From Thin Air: Minimalism and Process Music from Africa to Arvo Pärt

Professor Milton Mermikides

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I Simple Minded

1.1 Defining the simple, in bits.

This lecture is concerned with what one might describe on the surface, as ‘simple’ music. But more specifically simple music that seems to have a greater effect on us than it ‘should’. We might think – in general – the more complexity we put in our art (and music) the greater the aesthetic experience. Basic and functional music gets back in effect what it puts in in terms of content. Florid music (think Romantic or romantic) gets a worthy emotional impact from its complexity. Other music (for some listeners) might ‘waste’ its complexity for a poor aesthetic response. This lecture is about the opposite: simple music which somehow seems to outgrow its limitations of content. While complex music that affects can be impressive, there is something magical, ‘emergent’ and transcendent when simple music speaks to us deeply. It is the ‘more’ of ‘less is more’.

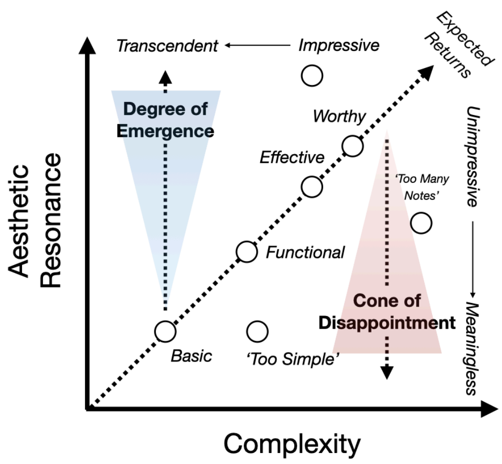

Figure 1: A model of musical emergence: Simple music that is more effective than expected. The simpler it is the higher the possible ‘unexpected’ impact.

Here I offer some explanations of how this paradoxical feat may be possible, but first we must define what we mean by ‘simple’. We cannot merely refer to duration. Consider Satie’s *Vexations*, in which a 13-beat melody is repeated 840 times. Gargantuan in duration, yet—after the first hour of its 18 or so—arguably, somewhat predictable. Compare this to one of Webern’s miniatures, pieces that can last as little as 20 seconds but within which lies a dizzying array of carefully sculpted, non-repeating gestures across pitch, rhythm, and timbre. If we judge only by duration or even count, *Vexations* appears vastly more complex than a Webern miniature—but this does not align with our intuitive sense of musical complexity. Is there a way to make sense of such intuitions? Can complexity be measured—not just in terms of quantity, but informational richness?

For much of human history, the notion of measuring information—in any domain, let alone music—remained elusive. We’ve long had units for time, mass, heat, and velocity, but there was no equivalent measure for informational content. How could one compare the ‘informational weight’ of two texts—or, for that matter, a Bach fugue and a pop song? Enter Claude Shannon, a reclusive researcher at Bell Labs whose cryptographic work contributed to the World War II effort. His continued interest in message transmission led to his 1948 paper *A Mathematical Theory of Communication*, published in two parts in the Bell System Technical Journal. This short but seminal article introduced a framework for encoding and transmitting messages, establishing the concept of the *bit*—the smallest unit of information—and laying the foundations for the field of information theory.

One of Shannon's key contributions was the concept of entropy—a measure of unpredictability or informational density in a message—which we'll call **Shannon Entropy (SE)**. In essence, SE quantifies how compressible a dataset is: the more predictable or redundant the data, the lower its entropy; the more variable and less compressible, the higher its entropy. SE depends in part on the size of the symbolic alphabet (e.g., how many distinct pitches, rhythms, timbres are used) and how frequently patterns repeat. This insight is profound, we could now have a method of comparing the 'informational weight' of anything that can be captured as data – measured in the now ubiquitous *bits*. In theory anything can be measured: this essay,, Van Gogh's *Sunflowers*, cauliflower DNA, a Bach fugue. Shannon in fact estimated on a scrap of paper (left) the 'bits storage capacity' of some objects from a 'digit wheel' (a mechanical counter), a phono record (as we did in Lecture 6 of *The Nature of Music*), the 'genetic constitution of man' (well before the structure of DNA was identified) and at the top – 'The Library of Congress'. In our case, it turns out that the repetition and limited symbol set of Satie's *Vexations* would – using Shannon's concepts – be classified as objectively simpler than Webern's complex and unpredictable miniatures despite the latter's massively shorter duration and note count.

