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hey, welcome to 12tone! in 1964, legendary minimalist composer LaMonte Young embarked on what would be his most ambitious project ever: a piece called The Well-Tuned Piano. it's a massive, sprawling composition, over 5 hours long when Young played it live for the final time in 1987, and requiring weeks of set-up in order to be performed correctly. more than that, it's largely improvised: Young defined a certain structure for the piece, drifting through harmonic spaces with names like the Opening Chord, the Magic Chord, and the Tamiar Dream Chord, each of which might take upwards of half an hour to complete, but the specifics changed each time as he experimented relentlessly with the soundscape he had created. it contains an innovative playing technique that Young described as "clouds", where incredibly fast notes would slowly build and combine into a towering sense of harmony, but for a long time, this piece also contained one of the greatest mysteries in all of modern classical music: the mystery of which notes he was actually playing.

you see, the name The Well-Tuned Piano is probably a reference to a collection of Bach pieces known as the Well-Tempered Clavier. Bach wanted to advocate for a new kind of tuning system, so he wrote a bunch of music to show off what that system could do, and it appears that Young was doing the same thing. however, unlike Bach, Young is a notoriously secretive composer who kept his new tuning system to himself for 27 years, and he only released it after composer Kyle Gann sat down with a tuner, a calculator, and some very well-trained ears and worked out ten of the twelve notes by hand.

so what was he doing? well, at its heart Young's system is a version of what theorists call just intonation, which is when the intervals we hear are mathematically pure. you see, when you hear a note, what you're really hearing is a sound wave with a specific frequency, and when you hear multiple notes at once, your ear calculates the ratio between those frequencies in order to determine the interval. for example, if you double the frequency, you get a note an octave higher. if you're playing on a normal piano, a lot of those ratios will be pretty messy because we've prioritized other factors, like being able to easily change keys. but just intonation systems instead aim to keep those ratios as clean as possible, using only whole numbers and often trying to stick with small ones.

the version Young uses here is what's called a 7-limit tuning, which means that it's built of ratios using numbers no larger than 7. because doubling a frequency just moves it up an octave, all the even numbers are actually just copies of odd ones, so we're really just working with 3, 5, and 7, which we can then multiply or divide by 2 to keep everything within a single octave. these are all pretty simple sounds: the $3/2$ ratio, for instance, is the perfect 5th, while $5/4$ is the major 3rd. the $7/4$ ratio, though, is a bit different: it's not that difficult in theory, but it has no real equivalent in the tuning system most of us are used to. it's kinda like a minor 7th, but it's almost a third of a half-step flat. we call it the harmonic 7th, and it adds an interesting flavor that's new to most listeners while still being fairly pure.

anyway, a 7-limit tuning is built by taking these three intervals and stacking them on top of each other to find the rest of the notes. or at least, a normal one is, but this is La Monte Young we're talking about, so of course it can't be that simple. for whatever reason, he apparently dislikes the sound of the $5/4$ ratio, so he leaves it out entirely, building everything from perfect 5ths and harmonic 7ths. and with that out of the way, we can finally talk about the actual notes.

when you're building a just intonation system, the first thing you need to do is pick a root. this is the note all your other frequencies will be tuned against, and for this piece Young chose Eb, probably as an homage to his time as a saxophone player. from there, he begins to stack 5ths, getting Bb as a $3/2$ ratio and above that F, at $9/8$. above each of those he goes up two harmonic 7ths, giving us these ratios. now, the note names here are a bit weird because, again, the harmonic 7th doesn't exist in normal tuning so it's not super clear which note we're supposed to land on, but for now we'll just use these. that gives us 9 of our notes, and from there Young just adds a couple more perfect 5ths to the end, and voila, we've got the tuning for the Well-Tuned Piano.

or at least we've got one of them: like many other aspects of the piece, Young changed the tuning over the years. but this is what he used for the 1981 recording that Gann worked from, and I don't believe he's changed it since, but he hasn't performed it live in over 30 years at this point, so who knows.

anyway, from here we can start making observations about the tuning, so let's start with the most obvious question: what's up with G#? I mean, first of all, the ratio is ridiculous, to the point where it's very unlikely you'd even recognize it as pure. but the biggest issue comes when we compare the G# to our G. did you hear that? they're pretty close, but it turns out the G# is actually lower.

