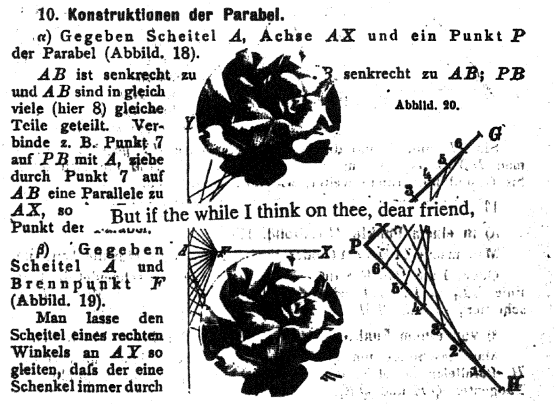

Figure 5. *"Mekanic", artist book, detail view of page 33. 1999.*

7. The Other Beauty of Mathematics

Within the community of mathematicians and scientists, there is an awareness of the conceptual beauty of mathematics. Books have been written on the art of mathematics [7]. There is another, less considered beauty within the practice of mathematics: the look of the mathematical document. Textbooks and technical publications tend to be conservatively designed, for clarity rather than style. Jan Tschichold asserts that the typographer's responsibility is "to divest themselves of all ambition for self-expression" [8]. In Tschichold's view, the most beautiful typography serves the text and does not call attention to itself. The traditional, suprapersonal aura of mathematical texts are part of their visual appeal.

Arabic numbers are highly designed symbols and, like the letters of the alphabet, their form has evolved over time. Arabic numbers have a refined beauty, particularly when they appear in classic fonts. Mathematical notation is rich in symbols, including many handsome ones taken from the Greeks. The signifiers, meaning the numbers and symbols, have their own beauty, apart from the beauty of what they signify.

Another aspect of mathematical texts is that they appear intimidating and mysterious to the uninitiated. Although there may be little comprehension, the texts "look" smart. It is somehow understood that the unfamiliar notations do not represent nonsense. Viewers with mathematical training are going to feel a familiarity with the material. For those without training, the allusion to the practice of mathematics will still be understood. In the author's artwork, the mathematical elements are used as imagery; the numbers and equations do not prove or solve anything, but instead refer to the logically rigorous practices of mathematics and science.

8. Dualities and Dichotomies

The same thematic dualities and dichotomies keep appearing throughout the artist's work. The analytic is seen with the emotional, the technical with the biological, the masculine with the feminine, and the permanent with the transient. The equations symbolize permanence, order, and clarity. The biological elements, such as the leaves, flowers, bones, and eyes, stand for the transience of life and the complexity of emotions. An iconographic reading of the images is further supported by the symmetry of the composi-

tions, which are generally flat arrangements of signs rather than pictorial spaces. The pieces have an intentional, deliberate, quality. Even the colors are selected semantically, pink for femininity and black and white for austere rationality. Although elements of geometric abstraction recur in the work, the images retain their roles as images and support a symbolic reading.

Using images and colors for their iconographic qualities is not an unusual part of developing an artistic sensibility. Using mathematical imagery as symbolic of analytical modes of thinking is less typical. In the case of the author's work, the ambition is to draw the aesthetic of reason into the dialogue of her art and to underscore the beauty and passion implicit in the practice of mathematics.

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[3] Spence, Woltman & GIMPS, $2^{2976221}$-1, downloaded in August, 1998 from http://www.utm.edu/research/primes/largest.html, a website maintained by the University of Tennessee at Martin.
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