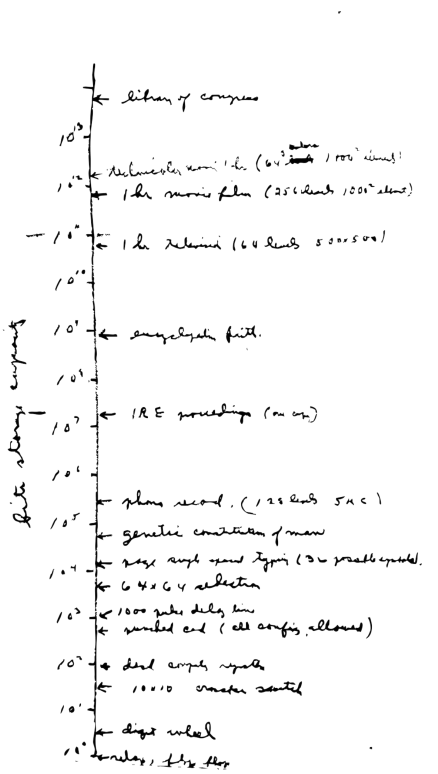

Figure 2: Shannon's handwritten estimations of the 'bit storage capacity' – the informational content of a ruler up to the Library of Congress.

1.2 A Simple Recipe for Music

Shannon's seminal work emerged from his classified work in cryptography – the sending of hidden messages – during the Second World War. At this time happened to befriend a British visitor at Bell Labs – another quiet genius – by the name of Alan Turing, who was working on a complementary problem – the cracking of the Enigma code. Neither Shannon nor Turing could talk about their classified work (in coding and decoding respectively), but their discussions would doubtless have involved that of information in its most fundamental form. And while Shannon's work is foundational to our digital world, it only takes us part of the way in analysing music. **SE** is concerned with the surface structure of music—the statistical properties of its symbols. Turing's work (among other things) involves the *computation* – and not just the structure – of information. This offers us another perspective we can apply to music: that of the algorithmic recipe or set of instructions – the score – that could produce the piece. While **SE** asks: "*how much can we compress the content of this music?",* we might instead ask *'how simply can we instruct the creation of this music?'*. How simple the content is the music or or how simple can we make the score respectively. This gives us another way of judging a piece's complexity, its most elegant score (or more generally its 'code' when it comes to electronic music). Thanks to another genius (from another side of a political curtain) – the Russian mathematician **Andrey Kolmogorov**, we can now have another objective measure of complexity. **Kolmogorov Complexity (KC)**. asks *what is the simplest score (or set of instructions) needed to deliver a given piece of music?* In this way, we're expressing the *compressibility of a piece's recipe*, rather than the compressibility of its *output*.

You might see how this aligns well with the *Vexations*/Webern comparison. The *Satie* piece, despite lasting multiple hours, has a score that fits on a postcard. *Webern's* work, by contrast, may last only half a minute, but it demands a far more intricate and less reducible set of instructions to realise. So, in this example the simplicity and complexity of the pieces (SE) is reflected in the simplicity and complexity of the scores (KC)[1] However, while it is generally the case that more complex scores (more complicated instructions) generally create more complex (informationally rich) music, the extraordinary thing about the universe (and music) is that complexity can arise from the simplest instructions. I suggest that in the case of music there are two

[1] Note that Satie could have chosen to write out all 840 repetitions manually. However, this would not be the *most efficient* instruction, which is the definition of Kolmogorov complexity. Thankfully – for all the trees and page turners around the world – Satie chose to simply write *"Jouer 840 fois"* rather than create a 500-page score.

broad mechanisms how this can happen. The first is objective and mathematical – what we will call **generative depth**, the second experiential and subjective – **perceptual depth.**

II More from Less

2.1 Generative Depth

For those who seek it, there is sublime beauty and creative power to be found in mathematics. Simple operations can produce startling, surprising, elegant, or strange patterns. Take the *Collatz Sequence*: a pattern of numbers produced by the leanest of rules. Start with a positive integer. If it's even, halve it; if it's odd, triple it and add 1[2]. What follows is… wild. Pure binary numbers—like 1, 2, 4, 8, 16, 32—drop neatly into an eternal 4–2–1 loop. But other numbers seem to have a life of their own, bouncing and orbiting through strange paths before, eventually, finding their way home. Even relatively small numbers take bizarre journeys: 27, for instance, takes 111 moves and climbs to dizzying heights before it settles into 4–2–1.

