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Professor Uses Mathematics to Decode Beatles Tunes

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By EASHA ANAND

HALIFAX, Canada -- It is here, in a cluttered mathematician's office, under blackboards jammed with equations and functional analysis, that one of Western culture's greatest mysteries has finally been solved: Why has no one been able to replicate the first chord in The Beatles' pop hit "A Hard Day's Night"?

Not stopping there, this sleuth is using math in his quest to answer an even more-elusive question, about the contested authorship of the Fab Four's "In My Life."



View Interactive

All You Need Is Math

See how Mr. Brown used math to figure out The Beatles' formula for success, listen to the clips he analyzed, and watch him perform his own Beatles-esque song.

about the British rock group, examined church records to find the precise day that John Lennon met Mr. McCartney.

"Whether they realize it or not, the best songwriters have always relied on mathematics," says Jason Brown, a mathematician who is tackling such puzzlers in between chairing the math department at Dalhousie University in Halifax, Nova Scotia, and playing his own Beatles-esque songs.

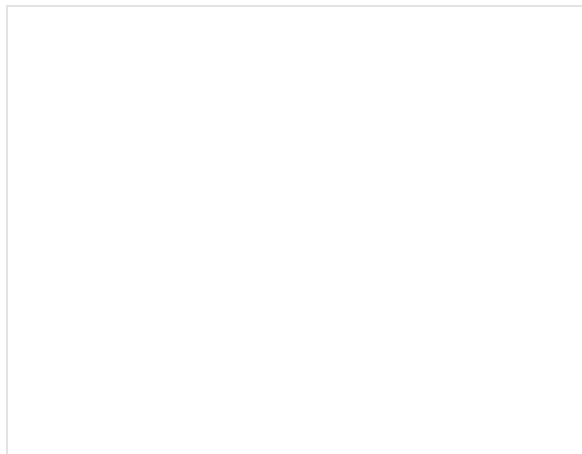
Since the 1960s, Beatles aficionados have pored over the group's recordings and memorabilia in search of answers to questions about both their music and their lives. An as-yet-unpublished Beatles track Paul McCartney recently mentioned made headlines internationally. Beatles historian Mark Lewisohn, who is working on a trilogy

Now Mr. Brown, 47 years old, is revisiting these questions from another angle. His approach is sparking controversy among fans who believe the band's mystique defies calculation. An article by Mr. Brown on his research published in Guitar Player magazine three years ago spawned heated

Math Professor Figures Formula for Beatles Success

3:37

Jason Brown listens to the Beatles with a uniquely analytical ear. The mathematics professor at Dalhousie University in Halifax, Nova Scotia, says he's figured out the math behind the best of the Fab



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Four. Now, using "mathematical tricks" he's picked up from the band, he's written a very Beatles-esque song of his own. WSJ's Christina Jeng reports.

Math Professor Jason Brown's 'A Million Whys'

Listen to Jason Brown's "A Million Whys." The mathematics professor at Dalhousie University in Halifax, Nova Scotia, used "mathematical tricks" he learned from analyzing songs by The Beatles and wrote a very Beatles-esque song of his own. WSJ's Christina Jeng reports.



discussions in both the math and music blogospheres.

"Some people thought what he was doing was sacrilegious," says Matt Blackett, an associate editor at Guitar Player. "As a fellow Beatles fanatic, I just thought it was awesome."

A spokesman for Mr. McCartney said he was unavailable and other former group members didn't respond to request for comment. Generally, the group has been

evasive when faced with fans' efforts to dissect their work.

Growing up in the Toronto suburbs, Mr. Brown learned piano, but gave it up at age 12 for guitar, after hearing the Beatles' "Red Album," and becoming obsessed with the group. Like many Beatles fans, Mr. Brown was fascinated with the opening chord of "A Hard Day's Night." The chord has at least four sheet music variants, but nobody has ever quite replicated it, and the Beatles haven't revealed how they produced the complex sound. Mr. Brown said he spent hours experimenting before it occurred to him: "Music is basically just math."

It isn't surprising that Mr. Brown turned to mathematics. He talks about the lyrics of 1960s songwriter Randy Newman in terms of metamathematics. When he sees broccoli, he thinks of fractals, a concept in chaos theory. Piles of graph-theory tomes litter his office, and Greek letters and Roman numerals cover his chalkboard.

Mr. Brown realized he could use a discrete Fourier transform, a mathematical technique for breaking up complicated signals into simpler functions and known as DFT. He used digital equipment to show the chord as a series of numbers, tens of thousands per second, and then applied a DFT to convert the chord into dozens of simpler functions, each representing a single sound frequency.

Mr. Brown knew there is no such thing as a pure tone: Each instrument emits one sound for the note played and then sounds that are multiples of that note's frequency, as the string vibrates back on itself. Of his dozens of frequencies, some were background noise and some--the ones he wanted to ferret out--were the notes the Beatles struck.

