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# Book Review: *Emblems of Mind, The Inner Life of Music and Mathematics*, by Edward Rothstein

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*We associate beauty with music, but not often enough with mathematics...*  
...Edward Rothstein

*Emblems of Mind: The Inner Life of Music and Mathematics*. Edward Rothstein. Avon Books: New York, 1996. 263 pp, ISBN 0-380-72747-1.

As a graduate student in mathematics with a serious second interest in piano, I often heard the platitude that mathematics and music go hand in hand. My own informal research was leading me to conclude that while composers had their mathematical work staked out for them and most of my mathematician friends loved music, nevertheless musicians very often disliked mathematics; moreover, the music loved by a mathematician was liable to extend as far as a mechanically-played Bach fugue. We might agree that those contrapuntal voices were . . . mathematical! But was there a mathematician, I wondered, who had feelings for the work of Scriabin or Brahms, or who wanted to discourse on Mozart's laughter through sorrow (or was it sorrow through laughter?) or the profound harmonies of Beethoven? The predominant hobbies among our mathematics group were chess and baseball. I gave up on comparisons that I felt were superficial — there was even a saying among my musician friends that people who *talk* about music can't *do* it. (Later I found that musicians talk about *musicians*.) At any rate, I decided that the best one could say is that both subjects are non-verbal, possibly indicating a brain deficiency, and I married an English major.

In *Emblems of Mind*, Edward Rothstein creates a galaxy of connections between mathematics and music. Analogies are everywhere. The title derives from Wordsworth's poem, "Prelude," a key statement of the romantic movement regarding the nature of art, in which the poet, walking up a mountain, is overwhelmed by the moon and the surrounding panorama of nature.

"There, I beheld the emblem of a mind  
The power, which all  
Acknowledge when thus moved, which Nature thus  
To bodily sense exhibits, is the express  
Resemblance of that glorious faculty  
that higher minds bear with them as their own."

Thus the "emblem of a mind" may be seen as the moon or something more -- a symbol of the outer world interacting with the artist's inner world vision, creating a sense of harmony or unity within the universe. Rothstein's plan is to explore the *metaphors* shared by music and mathematics, with emphasis on the *process* of discovering, comparing, and contrasting their natures. With this approach, we are very much engaged with the project of interacting with Rothstein's mind, but the journey is smoother than that found in many books which feature interpreters or guides; Rothstein's voice is always serene and poised, never capricious, cynical or evangelical. While he may be pointing the way up the poet's mountain, he never falls into the trap of lecturing, which is admirable, considering the scope of the book. Experts might recognize the influence of the University of Chicago, and in fact, Rothstein was on the Committee on Social Thought there, where he combined studies of music, philosophy and literature. If the Committee influenced his ideas, the book itself grew out of an essay which Rothstein a music critic for *The New York Times*, wrote about his "'two strongest intellectual passions.'"

My greatest challenge with the book, explained a little by my own history, was to bear through introductory formalistic explanations that seemed to deny music the emotional vocabulary I required. (The book is *Emblems of Mind* after all...but is this really how a music critic thinks?) It was not until halfway through the book that I saw that Rothstein perceives music with much more than an eagle eye. For example, when



Rothstein talks about music formalistically, it may sound like this -- describing the initial phrase in Bach's D# minor fugue:

"it begins with a leap upward, but it is felt less as a leap than an unfolding. It should be heard as if the second note grows out of the first, opposing it but also connected to it. The theme then turns with a plaintive caress, and, as if taking a breath, gently echoes its own beginning before sadly returning step by step, to its origins. The gesture's two parts have almost different characters--an excursion and return. . . ."

To the author the phrase is a living and breathing organism; however, I am still on the sidelines wondering about the faith and determination, loneliness and peace, fortitude and acquiescence in Bach. Until Chapter 4 where the book suddenly seems to melt in the warmth of its discussion of beauty, Rothstein is apt merely to shroud that which cannot be explained by reason, like the poet's moon, with the label, "mystery." Thus, the reader is advised to be patient.