The Collatz Conjecture suggests that *every* positive integer ends this way. Despite exhaustive testing—into the quintillions—and the attention of some of the brightest minds in mathematics, no one has yet proven it. It remains a beautiful mystery, a testament to the mischievous nature of numbers—and perhaps the universe itself—when operating under simple rules. There seems to be ghosts in the simplest of machines. Music is no different. It's easy to generate melody from the *Collatz sequence*—I just did, using a simple program I wrote: The *Collatz Sequencer*. Conway's *Game of Life* is a 'zero-player' cellular automaton where simple rules governing cell birth, survival, and death create complex, often surprising patterns over time and also be readily mapped to musical objects with beautiful effect. But musicians have long tapped this mathematical property of generative depth directly. A 'postcard' score can yield enormous informational depth. Take Terry Riley's *In C*: only 53 musical cells, played in order. But the instruction—freely layered by multiple performers—results in a highly complex, emergent tapestry. Or consider Kaija Saariaho's *Vers le blanc* (1982): described as "a chord changing into another chord so slowly, that the pitch changes are not audible as such." Yet this microtonal blurring produces widely complex interactions. From the tiniest rule, we can yield vast—sometimes immeasurable—entropy.

Indeed, if we treat the interpretation of a score as a source of new information, even conventional scores contain immense generative depth. A beautiful demonstration of this can be found in *Every Recording of Gymnopédie No. 1* (Hey Exit, 2015), which layers an unspecified number of recordings of Satie's piece—each time-stretched to the same duration. The resulting soundscape reveals a scintillating landscape of variation—a mesmerizing piece in its own right.

So how simple can the 'code' for a complex piece be? One extraordinary candidate is Alvin Lucier's *I Am Sitting in a Room* (1969), in which a short section of speech is played into a room, recorded, and re-played repeatedly until it dissolves into the acoustics of the space itself. The stunning elegance of the work lies in the fact that its instructions *are* its material. Like DNA, it functions both as substance and instruction—a perfect fusion of data and process.

2.2 Perceptual Depth

We must acknowledge that music is more than its content; it is how we experience it. Music often operates at the strange borderlands between complexity and simplicity. It invites us to recognise low-entropy structures—a melody, for instance—emerging clearly from a complex landscape, no matter its key, instrumentation, or expressive context. Yet we also find perceptual depth in the simplest elements. Take just four notes: two long, two short (with the long notes twice the duration of the short). If these are heard as long–long–short–short, we tend to have a modest, stable aesthetic response. But something remarkable happens if the pattern begins—or we latch onto it—from the second note: long–short–short–long. Despite having similar Shannon Entropy and Kolmogorov Complexity to the first pattern, this ordering feels more

[2] The pattern is also known as the (3n+1) An example pattern: 1 (is odd so triple and add 1) -> 4 (is even so half it) -> 2 (again is even so half it) and we are back at 1 in an eternal 4-2-1 cycle.

engaging, more ambiguous. Why? The first pattern is most naturally heard as three beats (with the final beat divided). But the second pattern admits two compelling, competing interpretations: one of three beats (with the middle beat divided—what musicians might call 3/4), and another of two beats (grouped long–short / short–long—suggestive of 6/8). Like an optical illusion, the listener may flip between these perspectives or hover in a kind of hypnotic limbo.

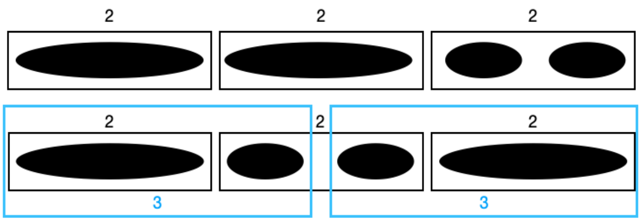

Figure 3: Two rotations of the same cycle of two long, and two short, notes. The second invites a perceptual depth and multiplicity despite its similar content.

This rhythmic ambiguity—this perceptual multiplicity—is a global phenomenon. You'll find it in countless musical traditions. Two modern examples: Radiohead's *Daydreaming* and Philip Glass's *Glassworks*. But the roots of such rhythmic complexity stretch deep to the birthplace of both mathematics and music: ancient Africa. This rhythm is found for example in the *Akom* of the Ashanti people of Ghana, the 3 vs 2 interpretations used to demarcate formal sections and as extended periods of liminal ambiguity.