so why? well, the short answer is that Young doesn't care about the G#. he never actually plays it in the piece, which is why Gann couldn't properly identify all 12 notes. that doesn't mean it doesn't matter, though: having a string tuned to that frequency is important due to a phenomenon called sympathetic resonance. basically, when you play a note with a specific frequency, strings tuned to a multiple of that frequency will also start to vibrate a little, adding to the original sound. so even though he never uses G#, you can still hear it ringing faintly when he plays an A.

this leads to an important observation: Young's notation is largely artificial. that is, it tells you which keys he plays, but it doesn't tell you much about what sounds they make. if the notation goes up a half step, for instance, we could get anything from this (bang) which is almost a whole step, to this (bang) which, again, is actually moving down.

an interesting product of this is that the notes of the piano tend to cluster. in standard tuning, everything is evenly spaced, but in the Well-Tuned Piano, we instead wind up with a couple pockets of notes with large gaps in between. for instance, E, F, and F# are all within about three

quarters of a half-step of each other, as are A, B $\flat$, and B. we already saw G and G $\sharp$, and there's a similar cluster at C and C $\sharp$, and finally D sits just barely below E $\flat$. this gives us something that resembles a pentatonic or 5-note scale, kinda like this: (bang) but with a couple different tuning options for each note. it's actually a lot like the major pentatonic scale, a classic device in traditional Western music, but the 3rd and the 6th are each about a quarter-tone sharp, because, again, Young left out the $5/4$ ratio we'd need in order to make them correctly.

this tuning variety leads to a somewhat paradoxical situation: we've got lots of intervals, but also not that many. like, standard tuning only has 12 possible intervals per octave, whereas Young's tuning has 38. but many of those are largely similar: for instance, E $\flat$ to E, E $\flat$ to F, and E $\flat$ to F $\sharp$ are all basically whole steps. in effect, Young has given himself access to lots of different shades of just a few kinds of intervals. however, much like we saw with G $\sharp$, he doesn't use them all evenly: most of the piece centers around the perfect 5th, the perfect 4th, the harmonic 7th, and then what are called the septimal 3rds and 6ths. "septimal" is a fancy word for the number 7, because as we mentioned before, these are constructed with the $7/4$ ratio, rather than the $5/4$ one you'd normally use. the septimal minor 3rd and 6th are a little bit smaller than their standard versions, while the major 3rd and 6th are wider. these septimal intervals play a huge role in giving the Well-Tuned Piano its unique sound, helping tie all the different versions together into one massive sonic experiment.

of course, there's more to it than just tuning: the structure of the piece is also fascinating, and if there's enough interest I may make another video about it at some point. but in the words of Kyle Gann, there is "virtually no way to analyze the piece" without understanding the tuning system on which it's built. That, more than anything, is the heart of the Well-Tuned Piano. heck, it's right there in the name.

so yeah, no analysis would be possible without Gann's dedication to solving Young's riddle, Which brings me to this video's sponsor, Brilliant! You see, I have a theory: I believe there's a significant overlap between people who enjoy music theory and people who enjoy difficult but ultimately rewarding puzzles, and if I'm right, you're gonna love Brilliant. Basically, Brilliant is all about learning through problem-solving: They have a bunch of fun, challenging puzzles to help develop your intuitions on things like math and science, plus each one comes with a really thorough answer so if you get it wrong, they'll explain what you missed so it doesn't happen again. I've been going through their number theory course because I like my concepts to be as abstract as possible, but they also have lots of other cool math, science, and computer stuff to try out, and each puzzle is different so you're not just drilling the same boring question over and over again with slightly different numbers. If you want to support the channel and learn more about Brilliant, you can go to brilliant.org/12tone or just click the link in the description to try it out for free. Plus, if you're one of the first 200 people to use that link, they'll even give you 20% off a premium membership if you sign up for a year!

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<https://www.jstor.org/stable/833045>

<https://pitchfork.com/reviews/albums/la-monte-young-the-well-tuned-piano-81-x-25-61750-111859-pm-nyc/>

<https://www.theguardian.com/music/musicblog/2013/mar/25/contemporary-music-guide-la-monte-young>

<https://www.kylegann.com/wtp.html>

<https://books.google.com/books?id=sc61Gy3r8HAC>

<https://www.villagevoice.com/2002/09/03/pinned-down-by-the-piano/>