In fact, Rothstein claims early on, that emotion is too simplistic a basis on which to found a definition of music. For example, the Indian rage may bring about meditative states, while chanting music may provide energy for hoeing a field, or a drum beat serve up the background language for a culturally expressive dance. A crescendo in Palestrina may be there to send us to heaven and not on any passionate route. These examples are slightly unfair, since the music Rothstein spends effort analyzing is definitely western, and classical or romantic at that -- never even contemporary. Eventually, Rothstein will pull out all the stops and will not only acknowledge the emotional countenance of music but will demonstrate ways in which music goes beyond what Thomas Mann calls 'cow warmth,' to the topic of music's power to affect our lives. But even while he is avoiding dipping into the emotional pool and is maintaining an arm's length (or mind's length) on his subject, the author always manages to convey his exuberant joy in these twin stars of the galaxy, these 'kindred mutations.' He convinces us that both subjects achieve their value when seen as a process; thus we have multiple layerings of processes in this book, recursion at play. Mathematically speak-

ing, mathematics and music are functions, and his job is to attempt to give a metaphor for the mapping (or fugue) between these functions (or voices); in this process we map onto Rothstein's mind, or the author's mind onto us.

In introducing the similarities between mathematics and music, Rothstein offers up the gamut. For example, he notes that both subjects are represented as languages encrypted in special notation which does not necessarily read linearly. They are subjects in which one talks of "giftedness," subjects with quasi religious roots ("mystery"), and which carry epical tales of their heroes. Some of the mathematicians (Pythagoras, Aristotle, Euler, Kepler, Galileo, etc.) we recognize as being at the job of trying to link mathematics and music long ago. The *tritone* (an augmented fourth -- from C to F#, an impossible interval for singers, best remembered by the opening two notes in the song *Maria*, from "West Side Story") was regarded as "unutterable," the *diabolus in musica* in the Western church, just as the irrational number  $\sqrt{2}$  was regarded as *alogon*, or unutterable, by the Greeks. (Rothstein does not push the parallel by pointing out

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that F# is practically halfway up the logarithmic scale, giving it a relative frequency of just about  $\sqrt{2}$ .) Mathematics and music also share levels of complexity, a sense of space, the creation of order, a reliance on axioms governing a style, and fundamental building blocks such as groups (in music, groups of tones). Rothstein disclaims "very little of what I say about mathematics will be news to mathematicians and very little of what I say about music will be news to musicians and composers. The hope is that much of what I have to say will still be of interest because of the juxtapositions I make and the hypotheses I propose." Since the translation is not exact, and there is no formula for the mapping, we find ourselves delightfully orbiting around a central premise, from time to time struck by meteoric insights. I marvel at the artful construction of the book; it is a virtual playground for seeking out connections. For example I have just no-



ticed that Rothstein begins with a description of *numbers* and introduces the musical scale as a *ladder of discrete tones*; in his summarizing chapter, titled "Chorale," he discusses Socrates' hierarchical ranking of *levels of thinking* about the world.

To hone in on the connections he wants to make, Rothstein first dialectically divides his subjects, with chapters on the inner natures of mathematics and music. In the mathematical chapter, dubbed "Partita" we are treated to a seamless transitional linking of mathematical topics where mathematics flows like a stream into a river, from numbers to the concept of the irrational, to the infinitesimal, and from there, to spaces characterized by their axioms, or *styles*. (A partita is a suite of dances.) A few parallels with music are thrown out, but the reader is probably already able to make his or her own connections, the choice of terms is so suggestive. In the chapter on the definitional character of music, "Sonata", Rothstein suggests that music exists for particular audiences and as such, is "modeled." Think, he suggests, how music accepted as appropriate in a horror film might be received in a concert hall or church.

But in music neither the model nor the object nor the map is clear. How could music possibly progress in its understanding of a concept or an experience? I spoke metaphorically about film scores 'modeling' an emotion and about a piece of music serving as a 'model' but what can this mean? Music does not even seem to be looking for something to model from the world; nor does it seem to involve the sort of reasoning we find in mathematics. In music we don't see the act of construction taking place . . . we are submerged in a realm in which at least at first, 'knowing' seems irrelevant.

He then returns to the argument that the *product* of mathematics too is more of a *process* than a *result* -- something which we probably forget all too often in our teaching. "There is," he claims, "a life to the ideas within a mathematical proof." In other words, the message is the modeling, mathematics itself is a model of mathematical activity.

Contemporary composers have used mathematics via computers to output random music or to model and blend styles, to fractalize a Bach fugue or to paint a page with notes in chaotic or planned patterns; Rothstein ignores these connections. But I confess to being at a loss when he follows on the trail of musicologists such as Heinrich Schenker and David Lewin with dizzying phrase-by-phrase and note-by-note dissections of musical pieces or phrases to make his points. Every corner of "muso-mathematics" is probed here: distance, connection, contraction and expansion, equilibrium, the vertical and horizontal, modulations, patterns, symmetry, variations, contradictions, ascending sequences, leaps, disorientations, pulsings -- it would hardly matter what conclusions are made with this tsunamic force of words. At least no one

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will be left believing that composers are not in possession of mathematical minds.