III Written in Sand

The origins of mathematics are found in Africa—inscribed in bone, traced in sand, and echoed in sound. The Ishango and Lebombo bones, (carved 20,000 and 40,000 years ago respectively), reveal early counting systems and a deep intuition for number, and perhaps the earliest evidence of prime number recognition. Across the continent, sand drawings and rock art – embody an elegant visual logic: emergent complexity from simple, generative rules. Take the *Sona* art of Chokwe-Lunda cultures of Angola, this stunning beautiful tradition (a fusion of decorative art and story-telling device), uses a simple generative code for the creation. The art requires simple rules: a series of nodes are placed in the sand; a continuous line is drawn around these nodes with only a short set of geometric angles allowed. In some cases, boundaries and 'mirror-walls' are placed to further constrain the artistic solution. Despite – in fact fuelled by – the simplicity of the underlying generative code, beautiful patterns emerge representing both mathematical patterns and natural forms (See Figure 4 for one example). The solutions to these puzzles are non-trivial, involve significant memory, skill and flow to execute smoothly, but the elegant results hide this complexity.

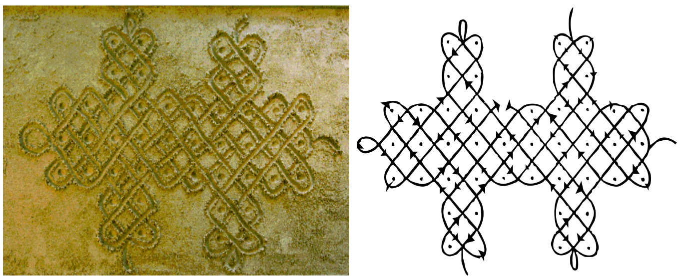

Figure 4: A *sona* piece of sand art: *Leopard with Cubs* In sand on the left, and an abstraction with guides on the right. One continuous line is drawn around a matrix of nodes to produce a beautiful yet wholly systematic 'naturally–occurring' pattern (two leopard heads and three tails are added). Images adapted from Chavey (2010)

Similar principles are alive in the music of Africa —not just reflected, but perhaps co-evolved or even born there. Most scholars believe that music – rather than an evolutionary side-effect – serves some purpose: such as social cohesion and organisation; individual expression; meditative restoration; event marking; knowledge transmission and cultural heritage; and a sense of connection to nature and ancestors. If so, then given its ancient history, it would become optimized – excellent and efficient – at such functions. An elegant and deceptive simplicity that would both survive the generation through oral transference and achieve the richness of musical experience necessary to fulfil its various roles. And even a short survey reveals such stunning elegance found not in patterns of sand, but that of music.

IV Written in Air

4.I Phase 1: Tools of Emergence

There are 1000s of distinct musical cultures in Sub-Saharan Africa, so any generalisation or illustrative example is futile and simplistic. Nonetheless, when it comes to emergent musical patterns and multiplicity we are spoiled with beautiful options. Take the *Baganda* music of Uganda, one form is played on the *amadinda* and *akadinda*, xylophones large enough so that the wooden bars can be played on either side by multiple players. The instrument is typically tuned in 5 notes per octave (stretched quite evenly). A (conceptually) simple melodic pattern is played in octaves by one player. The player opposite plays another complementary melody, but one that *interlocks* – filling the gaps – of the first part. An aesthetic choice built on the practicality of multi-player performance. At the tempos typically performed this involves remarkable skill and focus to execute. It is said that to achieve it effectively both players should consider their part as the rhythmic centerpoint, either part is the 'beat' – or syncopated. The resulting patterns are extraordinarily transfixing and perceptually complex, particularly when a third player adds *another* pattern designed to eke out emergent melodies between the two parts.

The *nyanga* dance music of Mozambique achieves a similarly beautiful collective complexity from limited resources. A *nyanga* ensemble consists of multiple bamboo pipes. Each pipe has just a few available notes, although there is a collective wide range and complexity is expanded in performance. A typical pattern would be to sing a pitch, blow one of the notes, and then take a breath in order to repeat the three-unit pattern. The breath is another example of aesthetic practicality. Sometimes the sung and blown pitch are matched, but when not two independent lines from one player can be implied. A complete melody usually involves an even number of three-note units (e.g., 8x3), which allows another layer of perceptual interest when the dance move (and associated leg-attached shaker) cuts across the sing–blow–breathe cycle in a binary pattern (e.g., groups of 2 similar to Figure 3). The shaker is then marking another – *slower and reversed* – cycle of sing–breathe–blow. The real beauty emerges however collectively. The other players play a similar three-unit pattern with their own two voice melodies but *rotated against each other*, so that at any one moment we have – distributed in space and pitch – a sung note, a blown pipe pitch, and silence which dances around the ensemble.