The professor started making deductions. The loudest notes were likely Mr. McCartney's bass. The lowest had to be the original note played, since a string can generate waves along half or a third of its length, but not twice its length. But no matter how he divvied up the notes, something didn't fit.

It is well-documented that Mr. Harrison played a 12-string guitar for the recording of "A Hard Day's Night." For every guitar note played, there had to be another one octave higher, since his guitar strings were pressed down in pairs.

But three frequencies for an F note were left, none of which were an octave apart. Even if Mr. Brown assumed Mr. Lennon played one F note on his six-string guitar, Mr. Brown still had two unexplained frequencies.

After weeks of staring at six-decimal-place amplitude values, Mr. Brown suddenly remembered how, as a child, he used to stick his head inside his parents' grand piano to see how it worked. He ran to a nearby music shop, and poked his head inside the Yamahas there.

Sure enough, there were three strings under the F key, corresponding to the three sets of harmonics he had seen. Buried under the iconic guitar chord was a piano note.

Other problems have since yielded to Mr. Brown's mathematics. Fans have always marveled at Mr. Harrison's guitar solo in "A Hard Day's Night," a rapid-fire sequence of 1/16th notes, accompanied on piano, that seemed to require superhuman dexterity.



Mr. Brown noticed that a piano is strung differently in its lower octaves, with two strings, rather than three, under each hammer. He saw only two frequencies for



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Christina Jeng/The Wall Street Journal

Jason Brown, chair of the math department at Dalhousie University in Halifax, Nova Scotia, and Beatles fan.

each piano note in the guitar solo, suggesting that the solo had been played one octave lower than the recorded version sounded. It had also been played at half-speed, he concluded, then sped up on tape to make the released version sound as if had been played faster and at a higher octave.

Mr. Brown's latest project is figuring out which Beatle wrote "In My Life." Both

Messrs. Lennon and McCartney claim to have written the majority of the tune.

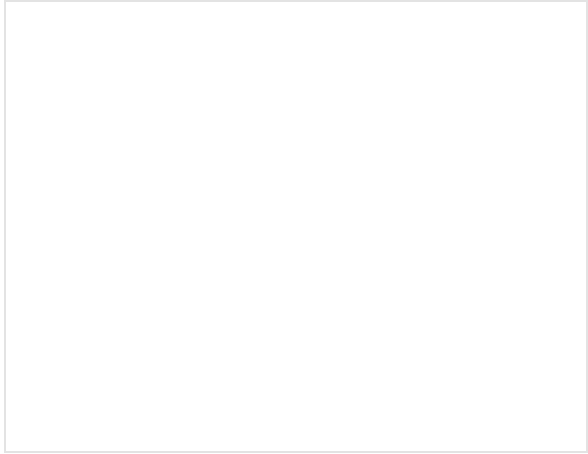
To settle the dispute, Mr. Brown is feeding hundreds of Beatles songs with known authorship into a computer program. In academia, his specialty is graph theory, which examines networks of points--called "nodes"--and arrows connecting them--known as "edges." In this problem, each chord in the Beatles canon is a node, and edges connect chords played in succession.

With a few dozen songs entered, the graphs are taking shape: Mr. Lennon's looks like a demented flower, with loops everywhere, representing his trademark repeated chords, while Mr. McCartney's is more freeform. When Mr. Brown is finished, he'll plug "In My Life" into his program and see which graph fits it better.

Meanwhile, Mr. Brown is applying his mathematical analysis to write his own Beatles-esque music. At the studio of sound engineer and drummer Scott Ferguson, Mr. Brown tunes up with bassist Alex Vaughan and vocalist Hal Bruce. Messrs. Ferguson and Bruce are professional Beatles "celebrators" (they prefer the term to "impersonator"), and the four are united by their love of the British band. Sketches of Mr. Lennon adorn the studio, and the musicians refer to the Fab Four as if they are old friends. "Paul was just so melodic," sighs Mr. Bruce.

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Jason Brown

The band launches in on "A Million Whys," a song Mr. Brown mathematically designed to sound like a Beatles tune. Mr. Brown croons into a studio mic, black Reeboks tapping.

Afterward, the group dissects the track. "I'm clashing with something or other," says Mr. Ferguson. Though Mr. Brown wrote the song based on formula, the musicians refine it based on their musical instinct.

Jim Vallance, who has written songs for Tina Turner and Aerosmith, says that's proof that some facets of music defy equations. "Scientists have discovered everything about Stradivarius' violins: the wood density, the varnish, the glue," he says. "But no one has been able to replicate the 'sound.' Same with the Beatles. You can't measure heart and soul."

Other Beatles fans describe Mr. Brown's research as a fancy way of packaging what they already know. Walt Everett, author of "The Beatles as Musicians," dismisses Mr. Brown's findings about the piano notes in the opening chord of "A Hard Day's Night," saying he had already noticed the piano presence.

Mr. Brown stands by his approach. "Everyone thinks they've analyzed a chord, but they don't agree," he says. "You can't argue with the math."

Write to Easha Anand at easha.anand@wsj.com

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