REVIEW OF "MATHEMATICS IN 20TH CENTURY LITERATURE & ART," BY ROBERT TUBBS

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This unique book, a successful blend of cherry-picked art history and light mathematical content and history, would serve well as required reading for anyone in the math-art community interested in seriously engaging the historical context of contemporary math-art work. By looking back to the times when it was really *new* to paint the fourth dimension, sculpt a pseudosphere, or construct a poem structured by a Möbius strip or the Fibonacci numbers or permutations, it offers wisdom for how to move forward.

A superficial perception of this books structure finds two halves, roughly divided by the words "art" and "literature" in the title. Chapters 1–3, with a chronological flavor, interweave the visual art and sculpture of the surrealists, and abstract artists like Malevich and Rauschenberg, with the developments of non-Euclidean geometry, the formalism of Hilbert, and Bourbaki's structuralism. On the other hand, most of Chapters 4–10 seem organized thematically around mathematics – non-orientable surfaces, infinities, the fourth dimension, graph theory, group theory, etc – that has been represented in, or used to structure or inspire, literature.

This superficial perception is in fact completely incorrect, and Tubbs is fascinating and successful as he intertwines the visual and written genres. But it remains true that the earlier chapters show more emphasis on visual art and reveal more historical continuity, and later chapters fragment and cluster around mathematical themes, emphasizing literature. Perhaps this is how it should be. No one can be blamed for the explosion of artistic genres and mathematical subfields of the last half-century, blurring awareness of any historical thread.

One theme of the book is the extent to which major artists and artistic movements were aware of trends in mathematics. The first chapter, on surrealism, Man Ray, and non-Euclidean geometry, makes the case that "some artists and writers who began their work with conceptions far removed from mathematics turned to mathematical ideas to help them realize their artistic ambitions." The second chapter discusses Malevich's use of squares in his suprematist works, and how their stark simplicity both engenders and emerges from an abstract, axiomatic interpretation. In his own writings about his *Black Square*, Malevich declares, "The square = feeling, the white field = the void beyond the feeling" (although, according to the art scholar Troels Andersen, Malevich later "vacillates" in his definitions). Later Tubbs analyzes abstract, structural works like Rauschenberg's *White Paintings* and

John Cage's *4'33"*, in light of the shift in mathematics towards structure, exemplified by Bourbaki and abstract algebra. In many instances, Tubbs provides quotations of the artists themselves referring to mathematical ideas. These chapters are my favorite, as they display connected trends in art and math history.

When the book shifts to cluster around mathematical themes, it does so in a way that is easy to follow and enjoyable to digest. We read about detailed examples of art or literature (for example, sonnets introduce sestinas, and an example from Elizabeth Bishop). Then we find out about the mathematics involved (in this example permutations, and groups generally). Iterating, we read that "The contemporary poet Paul Braffort exploited an interesting property of the Fibonacci numbers to provide a structure for his collection of poems *My Hypertropes*," read one of the poems, and learn about Zeckendorf's Theorem (Every positive integer can be represented as a sum of non-consecutive Fibonacci numbers in one and only one way). The most interesting part of these chapters, for me, was reading (or reading about) the copious examples of poems, novels, essays, and short stories, inspired by or structured by mathematics. The recurring mathematical explanations – of permutations, Möbius bands, Cantor's proof that the rationals are countable, etc – seem articulate and easy to follow, although as a non-novice I am not qualified to judge.

While the book is good at what it does, it perhaps overstates what that is. Far from comprehensive, it is clear that selections were made in deciding which pieces to include. By its own pre-text count the book considers 74 works. Nearly half were created in the three decades 1910–1940, and another third in the '50s and '60s. Eighteen are paintings; 9 are three-dimensional objects or music; 35 are books, poems, novels or other literature; and 12 are essays about art, often written by the artists themselves. Tubbs explicitly reveals his own bias in the Preface, where he admits to discussing "only artists and writers whose ideas or works are intellectually interesting... I have not discussed computer-generated art or literature, nihilistic appeals to chance, or abstract expressionistic splashes of paint that may or may not reveal some sort of fractal patterns... I have looked only at hands-on applications of mathematical ideas or the incorporation of mathematical images." Such a peculiar characterization of the works that are discussed! Surely the number of intellectually interesting works of art that apply or incorporate mathematics, since 1980, is greater than five (the most recent work considered is from 2011).