The mbira music of the Shona people of Zimbabwe adopts similar principles to the above. The mbira – a lamellophone with metal tongues played with fingers and thumb attached to a soundboard – has its notes arranged not in a linear fashion but in a 'bilateral symmetry'. The lowest in the middle and then expanding outwards and high in both directions. The mbira *dzavadzimu* (the 'mbira of the ancestral spirits') has a left side of the instrument arranged in two layers ('left high' LH and 'left low' LL), while the right side has just one layer and played with the right-hand thumb or index finger. These three layers are pitched on the voices of women, men and children respectively. Alternations of left and right side of the instrument (left - right - left - right), and LH and LL (LH – LL – LH – LL) create an in-built multiplicity – multiple melodic interpretations depending on the listener's focus. These emerge exponentially when a second mbira is added sometimes with chords, or a variant of the melody and *interlocked.* Patterns are often of 'mixed-duple' length e.g., 24 beats inviting multiple duple and triple groupings, particularly with the overlaid percussion and sung melodies. The resulting tapestry is indescribably complex and beautiful – with resultant melodies appearing magically with the slightest change. This perceptual richness is not a by-product or 'misreading' of the music, it is its core aim. These imagined, emergent melodies are 'whispered by the ancestors.'

It is as if musical forms in Africa converge on some maximal emergence, rich complexity from relatively tiny generative codes. One exquisite example of such emergence is found entangled in the *timelines* – the rhythmic cycles – of West Africa.

4.2 Phase 2: Metric Malleability and Maximal Multiplicity

The *Ewe* tribe (of the Ghana region of West Africa) perform an ancient dance song, the *agbekor*[3], involves rich interlocking percussion centred on a repeating rhythmic cycle - 'bell pattern' or 'timeline' – of 7 hits in 12. The pattern is in fact the same as the diatonic scale – 2+2+1+2+2+2+1 spells out the white and black

[3] Naming conventions for this and other timelines are not consistent or universally agreed. The same rhythm is also found (perhaps through 'export') in the *Bembè* of Afro-cuban music.

keys on the piano, demonstrating how similar concepts – and generative codes – can be found across musical parameters. This *diatonic rhythm* (and scale) has a number of remarkable and unique algorithmic properties: a) It has high **perceptual depth** - this multiplicity is apparent in the 12-beat cycle which can be heard in different groupings, such as 3 4s, 4 3s and 6 2s. Since it shares its pattern with the diatonic scale, which we know can be built along the circle of 5ths, we can even interpret – and build – the pattern as 12 5-beat or 12 7-beat pulses.; b) it is **euclidean** and **maximally even** – the rhythms are as even and spread apart as far as possible in the cycle. This provides a balance of predictability and memorability and optimises its possibility for higher tempos as it separates as much as possible the faster divisions); c) it is **maximally independent:** every starting point has a unique vista – just as every starting note in diatonic scale has its own *mode*). This means latching on to any beat as a downbeat is always rewarded with a new musical experience, and one that can be quickly re-orientated and recognised. d) It is **symmetrical**: it contains a palindromic rotation, offering a mirror-like reflection that deepens its perceptual and structural richness—akin to the *Akom* rhythm's perceptual depth. e) it is **intervallically** rich. Every possible gap between each hit (from 1 to 6) is represented. And the *tally* of each rhythmic interval is different in every case (254361 for gaps 1–6 respectively). Among the other 65 7-in-12 patterns, there is only one that shares this proprty: a simplistic burst of 7 adjacent hits.

In short, this seemingly simple pattern exhibits profound generative and perceptual depth—perhaps even *maximal*, given the constraints, and to this day still affords musical possibilities: The minimalist composer Steve Reich owes much to this rhythm. He studied percussion in Ghana for five weeks in 1970 with an Ewe master drummer before contracting malaria and returning to New York. *Clapping Music* is the Agbekor pattern (with pulse subdivided), starting in the lower left. His work employs the ideas of a movable barline, rotation of rhythms (‘phasing’) and regrouping of 12 beats as 4 3s or 3 4s – as in the last movement of *Electric Counterpoint* where a rhythm first heard in 3/2 is recast as 12/8 with stunning effect. *Piano Phase* takes a continuous series of 12 pulses but carves a rhythmic identity through a melodic pattern, this is played and rotated against itself (just like *Clapping*) but – perhaps Inspired by tape loops – the phasing here is gradual teasing out the extraordinary transition from one musical perspective to the next and revealing countless emergent melodies along its endless orbit. Steve Reich was considered a modernist, a musical revolutionary but these ideas are in fact insightful contemporary perspectives of ancient musical ideas.