It is a deserved pleasure when Rothstein climbs higher on the poet's mountain, to discuss what mathematics and music share as *art* forms. In Chapter 4, "Theme and Variations," he investigates the meanings of beauty and truth.

There is something about beauty that is both private -- because it involves silent feeling -- and public --because it makes us feel as if it is revealing something universal. It emphasizes both our isolation and our feelings of common sense and sensibility. For the same reason it can also risk inspiring contemplative withdrawal or impassioned absolutism. The judgment of beauty is not idiosyncratic -- or so we think and feel -- but something more fundamental. Beauty feels like an aspect of public knowledge. We may not actually assert that everyone *will* agree with our proclamation of beauty, but beauty inspires a feeling that everyone *should* agree. The feeling makes a claim



not only on us, as we view the beautiful object but on our sense of others. (This is the origin of snobbery.) Of course we haven't proved that taste is universal or that beauty is objective; the only assertion is that the judgment of beauty is treated as *universal* and felt as *objective*. . . .

Music, he asserts, allows us to dwell in a second nature; it intoxicates, it is more powerful than ourselves. Music is not merely abstract; it reflects the ways in which we experience the world. Mathematics also shares these attributes: the mathematical proof that loses touch with reality and becomes baroquely ornate for the sake of itself alone (the ring version of the Chinese Remainder Theorem) also loses some traditional notions of beauty. But note: music may not necessarily be beautiful in the sense of delighting (Chopin's "Dies Irae" prelude, in A minor); it may "disturb and overwhelm;" it is not so much beautiful, as . . . here the word "mystery" is converted to the romantic's word: "sublime." "To our rational minds . . . the sublime seems to subvert our judgment, perpetrating, in Kant's words, an 'outrage on the imagination.'" Mathematics as well has this quality of being sublime in its sheer immensity and depth.

Rothstein's last chapters are refined writing, as he continues to navigate where many authors might find the oxygen too thin. Retaining the idea of "metaphor," he keeps a charted course, scattering thoughts that in themselves could create books, and distributing wonderful quotes. Speaking, but not preaching, about the creative process in mathematics and music, Rothstein says: "our greatest risk is that our metaphorical interpretations will be willful, arbitrary, unenlightened, that connections will be made of trivial importance." He himself never falls into this trap. Now the topic has become the power (and soul -- but this is a word he never mentions) of music and mathematics; the ability of mathematics to interpret the universe, while the power of music is interpreted in its equally versatile ability to bear a variety of meanings, its role as "gesture" which makes it a voice in our cultures. From the heroic to the sarcastic, the diabolical to the religious, from the excellent to the inferior, it can present

us with a narrative of our history and a reflection of ourselves.

I occasionally felt some pang of regret that the book presumes a large body of prior understanding about these subjects. I know I would have enjoyed the book as a student, but wonder about the reaction of today's students; would they find the subjects of mathematics and music so exalted? Much of what I have learned in the past thirty years that has fascinated me about mathematics is the ways in which statistics and probability, chaos and computers have come to the inside track, and regarding music -- its manifestations outside the western classical idiom in the contemporary and ethno-cultural realms. Thus part of my understanding of mathematics and music is not covered in this book, which is more wrapped in the traditional and creates something of a backward look, perhaps a "bridge to the past." But *Emblems of Mind* is a tour de force in writing and thinking the concept of metaphor providing all of us (not just mathematicians or musicians) a way of seeing how thinking about one discipline can be a useful way to think about another, giving validity to the act of thinking on many levels. (If Socrates would have it, these levels would be: intellection, thought, . . . *trust*, and *imagination!*) And if the subjects of mathematics and music are still immutably divided for me in that mathematics will never have the emotional heart of music, the warmth of tone in this book comes as close as anything I have experienced in helping to span that gulf by humanizing mathematics.

The search for the sublime links music and mathematics. Both arts seek something which combined with the beautiful provokes both contemplation and restlessness, awe and comprehension, certainty and doubt. . . . The sublime inspires an almost infinite desire, a yearning for completion which is always beyond our reach. But we are then comforted by the achievements of reason in having brought us so close to comprehending a mystery fated to remain unsolved.