Reading between the lines, we see a conventional narrow-mindedness about what aspects of mathematical content and practice are worth communicating. As for content, Tubbs in the Preface makes it clear he is trying to use and explain mathematical ideas that a non-mathematician can grasp, but "this book is also written for mathematicians with an interest in art or literature or in just seeing how simple mathematical ideas were used in the creative arts in the twentieth century." Who will write, some day, about the non-simple mathematical ideas? After chapters about Fibonacci numbers, the Möbius strip, Cantor's infinities, basic graph theory, and the like, couldn't we have at least one chapter of exciting mathematics? Any artist worth the name has a curiosity for the unknown, and an appreciation for the difficult mysteries of the world; these artists do not deserve to be spoken down to.

More worrisome and self-defeating is Tubbs' remark that, "All of the examples in this book may seem a bit naive from our hypertexted, superconnected twenty-first-century perspective, but they reveal genuine attempts to bring mathematical ideas to the most human of all endeavors – the creative arts." While the statement seems false – I found several works discussed to be genius, insightful, and to point to the naiveté of our current twenty-first-century perspective – it is also condescending. The act of "bringing mathematical ideas to art" is only one of many ways to manifest an inspirational interaction between mathematics and art, and I doubt it is the preferred method. It seems that something more wise and nuanced is happening when, for example, Man Ray writes to André Breton, "Let me assure you, I have always been in accord with you on the necessity of perverting the legitimate legends of the mathematical objects, if we are to consider these as a valid source of inspiration."

Finally, I take issue with Tubbs' narrow and conventional representation of mathematical practice. The mathematics that appears in the book is very literal: presentations of either basic mathematical content or common philosophical trends like formalism or Bourbaki structuralism. The book is mainly about "mathematical ideas influencing artists" and how artists "turned to mathematical ideas to help them realize their artistic ambitions," as might be expected from the title, *Mathematics in 20th Century Literature & Art*. But there are a few places that Tubbs brings up "mathematical thinking" or how mathematics is done, and when he does he gets it wrong.

Tubbs' limited view of doing mathematics is revealed in the Preface. He announces he will examine "artists' and writers' use of mathematical images or forms or methods in the creative processes even though those processes seem to have no affinity with mathematical thinking." And then, "Clearly, artists and writers are not mathematicians, and the enterprise in which they are engaged – trying to understand what it means to be human and to make sense of our place in the universe – is not that of mathematicians, which is to prove new theorems." Personally, as a mathematician, I actively, and daily, use mathematics and my doing of mathematics to try to understand what it means to be human! This applies whether I am working alone with paper and pen on research, interacting with a colleague, or teaching. Proving new theorems is something that, in some situations, we can now program computers to do; certainly mathematics is more than this. Mathematicians are engaged in stating and choosing which theorems deserve to be proved, and thereby steering mathematical knowledge forward. We are engaged in performing those theorems in classrooms and lectures, to reify them not only as written proofs, but as lived, experienced understanding in ourselves and others.

To give a concrete example from the text, consider Tubbs' treatment, in the first chapter, of the surrealists' experiments in automatic writing. We learn that Breton wrote that the aim was to first get into "as passive, or receptive a state of mind as you can," and then write or speak "without any intervention on the part of the critical faculties" and to overcome "logical obstacles (narrow rationalism not letting anything pass that hadn't received its stamp of approval)." Tubbs declares that, "Both in its conception and in its realization automatic writing has no apparent affinity with any mathematical ideas." He holds out until Breton starts writing about "God's perpendicular," and then begins his discussion of how ideas from non-Euclidean geometry and of the fourth dimension were picked up by these writers as metaphors for this non-rational thinking.

In this example, while Tubbs sees no affinity between automatic writing and mathematical ideas, I see much affinity between automatic writing and mathematical thinking. While it is interesting that Breton uses the mathematically-inspired line "neat parallels, oh how neat parallels are beneath God's perpendicular", I doubt I am the only mathematician who will read this section and long for an exploration, or at least an acknowledgement, of the non-rational, non-linear, intuitive thought processes that, like the surrealists, guide us toward perceiving *le merveilleux*.

In order to support his one-way flow from math idea to art work, Tubbs sets up art and math as "perpendicular," and misses some "neat parallels."