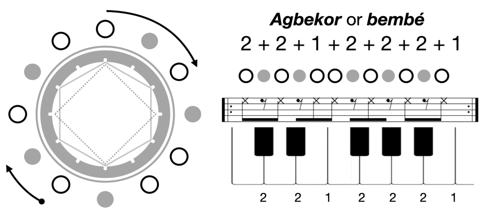

Figure 5: Two rotations of the same cycle of two long, and two short, notes. The second invites a perceptual depth and multiplicity despite its similar content.

V Credo: Arvo Pärt’s Simple Quest

5.1 Complex Simplicity

Arvo Pärt (1935–) is an Estonian composer whose music is particularly illustrative in our discussion. Now the world’s most performed living composer and associated with an accessible but transcendent ‘sacred minimalism’, Pärt had a complex relationship with musical simplicity. His musical talents and interests were pulled in many directions, both highly celebrated and condemned by the cultural constraints of Estonia’s Soviet rule. His informal and classical training coupled with his obsessive listening to radio broadcasts and his experience as an audio engineer exposed him to a wide range of music, and though highly capable, successful and well-respected (or at least infamous), he struggled to find his own pure voice. He produced highly complex (high SE and high KC) serial and avant-garde works, but also disarmingly simple pieces (low SE and low Kc) such as *Solfeggio* (1963). This is a choir piece generated by an ascending C major scale (sung with the solfege notes of Do, Re, Mi …). Again, we see the diatonic pattern make an appearance. Musical interest is generated within these tight constraints by a) Each note of the scale is distributed between the singers, so the scale is generated ‘collectively’ b) octaves are displaced to fit each vocal group range and ‘hiding’ the scale’s directionality c) the scale notes overlap to various extends creating shimmering clusters d) because there are 4 vocal groups and 7 notes: the resulting in a longer ‘arrangement cycle’ e) dynamics (louder and softer gestures) are overlaid. Musicality is reduced from the scantest structure.

Credo (1968) for mixed choir, piano and large symphony orchestra is a seminal exemplar of the friction between complexity and simplicity. From simple beginnings it builds to walls of dissonant clusters and raw timbres expanding to a load and maximal entropy. Somehow this huge information suddenly filters down to a beam of musical purity: J.S. Bach’s C Major Prelude from the *Well-Tempered Clavier* which is joined by the choir in shimmering chords. A stunning move from information overload to a distilled simplicity. *Credo* has been referred as Arvo Pärt’s ‘farewell to serialism’ and was his last major piece before his hiatus from composing, a period of seven years where he essentially started again; dismantling to their purest form the fundamental building blocks of music.

5.2 Seven Years, Seven Notes

From 1968–1976 Arvo Pärt withdrew from public composing life. Aside from some film commissions, he spent much of his time contemplating, rethinking, pruning his prior approaches to and assumptions about music in the quest for a pure musical ‘truth’, a “wisdom from reduction”. In parallel with his newfound Orthodox faith, he became fascinated with Gregorian chant with its simple rhythms and avoidance of chord-based thinking, but equally became absorbed in patterns of nature; how a small flower has the power to find its way through stone, the sound of falling rain, and the geometries and processes of the natural world. A manuscript of his survives which contains stemless notes on the stave arranged in the shape of a bird’s wings (which is also a symmetrical arc with an inverted smaller arc inside it). Pärt didn’t feel he was even composing here but exploring, meditating and hunting for “one note that holds life”. By 1977, he had started to compose again: pieces with simple ‘generative codes’ but deep aesthetic resonance. A hard-won ‘second simplicity’. Often the sketches of the pieces were encapsulated in just a simple geometric illustration – some with remarkable similarity to the *Sona* sand art. These illustrations hint at the underlying processes: motifs built on expanding or contracting waves (waves upon waves); musical material generated by the intersection of cycles (e.g., the pairing of a cycle of 12 rhythmic values with a cycle of 8 pitches); complete permutations of a set of musical symbols; and melodic rules driven by the syllable count of the Latin text in a setting. All these have generative and expressive depth, but in terms of underlying code (the Kolmogorov complexity) they are near weightless. It is in this context that Pärt’s most famous and recognisable compositional technique was formed, *tintinnabulation*.

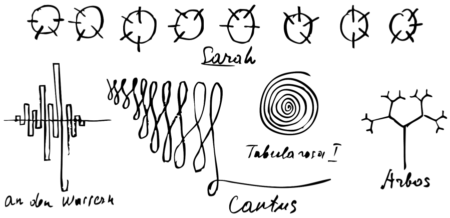

Figure 6: A collection of some of Arvo Pärt’s compositional sketches, revealing the simple codes behind the expressive content. Images from Shenton 2018.

VI Bells and Mirrors

6.1 Bells

On February 7 1976, Arvo Pärt was inspired to write a piece for a family friend who was sorely missing her teenage daughter, Alina. Alina was studying in London and out of reach thanks to the Soviet Union’s tight control on international calls. The resulting two-page solo piano work *Für Alina*, captures this pain of separation in stark, transparent beauty. Supported by a very low B drone, plays a simple melody in B minor. It is notated without stems to separate it from a sense of a rhythmic grid. Accompanying the melody’s every step is a second lower voice. This lower voice, rather than harmonised conventionally, has its notes drawn just from a B minor triad. In fact, it is completely systematic: when a melody note plays, the *nearest triadic note* below it is triggered in sympathy, “like a parent holding his child’s hand”, or the two wings of a bird allowing its flight. Like the bond between mother and child these notes are connected, almost like entangled particles. The resulting chiming effect – reminiscent of the bells of Pärt’s dear home town Tallinn, Estonia – has since been theorised as *tintinnabuli* (from the Latin for ‘little bells’). The melody is known as the M-voice (melodic voice) and its companion – or perhaps its guardian – the T-voice (drawn from the underlying triad). Pärt himself likened the M-voice to our mortal sinful lives, and the T-voice as the ever-present divine accompanying us wherever we go (think **m**ortal, or **m**an; and the **t**ranscendent perhaps). Sometimes Pärt would have the M-voice trigger the nearest triadic note below it (‘first position inferior’) above it (‘first position superior’) or the next nearest above or below it (‘second position above’ and ‘below’ respectively). Elsewhere the T-voice might orbit the melody from above and below, or be thrown forward in time.[4] This is such a simple, but quietly radical, concept. More so in that the lightness of ‘code’ in stark contrast to the magnitude of effect.[5] Common musical wisdom has a melodic line and a harmonic context which are generally heard together. However *tintinnabuli* reduces and distills this relationship to its essence. Somehow, through reduction, new life is breathed into the centuries old diatonic scale and triad.

6.2 Mirrors

Pärt adopted these elegant tools to great effect producing works that were at once contemporary, familiar and accessible. His works were at once systematic yet emotionally effective. Many contemporary listeners are aware of Pärt’s *Spiegel Im Spiegel* even if not the composer or the elegant mechanics behind the piece. In this stunningly effective work, the characteristic piano arpeggios follow the simplest of violin melodies which orbits around A in the key of F. The piano follows the violin line with three notes, the top and bottom notes of the voicing harmonising it in a conventional way (a 3rd and octave adobe respectively), but crucially the middle voice is a T-voice (always from the F major triad) adding an iconic shimmering beauty to the accompaniment despite it having lower informational content than a generic harmonisation. More from less.

We also hear low and high notes, and these too are entirely systematic, high and low T-voices orbiting and thrown forward in time from the violin melody. In fact how far they move in both pitch and time is defined by the duration of the melody note. As for the melody itself there is another pattern, hidden in plain sight. The melody always returns to the central A, by one scale note below, then one above; then two notes above and two below and so on. However this mirroring of the expanding diatonic scale (from above and below), is itself mirrored with the melody away from the A from below and above, and then *towards* the A from below and above. A mirror in a mirror as is the translation of the title.

Despite its accessible popularity and profound expression, and its 126 bars and seven-and-a-half minute duration, the underlying code of *Spiegel Im Spiegel* (its Kolmogorov complexity) is as light as air, fitting on a postcard score. A short, coded message with a hidden depth of meaning.

[4] *Tintinnabuli* is so systematic that I have built software to recreate it in real-time.
[5] For an illuminating comparison one can compare the coding of *Für Alina* with the slow section of Beethoven’s *Für Elise*. The latter having a far higher Kolmogorov complexity, closer to its informational content.

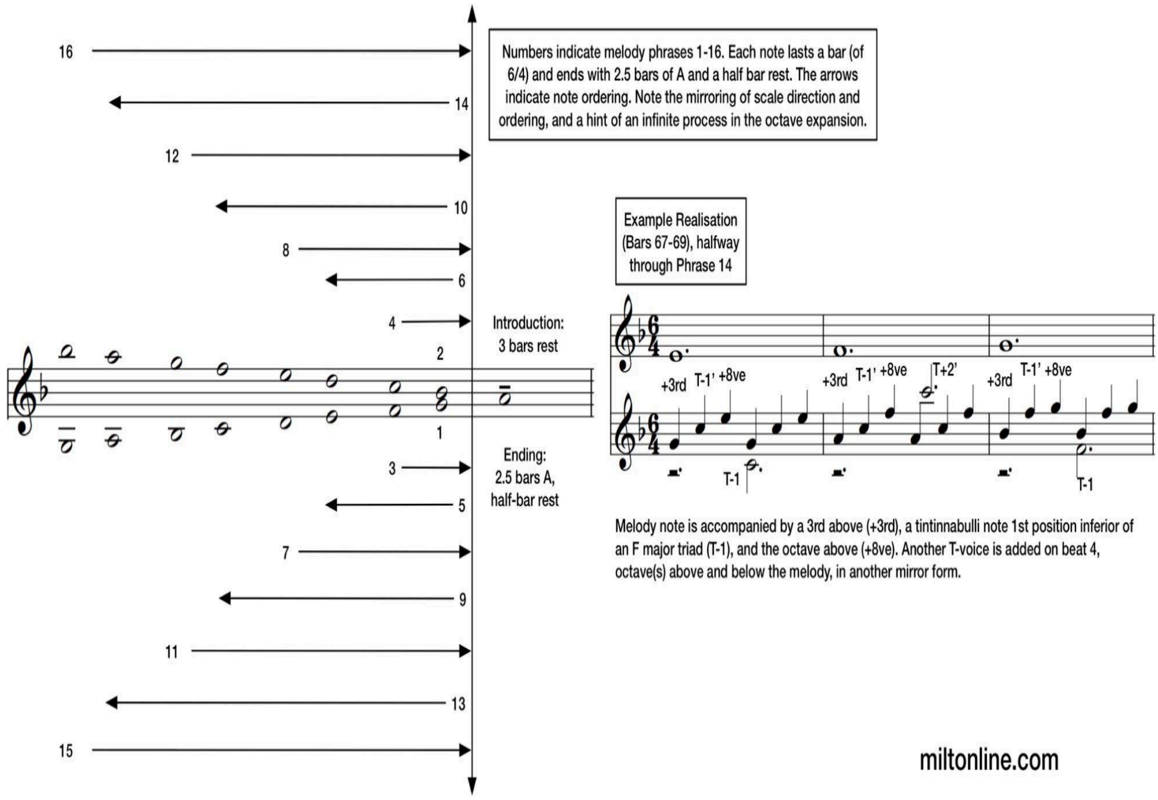

Figure 7: The underlying code of Arvo Pärt's *Spiegel Im Spiegel*. Despite its 126 bars, seven-and-a-half minute duration and deep aesthetic effect its underlying logic fits on a postcard.

VII Cycles Through Time

Arvo Pärt has said that he doesn't really believe in a musical evolution – a linear succession of ideas. Rather, we are each attempting to find our own truth, and in so doing often reaching back into the past in order to move forward (as he did with Gregorian chant, and Reich with West African drumming). A revolution – as in a *revolving* – rather than successive evolution and overturning of ideas. Music is more complex and interesting than that. It operates in a realm between meaningless noise and banal simplicity. We feel an emergent complexity from well-crafted simple musical ideas, and conversely sense a hidden simple structure in complex ideas,[6] and there are endless musical solutions and perspectives waiting to be discovered.

This beauty that can emerge from simple musical objects is related to the generative depth found in mathematics: from the Collatz sequence, Conway's Game of Life, to the chaotic effects from a flap of a butterfly's wing. We also find this force in physical processes like waves, swinging pendula and orbiting planets; and even animal behaviour, such as the murmurations and swarming patterns. These blind but beautiful processes are like the whispered spirits of the ancestors, ghosts in the machine and the emergent force behind consciousness and life itself. A music from thin air.

[6] You may notice that the structure of this lecture – like the African timeline or diatonic scale – is in the form of the 7 in 12 maximally even pattern, and can be started from any point.

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The Nature of Music

https://www.gresham.ac.uk/watch-now/series/nature-music

This lecture series and essays provide fundamental background material on rhythm, music as Language, harmony, dissonance, technology, tuning Expression and musical structures.

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